Impact of the Carbon Border Adjustment Mechanism

An economic and geopolitical assessment of the German-Chinese aluminium trade flows

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A thesis submitted to the Delft University of Technology
in partial fulfillment of the requirements for the degree of

Master of Science in
Complex Systems Engineering & Management

by

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To be defended in public on January 18, 2022

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Preface

At the faculty of TPM, "it depends..." is an often mentioned phrase in lectures, feedback meetings and project reports. For me, it perfectly grasps the multidisciplinary approach of any problem that is being tackled by people from the TPM faculty. During the past months, I often encountered new insights to the problem and system I was trying to define and then analyse. Each time I added that new insight to my analysis, I became more sure of the applicability of "it depends..." to the conclusions of my research. The vast uncertainty around the topic of the Carbon Border Adjustment Mechanism – it still is not fully negotiated and ready for implementation yet – made this master thesis a very suitable research for any study programme at the TPM faculty. There is never one answer, the nuanced view on the problem, its challenges and its way forward, it all depends. And that is what I also really like about the research, and the TPM faculty in general. New knowledge is constantly being acquired, via both quantitative and qualitative tools, in teams and individually. But never without careful consideration of the different perspectives that are relevant to the project, problem or system. I will never forget to carefully consider everyone's perspectives, both in my professional and personal life.

First of all, I would like to thank my supervisors. Behnam, thank you for your positive and constructive feedback! You often set me back during meetings and feedback sessions, but always with a realistic goal: to help me and my research at all times. One step back always meant many steps forward. Aad, thank you very much for all the time you have put in supervising my project! Always pushing me to think carefully about my decisions, guiding me to side tracks and always bringing me back on track as well. Also, Daniel, you helped me a lot in discovering the topic I wanted to research during this thesis. Your quick and constructive replies always helped me. Thanks a lot!

Obviously, I would not have come this far without the support of my father, mother, brother and sister. The past year(s) have not been easy, but we helped each other through. Completing the past 7 years of my time in Delft would not have been possible without your help. Also, I would like to thank all the people who have supported and helped me, to fuel my energy, to keep continuing. Klink, HvGL, Het 24e, TB-diner, Ariston 7, Feuners, Maarten, Tri-weekly Standup and De Eland: thank you so much for making the last years fantastic!

Before you lies the close of my student-era. This study has been written as part of the Complex Systems Engineering & Management Masters Programme at Delft University of Technology. This is also a great end to a wonderful time I had in Delft. I'm ready for the coming challenges!

Enjoy the read.

Flip Steenbrink *January, 2022*

Executive summary

Since the introduction of the Emission Trading Scheme of the EU (EU ETS) in 2005, it has been alternating between being successful and not, mainly due to the generally low price of the carbon emission rights (Prag, 2020). As part of the Green Deal, the European Union (EU) has announced several plans for an extension of the EU ETS (Killick, MacLennan, De Catelle, & Eglin, 2021). Still, the EU ETS has not been exploited to its full potential, thus the fossil fuel abatement has not been at the desired rate, triggering the need for extra policy instruments. Those inclusions are one way to do so, but new policy instruments have been proposed as well. A second driver for an extra policy instrument is that the EU has recently raised its targets to a reduction of 55% by 2030, instead of the previous 49% reduction in comparison to the 1990 levels (McGrath, 2020). A major policy instrument that the European Commission is planning to implement in addition to the EU ETS to reach those raised targets is the *Carbon Border Adjustment Mechanism (CBAM)*. With CBAM, companies from non-EU countries who want to import products from the selected CBAM sectors – Iron & Steel, Aluminium, Cement, Fertilizers and Electricity – into the EU, have to pay a certain tariff for the carbon content of that product. Initially, CBAM covers only imports and the carbon emitted during the actual production of the products (called direct, or scope 1 emissions).

One of the main problems that CBAM is targeting is carbon leakage, the phenomenon of industries relocating their carbon-emitting production facilities to countries that do not have carbon pricing policies installed (Antimiani, Costantini, Martini, Salvatici, & Tommasino, 2013). Carbon leakage occurs when those industries think that their costs will increase in the future due to higher carbon prices. Next to (i) preventing carbon leakage, CBAM is aimed at (ii) protecting EU industries against reduced competitiveness, (iii) incentivising non-EU trade partners to adopt measures comparable to the EU's, and (iv) yielding revenue to reuse in accelerating decarbonisation of the energy system (Marcu et al., 2020; European Commission, 2021b).

Four main problems arise from the planned introduction of the CBAM and the vast uncertainty accompanying it. First and foremost, the introduction of the CBAM can cause a decrease in the competitiveness of the affected (industrial) companies (Evans, Mehling, Ritz, & Sammon, 2021; Mcwilliams & Zachmann, 2020). Secondly, uncertainty surrounding the exact line of covered and non-covered sectors could lead to lobbying and even 'cascading protectionism', the latter is basically a trade war that neither of the involved players benefits from (Mcwilliams & Zachmann, 2020). Thirdly, the rest of the world is not keeping up with the frontrunners of decarbonisation, such as the EU. The EU aims at stimulating other countries to follow their lead in order to reach the worldwide targets (Bellora & Fontagné, 2020). Lastly, the compatibility with the World Trade Organization Law (WTO Law) is dependent on the precise implemented version of the CBAM, mainly because there is the risk of violating regulations that prevent protectionism (Mcwilliams & Zachmann, 2020). The objective of this research is to know better what influence CBAM will have regarding the first three problems, since the fourth problem can only be tackled by the WTO and the EU itself. A case study on the trade flows of aluminium between Germany and China is used to analyse that influence. The main research question was therefore:

What influence does the Carbon Border Adjustment Mechanism have on decarbonisation in the aluminium sector, given the economic and geopolitical dynamics between Germany and China?

To provide an answer, first the dynamics in the aluminium trade between Germany and China were analysed. These dynamics were described as follows. The German car-industry is significantly depending on Chinese aluminium production, but the volumes of aluminium trade from Germany to China are limited and thus substitutable. In both Germany and China, aluminium products from the whole value chain are produced, apart from bauxite mining. Low-end aluminium products are more vulnerable to geopolitical tensions between the two countries, compared to high-end products. Moreover, Germany is also considered to be the weak-spot of the EU, geopolitically, in its relation with China. That is mainly due to the dependency of Germany on China in their most important sectors, of which the car-industry is logically the most prominent one. Therefore, a CBAM that does not strongly frustrate China is of great importance to Germany.

Given these dynamics between Germany and China, the expected consequences of CBAM were studied along six themes: (i) compatibility of the policy instrument; (ii) administrative work needed; (iii) stimulation of decarbonisation in non-EU countries; (iv) competitive position of the German aluminium sector; (v) economic and geopolitical winners and losers; (vi) the three major risks of CBAM. Taking three perspectives – policy, society and experts – ensured a more balanced view on the influence of CBAM on decarbonisation in the aluminium sector. This led to a set of four main factors, which significantly overlap with the six themes identified. These four factors help in assessing the influence of CBAM and making CBAM more effective in achieving its objectives. These factors are:

- **Tailor-made**
  The more specified CBAM is in addition to the EU ETS, the more CBAM accelerates the decarbonisation in the (world-wide) aluminium sector.
- **Manageability**
  The work is expected to be manageable for aluminium companies from both the EU and non-EU countries. That should be in addition to the current declarations that are already being carried out by the sector when importing aluminium into the EU.
- **Export dependency**
  The more dependent the aluminium sector in a non-EU country is on the EU as export destination, the more CBAM will affect the aluminium trade between that specific non-EU country and the EU.
- **Geographical closeness**
  The closer the non-EU country is to the EU, the larger the impact of CBAM will be on that specific country.

For the case of the German-Chinese aluminium trade, CBAM will have the following effects, which are all surrounded by uncertainty. First, a switch to high-end aluminium products produced in Germany can be expected on the long-term. The same holds for the production of aluminium products in other EU countries. That is taking one assumption into account, namely that the EU Member States are still keen on products from the value chain of aluminium. If so, high-end products are going to be the best option in terms of viability. On the short-term however, resource shuffling in China can be expected, because the amount of the aluminium produced with energy from RES is higher than the amount of aluminium shipped to the EU. Moreover, there is a small chance of carbon leakage in all CBAM sectors, although the chance is expected to be highest in the aluminium sector. The chance is highest in the aluminium sector, because CBAM offers the least protection to the aluminium sector, of the proposed five CBAM sectors. Fourth, it is likely that (the major) trading partners of the EU will react to CBAM with counteracting measures of retaliation. Those measures have already been announced by the major trading partners of the EU, including China. Sectoral based agreements on the volumes traded under CBAM could mitigate that effect and prevent a potential trade war between the EU and its trading partners.

To conclude, assessing the impact of CBAM on a specific sector from an economic and geopolitical perspective has proven to be a highly complex process, where each factor is surrounded by a lot of uncertainty. This resulted in scattered information from a broad range of perspectives and fields of study. This makes it very hard to structure the system CBAM will be implemented in, as well as impossible to isolate factors of influence on CBAM. The interdependencies between the factors and the policy instruments complicated the situation even more. However, a set of factors that can be used and applied for future policymaking is identified, backed by the balanced views of the different perspectives on CBAM. This led to a set of policy considerations that decision makers can use in the future implementation of CBAM, as well as in other future implementation processes of renewable energy policy instruments. These policy considerations are: (i) excluding aluminium from the first group of sectors CBAM is implemented in; (ii) the likelihood of carbon leakage in the EU aluminium sector is not to be overestimated; (iii) installation of an independent monitoring and enforcement authority.

Contents

Abbreviations

Acronyms

Acronym	Definition
Domestic countries	Countries that are part of the EU27
Foreign countries	Countries that are not part of the EU27
Carbon leakage	Industries relocating to countries that have less stringent carbon policies in place.

Abbreviations

Abbreviation	Definition
CBAM	Carbon Border Adjustment Mechanism
GHG	GreenHouse Gas (emissions)
EU	European Union *The EU has 27 countries since the Brexit in January 2021, thus in this research 'EU' and 'EU27' are the same.*
EC	European Commission
EP	European Parliament
ETS	Emission Trading Scheme
EU ETS	Emission Trading Scheme of the European Union
FIT	Feed-In Tariffs
FIP	Feed-In Premiums
BCA	Border Carbon Adjustment
ROW	Rest of World. *Often used in (geopolitical) literature to address all other countries that still have some influence on the system, but are left out of scope.*
RE	Renewable energy
REPI	Renewable Energy Policy Instrument
RES	Renewable Energy Source
PI	Policy Instrument
ERCST	European Roundtable on Climate Change and Sustainable Transition. *An organisation researching climate change and the sustainable transition. They often organise meetups and conferences on the topics, and have produced several outlooks for the effects of CBAM.*
MNE	Multi-National Enterprises
SME	Small and Medium Enterprises
FTA	Free Trade Agreement

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Introduction

This first chapter entails the introduction to the topic of this research. First, the context will be discussed, followed by a brief introduction to the illustrative case used in this research. Then, the objective of the research and corresponding research questions will be explained after the knowledge gap is shortly identified. Lastly, the scope of the research and its societal and scientific relevance are discussed.

1.1. Context

1.1.1. Situation

Since the introduction of the Emission Trading Scheme of the EU (EU ETS) in 2005 the system has been alternating between being successful and being unsuccessful, mainly due to the generally low price of the carbon emission rights (Prag, 2020). The EU ETS is a cap-and-trade system, a system to trade CO_2 emission rights, restricted with an artificial cap on the total amount of the emission rights available(Grüll & Taschini, 2011). If the prices of the emission rights are high, then the rate of carbon emission abatement increases, resulting in a smaller probability of the economy being short on rights and, consequently, the price decreases (Grüll & Taschini, 2011). The ETS has been installed in the EU in 2005, and only in recent years have prices increased to a fairly effective level (Y. Liu & Wei, 2016; Sheppard, Dempsey, & Hollinger, 2021). As part of the Green Deal, the EU has announced several plans for an extension of the ETS, of which the two main ones are the inclusion of the domestic aviation and shipping industry (Killick et al., 2021). Still, the ETS has not been exploited to its full potential yet, thus the fossil fuel abatement has not been at the desired rate, triggering the need for extra policy instruments. Those inclusions are one way to do so, but new policy instruments have been proposed at the same time as well. A second driver for an extra policy instrument is that the EU has recently raised its climate targets to a reduction of 55% by 2030, instead of the previous 49% reduction in comparison to the 1990 levels (McGrath, 2020).

Several sectors were and are at risk in each of the four phases of the ETS implementation in the EU (European Commission, 2021a). Companies in those sectors – such as the manufacturing industry, electricity generation and the transportation sector – are subsequently offered free allocation rights, because of potential *carbon leakage* (European Commission, 2021a). Carbon leakage is the phenomenon where "the imposition of stringent climate policies may produce substantially distorting effects in terms of displacement and reallocation of carbon intensive production processes in unregulated countries where no climate policies are in force" (Antimiani et al., 2013). In other words, carbon leakage occurs when industries relocate their carbon-emitting production facilities to countries that do not have a comparable climate policy installed. Carbon leakage results in two major disadvantages for the country the companies are leaving (Antimiani et al., 2013). On the one side, decreased competitive positions could occur, as the countries installing carbon abatement policies pose higher standards and thus higher prices on the companies at risk. On the other side, carbon leakage could lead to an increase in carbon emissions in countries with less strict climate policies, resulting in a global net increase in carbon emitted (ESG Enterprise, 2021).

Various solutions for tackling the issue of carbon leakage have been proposed, amongst which the Carbon Border Adjustment Mechanism (CBAM) is a dominant one, often mentioned by politicians and other policymakers (Antimiani et al., 2013; Tamiotti, 2011; Bellora & Fontagné, 2020). The CBAM is the most recently proposed EU policy instrument targeting carbon leakage – amongst other objectives – and will be discussed in great detail in this research. Other proposed policy instruments tackling carbon leakage will also be discussed in chapter 3. Furthermore, the aluminium trade between Germany and China will be used as a case that allows a more concrete illustration of the concepts discussed. The aluminium trade between the two countries is suitable, because of the EU and China being two of the three major aluminium producers and consumers, the largely (58%) coal-powered aluminium production in China and China being in a large share of ETS-related research (Van Heusden, Harry, & Puleo, 2020; Ismer, Neuhoff, & Pirlot, 2020; Tang, Wang, Li, Yang, & Mi, 2020). Moreover, Germany and China have a highly complex relationship due to their economic dependency on each other in for example the car manufacturing industry. Thus, a possible trade war could disturb much more than the sectors affected by the CBAM. Next to that, the aluminium sector in Germany is the largest in the EU. A more extensive explanation of the case, the rationale for choosing it and thorough analysis of its elements will follow in chapter 2 and 4.

1.1.2. The Carbon Border Adjustment Mechanism

The CBAM has first been introduced in a publication on several 'key actions' such as a 'Circular Economy Action Plan', a 'Farm to Fork' strategy and the 'European Climate Pact' (European Commission, 2019). The CBAM is proposed as a renewable energy policy instrument (REPI) complementary to the EU ETS (Ireland, 2021). The two main and preliminary objectives of the CBAM are reducing the risk of carbon leakage, as well as making sure the price of imported products reflects its carbon content (European Commission, 2019). In September 2020, the European Roundtable on Climate Change and Sustainable Transition (ERCST) published a paper "Border Carbon Adjustment in the EU Issues and options". It proposed four key objectives of the CBAM, that are all in line with the mission as stated in the report of the EP that 'the CBAM will fuel a virtuous cycle aimed, first and foremost, at climate protection' (Jadot, Karlsbro, & Garicano, 2021; Marcu et al., 2020). These four objectives are (Marcu et al., 2020; European Commission, 2021b):

1. to limit the effects of carbon leakage
2. to protect domestic industries against reduced competitiveness
3. to incentivise foreign trade partners and foreign producers to adopt measures comparably to the EU's
4. to yield revenue that can be used to fund investment in the innovation of clean technology, to modernise the current infrastructure and to finance international climate measures

It is important to clearly distinct the different affected and involved actors when the CBAM is implemented, because that way the opinions of the actors with the most influence can be taken into consideration. The EU is obviously the governmental body implementing the policy instrument, i.e., more specifically the European Commission. In the relevant literature and policy documents, the term *domestic* is often used for all systems that concern the whole European Union (Marcu et al., 2020; Dybka, Maratou, & Monciatti, 2021). That is, when referring to *domestic energy producers*, all energy producers based in the EU are meant, and more specifically the companies that are in the sectors the CBAM is planned to be applied to. Similarly, the term *foreign* relates to all countries that are not part of the EU. Needless to say, *member states* relates to only the countries that are a member of the EU, while German energy producers are addressed accordingly. Besides, in the rest of this research, the term REPI will be used for policy instruments aimed at an increased share of renewable energy in energy production and usage (Holmes, Reilly, & Rollo, 2011). Initially, the CBAM should cover a narrow list of sectors, more specifically the power and energy-intensive industrial sectors (Dybka et al., 2021). These include cement, metals, chemicals, pulp & paper, fertilisers and refined petroleum products (Dybka et al., 2021). These were revised and the five currently included sectors are cement, iron & steel, aluminium, fertiliser and electricity (European Commission, 2021d; Killick et al., 2021). Also, only direct emissions are covered. Before the first phase of the implementation in 2023, the negotiation process of the European Parliament, European Commission and its trade partners will take place, as well as further consultations with the World Trade Organisation (WTO) to ensure the compatibility of CBAM with WTO Law (Ireland, 2021). This is expected to take at least until the CBAM comes into force in January 2023, when the first phase of CBAM starts. Until the start of 2026, companies importing products from the six sectors into the EU are only required to declare those products; starting in 2026 those companies also need to actually pay the border adjustments (European Commission, 2021d).

1.1.3. Problem statement

Four main problems arise from the coming introduction of the CBAM and the vast uncertainty accompanying it. First and foremost, the introduction of the CBAM can cause a decrease in the competitiveness of the affected (industrial) companies (Evans et al., 2021; Mcwilliams & Zachmann, 2020). Such a decrease is the result of smaller margins due to higher carbon costs. Via higher production costs and a deteriorated investment climate, this in turn could result in carbon leakage, as well as a weaker economy in general (Evans et al., 2021). Secondly, uncertainty surrounding the exact line of covered and non-covered sectors could lead to lobbying and even 'cascading protectionism'; the latter is basically a trade war that neither of the involved players benefits from (Mcwilliams & Zachmann, 2020). In recent years the trade wars between China and the US on a wide variety of products, and EU Member States & the US on aircraft subsidies – which both occurred when Donald Trump was in the Oval Office – have showed that such conflicts do not give any of the involved parties an advantage over the other (Boffey & Jolly, 2021; Mullen, 2021). Thirdly, decarbonisation efforts in all sectors and fields of industry have expanded drastically in the past years due to the fast-growing realisation of the direct causal relation between the emission of CO_2 and climate change. The CBAM is aimed at further accelerating the decarbonisation rate. The previously mentioned problems and phenomena resulting from a flawed implementation of CBAM, such as carbon leakage, will most definitely slow down the decarbonisation rate (Bellora & Fontagné, 2020). Lastly, the compatibility with World Trade Organization Law (WTO Law) is quite dependent on the implemented version of the CBAM, mainly because there is the risk of violating regulations that prevent protectionism (Mcwilliams & Zachmann, 2020). The more information there is on the projected consequences of the implementation of the CBAM from 2023, the better these problems can be prevented and mitigated. Even more so, because the CBAM is placing a tariff on carbon, meaning it can strongly affect the economic structure and trade patterns of the countries affected by the instruments (W. Zhang et al., 2019).

1.2. Knowledge gap

In pursuance of mitigating and preventing these problems, this research will focus on building more knowledge on the impact a new Renewable Energy Policy Instrument (REPI) has, in particular the CBAM. Via a structured analysis, the lessons from this research can then be extrapolated to the broader field of the impact of to be implemented REPIs. Proposing a new policy instrument in the EU – a domestic policy instrument, since it is implemented in the EU, by the EU – can have global consequences, even if the instrument does not directly target or influence a sector. When reviewing the literature on CBAM and its geopolitical and economic consequences, it is concluded that no method for assessing the impact of the CBAM has come up in a research – for a more extensive explanation of this rationale, see chapter 3.2.6 (Weko, Eicke, Marian, & Apergi, 2020; Evans et al., 2021; Talebian, Carlsen, Johnson, Volkholz, & Kwamboka, 2021). Moreover, the impact of such a domestic policy instrument on the policy efforts of other countries has not been researched either (Sattich, Freeman, Scholten, & Yan, 2021). A recent attempt to operationalise the risks of CBAM in three developing countries does look at the foreign countries, but skips the impact on the decarbonisation efforts of those foreign countries (Eicke, Weko, Apergi, & Marian, 2021). Additionally, Sattich et al. identify the need for more empirical research on the dynamics between countries in terms of geopolitics and economic relations (2021). The literature study on the geopolitics of the energy transition of Vakulchuk, Overland, and Scholten comes to a similar, although broader conclusion, highlighting the need for theorisation, an analytical framework and the build-up of an empirical basis (2020). The knowledge gap to be addressed in this research is embedded in that gap: how domestic policy instruments affect the dynamic relations between the implementing country – *the domestic actor* – and *the foreign country*.

To further specify that, the geopolitics of both renewable energy and climate change are relevant to this research, since those fields strongly correlate with domestic renewable energy policy instruments. Currently, there is a lack of theorisation in the field of the geopolitics of renewable energy, despite quite some research in the last couple of years (Vakulchuk et al., 2020). Several authors have highlighted the major challenges already, such as the need for multilateral agreements, generous funding and extensive cooperation (Goldthau & Westphal, 2019). When specified for one form of renewable energy, the same need for regulation and cooperation is denominated (Van de Graaf, Overland, Scholten, & Westphal, 2020). All conclude that despite the rapid increase of research in the field, coherent overviews are missing, and that more empirical evidence and suitable regulation is needed (Scholten, 2018; Scholten, Bazilian, Overland, & Westphal, 2020; Van de Graaf et al., 2020; Vakulchuk et al., 2020). Within that major gap, the knowledge gap in this research addresses the uptake of renewable energy being influenced by geopolitical changes and corresponding risks. Due to the limited time span of this research, full theory development in the field of geopolitics of renewable energy is not feasible, thus this research is more focused on a specific part of the geopolitics of renewable energy.

Several aspects of this knowledge can be analysed, but in their analysis of four designated areas, Sattich et al. highlight the need for a deeper dive into the industrial policy area, as well as the trade & investment policy area (2021). Of these four, a combination of two is used in this research. Taking a geopolitical perspective here means that the dynamics between two countries can change through political (including military) or economic (trade) interventions, thus addressing both the industrial and the trade & investment policy areas (Sattich et al., 2021). Where previous research focused on either the link to policy interdependence (Sattich et al., 2021) or just on one specific renewable energy source (Van de Graaf et al., 2020), this research addresses a new knowledge gap. Using insights from multiple perspectives and theories – geopolitics of renewable energy, economic policy instruments and policy interdependence – the dynamics between countries are analysed. Concluding, the knowledge gap addressed in this research can be formulated as: *There is a lack of empirical basis on the influence of a new renewable energy policy instrument on the dynamics between a domestic and a foreign country, seen from the perspective of geopolitics & economics.* A more extensive explanation of the literature study and the knowledge gap will be discussed in chapter 3.

1.3. Research objective & questions

Addressing this knowledge gap is the main objective of this research. Building more knowledge on the development of renewable energy sources being influenced by the geopolitical consequences as a result of the introduction of a domestic policy instrument is essential here. However, to ensure the tangibility of the concepts, a case will be used, namely the impact of the CBAM on the economical and geopolitical relation between Germany and China. The case will be rather illustrative, in line with the exploratory character of this research.

The main research question of this research is:

What influence does the Carbon Border Adjustment Mechanism have on decarbonisation in the aluminium sector, given the economic and geopolitical dynamics between Germany and China?

To know what this question actually means, it is essential to define each of the concepts mentioned in the research question. Starting with the *Carbon Border Adjustment Mechanism* (the CBAM), which is a type of border carbon adjustment to be implemented by the EU in January 2023. In chapter 1.1.2 the mechanism itself is already briefly addressed, further definition is thus not necessary here. The mechanism will be addressed in more depth in chapter 4. Decisions regarding the scope of the CBAM will be outlined in paragraph 1.4 and more extensively in chapter 4. Secondly, the *dynamics between Germany and China*. Being a member of the EU, the level at which the CBAM is being introduced, Germany's trade with China will be influenced by its implementation. The aluminium trade between Germany and China will be used as a further specification of the case, to be able to analyse the dynamics. These first two elements of the main research question relate to the case, emphasizing the use of the case in this research, making the research question more tangible and therefore easier to answer without using too abstract concepts. Then, the *geopolitical dynamics*: these include political changes, risks and interventions both in diplomatic, economic and military terms. As mentioned, geopolitical interventions can entail economic instruments as well, but to emphasize its importance in this research and in measuring the impact of CBAM, it is mentioned separately as well.

To be able to answer the main research question, several sub-questions are set up that need to be addressed.

1. *What is the Carbon Border Adjustment Mechanism and what are its objectives?*
2. *What theoretical issues and challenges of a renewable energy policy instrument should be taken into account when implementing the Carbon Border Adjustment Mechanism?*
3. *How do domestic policy instruments affect decarbonisation efforts in non-EU countries?*
4. *How are the aluminium trade flows between Germany and China affected by the implementation of the Carbon Border Adjustment Mechanism?*

5. *How are economic and geopolitical dynamics between two countries affected by a new renewable energy policy instrument in one of those countries?*

The next step is to determine the scope of the research. In chapter 2 the methods used for answering these questions will be explained.

1.4. Scope

Now that the research objective and questions are determined, the scope can be defined to ensure a feasible research. As clarified above, this research limits itself to the dynamics between Germany and China, the influence the CBAM has on it and any change in dynamics following from the introduction of the CBAM. As said, the aluminium trade between Germany and China will be used as an illustrative case to operationalise the concepts more easily. Also, the more economic consequences and potential dynamic changes include trade creation & diversion, as well as import tariffs installed to compensate for any extra expenses due to the CBAM. Besides, only the concepts related to the definition of geopolitics in this research as stated in paragraph 1.3 are within the scope of this research.

Marcu et al. identified four scoping decisions to be made regarding the CBAM and any case analysing it: the sectoral area, the emissions, the trade flows and the geographical area (2020). This research will build upon these four scoping decisions, since those also are identified in the publication of the European Commission (EC) (European Commission, 2021d). Starting with the most straightforward one: trade flows. Here, there are three choices: only imports to the EU, only exports leaving the EU, or both (Marcu et al., 2020). It is quite evident that at least imports should be included, since those regard the products that are being produced outside the EU, and then consumed within the EU borders. Hence, this research is limited to the imported products. Including exports would make it more difficult assessing the impact, since the trade would be going in two directions and would include more indirect emissions (Banerjee, 2021). Limiting this research to just export is not an option either, as that is not at all in line with the proposed CBAM. The next scoping decision regards the emissions, also a relatively easy one. Here, the authors have chosen just direct emissions, for reasons of convenience and most direct impact (Marcu et al., 2020). Assessing the impact of indirect emissions itself is already a complex task, let alone assessing the impact of the CBAM of indirect carbon emissions. This is supported by the choice of the sector, since the scoped sector only includes direct emissions as well.

Namely, the scoped sector is the aluminium sector, based on four arguments. First, the aluminium sector is included in the EU ETS. Secondly, there are three major aluminium producing regions in the world; China, the USA and the EU (Germany is the largest producer of aluminium in the EU). This opens up the possibility of analysing the relations between two of those, while still being of large value due to its size (Marcu et al., 2020). Third, the whole aluminium sector accounts for 2% of the global, human-caused emissions, making it a sector where significant reductions would cause a significant reduction in global emissions (Van Heusden et al., 2020). Lastly, there is a lot of information available on the aluminium sector (Hourcade et al., 2007). The case is later tested on a set of selection criteria, derived from literature on a case study, as explained in chapter 2.2.

Fourth and last scoping decision regards the geographical area. Here, Germany and China are chosen, including the trade between the two aluminium producing countries, with diverse production facilities and sources of the energy used (K. Zhang et al., 2020). These four scoping decisions are in line with the scoping decisions made by the EC, in the "Fit for 55" report published in July 2021 (European Commission, 2021b). Aluminium is one of the sectors to be included, only direct emissions are taken into account and exports are excluded from the proposed CBAM. The last one, the geographical area, is free to be determined for this research, as highlighted above, but the EC has determined the areas excluded from the CBAM for their inclusion in the EU ETS. Consequently, it is safe to say the decision of the Germany-China dynamics being the research area is a deducible choice.

The energy-intensity industry has become more aware of the need for the CBAM, and recently even called for rapid implementation of CBAM (Sheppard et al., 2021; Prag, 2020). Even more so, the EC has announced a more detailed implementation, consisting of a transition phase and end phase, to start in 2023 and 2026 respectively (European Commission, 2021b). In this transition phase, the actual fees will not need to be paid, but the administrative actions will need to be performed, allowing companies and other organisations to get used to the CBAM. Moreover, the transition phase allows foreign countries – those outside the EU ETS area – to adjust their policies if they want to, in order to eventually avoid having to pay the import tariffs as part of the CBAM after 2026.

On top of that, the industry and non-EU countries have been consulted in feedback sessions. These provided valuable information to the EC on what elements are necessary to make the CBAM a success for the EU, effectively reaching its objectives. Part of that is the distinction of the sectors affected by the CBAM (Dybka et al., 2021). Ideally, more and more sectors would be gradually included in the CBAM, to give both industries and governments sufficient time to adapt policies and together reach the more ambitious goal of a 55% reduction in CO_2 emissions by 2030 (McGrath, 2020). Lastly, the environmental benefits are increased with a higher amount of countries or regions that have adopted renewable energy policy instruments, since the total global carbon emissions could be reduced drastically. An example of the potential of one sector can be found in the aluminium sector, as also explained in chapter 1.4. Multiple efforts have been made to implement the CBAM in both the USA and the EU, thrice in both regions, and all failed (Prag, 2020). However, with the inclusion in the EU Green Deal and the expected WTO compatibility chances are much higher for an implemented CBAM by 2023 (Kogels, 2020; Hulten, 2020).

Now that the topic & objective of this research are introduced and the scope and research questions have been determined & defined, the next chapter will elaborate on the research design.

2

Research design

This second chapter on the research design starts with the approach that is used in this research. Then, the chosen research methods and their objectives are explained. Lastly, the structure of the thesis it outlined, consisting of the structure specific for the literature study and the structure of the presentation of the results.

2.1. Research approach

With the research objective, questions and the scope clear, the approach of the research can be determined. Besides a general approach, an approach for each of the sub-questions is selected as well. The main research question (chapter 1.3) aims at exploring a certain phenomenon, using theoretical or empirical evidence. At the moment, a theory for assessing the influence of a domestic policy instrument on a foreign region is lacking, thus the development of a theory is needed (Fletcher & Marchildon, 2014). Therefore, overall an inductive approach is used. This approach is also in line with the knowledge gap identified in chapter 1.2. The analysis of the phenomenon is performed in a structured manner, by first focusing on just one of the elements – such as just the CBAM, just Germany and just China – to set the context properly, after which the geopolitical and economic relations and other dynamics will be analysed.

Each of the sub-questions – which can be found in chapter 1.3 – serves a different objective and therefore needs a separate approach accordingly. The research starts with the first two sub-questions, that are both about defining and determining the concepts & current state of the existing knowledge, and the case. Because both have the same objective and approach, these first two questions are discussed at the same time. The first and second sub-questions are:

- *What is the Carbon Border Adjustment Mechanism and what are its objectives?*
- *What theoretical issues and challenges of a renewable energy policy instrument should be taken into account when implementing the Carbon Border Adjustment Mechanism?*

Using existing literature and other sources, the current state of both the used concepts and the case is determined, upon which the rest of the research will be built. This means the principles of a deductive approach are followed (Loorbach, 2007).

Differently, the third sub-question requires the output from the first two sub-questions as input to actually assess the impact of the introduction of the CBAM. Using the list of variables taken from literature, without real world data, the affected dynamics can be analysed. Consequently, the influence of the domestic policy instrument on the foreign region and sector can be determined. While the answers to the first two sub-questions provide the already existing tools necessary for the rest of the research, the answer to the third sub-question will pave a way that future researchers can use in their research. Therefore, this third sub-question follows a more inductive approach and is:

- *How do domestic policy instruments affect decarbonisation efforts in non-EU countries?*

A similar approach is used for the fourth sub-question. Whereas the third sub-question focuses on the case, this fourth question is less conceptual and more closely related to the objective of this research. Again, an inductive approach is used, as information from the case study is also used in addition to existing information. This fourth question is:

- *How are the aluminium trade flows between Germany and China affected by the implementation of the Carbon Border Adjustment Mechanism?*

The last sub-question is on the application of the information from theory on the case study of the aluminium trade between Germany and China. Again, an inductive approach is used, since the analysed theories will be used to address issues that previously could not be explained. Consequently, new data will be collected, despite the usage of prevailing information specified to the case. The last sub-question is:

- *How are economic and geopolitical dynamics between two countries affected by a new renewable energy policy instrument in one of those countries?*

Together, the case and phenomenon will be analysed from three perspectives, to come to an answer to the research questions. These three perspectives are:

- **The policy perspective**, namely the policymakers & official policy documents, on what their expectations are for the impact of the CBAM;
- **The societal perspective**, which relate to the expectations from news agencies and businesses;
- **The expert perspective**, relating to both academics, think tanks and industry experts and their expectations.

Taking these three perspectives into account when answering the research question allow for coming to a balanced conclusion, after carefully analysing and combining them in a synthesis.

2.2. Research methods

Now that the inductive approach of this research is explained, the methods to answer each sub-question can be determined. First, all methods used are explained, followed by determining the methods per sub-question. Several methods will be used in this research, of which *Case Study* is the main one to be used. Per sub-question the method(s) used will be explained. An overview of the methods and the chapter(s) they are used in can be found in table 2.1, with a more detailed explanation of the methods per sub-question in section 2.2.4.

Table 2.1: Overview of the methods per sub-question

sub-question	Chapter	Method	Objective(s)
1. CBAM & Objectives	3 & 4	Literature study Case study	Researching the context, defining concepts
2. Theoretical issues and challenges	3	Literature study	Identify the relevant issues and challenges from theory
3. Domestic PIs affecting foreign countries	3 & 5	Literature study Interviews	Exploring and defining the relationship between an implemented PI and decarbonisation in foreign countries
4. Aluminium trade flows affected by CBAM	4 & 5	Case study Interviews	Analysing the effects for the trade flows of aluminium
5. Economic & geopolitical dynamics	5 & 6	Interviews	Defining the economic and geopolitical aspects of the dynamics, extrapolate to REPIs

2.2.1. Exploratory case study

The first and main method is an exploratory case study. Yin described it as an empirical research project, which (1984):

- investigates a contemporary phenomenon within its real-life context: when
- the boundaries between phenomenon and context are not clearly evident; and in which

- multiple sources of evidence are used.

All three of the elements of a case study as defined by Yin are present in this research. The contemporary phenomenon can be found in the form of domestic policy instruments influencing foreign (decarbonisation) policy efforts, which will be researched in its real-life context (Yin, 1984). The latter means that it will not be analysed in a controlled system, but rather observed and found in a context where the phenomenon takes place in real-life, i.e., the real world of aluminium trade between Germany and China. Secondly, it is unclear how that trade is affected by the introduction of the CBAM, thus meeting the second element of Yin (1984). Lastly, to get to an answer to the research questions just using the existing literature does not suffice, since it would lead to a rather subjective answer with not full coverage from different stakeholders. Via semi-structured interviews, extra information is collected to add to the expectations from literature. The triangular use of data is outlined visually in figure 2.1.

A case study is typically used to gather a specified body of knowledge, often empirical knowledge. Its aim is to expand that body of knowledge by looking at a program, event, activity, process or individual that is bounded by time and activity (Verschuren & Doorewaard, 2010). Three different types of case studies can be identified, namely explanatory, descriptive and exploratory; combinations are possible because none of them excludes another (Verschuren & Doorewaard, 2010). In short, explanatory case studies entail explaining a particular phenomenon, while descriptive case studies are about describing such a phenomenon when it has already happened, and it has been closely observed and analysed. Thirdly, exploratory case studies involve an exploration of a new field of study and thus looking into new research possibilities, enabling future researchers to build upon their work and dive into that new field of study (Verschuren & Doorewaard, 2010). This research is a combination of the first and third type of case studies, since it on the one hand aims at explaining the future and practical impact of the CBAM, while at the same time its objective is also to explore the broader phenomenon of domestic policy instruments influencing foreign policies.

Selection case

To choose a case, a set of selection criteria is constructed, to be evaluated after the case study as well. Shakir identified different strategies for case selection based on previous research, structured along the possible objectives of a case study (2002). Both single and multiple case studies are included. Of the four possible strategies, the *prelude strategy* is the most suitable one, due to the explorative objective of this case study (chapter 2.1). Four criteria were identified using the insights from both Shakir, and Baškarada (2002; 2013), which are:

- **Typical**
  The case needs to be representative of the phenomenon researched, and its objectives.
- **Critical**
  The case needs to entail critical elements of the phenomenon researched, and its objectives.
- **Combination**
  The case needs to be flexible and meet different interest and needs of involved actors.
- **Convenience**
  It needs to be possible to gather sufficient data on the case within the time span and network of the research.

The case of the dynamics in the aluminium sector between Germany and China meets these criteria. First, the chosen case is typical, because the aluminium sector is one of the five proposed CBAM sectors and the impact for both a domestic (Germany) and foreign (China) country is researched. Second, the case is critical, because the aluminium sector is subjective to the risks of carbon leakage, it is influenced by the geopolitical landscape and it is one of the CBAM sectors. These critical elements are in line with the elements identified in chapter 1.4. Third, different needs and interests are included in the case, as potential outcomes can contribute to science, and to both sides of the case: Germany as an EU Member State, and China as a non-EU country. Fourth and last, it is possible to gather sufficient data on the case within the time span and network of the research, since it is an exploratory research. Any data available is a plus. As stated in the section 2.1 and 2.2.5 as well, gathering the data from the Chinese perspective is the most difficult, as that is the least in the network of the researcher.

2.2.2. Qualitative data analysis

A method for analysing a case study with interview of data gathering is conducting a qualitative data analysis. Auerbach and Silverstein define three phases in and a six-step process for conducting a qualitative data analysis (2003). The three phases are (i) making the Text Manageable, (ii) hearing what was said, and (iii) developing theory. The six-step process towards conducting the analysis are as follows, where each phase consists of two steps (Auerbach & Silverstein, 2003, 43):

1. Explicitly state your research concerns and theoretical framework.
2. Select the relevant text for further analysis, by reading through your raw text with Step 1 in min and highlighting relevant text.
3. Record the repeating ideas by grouping together related passages of relevant text.
4. Organise themes by grouping repeating ideas into coherent categories.
5. Develop theoretical constructs by grouping themes into more abstract concepts consistent with your theoretical framework.
6. Create a theoretical narrative by retelling the participant's story in terms of theoretical constructs.

Together, these six steps guide the researcher in constructing a theoretical narrative from text.

2.2.3. Desk research

The second main method to be used is desk research, in order to be able to build upon the current base of literature. The goal of this method is to get the state-of-the-art literature on the CBAM, measuring via impact variables and gaining more general information to do the research. Different tools can be used for analysing and doing desk research, of which a literature study is a major one. Partly, the literature study in this research provides a starting point and a knowledge gap to research. However, for the first two sub-questions a more elaborate literature study is needed to dive deeper into geopolitics, its influence on the uptake of the renewable energy and the case.

2.2.4. Methods per sub-question

Now that the three main methods used are explained, we can look at which (sub-)question(s) they can help answer. Each sub-question is stated, followed by an explanation of the approach of answering the sub-question and of the methods that are selected to answer it. Also, each explanation entails a reference to the section in which the sub-question is presented.

1. What is the Carbon Border Adjustment Mechanism and what are its objectives?

The first sub-question is aimed at researching the context thoroughly by defining the concepts in the scope. Logically, a literature study on both the current state and history of the CBAM, as well as on impact assessments of (renewable energy) policy instruments is conducted to answer this sub-question. The answer to the question on the CBAM and its objectives will be given in chapter 3 and later in chapter 4 where the case will be further defined.

2. What theoretical issues and challenges of a renewable energy policy instrument should be taken into account when implementing the Carbon Border Adjustment Mechanism?

Once it is clear what CBAM is, the focus can shift to the more theoretical part by identifying the theoretical issues and challenges of renewable energy policy instruments. This second sub-question dives deeper into the theories of REPIs. Here, only using literature is sufficient to get a proper overview of the instruments using other literature studies as well. Similar to sub-question 1 will this question be answered in chapter 3.

3. How do domestic policy instruments affect decarbonisation efforts in non-EU countries?

To discover how the information gathered in the previous sub-question can be generalised to the phenomenon of domestic policy instruments influencing foreign regions, this third sub-question is raised. Again, the case study will be used to answer this question. The literature study in chapter 3 and the semi-structured interviews are also used. Two outputs are vital for answering this sub-question, namely the theoretical embeddedness in and insights from other REPIs, and the answer to the previous sub-question on the influence of the CBAM on trading dynamics. Since the same interviews are used, qualitative data analysis of interviews is the method to answer this question (chapter 5), as is the literature study from chapter 3.

4. How are the aluminium trade flows between Germany and China affected by the implementation of the Carbon Border Adjustment Mechanism?

With the case being defined, demarcated and set forth, the actual case study can be executed, based on the answers to the first two sub-questions. The answers to the first sub-questions provide a theoretical basis, while the empirical research provides the in-depth information that is needed to answer this fourth sub-question. A set of interviews with a group of experts from various backgrounds, analysed via a qualitative data analysis, will ensure the different perspectives required to give a balanced and objective answer to this sub-question. The answer will be discussed in chapters 4 and 5.

5. How are economic and geopolitical dynamics between two countries affected by a new renewable energy policy instrument in one of those countries?

The fifth and last sub-question focuses on the actual dynamics between China and Germany, and used to deduce the answer to the broader field of the impact of any REPI. The economic and geopolitical aspects of the trade provide more focus in this answer and potential factors that are of great influence. Therefore, the main method used here is the qualitative data analysis of the semi-structured interviews. An answer to this sub-question will be given in chapters 4 and 6.

Once the sub-questions are answered, a reflection on the methods used, the research itself and its limitations will be given in chapter 6. Then, chapter 7 will entail the answers to the main research question.

2.2.5. Data gathering and usage

Most of the data gathered in this research comes from two major sources of information. Firstly, a large amount of information will come from books, journals, company reports, governmental websites, policy documents and newspapers, all accessible on the internet. A vast amount of sources has already been found and categorised, centred around the different concepts to be discussed in this research. Secondly, and most critical, is the data gathering from the interviews and expert consultations for the case study. As said, multiple experts from various backgrounds need to be approached and interviewed, a task that takes up quite some time and effort. It needs to be accounted for that a large part of the approached interviewees will not reply on time, nor be available at all. To ensure a limited to no delay, addressing the interviewees in an early stage of the research is essential. In addition to that, the interviews will vary in their information density and relevance for the case. To ensure an output from the interviews as homogeneous as possible, the interviews will be semi-structured. That way, a predetermined set of questions and desired outputs can be followed, while still allowing for follow-up questions on the spot and thus a higher quality of the output.

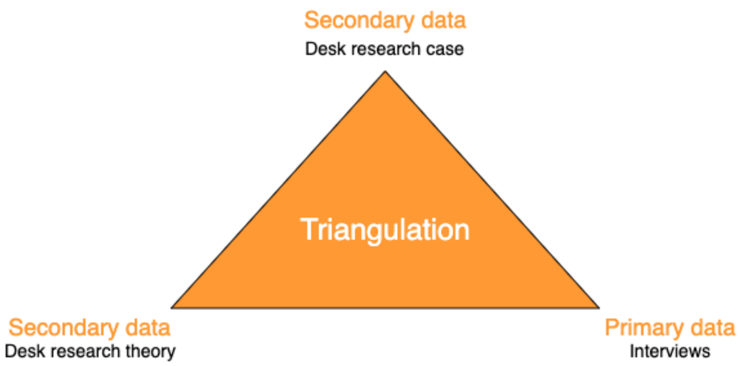

Figure 2.1: Triangular approach of the data collection.

Source: *Based on Creswell (2009).*

The aim of this research is to come to a balanced conclusion on the impact of domestic policy instruments on foreign policies, as well as the impact CBAM has more in general. The three types of data in this research and the triangular approach to gather it can be seen in figure 2.1, based on Creswell (2009). The data is either primary or secondary, and the methods used for the data collection can be seen in the figure as well.

Since the synthesis will consists of three perspectives – from policy, society (businesses and news) and experts – the interviewees will need to have a similar, broad background. Even though the background should not be exactly the same as the three perspectives, because the objective of interviewing the experts is to have balanced consensus, that adds to the found consensuses of the policy and society perspectives. Therefore, experts need to be at least from these four backgrounds:

1. Policymakers
2. Business
3. Scientists
4. Analysts

Together, they represent the full spectrum of perspectives on the CBAM. Ideally, interviewees are from both Germany and China, but due to the strategic character of the topic – taking the (business) culture in China into account – it is not very likely to be able to talk freely with a Chinese policymaker about its expectations of the impact of the CBAM. Even more so, being able to transcribe the interview word for word is expected to be a great challenge, especially for experts from China. Moreover, language barriers in documents from China are expected, thus it is expected that the Chinese perspective cannot be taken into account completely. Still, the Chinese perspective is essential and will thus, if needed, be covered by China experts based in the EU. In total, all this leads to a total of at least 8 interviews, with four backgrounds and 2 experts per background to cover both perspectives.

The gathered data in this research will be processed for this research only. However, the riskiest data comes from the interviewees, since the interviewees need to feel comfortable enough to share opinions, views and data. Potentially, that could limit the amount of data being shared by interviewees, which should be accounted for. Next to that, there are no substantial data usage risks.

2.3. Research structure

The research design can now be summarised into the structure of the research. The structure of literature study will be outlined, which aims at embedding this research in the current base of literature, as well as explaining the rationale for the use of the methods chosen.

2.3.1. Structure of the literature study

This part of the research focuses on researching the expected impact of REPIs from different perspective, in three increasingly complicated sections.

An ideal world

The expectations from the economic implications of REPIs in an ideal context are discussed in the first part of the literature study. Central questions here are: what are their objectives? What typical challenges and issues can be identified? What impact can theoretically be expected? A brief structure is:

1. Market failures
2. Three main REPIs
   (a) Carbon taxes
   (b) Cap-and-trade systems
   (c) Border Carbon Adjustments
3. Impact assessments

Complications when implementing in benevolent system

Secondly, the implications with an increasingly complex system are discussed. These implications arise when implementing the REPIs mentioned. These implications are mostly economical, but they are also more theoretical from an International Relations perspective. However, we still assume a benevolent system where actors behave in line with the greater good. There is no strategic behaviour. Also, there is no applied case part of the analysis yet.

1. Trade flows
2. International relations
3. Other implementation challenges from REPIs

As can be seen, only the three main REPIs are discussed, with each a section on the more complex situations they are being implemented in.

Complications with strategic behaviour of actors
Third and last is the situation where the actors start to behave strategically and the difference between actors starts to play a much larger role. Geopolitical tensions come into play, differences in budgets and responsibilities are increasingly of influence. Also, enforcing this type of policy instruments can be a huge hassle and a lot of insights can be taken from other policy instruments, even from outside the field of renewable energy. Again it starts being structured by the three main REPIs. Afterwards, the complicating themes will be leading in explaining the relations.

1. Geopolitics
2. Enforcement

2.3.2. Structure of the results

Similar to the structure of the literature study, the results are also structured threefold. As figure 2.2 shows, three main perspectives are distinguished. These three perspectives provide a balanced synthesis on the expectations of CBAM in the aluminium trade between Germany and China. They will be discussed in chapter 5.

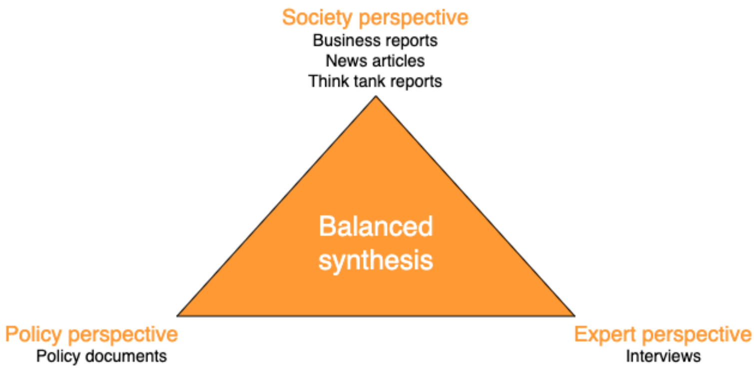

Figure 2.2: Structuring the results from three perspectives.

2.3.3. Research Flow Diagram

The research flow diagram (RFD) visualises the approach of the research. It gives an overview of how the research is started, what data needs to be used and when, what answers to particular sub-questions are needed to answer other sub-questions and how those questions as a whole provide an answer to the main research question.

In the research flow diagram, several elements can be distinguished. Firstly, the seven rectangle-shaped boxes represent the seven chapters of this research; in each box the corresponding name of the chapter is included. Then, the oval shapes represent the sections in each chapter when it is needed to already distinguish the sections. In this overview of the research design and research flow, it is not needed to do so for every chapter, as the divisions in some chapters are more straightforward than in other chapters. The third element that relates to the structure of the research are the hexagons, corresponding to the subsections, if needed. The coloured pieces of text near each box represent either an input (red) or output (green) of that particular box.

One thing that stands out here is that *chapter 4: analysis case* is not further divided into sub-parts. In this chapter the system of the case will be analysed, meaning that the actors involved will be discussed, as well as the independent and dependent variables in the system; a straightforward division of the chapter. Moreover, facts and figures about the trade between Germany and China will be highlighted in a dynamics section, as well as statistics on the aluminium trade and renewable energy production in both countries. Chapter 4 will use input from chapter 3, as well as input from sources outside the previous chapters through desk research. In chapter 5 all the information from the previous chapter will be bundled and the threefold structure of the results can be seen in both figure 2.2 and 2.3. Afterwards, the interpretation and reflection of the results will be explained in the discussion, followed by the conclusion.

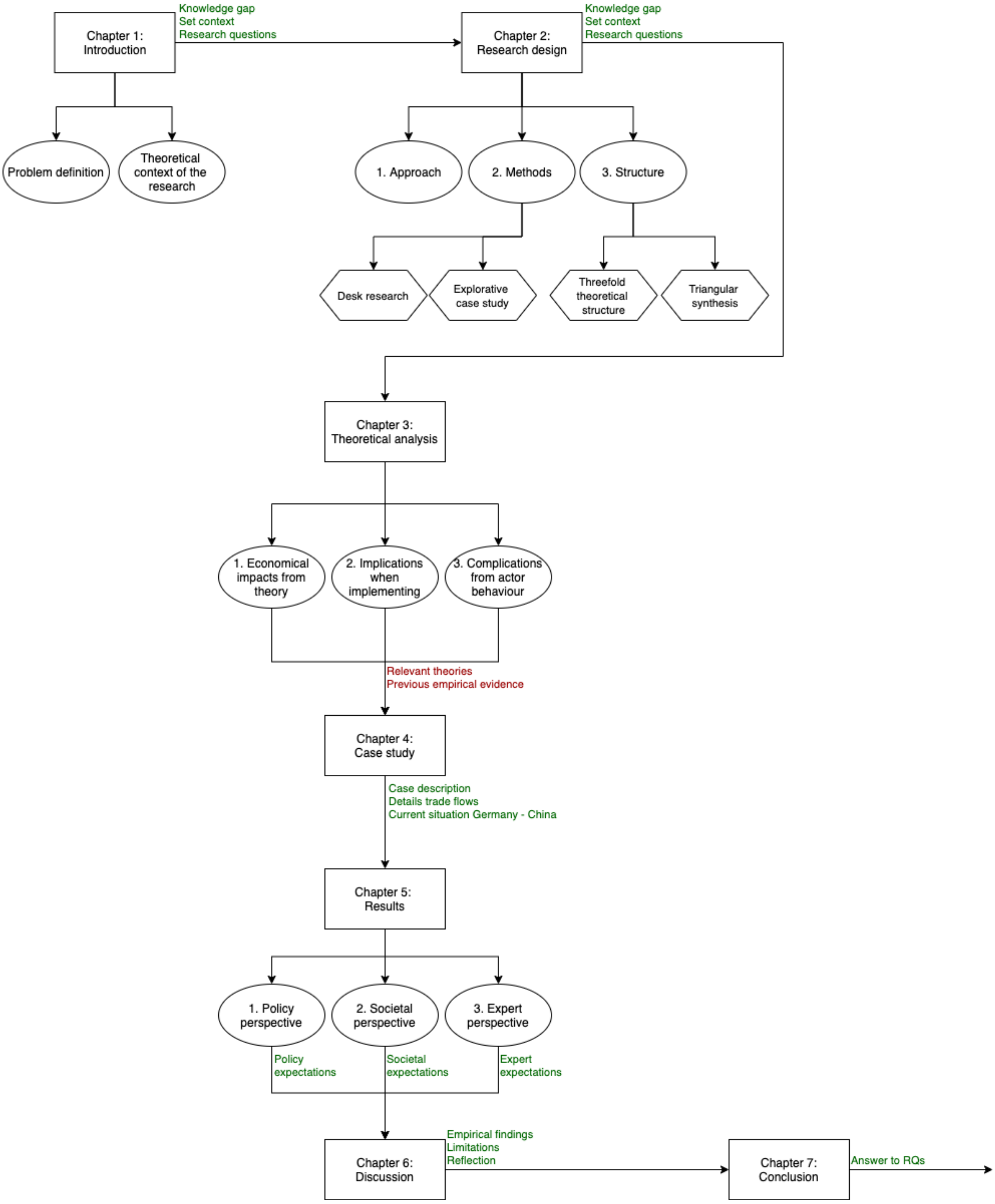

Figure 2.3: The Research Flow Diagram

3

Theoretical analysis

This third chapter will explore the *Tripartite structure*. The first part comprises the impact an economic policy instrument has on the system it is implemented in, theoretically. Then the second part dives into the complications a renewable energy policy instrument has when implemented, divided into complications related to trade flows, those related to international relations and more general implementation challenges. Third and last, the increasing complications that come with actors starting to behave strategically are discussed, when the dynamics between actors start to play an important role.

3.1. Article selection

To come to an article selection, first the search terms need to be determined. Since one of the goals of this research is to look at other REPIs to be able to formulate impact variables to assess the impact of CBAM, "renewable energy policy instrument" was the first search term, in combination with impact. However, as including "renewable" in one term resulted in too few articles, "renewable" was excluded from the term and added as an AND term. Also, "border carbon adjustment" OR "carbon border adjustment" needed to be included, to look for articles that already have assessed the impact. This led to the following search terms in four search engines (starting with the one most used, and ending with the one least used: Scopus, Web of Science, ScienceDirect and Google Scholar), containing the corresponding amount of articles found:

Search term	# of articles
TITLE-ABS-KEY ("energy policy instrument" AND "renewable" AND "impact")	15
TITLE-ABS-KEY (("border carbon adjustment" OR "carbon border adjustment mechanism") AND "impact" AND ("measure" OR "measuring"))	12
TITLE-ABS-KEY ("literature review" AND "economic instrument" AND "energy")	3
TITLE-ABS-KEY ("policy instrument" AND ("feed-in tariff") AND "comparison") AND (LIMIT-TO (OA , "all"))	2
TITLE-ABS-KEY ("literature review" AND "protectionism" AND econom*)	7
"renewable energy policy instrument" AND "impact assessment"	4
"renewable energy policy instrument" AND "impact"	17
TITLE-ABS-KEY ("enforcement" AND "policy instrument" AND "energy")	19
TITLE-ABS-KEY ("trade flows" AND "energy" AND "EU")	16
TITLE-ABS-KEY ("literature review" AND "international relations" AND "energy")	21
TITLE-ABS-KEY ("international relations" AND "renewable energy") AND (LIMIT-TO (LANGUAGE , "English"))	45
TITLE-ABS-KEY ("carbon leakage" AND "energy" AND "border" AND "adjustment")	28
TITLE-ABS-KEY ("geopolitics" AND "renewable energy" AND ("challenge" OR "issues")) AND (LIMIT-TO (LANGUAGE , "English"))	31

"

In total, 174 articles were found. Due to the large number of articles and the wide range of topics they cover, a large set of selection criteria was used to further sort the articles on relevance. The articles are not tested on every criterion, as that would leave out too many articles. Therefore, the selection criteria are grouped by their general topic. These are:

1. Geopolitics
   (a) Does it address the geopolitics of specifically renewable energy?
   (b) Does it include a case study?
2. Economic theory
   (a) Does it relate to either enforcement instruments, trade flows, trade creation or trade diversion?
   (b) Is it applied to an energy related case?
   (c) Preferably, is a literature review conducted?
3. International relations
   (a) Are the relations analysed in the light of the energy transition?
   (b) Are the relations between two specific countries or regions analysed?
   (c) Preferably, is a literature review conducted?
4. Renewable energy policy instruments
   (a) Is 1 or more policy instrument discussed?
   (b) Is a comparison of instruments made?
   (c) Is the impact assessment quantitatively, qualitatively, or a combination of both?
   (d) Is CBAM or a BCA included?
   (e) To what extent are the impact variables mentioned?
   (f) Is the risk of carbon leakage included in the research?

These selection criteria are used to bring the amount of articles down to a number that makes it possible to analyse them in a master thesis. Of the selected articles, they all meet various criteria, and other criteria only to some extent. A set of articles of 46 is the result, that are used throughout the various sections in this chapter. As explained in chapter 2.3 this chapter uses those articles in the three parts of the literature study.

With this selection, a literature study is conducted. For this research, a literature study is needed for two main reasons. Firstly, a literature study provides knowledge gaps that can be further addressed in the research (Snyder, 2019). Secondly, it enables the researchers to be at the forefront of the research, through assessing the current collective evidence in a certain field of research (Snyder, 2019). Here, the latter is of great importance, since this research is aiming at assessing the impact through the usage of best practices from similar studies.

3.2. Renewable energy policy instruments theoretically

This second section of the chapter dives into the theoretical implications of renewable energy policy instruments, the first part of the tripartite structure of the literature study. It starts with an overview of the relevant phenomena that the economic policy instruments given in this chapter try to solve or are included in. Then, an overview of the related policy instruments is given and discussed. Third, the dominant standard to which the policy instruments and countries need to adhere to is outlined. Subsequently, a separate possibility of reducing one's emissions is outlined. Lastly, a short conclusion is given.

3.2.1. System failures

To be able to identify and analyse comparable theories to CBAM, first the relevant phenomena that cause the need for a CBAM need to be discussed. As outlined in chapter 1, CBAM was proposed to anticipate on different forms of market failure. The ETS was installed in 2005 to internalise the 'expenses' of the emission of CO_2 from industrial production facilities (de Perthuis & Trotignon, 2014). The EU ETS aims at "minimising the cost of reaching a certain predefined emission target" (de Perthuis & Trotignon, 2014, 101). As said, the price of emission certificates has long been at such a low level that the decarbonisation has not progressed as quickly as intended (Y. J. Zhang & Wei, 2010; Weko et al., 2020; Bellora & Fontagné, 2020). Three weaknesses have been identified that together are at the root of that lack of progression. Besides the off and on mentioned rationale of the economic crisis of 2008 strongly affected industrial output and thus creating a surplus of allowances (de Perthuis & Trotignon, 2014).

Firstly, since the 2008 economic crisis there was an unforeseen and widespread decrease in activity in industrial sectors, which resulted in different perspectives on the second phase of the EU ETS implementation. A decrease in production was the result on the short term, while degraded growth prognoses changed the prospects on the longer term (de Perthuis & Trotignon, 2014). Secondly, the allowed offsets – reduced GHG emissions used to compensate for an increase in GHG emissions in another geographic area – were on a relatively high level (de Perthuis & Trotignon, 2014; Carbon Offset Guide, 2021). Considering the fact that offsets can be banked – 'stored' for later use – participants in the EU ETS could freely choose when to use those acquired offsets, e.g., when the price in the ETS was higher. In turn, this led to an extension of the period that the price of an emission certificate was at a low level, slowing the decarbonisation process. A key takeaway from this mismatch between the allowance of offsets and the objective of the ETS is that the more offsets are allowed in the system, the less control the public authority has over the abatement pace (de Perthuis & Trotignon, 2014; Kogels, 2020). The third reason mentioned by de Perthuis and Trotignon for the malfunctioning of the ETS market is the interactions between the ETS and other energy and climate policies that also aim at reducing the carbon emissions in the EU (2014). A potential solution for this market failure is better alignment between the different government levels; different policy instruments aimed at a similar objective can only amplify each other when implemented at the same level of government, regardless whether that is at an intergovernmental, national or regional level.

Another market failure that drives the need for a CBAM from the perspective of the European Commission is the risk of carbon leakage when the price of emission certificates in the ETS has advanced to a much higher level (Ismer et al., 2020; Droege & Fischer, 2020). As discussed in chapter 1 extensive carbon leakage would mean considerable damage to the economy of the EU with a loss of jobs, competitiveness and sovereignty (Evans et al., 2021). The proposed version of CBAM – as explained in chapter 1 – shows elements of protectionism. The EU has already been accused of only wanting to protect its industry and 'falsely' using the emission argument to justify the implementation of CBAM (Sheppard et al., 2021). Similar accusations have been made in 2019 and 2020 when import tariffs were being implemented reciprocally between the US and the EU on agricultural products. The EU stated that some products being imported from the US to the EU did not meet the EU standards, which the US denied and in turn reacted with their own import tariffs (Abbott, 2020). Despite this precedent, protectionism generally does not comply with WTO Law when it violates the discrimination and fair competition standards set by the WTO. Consequently, it is forbidden for the EU to protect its industry to the extent that it gives its domestic industrial companies a comparative advantage over foreign competitors (Chikezie & Chen, 2020).

To tackle these weaknesses of the market and consequent market failures in the energy sector, many policy instruments have been proposed in different forms and by various countries. In the rest of this first part of the tripartite-structure the insights from these policy instruments will be discussed.

3.2.2. Carbon tax

One of the most self-explanatory policy instruments is a *carbon tax*, a specific type of Pigouvian tax. A 'Pigouvian tax' is defined as a tax that aims to internalise the negative externalities generated by the market activities, introduced by Arthur Cecil Pigou (Elkins & Baker, 2001; Wang, Hubacek, Feng, Wei, & Liang, 2016). A carbon tax is a perfect example of a Pigouvian tax (Elkins & Baker, 2001; Shmelev & Speck, 2018). The emission of CO_2 in the energy sector can be seen as a cost in the sector. Implementation of a carbon tax would put a price on those costs (Wang et al., 2016). While a carbon tax cannot follow the standard economic process by valuing the damages and including them into the price, as Pigou explains, approximations of the social costs of carbon emissions still need to be made to determine the rate and other details of the carbon tax (Shmelev & Speck, 2018). As with comparable carbon pricing instruments such as a cap-and-trade market (see section 3.2.3 for a more detailed explanation of that instrument), approximations are necessary for progressing towards including the negative externalities in the price of products (Shmelev & Speck, 2018). A carbon tax can be implemented relatively easy, due to its rather straightforward design and similarities to other taxation schemes. Additionally, no extra market needs to be installed and there is no risk of exceeding the instrument's budget – as with subsidy and premium schemes (Maestre-Andrés, Drews, & Bergh, 2019; Shmelev & Speck, 2018). In other words, a carbon tax does not cause a lot of extra work for the affected actors administratively. However, it has been much easier for the EU to implement a CO_2 market, since unanimity is needed to implement a tax in the EU (de Perthuis & Trotignon, 2014). As with most of the policy instruments being highlighted in this research, often countries implement a combination of instruments, since only one policy instrument does not suffice to reach the more ambitious targets (Kammermann & Ingold, 2018). Besides being part of the EU ETS, the European CO_2 market, several countries have implemented a (national) carbon tax as well – among which Finland was the first, currently followed by 11 other EU Member States (WorldBank, n.d.). When comparing a carbon tax to other policy instruments than a trading scheme, the dominant view is that both a carbon tax and a carbon emission trading scheme like the EU ETS are generally more efficient policy instruments in terms of cost (Elkins & Baker, 2001).

Following the overview of Wang et al. about the different taxation designs, a distinction can be made between two types of measures and designs (2016). On the one hand, *ex ante measures*, such as exemptions for certain groups of consumers, as well as tax rate differentiation for specific sectors or consumers (Wang et al., 2016). On the contrary, *ex-post measures* go evidently into effect after taxation. Examples are a reduction for other types of taxes, or compensation measures. Moreover, recycling the revenue of the carbon taxation can have a double effect when used properly (Wang et al., 2016; Shmelev & Speck, 2018). More comprehensive carbon tax designs certainly would make use of this effect by considering both parts of the equation simultaneously. Conclusively, the only general design choice would be for governments to precisely analyse one's own social situation and priorities and tailor the policy design according to that analysis (Wang et al., 2016). This is supported by economic modelling results focused on the pricing of carbon, where in the most ambitious scenarios linked to the most ambitious targets the price of carbon will rise to politically infeasible levels (Pollitt, Neuhoff, & Lin, 2019). This implies aiming at comprehensive and tailor-made solutions for countries to minimise that increase in prices. Carbon pricing is however still essential in reaching those targets, thus an essential and major part of the mix of policy instruments needed for a more smooth transition (Wegner, Hall, Hardy, & Workman, 2017).

Despite the tremendous challenge of designing a general carbon tax, several aspects still need to be determined to form the carbon tax. These are the carbon price rate, possible inclusion of free-allowances and the sectors it applies to (Flues & Van Dender, 2020). Of these three, the latter one is not as interactive with the other two as the first two are with each other. The applied sectors do determine the size and scope of the carbon tax, and consequently also the eventual, long-term pace of the transition. However, when put together, the rate of the carbon price and the amount of allowances freely allocated are much more influential on the transition pace (Flues & Van Dender, 2020). Flues and Van Dender illustrate that the higher the amount of free-allowances for a company, the less innovation efforts can be observed in that same company, causing a slower transition (2020). Correspondingly, the carbon price rate and its development over time has shown to be significant in predicting the investment rates in the clean technology market: the more linear the rate, the more predictable it is, and the consequent stability drives more investment in clean technology (Flues & Van Dender, 2020).

Because of the abundant empirical evidence of an implemented carbon tax in a country or region, a proper evaluation of the theoretical expected impact can be made. The first one is highlighted by many scholars: the difficulty of predicting the long-term effect of such drastic regulatory instrument changes; a comparison between the empirical evidence and the theoretical expectations can extirpate some of that uncertainty (Flues & Van Dender, 2020; Kammermann & Ingold, 2018; Alreshidi, 2018). As said, a more stable and predictable carbon pricing mechanism, such as a set taxation scheme in the form of a carbon tax, is expected to induce more innovation efforts in clean technology and subsequent reduction of total emitted CO_2. Since the introduction of a carbon tax in several countries, several designs have been implemented with alternating success. Whereas in Switzerland the rate was dependent on the current pace of the decarbonisation, the carbon tax in California and Quebec was planned and executed to increase with 5% each year beforehand (Flues & Van Dender, 2020; Kammermann & Ingold, 2018). So far, it can be concluded that the Swiss application has proven to be more effective and efficient in terms of cost. Research from the UK comes to a similar statement, with a stronger call for more innovative and flexible policy (Wegner et al., 2017). Thus, the hypothesis arises that more flexible versions of a carbon tax are more effective. The more tailor-made solutions mentioned in the previous paragraph add extra body to that hypothesis.

A second major effect that is to be expected from literature, is the effect a carbon tax has on the industrial competitiveness of mainly energy-intensive sectors (Elkins & Baker, 2001). Generally spoken, those industrial clusters are expected to emerge as the losers of the introduction of a carbon tax. As discussed earlier in this research, this effect on the industrial competitiveness has been part of the carbon leakage effect (Rocco, Golinucci, Ronco, & Colombo, 2020). However, so far that effect has not been as significantly observed as expected – although still being present mainly when the taxation is production-based (Rocco et al., 2020). A factor that mitigates this effect, as well as making all types of carbon taxes more effective, is using its revenues for decarbonisation stimulating measures (Elkins & Baker, 2001).

Six key conclusions on the expectations of the impact CBAM has, taken from literature on carbon taxes, are:

- A carbon tax works best in combination with other policy instruments aimed at decarbonisation.
- The key choice, and major factor of influence on the effectiveness, is the price level.
- The more stable the market gets due to the instrument, the better.
- Flexibility improves the effectiveness.
- Carbon leakage has not yet been observed significantly enough to prove its existence resulting from a carbon tax.
- Re-using the revenue generated by the carbon tax for measures stimulating decarbonisation increases the effectiveness.

3.2.3. Cap-and-trade mechanism

Until CBAM, the other major choice of policy instruments of carbon pricing is a (Carbon) Emissions Trading Scheme, such as the previously mentioned EU ETS (Pollitt et al., 2019). In their paper on carbon taxes, Elkins and Baker also summarise options and opportunities of an Emission Trading Scheme (ETS), including a comparison of a carbon tax with an ETS (2001). Whereas the EU ETS originated from other environmental sectors, such as the sulphur dioxide in the US, it was also being applied in the energy sector in the early 2000s (Elkins & Baker, 2001). As said, the EU implemented an ETS in 2005, setting the scene for implementation in other countries as well. Many followed at both an international, national and sub-national level (European Commission, n.d.; Talberg & Swoboda, 2013). The main difference between a carbon tax and a trading scheme is the flexibility (quantity vs price respectively); where a carbon tax has a fixed price with fluctuating quantity, a trading scheme sets a fixed quantity and the price of emitting carbon fluctuates (Elkins & Baker, 2001). The quantity of emissions being ensured is achieved by the cap that is set on the emissions. To provide a more stringent policy, the cap on the emissions can be lowered over time, creating scarcity on the emissions trading market and thus increasing the price of emitting a unit of CO_2. This is also where the synonym of the name ETS originates from: a *cap-and-trade* system. Identical to a carbon tax, the decarbonisation rate thrives with stability in an ETS, providing a predictive investment climate (Lago, Mysiak, Gómez, Delacámara, & Maziotis, 2015). Evidently, in an ETS a stable price provides that stability, while in a system with a carbon tax it is ensured by the tax rate – i.e., the way the tax evolves over time.

An ETS can apply to the emissions upstream, downstream, or both. When it is focused on upstream emissions, the producers of raw materials, delving companies and other companies higher 'up' the value chain of the product are targeted (Elkins & Baker, 2001). In the aluminium industry this includes the delving companies, transporters of bauxite and producers of alumina and raw aluminium. Downstream emissions would target the emissions from activities lower 'down' the value chain (Elkins & Baker, 2001). When looking at the value chain of aluminium, the companies processing the aluminium for their final products – foil, pipes, aeroplanes, cars – will need to buy emission permits in the ETS (Pollitt et al., 2019). When looking at both upstream and downstream, all emissions in the sector are targeted and are included in the ETS, although so far that has not yet been observed empirically (Flues & Van Dender, 2020).

To provide stability in the investment climate in each of the sectors, several supportive structures are possible in an ETS. The first of four of those structures is an *auction reserve price*. This ensures low permit prices in the entire ETS by setting a floor on the price, encouraging clean investment by guaranteeing a return (Flues & Van Dender, 2020). Similar to this, the second structure, a *carbon price support*, also provides encouragement of clean investment through a stable return on investment (Flues & Van Dender, 2020). It is however distinctive from an auction reserve price because a carbon price support is a fixed tax rate, while still fluctuating depending on the stringency of the cap (similar to auction reserve price) (Flues & Van Dender, 2020). The third structure supporting an ETS is also a price floor, namely an emission containment reserve. Here, when the price of the permits falls below the set threshold, trading in new permits is not possible any more because of cancellation and withdrawal of the new permits from the auction (Flues & Van Dender, 2020). Thus, it causes an upward step in the supply curve of the permits. However, an emission containment reserve is not much mentioned in other literature, due to a lack of empirical applications. Fourth and last, a market stability reserve does not regulate the price, but the quantity of the permits; making it a much more complex supportive structure to use (Flues & Van Dender, 2020). In principle, it is fairly simple: when the price of the allowances exceeds the set cap, permits are put into the stability reserve; when they fall below the set floor, the reserve is further emptied. The major issue with this structure is however the limited amount of permits in the reserve once the price keeps increasing (Pollitt et al., 2019). Moreover, price volatility is increased when permits are banked and abatement costs keep increasing as well. Nevertheless, mainly due to the long-term low prices of the permits in the EU ETS, the EU has installed a market stability reserve in addition to the ETS in 2019 (Pollitt et al., 2019; Flues & Van Dender, 2020). At the same time, carbon leakage has not been observed significantly since the introduction of the EU ETS (Healy, Schumacher, & Eichhammer, 2018). However, it cannot without doubt be concluded that carbon leakage is the direct result of Phase III of the EU ETS, nor of one of the earlier phases (Healy et al., 2018).

Assessing the effects of the introduction of an ETS is much more straightforward than of a future REPI, since the EU ETS has been observable since its installation in 2005, amongst other examples. In their research, de Perthuis and Trotignon have constructed an extensive evaluation of the introduction of the CO_2 market in Europe, formulating several main takeaways for future governance (2014). To avoid repeating the research, this research will entail those main insights. Therefore, moving to the first insight from de Perthuis and Trotignon: ex ante expectations tend to overestimate the capacity of the cap to provide a sufficient incentive for decarbonisation (2014). An overestimation could then in turn lead to a lack of supportive instruments, such as the ones outlined above. After all, PIs tend to work most effectively when in a mix of PIs (Kammermann & Ingold, 2018). Secondly, weaknesses in the EU ETS have been caused by some market failures, all leading to a low carbon price: (i) an unforeseen decline in industrial activity since the crisis of 2008; (ii) an unforeseen high use of carbon offsets in a relatively short period of time; (iii) unintended interactions between other PIs and the EU ETS (de Perthuis & Trotignon, 2014). For newer ETSs in other regions and countries, the crisis of 2008 is less relevant, since those became active years after that crisis. However, disruptive changes in the economic environment of the ETS are of great influence on the effectiveness of the ETS, as is again proven by the COVID-19 crisis (Schotten, Hemmerlé, Brouwer, Bun, & Altaghlibi, 2021). Thirdly, manual changes in the cap – following a shift in the reduction targets and midway evaluation of the ETS – are needed, but not sufficient in reaching those renewed reduction targets (de Perthuis & Trotignon, 2014). More recent observations have supported this claim from 2014, as the price of the emission certificates remained at a fairly low level until recently, despite changes in the cap (Flues & Van Dender, 2020). Next, de Perthuis and Trotignon called for an Independent Carbon Market Authority, because it could ensure the medium and long term targets were met, while maintaining the flexibility needed in the short term (2014). Naturally, such an authority should have the right level of expertise, a precise mandate for its responsibilities, and strict & clear reporting and accountability rules (de Perthuis & Trotignon, 2014). However, the last key insight from de Perthuis and Trotignon – 'backloading' the amount of allocated free allocations – has not proven to be accurate. Whereas the insight was that backloading does not solve any structural ineffectiveness of the ETS, recent years have shown that bringing back the amount of free allocations allocated yearly does provide a stronger incentive to innovate and decarbonise (Pollitt et al., 2019; Healy et al., 2018; Flues & Van Dender, 2020).

Five key conclusions on the expectations of the impact CBAM has, taken from literature on a cap-and-trade systems, are:

- Supportive policy instruments significantly improve the effectiveness of a policy instrument.
- The power of a cap driving innovation should not be over-estimated.
- Nevertheless, 'manual' changes in that cap are required.
- An independent authority regulating the market and the rates greatly improves the ability of the policy instrument to achieve its short, medium and long term objectives.
- Carbon leakage has not proven to be a direct result of only a cap-and-trade system.

3.2.4. Carbon Border Adjustment Mechanism

Border Carbon Adjustment

As aforementioned, the CBAM is a form of Border Carbon Adjustment (BCA), a term that bundles different approaches to level the playing field between regions and countries, as well as to avoid carbon leakage (Marcu et al., 2020; Dybka et al., 2021). Apart from this section, the term CBAM will be used in this research as a BCA, to avoid any confusion between the two.

The first introduction of this particular form of CBAM was in July 2020, when it was officially proposed to the European Commission as the policy instrument to target carbon leakage and level the playing field (Ireland, 2021; European Commission, 2021e). It was designed by the Directive-General (DG) TAXUD, in collaboration with the DG CLIMA and DG TRADE (Jadot et al., 2021). This collaboration explicates which majors areas CBAM touches upon: it is a tax, that improves climate measures and strongly influences trade flows.

Coverage of CBAM

Several choices need to be made when implementing a CBAM, which were also discussed during the feedback sessions (see appendix C). The first and foremost decision concerns the *geographical scope* to which the mechanisms apply (Dybka et al., 2021). This scope is essential for further implementation, since the complexity is determined by whether all countries without some form of an ETS, or only few selected ones are included. With the latter, the range of selection criteria are vast (Condon & Ignaciuk, 2013). Would a selection be based on GDP per capita? A country's emission levels? Just a geographical area, for example only middle eastern countries? With any decision made on this part of the scoping, international trade and discrimination laws need to be considered, since most likely not all scoping decision are legislative (Condon & Ignaciuk, 2013; Tamiotti, 2011; Fouré, Guimbard, & Monjon, 2016).

Secondly, the *coverage of trade flows* needs to be determined (Dybka et al., 2021). Here the options are not as vast as with the first scoping decision. There are three, surprisingly simple options, the first being to *include only imports* to the EU (Y. Li & Su, 2017). The complete opposite, *including only exports* is an option that is less likely to be chosen, as that is the least effective option (Y. Li & Su, 2017; Holmes et al., 2011). The last and most likely option is both imports and exports. This is the most far-reaching option and consequently also the most complex one (Delbeke & Vis, 2020). Not so surprisingly, these options are the same as the ones brought forward in chapter 1.4.

Next is the *sectoral scope*, that can include many choices (Dybka et al., 2021). Are only upstream businesses included, only downstream, or both? Is implementation limited to electricity, or other energy sources as well? Are agricultural products also included? Depending on the sector, the categorised partners businesses react differently (Pauer, 2018; Holmes et al., 2011).

The last of the scoping decisions to be made is the *scope of the emissions*: to what extent are indirect emissions included, or is the intention that more indirect emissions are included in the price of raw materials and their preliminary assemblies (Dybka et al., 2021; Bellora & Fontagné, 2020; Tang, Bao, Zhang, & Wang, 2015)? These and other questions regarding the coverage of a BCA need to be answered when designing a BCA.

Carbon Border Adjustment Mechanism in theory

So far, CBAM has been mentioned a couple of times in the literature. Many reports and policy briefs from organisations have been published, with varying focuses. For example, Delbeke and Jos present seven recommendations on the implementation of CBAM (2020). Banerjee makes a tangible suggestion however, to link the level tariff itself as closely as possible to more domestic carbon policy instruments, such as the EU ETS (2021). The author did an analysis from the perspective of a country that the tariff would be levied upon, namely India. Others, such as Bistline, Merrick, and Niemeyer, take the only precedent of a BCA as example to assess the impact of CBAM, especially to leakage rates (2020). In that article, it is argued that the leakage rates strongly depend on the exact implementation, but the phenomenon is also questioned for its extensiveness. The latter is more strongly argued for by Mcwilliams and Zachmann (2020). Main reasons for that are the lacking empirical evidence of carbon leakage, the risk of evasiveness - or 'trade deviation' as they call it - which would lead to lobbying and 'cascading protectionism', and lastly a rather vague distinction between the covered and the non-covered sectors (Mcwilliams & Zachmann, 2020).

Three main types of implementation issues are brought forward: legal, political and logistical issues. Main legal issue is the WTO compatibility, since CBAM would be an instrument discriminating countries (Hulten, 2020; Kogels, 2020; Evans et al., 2021; Marcu et al., 2020). However, when designed properly and making sure CBAM is not a form of protectionism, the legal barriers should be able to overcome (Talebian et al., 2021; Mcwilliams & Zachmann, 2020). Political issues concern the previously mentioned cascading protectionism, potentially leading to trade wars, or retaliation from countries that the tariff is levied upon (Fouré et al., 2016; Mcwilliams & Zachmann, 2020). Next to studies discussing different implementation 'versions' and the issues linked to that, there is a lack of literature on a methodology to analyse and assess the implications of CBAM (Weko et al., 2020; Ismer et al., 2020). This research partly tries to fill that gap, as explained in chapter 1.2, by generating more data on potential impacts and using methods of related fields of research. All in all, these issues have proven to be significant barriers to the implementation of a CBAM, since the previous attempts of implementing a CBAM have all failed so far, apart from a CBAM specifically for electricity in California (Pauer, 2018).

Four key conclusions on the expectations of the impact of CBAM are:

- The existence of the phenomenon of carbon leakage is questionable when looking at CBAM.
- Cascading protectionism is a major risk, mainly due to the immense impact it can have. It is less likely though due to many dependencies.
- Significant issues regarding the legal, political and logistical implications have proven to be able to block a CBAM before.
- The implications of CBAM are highly uncertain and vary tremendously in literature.

3.2.5. Other renewable energy policy instruments

Next to these three main REPIs, several other REPIs – mostly smaller in scale or effect – are discussed in literature as well: feed-in tariffs / premiums; consumption charges; contracts for difference. These are often used in combination with either of the three PIs mentioned above, to improve the effectiveness of the major policy instrument in place.

Feed-in tariffs or premiums

Feed-in tariffs (FIT) or *feed-in premiums* (FIP) are two of the most commonly used PIs, of which FIT is far more often used. Many countries have already installed one of these two instruments, a FIT is dominant in Europe, South-America, Asia and Africa (Hu & Suljada, 2020). A FIT is a policy containing a fixed price that producers are being paid for their electricity, differentiated according to the technology used and the size of their production facilities (Shum, 2013). Its main objective is to encourage investment in renewable energy sources, via the guaranteed prices for fixed periods of time (Gullberg & Bang, 2015). FIPs have the same main objective, but different means are used. With premiums, producers receive an additional 'premium' price on top of the market price for each unit of electricity sold (Azhgaliyeva, Belitski, Kalyuzhnova, & Romanov, 2018). Consequently, FIPs provide a fixed budget for the government body that pays the premiums to the producers, while FITs give a more stable investment climate through the guaranteed prices, which can result in exceeding the government budget (Azhgaliyeva et al., 2018; Blazquez, Nezamuddin, & Zamrik, 2018; Hu & Suljada, 2020). As said, most governments have so far preferred a more stable investment climate over the risk of exceeding the subsidy budget, the latter is the biggest issue with FIT (Hu & Suljada, 2020).

Consumption charges

Consumption charges are a means to ensure that the cost of carbon is internalised along the entire supply chain of key basic materials and that it can reach the customer (Pollitt et al., 2019; Karakaya, Sarı, & Alataş, 2021). Similar to a BCA, a consumption charge is a destination-based measure (Ismer et al., 2020). However, when compared to a CBAM, consumption charges requires a lot of transparency in the contents of a certain product, which is something that cannot be expected from a CBAM (Ismer et al., 2020). Even if such a level of transparency could be attained for a certain sector, the comprehensiveness of CBAM would make it increasingly complex to combine that (Pollitt et al., 2019; Ismer et al., 2020).

Contracts for difference

The next comparable REPI is *Contracts for difference*, which is a means of reducing risk in capital-intensive projects with long investment periods by effectively guaranteeing a certain return for the incremental costs of an investment that delivers emission reductions below the current best available technology (based on feed-in premium) (Mcwilliams & Zachmann, 2020). It pays out the difference between the strike price and a variable carbon price, such as the price of allowances in an ETS.

Since the issues of the latter two REPIs are very similar, we will dive into both at the same time. Several issues need to be addressed with these two approaches. For example, the continuation of the carbon leakage protection, which means that consumption charges is not superior over BCAs in that respect, in view of (Marcu et al., 2020). A second issue is the impact of free allocation on downstream price signals, since that impact is significant (Mcwilliams & Zachmann, 2020). Mcwilliams and Zachmann also conclude that reducing the amount of free allocation rights could accelerate the reduction in emissions, but discourage investments at the same time (2020). The third main issue is the creation of a market for low carbon products (Mcwilliams & Zachmann, 2020). That could serve two purposes. On the one hand, it would create more awareness among customers on the carbon intensity of certain products. On the other hand, it could incentivise companies on getting their products on the low carbon market, to take advantage of the separate markets.

Table 3.2: An overview of the REPIs and their main insights for CBAM

REPI	**Principle**	**Main insights for CBAM**
Carbon tax	A unilateral tax that internalises the carbon costs of a good.	Determining the tariff is key to effectiveness. Flexibility improves effectiveness. Carbon leakage is not significant from a tax. Re-using the revenue is highly stimulating.
Cap-and-trade system	A separate market in CO2 emission rights.	The power of a cap should not be overestimated. An independent authority is highly valuable. Carbon leakage is not a proven result from an ETS.
Border Carbon Adjustments	A border tariff on goods, to level the playing field between countries.	Existence of carbon leakage is questionable. Cascading protectionism is a major risk. Tremendous uncertainty around CBAM so far.
Feed-in tariff / premium	A fixed price for electricity sold (FIT) An additional premium that producers receive per unit of electricity sold.	Both FIT and FIP serve best in combination with other PIs. FIT might disturb CBAM with contrasting incentives.
Consumption charges	Internalising carbon costs of a good.	The levels of transparency needed for declaring the carbon content of all goods cannot be achieved in CBAM (yet).
Contracts for difference	Guaranteeing a return of investors through paying difference between the strike price and the carbon price	Discouraging investment in RE is not at all desirable. A low carbon market could be very valuable.

In table 3.2 an overview of each of the discussed REPIs can be found, with in short the principle of each instrument and the insights that are valuable for CBAM listed.

3.2.6. Impact assessments

Research on geopolitics, policy instruments and assessing their impact is vital for being able to get to valuable and insightful results. This section dives deeper into measuring that impact via variables, and what insights existing literature provides. First, an overview of the impact variables derived from literature is given, after which the main takeaways are discussed. Three categories are left out in this overview because of their limited relevance to the research, namely *technology*, *innovation* and *Corporate Social Responsibility*. A description of those and the other categories can be found in appendix A.

Overview impact variables

An overview of the impact variables derived from comparable renewable energy policy instruments, as explained in more detail in appendix A, is given below:

1. (Neo-)Classical Economics:
    - Efficiency (Y. Li & Su, 2017; Ockwell, 2008)
    - Effectiveness (Azhgaliyeva et al., 2018; Y. Li & Su, 2017; Condon & Ignaciuk, 2013)
2. Environment:
    - Total carbon emissions (absolute): regional vs global (Banerjee, 2021; K. Zhang et al., 2020; Condon & Ignaciuk, 2013)
    - "Exported emissions" (Banerjee, 2021)
3. Mitigation costs: (Y. Li & Su, 2017; Bistline et al., 2020)
    - Policy changes (Azhgaliyeva et al., 2018)
    - Policy implementation (Azhgaliyeva et al., 2018)
    - Abatement costs (Banerjee, 2021)

- Government expenditures on policy measures (K. Zhang et al., 2020; Y. Li & Su, 2017)

4. Competitiveness companies: (Fouré et al., 2016)
    - Trade rates (Dong & Walley, 2012; K. Zhang et al., 2020; Condon & Ignaciuk, 2013)
    - Investment rates (K. Zhang et al., 2020; Shi, Ren, Cai, & Gao, 2019)
    - Dependency on financial support (Thapar, Sharma, & Verma, 2016)
    - Prices (elasticity as well) (Banerjee, 2021; Bistline et al., 2020)
    - Tax share in the price (Shi et al., 2019)
    - Size of the annual demand (Shi et al., 2019; Marbe & Harvey, 2006)
5. (Geo)politics:
    - Risk of retaliation (Fouré et al., 2016)
    - GDP & welfare losses / wins (Bistline et al., 2020)
    - Import / export dependency (Banerjee, 2021)
    - Human capital development (Sodiq et al., 2019)
    - Social justice (Sodiq et al., 2019)

Neoclassical economics

This first category of impact variables is variables which are most often used in impact assessments; usually more quantitative studies. These two are *efficiency* and *effectiveness*. In generic terms, efficiency is the rate in which a certain amount of input - whether that be money, energy or time or something else - is converted into a particular amount of output - which could be the same concepts as with the input - during a process (Cambridge English Dictionary, n.d.). In terms of the efficiency of policy instruments, an example could be the return rate of money into an X amount of CO_2 emission reduction. In energy-related literature, often the term energy efficiency is used, to express the amount of energy that is wasted by using it (Ockwell, 2008). Y. Li and Su use the term similarly to Ockwell, related to energy efficiency (2017; 2008). It is a highly rational and quantitative variable, stemming from the theory of Neo-Classical Economics (Ockwell, 2008).

Correspondingly, *effectiveness* is a second widely used variable in impact assessments. Again, it is highly rational and quantitative, since effectiveness means the extent to which the measures taken have the desired effect (Azhgaliyeva et al., 2018). Azhgaliyeva et al. have focused their entire research on the effectiveness of policy instruments, more specifically those related to increasing the uptake of renewable energy (2018). Often these two are taken together; in economic studies, as well as in impact assessments of renewable energy (RE) policy instruments (Y. Li & Su, 2017; Condon & Ignaciuk, 2013). Yet, these two have been researched over and over, thus it is enriching to look more in detail to other impact variables for research on RE policy instruments.

Environment

A second category of impact variables used is the ones concerning the environment, mostly emission-related. The first one, universally used in all research regarding reducing CO_2 emissions, is the total carbon emissions, measured in tons (T), kilotons (KT) or megatons (MT) (K. Zhang et al., 2020). Depending on the research and the case study, these concern the absolute emissions of either countries, regions or the total carbon emissions globally (K. Zhang et al., 2020). Next to these predominantly direct emissions, the "exported emissions" also need to be taken into account when assessing the impact (Banerjee, 2021). These exported emissions come into play when a country does have a carbon restricting policy instrument in place, while still having to pay the border taxes when exporting products to a CBAM-implementing country (Banerjee, 2021).

Mitigation costs

In this third section of variables, the costs related to any mitigation or abatement efforts are included (Y. Li & Su, 2017; Bistline et al., 2020). Four different terms have been proposed by different researchers. The impact for "policy changes" or "policy implementation" for example mean the costs of the actual process of making the changes in policy, or implementing it (Azhgaliyeva et al., 2018). This could include costs for providing subsidies (Azhgaliyeva et al., 2018), however a clear distinction is lacking. Others call it simply the "abatement costs" or "government expenditures on policy measures" - much broader terms - what implies that those subsidy costs are by definition also included (K. Zhang et al., 2020; Y. Li & Su, 2017).

Competitiveness companies

The next category is highly related to one of the main objectives of a CBAM: the competitiveness of the companies. One of the objectives of a CBAM is to level the playing field, which is all about protecting the competitiveness of the emitting companies (Fouré et al., 2016). Naturally, the majority of these companies are in the energy intensive sectors. Despite some of them being fairly economical, they are still highly relevant as a result of their strong ties to CBAM objective.

Starting with the trade rate, which is about the rates in the current situation: those not linked to CBAM (Dong & Walley, 2012; K. Zhang et al., 2020; Condon & Ignaciuk, 2013). Also, the investment rates need to be taken into account, because these need to be carefully monitored when introducing new technology on a large scale, as with new policy instruments (K. Zhang et al., 2020; Shi et al., 2019). The better the rates are, the more projects depend on financial support from governmental bodies: a third variable mentioned in previous literature (Thapar et al., 2016).

Furthermore, market dynamics need to be monitored and taken into account when assessing the impact of a policy instrument. Prices and their elasticity (Banerjee, 2021; Bistline et al., 2020), and the tax share in those products prices alike (Shi et al., 2019). Lastly, the size of the annual demand of the sector and the scoped trading partners needs to be adjusted for (Shi et al., 2019; Marbe & Harvey, 2006).

Politics
One of the major risks of a CBAM is the risk of retaliation of countries being inflicted on, related to the political variables (Fouré et al., 2016). Each country and region will want to protect their citizens and their GDP, by preventing any welfare losses (Bistline et al., 2020). This very practical variable is of vital importance to governments, their re-election depends on it. A variable that is less in sight of a country's inhabitants is the import / export dependency of the country, as well as its companies (Banerjee, 2021). Being a major EU-exporter would mean larger costs and vice versa.

A last set of variables linked to the political dimension is human capital development of the instrument posed on both the implementing country, as well as the country that the mechanism is posed upon (Sodiq et al., 2019). Sodiq et al. also highlight the need for an assessment of social justice, although that might be lower on the agenda of some countries (2019).

Conclusions from the overview of variables
Concluding from the review of variables that help in measuring the impact of a policy instrument, four take-aways can be obtained. First, impact is usually measured through a formula of $impact = risk * chance$, which is a rather abstract definition, considering the fact that it is applicable in any field with any concept. That does not provide a solid and tangible method of measuring the impact in the case of this research. Similarly, in economics the impact is often measured through efficiency and effectiveness, placed under the umbrella of Neo-Classical Economics (Ockwell, 2008). Due to the nature of this research, it is needed to look further than these three straightforward measures of impact. The second insight is to include not only the rather straightforward variable of total absolute tons of emissions of carbon or other GHGs, but also look into more indirect emissions – such as the *exported emissions*. Next, clear distinctions are necessary to be made regarding the variable *cost*. Here, it is rather simple to take variables that are not aligned with the chosen scope of the research. Combining or merging the KPIs of the different studies can fill the need for a better quality impact assessment (Healy et al., 2018) Lastly, many economic variables were found in literature, that all to some extent relate to the competitiveness of (domestic) companies. Again, choosing neither too specific, nor very broad variables is vital for being able to maximise the added value of including the variables. One that deserves extra attention here is monitoring the trends in the market dynamics, as they often indicate the changed dynamics of the trade activities between two countries.

3.2.7. Addressing carbon leakage
Policy instruments that target carbon leakage are a major topic in the energy transition, and so far CBAM is now added to the line of instruments. In this section, options to prevent carbon leakage are discussed, as well as an introduction to the phenomenon, its drivers & factors of influence effects and observations.

Carbon leakage is defined as "an increase in emissions outside a region as a direct result of the policy to cap emissions in this region" (Spassov, 2012, 315). I.e., newly installed PIs in region A cause a reduction in the emissions in region A. However, due to the relocation of the place the carbon is emitted to region B – with no such PI in place – the emissions levels in region B rise with a comparable amount to the reduction in emissions in region A, thus not resulting in a de facto reduction of total emissions of carbon. It can occur in different forms (Spassov, 2012):

- the relocation of the manufacturing facilities.

- carbon intensive companies operating in region A experience a loss of market share relative to the companies in region B.
- the microeconomics of investment decisions in the future could be affected. as well

Carbon leakage is said to be one of the failures of an ETS, although that is hard to solidify (Eicke et al., 2021). Four drivers of the failure can be identified, all internal factors of the ETS: (i) an inadequate cap of the emissions is set, leading to a lack of incentive; (ii) an over-allocation of allowances to the emitters, leading to the same effect; (iii) excessive reserves of new entrants on the CO_2 market also cause a lack of incentives to reduce the emissions, although that often is a timed risk; (iv) an over-reliance on the use of 'offset credits', which is a broader term of emission reduction that can also be achieved by increase the capacity of carbon storage – i.e. planting trees (Spassov, 2012). Burniaux and Martins state it slightly different by listing five 'channels' that generate carbon leakage. Some overlap with the previously mentioned drivers, while others are much more specified for the sectors that are quantitatively researched: oil and coal (Burniaux & Martins, 2012). These five channels are:

- The reallocation of direct investments.
- A fall in the oil price.
- Possible income losses in energy-exporting economies.
- When looking at energy markets: the supply elasticity of coal is the most influential factor on carbon leakages.
- When looking at non-energy markets: the intensity of the carbon leakage – i.e. how quick carbon leakage occurs and emissions are relocated to another region – depends on the extent to which the trade products can be substituted by other products.

These effects can be seen as sub-factors of the aforementioned four internal factors of Spassov, since the five channels are more specific than those four factors and many are a form of price effects as a result from the lack of incentive to innovate.

To prevent carbon leakage from happening, three main options are mentioned in literature. These are exemption from carbon pricing, output based rebating and border carbon adjustments (Lininger, 2015). These three are already explained in more detail in the sections 3.2.2 to 3.2.4. The first, exemption from carbon pricing, has been discussed many times already, with slightly different names that are all based on the same principle. Such exemptions are direct subsidies to producers, and the allocation of free allowances in the EU ETS (Lininger, 2015). Output based rebates can exist in the form of benchmarking and returning paid tax to the producers that produce less emissions than the benchmark and vice versa (Lininger, 2015). The third measure to counter carbon is the one central in this research: a border carbon adjustment – CBAM is as said a version of a border carbon adjustment. In section 3.2.4 this mechanism is further explained already.

A wide range of effects of carbon leakage have been highlighted before, although a few will be discussed here, selected on their relevance to this research. In their research on the actual working of carbon leakage, Takeda, Tetsuya, and Arimura conclude that carbon leakage does take place in that specific scenario, but also that a policy instrument such as CBAM effectively counters carbon leakage from Japan to China (2012). Their research is one of the few examples of actual carbon leakage and an effective counter mechanism found. Additionally, Takeda et al. also conclude that there is no difference in impact between including only direct emissions, or both direct and indirect emissions (2012). A major remark however is that there is no design of a border carbon adjustment that is more effective in every aspect than the other designs. The actual design of the mechanism is essential to determine whether the mechanism prevents carbon leakage or not. On the contrary, Allevi, Oggioni, Riccardi, and Rocco found that in the cement sector, one of the proposed sectors of CBAM, none of the measures mentioned in the previous paragraph are actually effective in preventing carbon leakage (2017). They do not take the insights of the study of Takeda et al. into consideration, potentially causing the non-observation of carbon leakage in the Italian cement sector.

Sectional conclusion

From this first part of the tripartite structure of increasing complexity, many insights can be taken from the theoretical functioning of the discussed PIs. The literature studies on carbon taxation and a cap-and-trade system provide insights in the need for supportive instruments for each of them to be effective, ideally a combination of both instruments supported by sub-instruments like a market stability reserve. Moreover, with both a carbon taxation and a cap-and-trade system some form of flexibility is essential, where the use of an independent regulation authority can provide such flexibility as tested in cap-and-trade systems. The third main insight from both mechanisms is that carbon leakage is theoretically a large risk, but that in practice it is often not observed. The sections on CBAM and other REPIs provided insight in the theoretical types of implications that can be expected from CBAM. To assess that, the different impact variables found in literature as discussed in chapter 3.2.6 could be used. The next section looks into what insights can be derived from literature when looking at implemented systems with existing REPIs, and which challenges emerge.

3.3. Implementation of renewable energy policy instruments

In a benevolent system, what challenges and issues theoretically arise when implementing an instrument such as CBAM? This section tries to answer that question. First, two new theories are analysed, in order to identify emerging policy implications when implementing REPIs. Policy implications from trade flows are first discussed, followed by those from International Relations. This section is finished with the other challenges and issues identified in the literature on the REPIs themselves.

3.3.1. Trade flows

The effects of the implementation of a policy instrument on a specific trade flow is central in this research, thus it is essential to explain what trade flows mean, how they relate to the energy transition and what implications for policy they bring about. In this research, the term *trade flows* relates to the route a material or product travels by being traded, in this case specified to the trade of aluminium (Milovanoff, Posen, & MacLean, 2021). Logically, trade relationships can have a great influence on shaping green energy policies, in both a positive and a negative sense (Carfora, Pansini, & Scandurra, 2021). Mostly because a good trade relationship creates a stable economic climate between the countries, without any unnecessary barriers installed as a result from tensions between countries. This paves the way for companies to compete with each other, accelerating innovation and improving quality standards in the sector (Carfora et al., 2021). Green investment therefore correlates with the exogenous factor that influences it, a factor represented by trade flows (Carfora et al., 2021). The same correlation can be found in the ETS market in the EU, as researched by Balietti, where the volatility of the allowance price has a positive link to the volume of the trading activities (2016). This is a rather straightforward conclusion from both authors – Carfora et al. and Balietti. All economic literature state that stable environments drive up economic growth and vice versa. A very similar conclusion is drawn when looking at a case and testing this theory. When applied to forest based feed stocks, it is found that the GDP of both the importing and the exporting country affect the trade flow between the two countries (Olofsson, Wadsten, & Lundmark, 2018). Although quite evident, it does point at tangible factors to take into account when researching trade flows. Seen in that light, a tangible factor to take into account is that the ratio between the level of production domestically versus the level of 'production' from imports matters, indicating changing trade flows, as seen in the EU aluminium sector (Healy et al., 2018).

For policymaking, the literature on trade flows provides ample possibilities of directions. More specifically, two policy directions are highlighted, when aiming at a more renewable energy based trade flow. First, to promote a more stable economic environment, the price volatility needs to be minimised, which can be achieved by targeting the engagement of all relevant actors in a system (Balietti, 2016). In many systems, a handful of actors is extremely dominant, while other actors are more passive; staying at the sidelines. However, all these actors need to be engaged in the system, in order for a smoother energy transition and thus a more efficient market (Balietti, 2016). Policies targeting this engagement of less dominant actors are therefore needed. Secondly, governments should start favouring materials and minerals that are linked more to renewable energy (T. Li, Wang, Xing, Li, & Zhou, 2019). The Chinese government for example has favoured targeting coal over other minerals that are increasingly important in slowing down the process of reaching the sustainable goals (T. Li et al., 2019). Examples of such minerals are aluminium, gypsum and potash, the raw materials used in many energy-intensive production processes (T. Li et al., 2019).

In addition to that, the analysis of Carfora et al. leads to a set of four policy implications that target taking away the current barriers of investing in renewable energy sources and changing trade flows to do so (2021). Firstly, whereas *feed-in tariffs* (see chapter 3.2.5) are a commonly used policy instrument supporting RES generation policy, it could be even used better by explaining the heterogeneity of RES through differentiation between countries (Carfora et al., 2021). Taxation instruments have a contrasting effect on trade flows however, as the higher the taxation level is, the less likely companies are to invest in green technologies and thus change the trade flows. A third policy implication is that "when an exporting country increases its capacity to generate renewable energy, the effects on its trading partners are all higher than the relative weights of their imports" (Carfora et al., 2021, 8). In other words, increasing the amount of renewable energy generated domestically amplifies the improved competitive position of that country, since even less imports of energy are needed. Fourth and last, which is specified to trading unions such as the EU, intra-EU imports not only enhance economic growth through larger domestic trade flows, but it also provides a channel to share technological skills (Carfora et al., 2021). Sharing these skills greatly helps in further amplifying the positive effect of increasingly more renewable energy on trade flows.

Besides policy implications, the literature also formulates several takeaways for future research. Their propinquity is a method or framework that allows for research of a higher quality. For example, Life Cycle Analysis (LCA) is a commonly used method in research on sustainability, such as making trade flows of particular materials more sustainable. Milovanoff et al. use LCA to analyse a multi-level traded product – such as aluminium – making it better possible to compare the product with other products in different stages of its life cycle (2021). Research that tries to give an overview of the sustainability of different products and how to achieve a more sustainable trade flow of the product could benefit from it, but so far this kind of overviews are lacking (Milovanoff et al., 2021). Another example of a theory that could help in this research is applying the *telecoupling framework* on the field of trade flows and the role geopolitical tensions play in it (Kapsar et al., 2019). Namely, the telecoupling framework is pre-eminently suited for analysing dynamics in a socio-economical system, such as the trade flows of aluminium (J. Liu et al., 2013). With its large distances covered by the trade of aluminium and the sustainability challenges at all levels - local to global - in the sector, and the ever-changing dynamics as a result from geopolitical changes, the telecoupling framework could guide the analysis of the dynamics in this research. However, the limited time available for this research does not allow including the telecoupling framework into the research, and thus it will not further be taken into account.

Three key conclusions that can be derived from the literature on implementation issues on the dynamics of trade flows in benevolent systems, are:

- Policy instruments that destabilise the market have a negative effect on the trade flows of the affected sectors.
- The price volatility needs to be minimised after implementation of the policy instrument in order for a minimised effect on trade flows.
- The use of the telecoupling framework could assist in analysing the dynamics of the case.

3.3.2. Trade creation and diversion

CBAM is a policy instrument in which the (trade) union of the EU is further strengthened and demarcated. Where before CBAM trade in the affected sectors was free of permanent import tariffs, the introduction of CBAM ends that period. The Agreement on the European Economic Area (EEA) - where Norway, Iceland and Liechtenstein join the EU in a trade union, as well as the EU ETS coverage - has extended and strengthened similarly (Sanner, Rotevatn, & Nybø, 2021). When a union is formed, trade creation and trade diversion are two of the effects, as first explained by Viner in 1961 (Viner & Oslington, 2014). Both are opposing effects of the formation or expansion of a trading bloc: *trade creation* leads to more trade between Member States of the trading bloc, *trade diversion* decreases trade activities between those same Member States (Economics Online, 2021). In the former, previous trade barriers between the Member States of the trading bloc are removed, allowing for more specialised activities and the consequent comparative advantages. Prices fall and trade thrives. With trade diversion however, the relatively high cost of trading with bloc members replaces the trade with low-cost non-trading bloc members. Higher prices and less trade are the result. For example, when applied to carbon economics, trade diversion occurs when the tariff rates of emitting carbon are higher than the subsidies in place for exporting carbon-intensive products (W. Zhang et al., 2019). However, when the consumption shifts from high-cost to low-cost producers, the trade expands and thus trade creation occurs (W. Zhang et al., 2019). Important to state as well is that trade creation effects are often asymmetrical and concentrated to certain groups of products, often only a few (Fathelrahman, Davies, & Muhammad, 2021). Taking the concentration and asymmetry into consideration is therefore valuable when designing policy, since not all product sectors will experience the same effects of trade creation - something that is often a positive side effect.

In turn, both trade creation and trade diversion have several effects that are reasonable to take into account when addressing the consequence of a PI such as CBAM. For example, Fathelrahman et al. highlight the elimination of tariffs as a result from both creation and diversion, which in turn could lead to negative welfare effects (2021). While their research focuses on food commodities, the area of study is merely an example and such effects could well be observed in the renewable energy sector as well (Fathelrahman et al., 2021). Trade diversion also causes an amplified effect of raising tariffs in carbon taxes (W. Zhang et al., 2019). In their study on the export structure of China, (W. Zhang et al., 2019) found the causality between trade diversion and the flexibility of carbon tariff rates (2019). At the same time, rising export subsidy rates weakens the effect of trade diversion as well. A third effect of both phenomena is in a situation with Free Trade Agreements (FTAs), such as the one between China and South Korea. However, that effect varies in direction (Yu & Chen, 2017). It could lead to two situations, to either trade creation or trade diversion, but which one depends on the trade rate coefficients of the Member States; the closer they are, the weaker the effect; and vice versa (Yu & Chen, 2017). As a result, emissions are often not reduced when there is trade diversion, because the Member States of the trading bloc often have similar and more stringent environmental policies in place as well (Yu & Chen, 2017). Lastly, in previous research on border measures such as CBAM, Weitzel, Hübler, and Peterson found that low-income countries could gain from trade diversion effects as well, due to their lower salaries and thus higher margins (2012). Correspondingly, their analysis shows that the high-income countries will lose from a trade diversion effect (Weitzel et al., 2012). Therefore, depending on which of the two effects is most likely to happen with CBAM, it can be concluded which type of countries would be in favour or against the implementation of CBAM.

When further relating trade creation and trade diversion to REPIs, several considerations and policy recommendations can be found in literature. First, as mentioned above, the carbon tax rate plays a very dominant role in reducing emissions in China, in relation to other REPIs (W. Zhang et al., 2019). While in other situations, trade diversion could weaken that effect significantly, effectively levelling out the decreased amount of trade with non-bloc Member States. In the case of China and its carbon tax, the carbon tax rate is so dominant that effects like trade diversion and creation are of small influence - possibly even negligible (W. Zhang et al., 2019). W. Zhang et al. also provide three more policy recommendations to take into consideration when forming or expanding a (trade) union (2019). First, it is useful to compare the expected trade losses from forming or expanding a trade union with the gains in trade diversion, as they might level each other out or the consequences could be amplified. In decarbonisation policy, the development of low carbon sectors should thus be supported by the policies. Also, in the case of China carbon tariffs change its energy structure so significantly, while at the same time not reducing the emissions due to shifts in trade amounts – for which the cause can be found in the previously mentioned phenomenon of *carbon leakage*. Third and last, the response of REPIs such as carbon taxes and tariffs should be carefully considered by governments, because of their potential social welfare reductions.

Three key conclusions that can be derived from the literature on implementation issues related to trade creation & diversion in benevolent systems, to add to the expected consequences of CBAM, are:

- With CBAM, a trading bloc is formed and expanded.
- The exact tariff rate of CBAM is going to determine either trade creation or trade diversion.
- The trade rate coefficients between countries determine the strength of CBAM: the larger the difference, the stronger the effect of CBAM, and vice versa.
- When trade diversion is likely to occur after CBAM, low-income countries are more likely to be in favour of CBAM; high-income countries are more likely to be in favour of CBAM when trade creation is more likely to occur after CBAM.

3.3.3. International relations

A third field of research that rises in relevance when looking at the implementation of REPIs is the field of International Relations (IR). Especially when those policy instruments have supranational effects, such as CBAM, IR come into play. In their literature review, Utaminingsih and Cangara also summarise previous research on the environment as a global issue in IR, distinguishing two main views on IR: the classical and the contemporary IR perspective (2020). Whereas the classical view focuses on classical themes such as economics and military alliances, the contemporary perspective also considers environmental issues as one of the major aspects of influence on IR (Utaminingsih & Cangara, 2020). Also, IR can both be a dependent field of study when factors of influence are the focus of the research, as well as a tool for further analysis. The latter applies when its concepts and underlying theories are used to structure case studies on global issues, as conducted by Utaminingsih and Cangara as well (2020). Munir and Purnomo analyse what type of actors are at play in an IR research, concluding that actors of substantial influence are not only nation states, but also sub-states – such as large multi-nationals and some oil super-majors from the start of the 21st century (2019).

Several aspects could be considered more often in research on IR. A highly important aspect in IR is energy security (Proskuryakova, 2021). With the ever-increasing share of RE in the energy mix, the definition of energy security also evolved over time; in the 70s and 80s it referred to a stable supply of cheap oil, while now it refers to the 4A's of energy security - availability, accessibility, affordability and acceptability (Proskuryakova, 2021). Cherp and Jewell rephrased the definition as "low vulnerability of vital energy systems", which mainly focuses on the robustness of the energy supply (2014, 418). Other aspects to be considered are the dependent & independent variables and their categorisation, roughly split between domestic and systemic variables (Chaudoin, Milner, & Pang, 2015). The debate on what type of variables explains international relations best is a long one, with most scholars choosing one of the two. The main distinction between the two is the variation within the system analysed; where domestic variables vary across the system per country and over time - sometimes changing, and if they do, slowly (Chaudoin et al., 2015). Systemic variables on the other hand also vary over time, but do not vary between the countries analysed in the system (Chaudoin et al., 2015). An example of varying domestic variables is highlighted by Vakulchuk et al., stating that the influence of fewer fossil fuels in the energy system on IR used to be not as great as now, while the influence of more and more renewable on IR decrease with a growing share of RE in the energy system (2020).

Next to these aspects to be considered when researching the role of RE in IR, other factors also lack in IR research and should thus be taken into consideration. Kuru advocates an increased usage of the Mediterranean countries as a case, bringing attention to other areas outside the frequently studied one - i.e. the USA, the EU, China and Brazil (2019). Such cases could provide valuable insights to new dynamics in IR, with often a rich history. Moreover, developments in the field of energy research and development are often overlooked in IR research (Proskuryakova, 2021). Two examples pointed out by Proskuryakova are forecasted changes in energy research itself, as well as developments in new technologies - such as improved and cheaper hydrogen technology (2021). Usually the research only mentions the current state of technology, or long-term outlooks, and the dynamics between them are often omitted. Lastly, effects of increased share of RE on IR have been researched quite often, as presented above, but should be taken more thoroughly into consideration in research (Vakulchuk et al., 2020). In their literature review, Vakulchuk et al. present three main effects. First, a shift of energy relations from asymmetric dependencies to more horizontal dependencies, meaning that the field of actors involved is more equally distributed in terms of power over each other and their interdependence on each other increases. Also, a greater diversity of actors is involved in IR, with more sub-state actors besides the more traditional nation states as actors (Munir & Purnomo, 2019). Lastly, the energy alliances moving towards more regional grid communities are less dominant in recent research.

Three key conclusions that can be derived from the literature on the influence of CBAM on IR in benevolent systems, to add to the expected consequences of CBAM, are:

- The influence of policy instruments on energy security should not be underestimated, since energy security issues have the potential to agitate tensions in IR.
- Sub-state actors can also cause sufficient tension for a policy instrument to be less successful or even rejected before implementation.
- The effects of an increased share of RE in the energy mix should be taken more into account, looking at scenarios made by previous studies to better anticipate on the eventual dynamics of the system.

3.3.4. Implementation challenges

With the policy implications from trade flows theory and the theories on IR now being clear, what other challenges arise when looking into the literature on the REPIs themselves? Many types of challenges are identified in literature, of which an overview is provided below. These are challenges related to the:

- Legal compatibility
- High (transaction) costs of implementation
- Possibly discriminating effects
- Reduced competitiveness and distributional outcomes
- Use of revenue
- Performance evaluation
- Changes in ambition during implementation
- Applicability on multiple types of RE
- Acceptance by stakeholders

First, for many PIs the *legal compatibility* is a large issue, although often tackled in the design phase of the PI. However, here the challenge is to align the PI with other levels of law (Rocco et al., 2020; Apolonia, Fofack-Garcia, Noble, Hodges, & Fonseca, 2021). Rocco et al. argue that often the WTO Law compatibility is dubious (2020), or the transposition from EU law to national law causes implementation issues for the individual Member States (Apolonia et al., 2021). Issues regarding the WTO Law compatibility of CBAM have already been identified by many of the foreign countries affected, as explained in 1.1.2. A second challenge are the *implementation costs*, including enforcement (see chapter 3.4.2) and transaction costs (Rocco et al., 2020; Lee & Yik, 2004; Apolonia et al., 2021). These costs can arise at private levels, as well as at an institutional level (Lee & Yik, 2004). Costs at a private level are costs associated to companies having to pay tariffs that are extra high due to the increased implementation costs, while costs at an institutional level could comprise the installation of enforcement institutions, as well as transaction costs associated with all the accumulated tasks needed to comply with the new PI (Rocco et al., 2020; Apolonia et al., 2021). Rocco et al. also identified the potential of the new PI *being discriminating* towards any actor involved, for example by putting imported products originated from third countries at a significant disadvantage when the PI is installed by a supranational organisation such as the EU (2020). Moreover, the new PI can also lead to *unexpected reduced competitiveness*, or undesirable distributional outcomes (Peñasco, Anadón, & Verdolini, 2021). While larger companies and Multi-National Enterprises (MNE) could still be protected or have sufficient resources to cope with the change, the negative distributional outcomes of the PI could have a large impact on small and medium enterprises (SME). In 2001, Elkins and Baker identified potential implementation issues regarding the *use of the revenues* of the PI. Especially for a carbon tax that argument preserves, while the proposed CBAM also generates revenues that can be spent. Usually in PIs regarding the energy transition, the use of revenue is meant for reuse in the same or a similar sector, to ensure the previously mentioned double effect (Elkins & Baker, 2001; Lai & Shi, 2020).

A sixth challenge identified is *what method to use to assess and evaluate the performance* of the PI once it is implemented (Shi & Lai, 2013). Regularly, the methods used are precisely tailored to the specific PI, even for the exact system it is operational in. Thus, policymakers need to design new methods, or alter an existing one (Lee & Yik, 2004). CBAM being a PI with hardly any close precedent will most likely take the issue into account. Also, *policymakers do not always remain consistent* in their ambitions after implementation of the PI, in comparison to the ambitions when designing the PI (Peñasco et al., 2021). Changed policy ambitions during implementation can remarkably alter the course of the PI once implemented. The eighth issue that could emerge during implementation is the *applicability of the PI* to all types of RE technology, ranging from solar and wind to geothermal and hydrogen (Lai & Shi, 2020). Often being tailored to one or few of the types of RE technology, a trade-off needs to be made during design and implementation of the PI between specificity or general applicability, since the two do not go hand-in-hand. Last but not least, Kammermann and Ingold identify the challenge of stakeholder acceptance (2018). Depending on the exact situation and context, all stakeholders need to accept the new PI, at least to some extent. If not, a smooth and successful implementation is at stake.

In the same base of literature, possible strategies for tackling these issues and challenges can be found, to ensure a smooth and successful implementation as desired by many. A first strategy is *benchmarking*, aimed at tackling the challenge of the evaluation of performance (Lee & Yik, 2004). Benchmarking is the act of defining a threshold value as the benchmark, and consequently "measuring and comparing performance against the benchmark" (Lee & Yik, 2004, 493). Lee and Yik continue by clarifying when a PI or mix of PIs is well-articulated, namely when "the benchmarks in the individual instruments are well-coordinated (2004). Secondly, *a set of evaluation criteria* can help in evaluating the performance of the PI as well (Lago et al., 2015). It is slightly different to benchmarking, due to its more gradual evaluation; with benchmarking you either reach the benchmark or not, making it quite black-and-white. Such a set of evaluation criteria allows for more nuances in the evaluation. A last strategy that is aimed at evaluating the performance of a PI is *defining a set of preconditions needed before implementation*, although it is also suited for tackling other challenges such as the legal compatibility and the potential discrimination (Lago et al., 2015). Defining such a set allows the designers of the PI for a structured preparation, while it is at the same time a very transparent method of designing and preparing a PI. Lastly, Rocco et al. introduce a new method of measuring, namely *Consumption* Based Accounting instead of *Production* Based Accounting - the dominant method (2020). As the name indicates already, the main difference is whether you starting accounting, at either the production or the consumption side. For emissions of cars, that production based accounting means at either the petrochemical companies such as Shell and Total, while with consumption based accounting the emissions are measured at the cars themselves (Rocco et al., 2020).

Four key conclusions that can be derived from implementation issues based on empirical evidence of implemented policy instruments, to add to the expected consequences of CBAM, are:

- Legal compatibility is vital in all the researched policy instruments and always an issue that can be

overcome.
- Implementation costs, including enforcement and transaction costs, should be taken into account.
- Potential discrimination between countries or types of companies should be ruled out. SMEs should not be overlooked.
- Performance evaluation methods are to be chosen before implementation and the PI should be designed accordingly, several options are possible, as well as a more tailor-made method.

Sectional conclusions

From the second part of the tripartite structure, issues and challenges are emerging when implementing a REPI, thus more expectations can be derived. Concluding, the first of three main ones is the price volatilities that destabilise the market and investment climate, which have negative effects on trade flows. Also, many of the factors related to International Relations should not be overlooked and underestimated, such as tensions as a result from decreased energy security and an increasing share of RE. Lastly, it is best to take the implementation issues into account when designing a PI as drastic as CBAM; legal compatibility, costs and the performance evaluation methods are the main ones, accompanied by other issues.

3.4. Applying a renewable energy policy instrument

Further issues that arise when applying a renewable energy policy instrument to a case are discussed in this third section of the tripartite structure, as explained in paragraph 2.3. First, complications from the geopolitical tensions will be discussed by looking into what geopolitics is and what challenges and issues arise with it. Then, strategic behaviour from actors will be discussed along the complications caused by it, followed by an analysis of the types of enforcement instruments that could enforce the correct succession of a REPI is discussed.

3.4.1. Geopolitics

This research focuses on the economic and geopolitical impacts of REPIs, in line with the knowledge gap as stated in paragraph 1.2. Therefore, after the fields of international relations and economic theories behind REPIs, the geopolitics of both energy and renewable energy will be discussed in this section, as well the major challenges, issues and scenarios. That leads to several insights to take into account when assessing the impact of the implementation of a PI, to better know what to expect after implementation.

While the field of geopolitics has currently extensively been studied, a short introduction will still be given for the sake of completeness. Geopolitics in this research relates to the same concept Dodds delineates in his book, as a way of looking at the world, considering aspects of political power, geography and cultural diversity (2007). It is such a comprehensive term that a definition would not suffice for the majority of the people, but Dodds highlighted two distinct understandings. Firstly, the term is used as a language that enables the user to describe the global landscape, often by using geographical locations and metaphors (Dodds, 2007). Additionally, the more academic way entails how the assigned labels “generate particular understandings of places, communities and accompanying identities” (Dodds, 2007, 234). In this research, the second understanding of geopolitics is used, considering the academic objective of this research and the objective of understanding the geopolitical consequences of implementation of CBAM. However, a further review of geopolitics is irrelevant here, since only energy related geopolitics is of importance for this research.

Geopolitics of energy The geopolitics of energy relates to the geopolitical risks and issues as a result from the energy sector and its trade flows (Gupta, Gozgor, Kaya, & Demir, 2018). In the past, the petroleum sector was the uppermost driver of geopolitical tensions between countries, of which the Gulf War in the early ’90s is an excellent example of an escalated conflict as a result from energy geopolitics (IRENA, 2019). More recently, the project *Nord Stream II* have caused tensions between the EU and Russia, as well as between them and the USA (Economist, 2021). In order to understand the positioning of countries in these type of matters, a proper interpretation is needed, which can be achieved by understanding the control of geographical spaces with important energy resources such as oil and gas (Mousinho, Torres, de Melo, & Janardhanan, 2017). Despite the ongoing transition to renewable energy, the lessons learnt from these geopolitical tensions and conflicts can provide valuable insights for the potential geopolitical tensions when renewable energy sources are dominant over fossil fuels (Harunoğulları, 2017). Nonetheless, the geopolitics of *renewable* energy will most likely lead to different countries being the major energy producers, if any at all (Scholten et al., 2020).

Geopolitics of renewable energy Many researchers and experts have been highlighting the importance of a proper understanding of the geopolitics of renewable energy (Mousinho et al., 2017; Overland, Bazilian, Ilimbek Uulu, Vakulchuk, & Westphal, 2019; Vakulchuk et al., 2020). Since the energy transition from fossil fuels to renewable energy inherently means that the power of current fossil fuel exporting countries will decrease, geopolitical powers will shift (IRENA, 2019; Scholten, 2018; Scholten et al., 2020). This leads to the large former fossil fuel producing countries being the ’losers’ of the energy transition, as their geopolitical power decreases with the reduced production of fossil fuels (Scholten, 2018). However, many of those countries also have ample opportunity to become a ’prosumer’ country’, by starting to provide in their energy needs via the produced renewable energy in their country, of which the type of renewable energy source depends on the natural and geographical features in the country (Scholten & Bosman, 2016). For example, Algeria currently is one of the largest hydrocarbon producers, where oil and gas comprise 90% of all exports annually (Hochberg, 2020). Having over 3000 hours of sun yearly the potential of solar power becoming the main energy source for the country is evident, acknowledged by the government, researchers and institutions (Hochberg, 2020; Vakulchuk et al., 2020; IRENA, 2019).

A second major change that is likely to unfold with an increasing share of renewable energy in energy production around the world is enhanced electrification in the whole energy sector (Dupont & Oberthür, 2015). Such electrification presumably causes a shift to more “local” energy systems due to the fact that electricity is not an energy carrier that is easily transported over large distances, in contrast to oil, natural gas and hydrogen (Dupont & Oberthür, 2015; Scholten, 2018). In turn, this could lead to decreased geopolitical tensions between countries, due to more locally produced energy and amplified collaboration between neighbouring countries (Sattich et al., 2021). Still, these developments come with a significant amount of uncertainty and depend on many factors and drivers, as highlighted by Dupont et al. (2015).

3.4.1.1. Scenarios

Several scenarios have been drawn, both from the two developments outlined above, and from different and more specific variables. Scholten and Bosman were one of the firsts to do so in their thought experiment, depicting a system with only renewable energy and fossil fuels being completely pushed down (2016). The authors highlight two distinctive scenarios: one focused on a centralised system – the "Continental" scenario – where importing energy from other countries is still dominant over utilising domestic energy sources; the other – the "National" scenario – entails the decentralised of each country producing as much energy as possible domestically. Whereas the *prosumer* countries prevail in the *National scenario* and geopolitical tensions mostly come from the trade of the technology needed for domestic renewable energy production, the *Continental scenario* retains a similar geopolitical game as the current, fossil-fuel-based landscape (Scholten & Bosman, 2016). Afterwards, several researchers have made use of this distinction (Scholten, 2018; Scholten et al., 2020; Vakulchuk et al., 2020), or come up with different ones, although all gave the scenarios various labels depending on the specific characteristic of the respective scenarios.

In general, four scenarios have been constructed, each containing elements of the developments and two scenarios as described above. The first scenario is the *Big Green Deal*, entailing and assuming full cooperation between all countries, leading to a "wave of green globalisation" in light with the Sustainable Development Goals (SDGs) (Goldthau & Westphal, 2019, 30). Geopolitical frictions would hardly be present due to compensation for former petro-states. Investment in all types of green technology would enable production from many types of renewable energy, meaning that the electrification is applied where possible, as is energy storage via hydrogen (Goldthau & Westphal, 2019). This scenario sounds like the most win-win scenario for both climate and security, although this appears to be an ideal scenario with all parties and countries are on the same page regarding the urgency of the problem.

Secondly is the *Technology Breakthrough* scenario, a scenario that would mean a more fractured world, leaving the world in two camps (Goldthau & Westphal, 2019). The most innovative and largest technology producers would be the leaders, with other countries strengthening their ties with one of those leaders; two blocs are the result, aiming at becoming the leading bloc in control of the materials needed. Evidently, political tensions rise, even more so because some former fossil fuel producing countries fail to adapt at a sufficient speed.

The third scenario, called *Dirty Nationalism*, is centred around a more fractured world with many nationalistic governments that focus primarily on self-sufficiency with corresponding policy instruments such as premiums and import tariffs (Bazilian, Bradshaw, Goldthau, & Westphal, 2019). As with the second scenario, (geo)political tensions rise due to high prices, drought & water scarcity and conflicts over shared resources. Indisputably, the consequences of this scenario for the global decrease in GHG emissions would be disastrous, forcing the world into a situation with an increase of over 2 degrees Celsius compared to 1990 levels. It has the potential to be worse than the next scenario.

Namely, the *Muddling on* scenario; where business as usual is resulting in a mix of separate energy clubs hardly cooperating (Bazilian et al., 2019; Goldthau & Westphal, 2019). Those different energy clubs pursue diverse strategies; whereas some are more concerned with climate change, others are still improving the quality of life of their citizens, and some may even keep themselves on the sidelines.

3.4.1.2. Issues and challenges in the future

Researchers and energy organisations from around the world have highlighted issues around the uncertainties in these scenarios. The first issue is that oil exporting countries might lose their power in the global market with a decreasing share of fossil fuel in the energy mix of countries, also found in the muddling on scenario (Bazilian et al., 2019). Correspondingly, former petro-dominated organisations such as OPEC (Organisation of Petroleum Exporting Countries) could lose power as well, potentially resulting in growing uncertainty (Goldthau & Westphal, 2019). Some main challenges in addressing these geopolitical uncertainties have been summarised by Goldthau and Westphal as well, highlighting the need for three main aspects

(2019). First, the need for multilateral agreements between countries. Aligning these different countries to one common goal is expected to be highly ambitious, due to geographical & political differences. Closely related to it is the second need, the need for extensive cooperation between the industry and policymakers. There is much to gain from both a technological and a legal perspective, with subsidies and rebates driving technological innovation, and the maturity of those innovations driving the rationale for spending those large budgets of promising technology. Moreover, legal instruments about those same innovations often lag behind the pace of the innovations themselves due to the extensive preparation needed to pass the legal instruments. Thirdly, there is the need for generous funding for the technology development, large-scale implementation and the transitions of industry leaders. Evidently, that is also closely related to the second need. On top of that, Sattich et al. highlight the need for market access for trading and investment. The more actors that are able to participate in trading and investing, the larger the opportunities are for both promising and matured technologies are for a large scale diffusion of the technology, and consequent increase of the decarbonisation rate.

Concluding, geopolitics of the energy transition will always be amidst vast uncertainties, due to the large number of factors affecting it. However, Vakulchuk et al. conclude in their literature review that there are several scenarios possible, with three main points of uncertainty in each scenario. In the first place, the use of (critical) materials is expected to be an influential source of tension, both in from a security and geopolitical perspective (Vakulchuk et al., 2020). Similarly, cybersecurity risks are exacerbated with an increased share of renewable energy production in the energy mix in countries, due to the increased dependency on digitisation for balancing activities and netting arrangements. Secondly, the role of (former) hydrocarbon exporters is substantially important for geopolitical tensions around the world (Vakulchuk et al., 2020). If they are able to rapidly change from a hydrocarbon exporter to renewable energy exporters, tensions will be relatively evaded, and vice versa (Goldthau & Westphal, 2019; Scholten, 2018; Van de Graaf et al., 2020). Thirdly, the degree of multilateral cooperation determines the pace of the transition (Vakulchuk et al., 2020). When countries cooperate – with each other and with the industry – towards a rapid transition with a lot of attention to the decarbonisation efforts, especially in developing countries as well, that rapid transition can be achieved. However, a more nationalistic approach, focusing on self-sufficiency, could lead to a more fractured world with countries and companies even fighting over who provides the last volumes of fossil fuels, diverting the attention away from a rapid transition (Bazilian et al., 2019; Scholten, 2018). Generally, the energy transition towards more renewable energy certainly can reduce geopolitical tensions, apart from potential conflicts over the use of critical materials. Winners of the transition are unclear, while chances are high that former fossil fuel exports will become the losers. Therefore, they need to be taken on board of the transition, to prevent the *Dirty Nationalism* scenario. Ultimately, energy relations need to shift away from existing energy alliances to more regional grid communities, with a greater diversity of actors involved. To achieve that, more empirical research is needed on the exact effects of the transition, to move past forecasts and provide a coherent picture combining conflicting perspectives and be able to install suitable regulation.

3.4.2. Enforcement

As with all policy instruments, CBAM needs to be enforced after being implemented. Therefore, the enforcement of (RE) policy instruments is part of this literature study, after sections on geopolitics of the energy transition, REPIs and impact assessments. One of the major risks of a successful implementation of CBAM is the phenomenon of 'resource shuffling' in affected countries or regions (Caron, Rausch, & Winchester, 2015; Hogan, 2017; Pauer, 2018). This relates to the countries and companies changing the source of energy of the carbon emitting production facilities to a renewable source, but just administratively (Pauer, 2018). For example, a government would change the source of energy of the steel production facilities to hydro, sun or wind, while in other industries that are not affected by CBAM the source of energy would change from renewable energy to fossil fuels. In the end, no emission reduction would be achieved, but the country as a whole would not pay any of the tariffs of CBAM. This and the other risks will need to be addressed in CBAM as well to correctly implement it.

The importance of taking the enforcement strategies and instruments into account when designing a new policy instrument is proven by both successful and unsuccessful examples. Lord, Noye, Ure, Tennant, and Fisk summarise the importance by stating that a higher quality of commissioning and regulation – i.e., policy instruments – leads to more enforceable regulations, supported by their comparative case study of the jurisdictions of both California and England (2016). Some crucial elements in achieving a higher quality are focusing more on the output, instead of the input (Lord et al., 2016). Also, more training and clarity of the agents and the process can improve the quality greatly (Lord et al., 2016). In addition to that, the planning of the implementation of the REPI should be as specific as possible, but no matter how specific or broad the policymakers explain the proposed implementation of the REPI, it will always be different from the actual implementation (Zhao & Pendlebury, 2014). Their study proves even that such as specific plan of the implementation phase – which normally leads to a higher quality of REPI – can also evolve into an institutional barrier, at least in the sustainable transport sector, as they researched (Zhao & Pendlebury, 2014). Obviously that does not mean that that specific contradiction can directly be copied to the RE sector, but it does provide insight in the size of the challenge of designing an effective and high-quality enforcement instrument.

There are quite some variations of enforcement instruments, but they basically boil down to three major ones. Most intuitively, fining is an effective tool for enforcing the REPI, shown by Bekchanov, Mondal, de Alwis, and Mirzabaev (2019). Compston and Bailey come to a similar conclusion in their comparison of six REPIs implemented by the then six largest total emitting countries of the world (2014). Cutting the existing subsidies is the second type of enforcement instruments (Wachtmeister, 2013; Bekchanov et al., 2019). That is mostly done on the subsidies for fossil fuels and electricity, to include the carbon emissions more directly into the price. At the same time, the RE sources the REPI tries to promote become more attractive with more competitive prices. As explained in chapter 1.1.2 part of the introduction of CBAM is to reduce the amount of free allocations for the industry over time, which is a version of this cutting subsidies type of enforcement instrument (Talebian et al., 2021). Thirdly, increasing fees is another major type of enforcement instrument. For access, for providing the service of the enforcement company or for registration (Bekchanov et al., 2019; Zhao & Pendlebury, 2014; Lord et al., 2016). It is however a more indirect instrument, usually applied to some other product and not the carbon emitting product itself. Still, it does provide an extra means to enforce the REPI.

To get from the regulatory potential to a well-performing instrument in practice, Schüle et al. pointed out a set of preconditions needed to be working in synergy to ensure the effectivity of the regulation (2011). These four are, rephrased by Enker and Morrison: "sound performance processes and strong compliance mechanisms; supportive political strategy; use of both financial incentives and information provision in parallel; stringent energy performance requirements" (2020, 799). Enker and Morrison took these preconditions and used them to come up with a four-stage idealised process to set up an enforcement instrument, which address five identified gaps in that same process (2020). That idealised process is as follows, specified for an energy-efficiency-construction enforcement process:

1. **Identify the shortcomings in performance assessment methodologies.** These typically follow from the misuse of software, their dishonest interpretation and inherent flaws in that same software.
2. **Sticking to the original responsibilities and documentations during the construction of the instrument.** Often, policy administrators diverge from the original responsibilities, because of a reliance on the professionalism of enforcement entities.
3. **Substitute product of inferior quality with higher quality products, preventing construction errors.** The quality again often depends on the professionalism of stakeholders in individual projects.
4. **Rule out any inconsistencies between performance outcomes and ex ante assumptions.** Regularly, rebound and pre-bound effects occur due to those inconsistencies, for example due to the absence of an effective validation of the effects. A missed opportunity of valuable evidence for the effectiveness of policy interventions is the result.

These idealised stages give policymakers a set of starting points and common mistakes to build upon. Such integrated processes are also identified as helping to enhance the enforcement capacity, increasing the quality and effectiveness of the enforcement as well, usually via integrated and complementary policy instruments (Zhao & Pendlebury, 2014). Lastly, there is a constant (political) consideration between building a flexible – to increase its scope – versus a specific enforcement instrument (Lord et al., 2016; Wachtmeister, 2013). Literature is here less single-minded, with Lord et al. arguing for ex ante specificity improving the quality of the enforcement regulations (2016), while Wachtmeister focuses more on the needed flexibility of the regulation, ex ante (2013). It is up to policymakers to consider these options and nuances.

3.5. List of expectations from literature

From this chapter as a whole, the following list of expectations for CBAM and its impact can be constructed. They serve as a starting point for the next parts of the research, to be reflected on during the case study. After each expectation, the most important studies that led to the particular expectation are added.

1. Some form of retaliation of the foreign countries will occur. Be it countered tariff installation, market access denial for EU companies (W. Zhang et al., 2019; Eicke et al., 2021).
2. CBAM and ETS amplify each other in their effectiveness (interviews, (Marcu et al., 2020; Eicke et al., 2021; de Perthuis & Trotignon, 2014).
3. When CBAM is only applied on imports, models on anti-leakage policies suggest that the consumption of domestic goods grows and imports decrease (Eicke et al., 2021).
4. When looking at the possible impacts for different country groups and major trading partners, most policy design options would have a negative impact on developing country exports and economic welfare (Eicke et al., 2021).
5. The risk of carbon leakage is often overestimated and in practice has not been observed greatly (Allevi et al., 2017; Eicke et al., 2021).
6. Price volatility in the EU ETS and the CBAM sectors destabilise the market and its investment climate (Carfora et al., 2021).
7. Enforcement of a PI like CBAM is hindered when CBAM is not very flexible (Lord et al., 2016; Enker & Morrison, 2020).
8. Overall, RES are expected to democratise domestic politics and international relations, stabilising them in the process (Vakulchuk et al., 2020).

3.6. Operationalised questions

The conclusions from the sections in this chapter lead to a set of operationalised questions, which in turn can be used as starting points for the rest of the research. These questions allow splitting the sub-questions from chapter 1.3 into manageable elements and to structure the case. The expectations from literature are used as further input for the case analysis in chapter 4 and 5.

1. What is the Carbon Border Adjustment Mechanism?
2. How is CBAM implemented, and what is its scope?
3. What variables for assessing the impact of a renewable energy policy instrument can be best used to measure the impact of CBAM?
4. What factors drive the need for CBAM?
5. What is the history and current state of the aluminium trade between Germany and China?
6. What role does renewable energy have in the production of aluminium in both Germany and China, as well as in the transport of aluminium?
7. How can the geopolitical relationship between Germany and China be defined?
8. How can the economic relationship between Germany and China be defined?
9. What is the decarbonisation rate in Germany and China?
10. What do policy documents say about the role of CBAM in the energy transition?
11. How have non-EU countries to date reacted to the announcements of CBAM?
12. To what extent have businesses announced plans of coping with CBAM, and what are those plans?
13. Which issues and challenges from literature have been highlighted in the announcements of CBAM?
14. What issues and challenges from literature are already taken care of in the proposed version of CBAM?
15. How are experts looking at the expectations of CBAM in literature?
16. What role does strategic behaviour of Member States play in the geopolitical environment around CBAM?
17. What risks are most dominant in the design of CBAM?
18. What countries play an important role in the design of CBAM? What non-EU countries are of significant influence?

4

Case study

This chapter presents an in-depth analysis of the case in this research. As shortly explained in chapter 1 and 2 this research entails an illustrative case study of the dynamics between Germany and China, specifically looking at the aluminium trade flow. Therefore, this chapter first dives into CBAM once again to presents an overview of the current state, its timeline so far and the future challenges before its implementation in 2023. Then, we'll discuss the current geopolitical and economic relations between Germany and China, as well as the aluminium sector itself. This includes an analysis of the factors of influence in the system, as well as the value chain of aluminium.

The knowledge gap is formulated in chapter 1.2 as follows:

There is a lack of empirical basis on the influence of a new renewable energy policy instrument on the dynamics between a domestic and a foreign country, seen from the perspective of geopolitics & economics.

Doing the case study will provide more information on what can be expected from a new REPI, that is yet to be implemented. This is specified for a particular interaction between actors; namely the domestic and the foreign country. That interaction leads to dynamics between the countries, both related to decarbonisation efforts via installing policy instruments and to countering measures. As argued for as well in chapter 4.2, the trade between Germany and China is particularly influenced.

4.1. Carbon Border Adjustment Mechanism

4.1.1. Timeline

On December 11, 2019, with the publication of the Green Deal of the EU, the CBAM was publicly mentioned and proposed for the first time. It was published amongst other key actions such as a 'Circular Economy Action Plan', a 'Farm to Fork' strategy and the 'European Climate Pact' (European Commission, 2019). The CBAM was proposed as a REPI complementary to the EU ETS (Ireland, 2021). Initially, the CBAM should cover a narrow list of sectors, more specifically the power and energy-intensive industrial sectors (Dybka et al., 2021). These include cement, metals, chemicals, pulp & paper, fertilisers and refined petroleum products (Dybka et al., 2021).

In July 2021, the next step in the development of the CBAM was taken, the updated proposal was part of the "*Fit for 55*" report. Here, the scope of the CBAM as proposed by the European Commission has been defined. It covers indeed a narrow list of sectors, namely cement, iron & steel, aluminium, fertilizers and electricity; thus leaving out the petroleum and pulp & paper sectors (Killick et al., 2021; European Commission, 2021b). Also, only direct emission are covered. Since then, the negotiation process of the European Parliament, European Commission, the European Council and its trading partners has started, as well as further consultations with the World Trade Organisation (WTO) to ensure no violations of WTO Law (Ireland, 2021). This is expected to take at maximum until the CBAM comes into force in January 2023.

In the meantime, taking the far-reaching consequences for many sectors and trading partners into account, the European Commission decided to organise feedback sessions with many of those sectors and trading partners, allowing them to influence the implementation of the mechanism (Dybka et al., 2021). These consultations were held over the course of July until October 2020. The included trading partners that were consulted are: India, Japan, Mexico, South-Korea, Russia, South Africa, Ukraine and the US (Dybka et al., 2021). Also, different types of organisations have participated, roughly categorised in three categories (Marcu et al., 2020). One major trading partner is however missing: China. It is yet unclear why the Chinese government has not been consulted.

The first category of organisations is think tanks, academia and environmental organisations (Marcu et al., 2020). In general, they were quite enthusiastic about an implementation of the CBAM, although a minority of them were more nuanced concerning the motives for implementing the CBAM. Secondly, governments and governmental bodies, for example of the mentioned countries (Marcu et al., 2020). It makes sense that the second category of participants of the feedback sessions were more opposed to the regulation, since the position of companies in their countries will likely deteriorate. Third are businesses (Marcu et al., 2020). They had a *wait and see strategy*, since their new position heavily depends on the exact execution of the mechanisms, varying per sector and the degree of trade with partners from outside the EU.

After the feedback sessions, the EC has been outreaching its activities around the CBAM, by involving the different related Directive-Generals (DGs) and EU delegations of the European External Action Service (EEAS) (Ireland, 2021). As with previous attempts of implementing a CBAM, the involved DGs are the designing DG TAXUD, together with the DG CLIMA and the DG TRADE. This period ended with an EC Conference and plenary sitting specifically on the CBAM on February 15, 2021 (Jadot et al., 2021). Among its conclusions was a summary of the objectives and criteria to be met in order to meet those objectives.

4.1.2. Affected sectors

The affected sectors of CBAM are, as proposed in the 'Fit for 55' report in July 2021: Iron & Steel; Cement; Fertilizers; Aluminium; Electricity (European Commission, 2021c). This section will shortly address each of these sectors, highlighting some key figures and players in the sector, as well as a brief explanation of the expected impact as explained by the EC and the sectors themselves.

Iron & Steel

The Iron & Steel is the largest sector of the ones affected by CBAM. In terms of dollars, on average 35.9 billion USD of Iron & Steel was imported into the EU27 annually over the period 2015-2019 (Kardish, Mäder, Hellmich, & Hall, 2021). In tonnes, this means an amount of 25.3 million tonnes of finished steel products being imported into the EU in 2019, while the total exports of the EU are estimated at roughly 20 tonnes of finished steel products, making the EU a net importer of steel (EuroFer, 2021). Russia and China both were responsible for a large share of the exports into the EU, with 14.6% and 14.3% respectively (Kardish, Mäder, et al., 2021). Other exporters include Brazil, the USA, Switzerland, Turkey and Ukraine, among many other countries that export much smaller volumes. These exporting countries have each a unique situation depending on both the volume of the exports as well as the share of the EU exports in their total exports. Ukraine for example, has a much larger dependency on the EU as destination of steel exports, compared to Russia and China (Andrii Tarasenko, 2021). The impact of the CBAM would be therefore much larger for Ukraine than for Russia and China, when just focusing on steel. The result of the ongoing negotiations determine the extent of the impact, leading to indicative carbon prices for a ton of steel. A vital element in the negotiations is whether the free allocations are still being allocated and until when (European Commission, 2021c; Andrii Tarasenko, 2021). On the one hand, when allocating the free allocations are continued the CBAM fee has an indicative price of 30 euros per ton; at the other end of the spectrum, that the allocations will be phased out when CBAM goes into effect in 2026 the CBAM import fee would be 100 euros per ton of steel (Andrii Tarasenko, 2021). The actual effect is most likely to be in between these two ends of the spectrum. However, prices of the CBAM are not at all certain, thus can be higher as well, or lower – as happened with the EU ETS for a long period of time.

Cement

The cement sector is the smallest of the affected sectors in terms of worth of the traded goods (Kardish, Mäder, et al., 2021). With a total imported cement volume of 270 tonnes per year, approximately, it is roughly a factor 10 smaller than the iron & steel sector (Kardish, Mäder, et al., 2021). That is equivalent to 268.9 million USD annually. Major exporters to the EU are Turkey, Colombia and Vietnam with a share of the total exports to the EU of 29.6%, 9.4% and 6.1% respectively, again an annual average of 2015-2019 (Kardish, Mäder, et al., 2021). Consequently, the impact of CBAM is expected to be the largest for the cement sector in Turkey, due to its large dependency on the EU as a destination of export and the large size relative to other exporters. This is acknowledged by both the EU in its most recent CBAM impact assessment, as well as by the Turkish cement sector (European Commission, 2021c; William Fleeson, 2021). In absolute numbers, the CBAM will therefore have less of an effect. Because the sector is relatively less affected, the cement sector will not further be addressed in this research.

Fertilizers
The third affected sector as proposed in the 'Fit for 55' report is the fertilizer sector (European Commission, 2021c). Usually the term fertilizers refers to the three elements of nitrogen, phosphate and potassium (Dybka et al., 2021). The exports into the EU accounts for a total of roughly 5 billion USD, of which a third comes from Russia (Kardish, Mäder, et al., 2021). Other major exporters are Algeria, Egypt and Morocco. The worldwide sector has a huge focus on the EU, since almost 80% of the traded fertilizers have a country in the EU as destination (Dybka et al., 2021). Consequently, the sector is expected to be strongly affected by CBAM, which is even further amplified by the fact that all the above-mentioned countries – the four largest exporters to the EU – do not have carbon pricing installed (Dybka et al., 2021). Both the sector and the EU are aware of the fact that most emissions are direct, making it relatively simple and straightforward to decarbonise: hydrogen and CCS are the two most promising innovations to quickly decarbonise the sector (European Commission, 2021c).

Electricity
The fourth sector is an outsider in the group of affected sectors, since it is an energy carrier and not a physical product traded. Because its transport is limited, due to the maximal length feasible of a cable, and the limited possibilities of storage, the biggest exporters of electricity into the EU are its closest neighbours as well (European Commission, 2021c). These include Norway, the UK, Switzerland and Serbia, amongst the other European countries that are not part of the EU27. With a total of 4 billion USD worth of exports into the EU, it is a rather small sector, comparable to cement and fertilizers (Kardish, Mäder, et al., 2021). Most of these countries affected have trade agreements with the EU, have carbon pricing installed, or even linked their carbon pricing to the EU ETS. That way, the CBAM has a relatively smaller effect on the sector. Nevertheless, it is still being included into the CBAM, because of the increasing electrification of the energy market in the EU (European Commission, 2021c).

Aluminium
Because the aluminium sector will be explained into more detail in the rest of this chapter, as it is included into the case.

Table 4.1 shows an overview table the information from this is summarised, with the respective market sizes per CBAM sector, with the largest exporters and their market share of imports to the EU as well.

Table 4.1: Overview of market sizes and largest exporters per CBAM sector.

Sector	Market size (USD)	Largest exporters (% market share)
Iron & Steel	35.9 billion	Russia (14.6%) China (14.3%)
Aluminium	19.3 billion	Norway (17.7%) Russia (17.6%) China (6.6%)
Cement	268.9 million	Turkey (29.6%) Colombia (9.4%) Vietnam (6.1%)
Fertilizers	5 billion	Russia (33.1%) Algeria (11.2%) Egypt (8.9%)
Electricity	4 billion	Other Europe, non-EU (20.3%) Norway (16.6%) Switzerland (14.9%)

4.1.3. Design elements of CBAM to be negotiated

The proposal of CBAM of the EC was finalised in July 2021, the European Parliament and the Council of the European Union (the Council) have the opportunity to help make amendments to the eventual design of the CBAM. The following elements of design are still negotiated on (European Commission, 2021f):

- The six options of design of the CBAM. These are explained below after this list.
- The pace of the phase out of the free allocations of the CBAM sectors. The proposal is a start of the phase out in 2025, with a reduction of 10% of the free allocations each year.
- The length of the pilot phase and the corresponding starting dates.
- The sectors affected, the ones proposed now, are listed above.
- The type of emissions: scope 1, scope 2 and scope 3.
- Measures to ensure an effective and efficient enforcement.
- Other measures to mitigate the risks as identified in chapter 3.2.4.

The six options of design of the CBAM, as proposed by the EC, are highlighted as follows (European Commission, 2021f):

1. **An import tax**
   The tax is collected at the border of the EU by the customs, at a price related to the carbon price in the EU. Products would have a default carbon content and relating price to it. Companies can prove their carbon footprint and whether they already paid a carbon price elsewhere, and the level of the tax can be adjusted accordingly.
2. **A certificate system for carbon content**
   Similar to the EU ETS, a new market of certificates could be installed for the carbon content of products imported into the EU, linked to the price of the allocations at the EU ETS. Carbon content of products would again be based on default values per product, and importers would also have the opportunity to prove a lower content and an already paid carbon price.
3. **Certificate system based on actual emissions**
   Highly similar design as option 2, but the price of carbon is now based on the actual emissions of the production process, and not on the default values of the products as determined by the EU.
4. **Certificate system based on actual emissions with phase out of free allocations in ETS**
   This option is the same as option 3, but with an added phase out of the free allocations in the EU ETS over a period of 10 year: each year 10% of the initial allocations in the start year of CBAM (2026) is reduced. At the same pace, CBAM is phased in.
5. **Extended scope of the actual emissions certificate system**
   Again, an extension of another option: option 3. This fifth option is the same as option 3, but with an extended scope of the emissions along the value chain. Now also semifinished and finished products are also included.
6. **Excise duty on carbon-intensive materials**
   In contrast to the previously mentioned options, this sixth and last option places an excise duty on both domestic and imported products, while at the same time the EU ETS with free allocations is preserved.

These options differ in their effectiveness on achieving the identified objectives of CBAM and in their ease of implementation. Especially the addition of basing the system on actual emissions in the production country ensures a fair treatment of all imports (European Commission, 2021f). That does however make the execution significantly harder and the implementation more complicated.

4.2. Case description

The second part of the case study dives into the system the research is placed in, namely the aluminium trade flows between Germany and China, as well as the broader network those trade flows are a part of.

4.2.1. Scope

The scope for CBAM is clear, as identified in chapter 1.4, but the scope of the dynamics researched is yet unclear. The case study focuses on the dynamics between Germany and China, looking from both an economic and geopolitical perspective. An economic perspective of looking at dynamics between two actors is rather straightforward, since it entails assessing the trade flows between the two countries, specifically the trade flow of aluminium as argued for in chapter 2 (Eicke et al., 2021). Insights from theories on trade creation & diversion, trade flows and comparable economic policy instrument can be used indicatively. Secondly, looking at dynamics between two actors from a geopolitical perspective entails a less evident approach.

4.2.2. System analysis

Value chain Aluminium

To be able to look at the trade flows of aluminium, it is essential to map the value chain of aluminium and its products. This section will therefore dive deeper into the general value chain and highlight the most important actors involved from the list from the previous section.

Aluminium used in manufacturing in for example the aviation and automobile sector comes from the semi-fabricated product; the end of a linear process, as can be seen in figure 4.1 (International Aluminium Institute, 2021a). Bauxite is the raw material that is the base of aluminium (European Aluminium, 2018). Mines of bauxite are generally found in tropical areas – in countries such as Guinea, Indonesia and Guyana – but also in areas like Australia and China. Australia is the largest producer, followed by China and Guinea. Evidently, Guinea has a much larger production per capita than Australia and China, even more so per square kilometre and is thus considered as one of the main countries that mine bauxite (European Aluminium, 2018). Most of the raw bauxite mined is then transported to China: an astonishing 72% in 2019, with about 22% of the bauxite being transported to the Atlantic region – both the EU and US/Canada (Hellenic Shipping News Worldwide, 2020). There, the bauxite is further processed: from the bauxite, pure aluminium oxide – called *alumina* – is extracted from the bauxite in a refining process consisting of two steps of first digestion and secondly calcination (European Aluminium, 2018). After going through these alumina refineries – the majority is located in China, but large alumina refineries are also in countries like Indonesia, Brazil and Australia present – the alumina is transported to the primary aluminium smelters. In the smelters, the molten aluminium is extracted from the alumina via an electrolytic process, that requires huge amount of electricity. Many of these are located in China as well, but compared to alumina refineries the smelters are relatively more scattered around the world (International Aluminium Institute, 2021b). In Europe there are 25 primary aluminium smelters located, on a total of 247, meaning that still a small share of the primary aluminium production is located in Europe; the majority of primary aluminium smelters are in China (European Commission, 2021a).

From these smelters, the resulting semi-fabricated products are then transported to the manufacturers that actually use the aluminium in their products (European Aluminium, 2018). With that, the cycle of aluminium use as displayed in the right part of figure 4.1 is started. Large application areas in Europe are the car manufacturing industry in for example Germany, or for example usage of aluminium is aeroplanes at the Airbus factories in France. Other applications as highlighted by the OECD are: small iron containers, foil, pipes, cans and wire (2019). The scrap aluminium that is the result of the production process of the products containing aluminium – such as the ones mentioned – is in turn returned to aluminium recycling facilities, that also receive the used aluminium after the end-product cannot be used any more (European Aluminium, 2018). Aluminium is an easily recycled material, and the use of recycled aluminium has two major advantages over newly produced aluminium from bauxite and alumina: the processing of recycled aluminium produces 95% fewer emissions; the scrap aluminium has a new use and thus does not need to be thrown away or burned (European Aluminium, 2018). Currently, this has led to 75% of the aluminium ever produced is still in use today; either in the end products like cars, planes and window frames, or via recycling the scrap aluminium (European Aluminium, 2018).

Relevant factors

What are the main factors of influence, and the ones being influenced greatly?

To be able to dive into the dynamics between Germany and China related to the trade of aluminium, it is essential to know what factors are part of these dynamics and how they influence each other. Many methods for defining the relevant factor have been proposed in various studies, of which the work of Enserink et al. is one of the main ones (2010). This research will entail some of their methods, of which a *causal map* is one of the most relevant ones (Enserink et al., 2010). The objective of a causal map is to identify the factors that influence the criteria in a system, by mapping the causalities between the factors: both the dependent and independent factors, of which *variables* is another term. Using the process of *backward reasoning* these

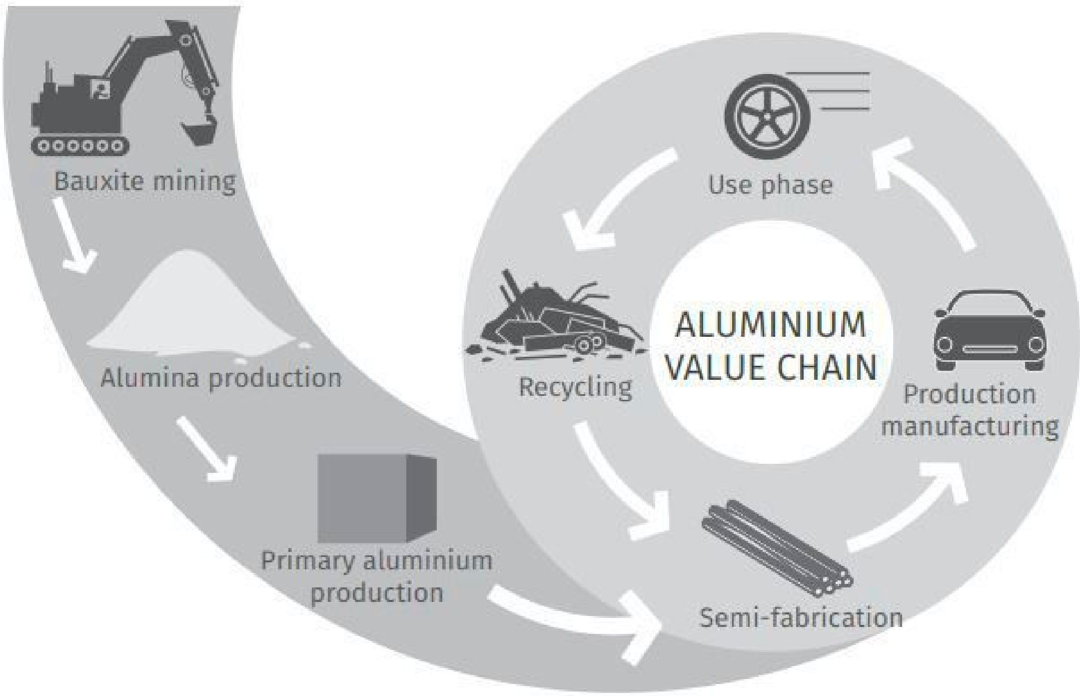

Figure 4.1: The value chain of aluminium.
Source: *(European Aluminium, 2018)*

variables are identified starting with the performance criteria as identified in the literature research in chapter 3. The main ones will be discussed here, while a full list of the factors can be found in appendix B.

These performance criteria are mainly taken from the literature review on impact assessment, which can be found in chapter 3.2.6. Also, the analysis of performance criteria from related REPIs led to a further defined definition of the performance criteria. These are as follows:

1. **Abatement costs**
   The abatement costs are the total costs needed for achieving a set target of emissions reduction. As this is a more conceptual research, setting an exact target for just this research is irrelevant.
2. **Trade rates in the aluminium sector**
   The trade rates in the aluminium sector are the amounts of aluminium being traded between Germany and China.
3. **Efficiency**
   The efficiency is usually determined as the rate between what amount is put in to result in a certain performance of the output. The higher the rate, the smaller the loss and the more efficient the instrument is. Here, how much money needs to be spent to reach the set reduction target over a predetermined period of time?
4. **Effectiveness**
   Often accompanies the efficiency. This is to what extent the instrument does what it is designed to do. Here, to what extent does CBAM actually cause decarbonisation in non-EU countries.
5. **Increased GDP Germany**
   This is solely relevant to this research because it is a result of carbon leakage. Only that effect is taken into account, all other factors affecting the GDP of Germany are out of the scope of this research.

These criteria all have a rather economical character, apart from the effectiveness. The reason that the criteria here are limited to just the economical ones, is that the geopolitical criteria are not as clear as the economical ones, mainly because geopolitical factors cannot be fully isolated. As mentioned in chapter 3.3.3 and 3.4.1

4.2.3. Variables

After the literature review in section 3.2.6 the mentioned set of variables can be used for measuring the impact of REPIs in real life systems. These are in addition to the performance criteria as outlined above. Before moving into the case study, it is essential to divide these into both dependent and independent variables. The section is concluded by the performance criteria of the case, the factors on which the performance is measured.

The importance of identifying the variables in this case is significant, due to the qualitative nature of the research. In more quantitative research *Key Performance Indicators* (KPIs) often indicate what factors are key in assessing the consequences or impact of policies in a system, where the KPIs are usually related to tangible numbers; a result above the threshold of the KPI means a success of that result on that specific KPI, and vice versa. As said, in qualitative research such as this research it is essential to define what to look at, and how these elements relate to each other. In line with that, this section defines the most important dependent and independent variables, based on literature as explained in chapter 3.2.6 and the interviews conducted for the case study.

Include: other phenomena that can be of great influence on the aluminium sector and potential carbon leakage; namely the energy crisis in China and the current gas price crisis in Europe. Especially in Europe the gas crisis is hard felt, leaving the room for higher production rates in countries like Brazil and Australia. This is shown by the recent stop in production in autumn 2021 at Aldel, the Netherlands (Stooker, 2021).

Independent variables

The goal of identifying the variables present in the scoped system provides an indication of what factors are influential and which are less important. Also, the dependencies and relations between the factors are identified. In turn, those can help in assessing the impact of CBAM on the system. The variables are grouped in independent and dependent variables. They are in addition to the criteria identified above, as well as the means the EC has. The most important independent variables in this case are the listed below. These are based on literature on REPIs comparable to CBAM, as well as the interviews and the system analysis. The latter can be found in appendix B.

1. **Technological innovation of RE**
   The innovation of energy production from renewable energy sources, such as solar and wind power. This variable also entails cheaper costs of one production unit when the technology is more commercialised.
2. **Production capacity of RE in China**
   The production of RE in China determines the maximal capacity of aluminium produced with RE. As said in paragraph 4.3, the percentage of aluminium produced with RE was 10% in 2019. The variable is independent, because both the EU and Germany do not have a direct influence on it. It can merely be influenced by policy, no coincidentally that is actually one of the objectives of CBAM.
3. **Government expenditures on REPIs**
   The government expenditures of both Germany and China on REPIs is considered to be fixed in this research. The budget is limited to prevent unnecessary complications from extra uncertainties. Varying the budget of each of the actors is left out of the scope.
4. **Stable political climate**
   A stable political climate results in a stable investment climate, in which innovation and the decarbonisation can thrive.
5. **Production levels of aluminium of ROW**
   Aluminium is a global sector, and the price of it is set globally as well. Therefore, it is important to include the production of ROW as a constant as well in this research.

Dependent variables

Next to the independent variables, defining the dependent variables is important to do as well. The full list can be found in appendix B.1 The most important ones are:

1. **Energy prices**
   These include the prices of electricity, gas and other sources of energy, but only gas and electricity are used in this research.
2. **Certificate price**
   The certificate price is the price of emitting a ton of carbon, as determined in the EU ETS.

3. **The volumes of aluminium production of both Germany and China**
   These volumes can be actively influenced by the governments, as well as exposed to regular market dynamics of supply and demand, including marginal production costs. Together with the production of ROW these form the total volumes of aluminium traded.
4. **Investment rates**
   These are the amount of invested money in relation to the amount in the previous time step, in this case a year. The better the investment climate, the better this rate, since the investment in aluminium is growing.

Means
Lastly, the means of the EC are discussed, that determine what factors can directly and actively be used by the EC. The three main ones are:

1. **Maximum amount of free allocations**
   Also known as the cap in the EU ETS. The lower the amount, the tighter the certificate market and the higher the price of emitting a ton of carbon.
2. **Installed tariff EU on aluminium**
   A rather abstract means, but it indicates the currently installed tariffs for importing or exporting in the aluminium sector, installed by the EU.
3. **Governmental expenditures**
   In contrast to the expenditures of Germany and China, the ones of the EU are adjustable by the EU.

4.2.4. Actor analysis

Actors
In this section only the key players in the system are described in detail. Using the technique of a Power-Interest Grid these five key players were identified, of which a detailed explanation can be found in appendix B. These key actors, as well as the other actors, are then to be used in the further analysis of the dynamics between Germany and China. An overview of the key players, as well as a short description of the actors, can be found in table 4.2.

Table 4.2: The key players in the system.

Actor	Group	Description
European Commission	Governmental body	The governmental body that designed the current proposal of CBAM.
German Government	Governmental body	The government that is in charge of the national regulations in the aluminium sector.
Chinese Government	Governmental body	The Chinese government has a lot of power in helping the Chinese aluminium sector in dealing with CBAM.
WTO	Regulatory authority	The World Trade Organisation determines the laws that CBAM has to comply to, which is the first step of the implementation of CBAM
Producers Germany	Aluminium sector	The producers of aluminium based in Germany.

The key players are self-explanatory and also already explained in the previous chapters. It is more important to discuss what players are left out of this selection and why. First, the Chinese aluminium producers are left out because of the lack of power on CBAM. Aluminium producers based in Germany have a stronger influence on CBAM. Moreover, only about 6.6% of their production goes to the EU. Secondly, interest groups with both a focus on the environment as well as aluminium are left out because of a lack of power as well. Other governmental bodies of the EU, such as the EP and the Council, lack interest to be a key player. Lastly, users of aluminium downstream in the value chain are also left out.

4.3. Dynamics Germany - China

4.3.1. Economical relation Germany-China

In the past, China made the shift to a net exporter of manufactured aluminium and a net importer of raw materials, it first was the complete opposite: a net importer of manufactured aluminium and an exporter of raw materials (Chen & Shi, 2012). This indicates that China has come a long way and three factors drove the increase in trade in aluminium by China: (i) a growing demand of primary aluminium; (ii) China's primary aluminium production was increased drastically to meet that demand; (iii) environmental losses due to aluminium production have been substantial, although production processes were not changed, keeping the business as usual by focussing on growth (Chen & Shi, 2012). That has more or less remained the status quo (S. Liu, Li, & Wang, 2016; International Aluminium Institute, 2021b). Over the period of 2015-2019, China exported on average an amount of aluminium worth 1.6 billion US dollars (USD) to the EU27 annually, obviously including to Germany (Kardish, Mäder, et al., 2021). Placing it into the right context, that is 12% of the total exports of aluminium of China, and 7% of the total import of aluminium of the EU27 (Kardish, Mäder, et al., 2021). A significant larger share is imported into the EU27 from Norway (3.7 billion USD) and Russia (2.8 billion USD) (Kardish, Mäder, et al., 2021). However, since Norway is included in the EU ETS, its industries will not be affected by the CBAM, meaning the enormous amount of exports from Norway to the EU27 are not accounted for by CBAM, though they are accounted for in the EU ETS. With China being the largest producer of aluminium products, exporting much of that to the German machinery industry, the China-Germany trade is of relatively great influence to the stability of the German importing/exporting rates (Export Genius, 2017). Since 2000, Chinese aluminium exports have increased drastically from about 2 million tons to nearly 35 millions tons in 2017, only temporarily stopped during the 2008-2009 economic crisis (European Aluminium, 2021). Since then, the demand of aluminium from the EU has stalled, the increase in exports from China has so accordingly. The recovery of China from the COVID-19 pandemic has so far been quicker than other aluminium producing countries, making it likely that Chinese aluminium exports to the EU27 will increase again (European Aluminium, 2021). Possibly, more EU27 aluminium factories can be pushed out of the market, a process that has started since the rapid increase of Chinese exports of aluminium to the EU in 2000. Even more so, that is proof of carbon leakage in the EU aluminium sector, although the rationales for the companies to relocate can be disputed over. On top of that rapid recovery from Chinese producers, the energy crisis China currently is in is also affecting the trade flows. Moreover, the gas price crisis present in the EU might be of larger influence than the Chinese energy crisis, raising the prices for electricity greatly. Both crises are forcing producers to stop their production lines, although with different reasons – power shortages and extremely high prices respectively in China and Europe (Stooker, 2021).

Besides aluminium, China has proven to be one of the main trading partners of Germany in general, with a bilateral trade volume of over 220 billion euros in 2020, despite the COVID-19 pandemic (Federal Foreign Office, n.d.). Only Volkswagen for example, has exported 4.2 million cars to China, while their exports to the USA are 350,000 cars, an enormous difference (Hanke Vela, 2020). German car manufacturers and German medium-sized enterprises using semi-fabricated aluminium are dependent on their Chinese supplier, making Germany both economically and political vulnerable to changes in the supply side (Karnitschnig, 2020). The worth of the goods sold by Germany in China – 106 billion USD in 2018 – shows the massive importance of China being a consuming country (Hanke Vela, 2020). This has led to the situation where Germany has become the weak spot of the EU's China-policy (Hanke Vela, 2020). The leverage Beijing has built over the EU, and especially Germany, over the years is a potential threat to the negotiations surrounding both CBAM and other political disputes between the EU and China – such as human rights and Chinese unity efforts in Hong Kong and Taiwan (Hanke Vela, 2020). So far, Beijing and Berlin both aimed at keeping business and politics neatly separated, despite several provocative steps set by both governments, but never has that escalated to very stringent countering actions (Karnitschnig, 2020).

The main elements and factors from the Germany-China dynamics are to be taken into account when looking at the influence of CBAM, both specifically from the aluminium trade, and the trade in other goods. These can be summarised as follows:

- Factories producing aluminium are already being pushed out of the EU by various drivers; CBAM has the potential to accelerate that.
- China is not vital for the aluminium supply of the EU27, Norway and Russia
- German car manufacturers are dependent on Chinese consumers, thus Germany is putting the trade of their companies at risk when (geo)politically attacking China's endeavours.

- China does not want to lose its leverage over Germany, and thus over the EU, so it will keep Germany at a close distance as well.

4.3.2. Geopolitical relations Germany-China

When looking at the (geo)political relations between Germany and China, a lot of it is related to the mentioned economic activities and trade flows of goods between the two countries. Besides the two driving crises in both China and Germany, the introduction of CBAM as a policy instrument needs to be placed into the bigger context of geopolitical tensions between the two countries. Germany has been at the forefront of the fight for human rights, but that position contrasts with their economic activities and stakes with respect to China (Karnitschnig, 2020). For a long time, Germany had a rather fatalistic approach to China, basically looking away from tensions related to justice and human rights (Karnitschnig, 2020). The Hong Kong riots, "re-eduction camps" and rumours on surveillance via 5G technology have triggered the disapproval of the German public, forcing the German politicians to make a stand as well (Karnitschnig, 2020). Recently, Germany has been able to make deals with other powers in the Indo-Pacific area, to diversify their foreign policy and decrease their dependency on China (Hanke Vela, 2020). Efforts to involve China more in tackling climate change have succeeded, but those efforts highlight the lack of efforts of Germany regarding human rights violations in China (Hanke Vela, 2020; Eyl-Mazzega & Mathieu, 2020).

Several of the issues as identified in chapter 3.3.3 and 3.4.1 regarding IR and geopolitics of RE can be found in this as well, issues that have played a role in the past or influence the future relations between Germany and China. First, the above-mentioned energy crises in both Germany and China – caused by the gas prices and unstable supply – proves to be destabilising factors in Germany-China relations (Proskuryakova, 2021). The consequent energy security issues are a powerful driver for that, weakening the position of the countries affected by the decreasing energy security, in this case both. A second factors related to this is the role of critical materials needed: both for the production of aluminium, as for manufactured goods (Vakulchuk et al., 2020). Both countries are in dire need of these type of materials for the manufacturing processes, and the affected trade in aluminium – a perfect example of such a critical material – could destabilise the geopolitical relations between Germany and China. Next, as stated in chapter 3.3.3, not only states are actors that influence the relations between the states. Sub-state actors can do that as well, as proven by Volkswagen in this case. The lobby of Volkswagen in the German government is so strong and significant, that the foreign policy of the country with respect to China is greatly influenced by it (Hanke Vela, 2020). A fourth issues identified in chapter 3 is the degree of multilateral cooperation driving the pace of the broader energy transition in all countries. In this case of Germany-China relations, it can clearly be seen that Germany is looking over certain principles they would normally not forget in their relation with China, to keep their relation good enough. Despite the steps taken in combating climate change, China does not follow the same pace of Germany, at least not for the same reasons (Karnitschnig, 2020). Lastly, cybersecurity risks are a threat to the international relations between Germany and China, as stated in chapter 3.3.3. The aforementioned *perceived* surveillance threats via 5G technology disturb the relations between the two countries (Karnitschnig, 2020).

Summarised, the main factors to consider when assessing the geopolitical relation between Germany and China are as follows:

- Germany is affected by the increasing split between human rights and strong economic ties with China.
- Germany is the main weak spot of the EU when it comes to the leverage China has over the EU.
- Energy security is an increasingly dominant factor in both countries, diluting the geopolitical power of the CBAM could have.
- Trade in critical materials such as aluminium can strongly shape the geopolitical tensions between the two countries.

4.3.3. Aluminium production Germany

In the EU, the emissions per ton of aluminium produced is well below the global average of 18 tonnes of CO_2 per tonne of aluminium. In total, the aluminium sector in Germany has produced about 2 million tonnes of aluminium on average over the last six years (Kardish, Li, Hellmich Adelphi, Duan, & Tao, 2021). All types of plants are present in Germany: alumina, extrusion, primary aluminium, recycling and rolling (European Aluminium, 2018). These plants are scattered over the country, but can roughly be divided over four areas: the 'Ruhr Area' in the west, near Bremen in the north, around Leipzig in the east and in Bavaria in the south. In figure 4.2 the location of the four primary aluminium smelters can be found, three of which can be found in the Ruhrgebiet. Germany is a net importer of aluminium, with around 15.5 million USD worth of exports annually, and 16.5 million USD worth of imports (Export Genius, 2017).

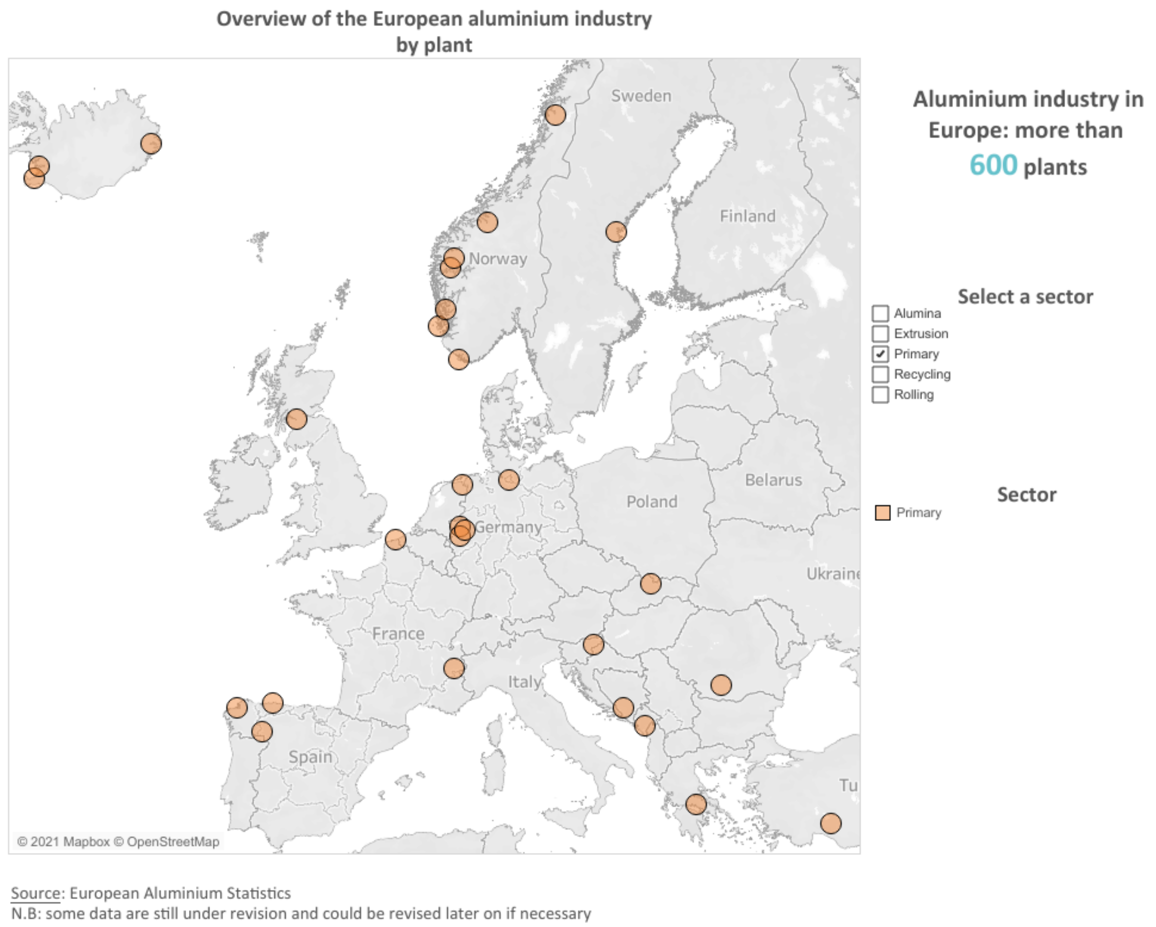

Figure 4.2: The locations of the primary aluminium smelters in Europe

Source: *(European Aluminium, 2021)*

4.3.4. Aluminium production China

In China however, per ton of aluminium 3 times more CO_2 is emitted during the production process (Appendix E.1.2). In total, China produces 38% of the total aluminium production worldwide, while 6.6% of the EU's import of aluminium comes from China, and 12% of the aluminium produced in China is exported to the EU (Kardish, Li, et al., 2021). In other words, the market for aluminium is currently larger in the EU than in China, but that ratio is expected to turn over the coming years (Appendix E.1.2). 92% reduction is carbon emissions for secondary aluminium, compared to primary aluminium – i.e., recycled aluminium from scrap versus non-recycled aluminium from bauxite (OECD, 2019). The Asia-pacific aluminium production is expected to grow with 7% until 2024 (Market Research Future, 2021).

Figure 4.3 gives an overview of the most important trade flows of aluminium that end in the EU, with Norway and Russia being the largest ones, and China on fifth place with 6.6% of all aluminium imported into the EU (Kardish, Mäder, et al., 2021).

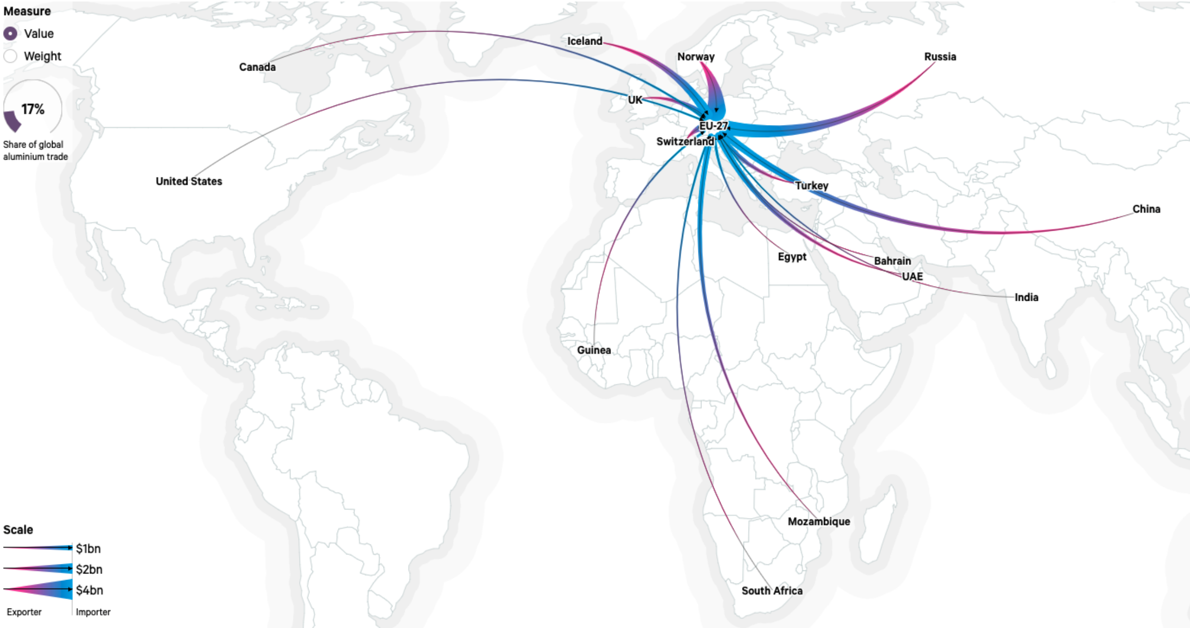

Figure 4.3: The trade flows of Aluminium imported into the EU.

Source: *(Kardish, Mäder, et al., 2021)*

4.3.5. Subsequent dynamics

To analyse the trade of aluminium, the framework of W. Zhang et al. is used, because it is suitable to 'understand the impact of policies on China's trade structure' (2019). The framework analyses the impacts on the trade structure by focusing on three areas, which will each be addressed shortly: (i) Regional Export Structure; (ii) Commodity Export Structure; (iii) Foreign Trade Dependence.

First, the regional export structure, which relates to the proportion of China's aluminium exports to the EU to their total aluminium export (W. Zhang et al., 2019). PIs can cause trade diversion or trade creation, as defined in chapter 3.3.2, which in turn changes that proportion. As stated in the previous paragraph as well, 12% of the aluminium produced in China is exported to the EU; the proportion without CBAM is therefore also 12% (Kardish, Li, et al., 2021). When CBAM is implemented, the carbon price of producing one ton of aluminium is increased as well, as the Chinese exports will have to pay the CBAM tariff starting from 2026, causing a degree of trade diversion. The research of W. Zhang et al. showed that a carbon tariff in addition to a fixed carbon tax – as is now implemented in China – has a greater impact on China's regional export structure (2019). When the tariff is raised, trade diversion is promoted. To ensure its stable exports to the EU, China will have to react. Still, the impact of only CBAM might be fairly weak, since China can also choose to export the changed proportion to any other buyer in the ROW.

Next in the framework is the commodity export structure. This is the proportion of a commodity in relation to the total exports. As showed by W. Zhang et al. as well, a carbon tariff like CBAM has a high impact on energy intensive industries like aluminium because of its high elasticity of demand (2019). At the moment the aluminium exports of China represent a fairly small amount of around 1% of the total exports (TrendEconomy, 2021). With CBAM in place, the commodity export structure of China will likely change and aluminium will account for a smaller proportion. Again, that does not directly cause a reduction in the production levels of aluminium in China, but CBAM might be able to do cause an effect like that.

Lastly, the foreign trade dependency: Foreign trade dependence is the proportion of export and import values relative to GDP (W. Zhang et al., 2019). For the Chinese aluminium sector, the exports in 2020 valued 24 billion USD, and the imports 8.4 billion USD (TrendEconomy, 2021). With GDP of 14.72 trillion USD in 2020, the foreign trade dependency of the Chinese aluminium sector is 0.22%, a much smaller amount than the 1% of exports. Therefore, it can be concluded that china has a low foreign trade dependency, which is very plausible. The research of W. Zhang et al. shows that the foreign trade dependency is only mildly affected by a carbon tariff – CBAM – due to the only mildly affected export rates.

5 Results

This chapter presents an overview of the results per theme discussed during the interviews. The literature study in chapter 3 and the case study in chapter 4 are used as input to understand the six themes discussed in the interviews. The results from the interviews are discussed in this chapter. The insights per interview can be found in appendix E. Each of the themes is discussed using the three perspectives as discussed in chapter 2, which can be seen in figure 2.2: the policy perspective, the societal perspective and the expert perspective.

5.1. Complementary policy instruments

This first theme was derived from the literature on (economic) policy instruments and is in line with one of the objectives of CBAM. As stated before, CBAM is a policy instrument in addition to the EU ETS, designed to accelerate the decarbonising effect of the EU ETS. In the proposal being considered by the EP and the Council, the free allocations in the EU ETS are eventually being phased out, although it is only the intention to explore the time path of phasing out the free allocations (European Commission, 2021c).

In general, it is hard to confidently say whether complementary PIs indeed strengthen the effectiveness of each individual PI. Namely, only a selection of the experts interviewed felt confident enough to provide insights in the operation of a combination of PIs. As expected, two of the three scientists interviewed were among that those confident enough (appendix E.3.1 and E.3.2). Also, the comments of the analysts interviewed were not surprising either (Appendix E.4.1 and E.4.3). Namely, the perspective of the analysts was more in line with the perspective of the companies in the aluminium sector: the designed operation of the PIs does not matter that much, as long as the affected companies follow the regulations. As seen from the societal perspective as well, the compensation of the free allocations is vital for ensuring the cooperation of the aluminium sector (appendix E.4.1). Moreover, the specificity of the instruments also determines their success: when designed for each other – and the eventual version of the PI is in line with the design – PIs certainly help each other in achieving the other's objectives.

Looking at the extent to which PIs complement each other from a scientific perspective leads to the conclusion that achieving an objective via PIs is usually done following a *carrot-and-stick approach*. This approach relates to the two types a PI can be: a *push* and a *pull* (Fouré et al., 2016; Eichenberg, 2009). All discussed REPIs in chapter 3 are either one of the two. On the one hand, a *push* PI is a forcing mechanism. In the case of CBAM, the tariff levied on the import of goods from the CBAM sectors provides that push, which has to be paid if the import is to be completed. On the other hand, a *pull* PI is trying to achieve the objective by attraction rather than force. Of the PIs discussed in section 3.2.7, a cap-and-trade system stimulates companies to decarbonise their business on a more voluntary basis. CBAM is a *push* PI, the stick, while the other PI should be the carrot (the pull) (Eichenberg, 2009). Although at first the EU ETS might not be described as a voluntary 'pull-PI' – due to the obligation for ETS sectors to buy allocations for their emissions – the trade of emission certificates make it voluntary (Fouré et al., 2016). Identifying the carrot and stick when combining PIs was also brought up by several of the scientists interviewed, adding extra theoretical justification to why PIs are most effective when used in a combination.

Two more insights came from the interviews as well: one of the scientists also argued for designing complementary PIs because of the reason of being able to learn from the best practices when a precedent is in place (Appendix E.3.1). The more inter-compatibility, the more both PIs strengthen each other. Secondly, in line with some analysts (Droege & Fischer, 2020; Dumitru, Kölbl, & Wijffelaars, 2021; Bellora & Fontagné, 2020), one of the scientists also emphasised the inherent inefficiency of CBAM because of its size (Appendix E.3.1). That does not mean that the instrument is ineffective, as it can still 'get the job done', as seen in the example of the EU's requirement of having an interconnection level of 15% (Appendix E.3.1). Therefore, it can be concluded from the three perspectives that combining two PIs is preferable, but only those PIs are properly designed and implemented. If the policy instruments have the same objective, which CBAM and the EU ETS have, one should be the stick, and the other the carrot. Also, it greatly helps when one of the two is already in place to set a precedent for the second. Their inter-compatibility determines the extent to which they amplify each other.

5.2. Administrative burden

This second theme relates to a barrier in the ease of implementing CBAM: the *perceived burden* of declaring all goods in the CBAM sectors when exporting products to the EU27, as well as the financial transaction costs. Similar to the first theme, this theme was derived from the literature study conducted in the first phase of this research. It was one of the barriers that successfully halted the proposal of a CBAM in the past (Marcu et al., 2020; Evans et al., 2021).

The pilot phase – as explained in detail in chapter 4.2 – allows all actors involved to get used to the process of declaring the carbon content of the imported products, as well as the regulatory and monitoring agency needed for proper enforcement. However, both businesses from the aluminium sector, and analysts of independent institutions raise more serious concerns. These are the tariff setting, and the uncertainty surrounding the exact design of the instrument (Gläser et al., 2021; Mcwilliams & Zachmann, 2020). Next to the results from literature, experts interviewed raised the same concerns (Appendix E.1.3 and E.4.2). Moreover, another major issue is that affected companies have to disclose value chain information (Appendix E.1.3). Those companies will try to avoid that at all costs, because of the sensitive information such disclosures contain, and the complexity of disclosing that information (Gläser et al., 2021). Consequently, the sooner the scope and coverage of CBAM are defined in detail, the lower the administrative costs for the companies will be. The larger the scope and coverage of CBAM, the higher those costs will be as well (Eicke et al., 2021). More downstream products included in CBAM would lead to higher prices of those products due to higher transaction costs, which is especially devastating for developing countries . International trade conflicts could spur from that as well, partly due to the limited substantiation of the WTO-compatibility and consequent 'undermining of the multilateral rules-based system' (Appendix E.3.1 and E.4.3).

For the aluminium sector, these concerns are all the more relevant because of the large variety of products containing aluminium. Delving aluminium is often done in developing countries, hence aluminium is even more vulnerable to potential rising prices in the sector as a result from the higher administrative costs. Still, as stated in chapter 4.2, these prices are exposed to a vast amount of factors, and there is great uncertainty around the power the administrative costs have on the aluminium prices. With the proposed CBAM and corresponding limitation of just the upstream part of the value chain exposed to CBAM, the administrative costs are still manageable; the price of aluminium is more vulnerable to the ongoing energy crises in the world.

That manageability also came forward from the policymakers and analysts interviewed, who did not perceive the burden of the administrative costs as a decisive problem. Despite, the affected companies probably will not be happy with the added processes of declaring the goods (Appendix E.2 and E.4.1). The financial costs of paying the import tariff are definitely the bigger hurdle from their perspectives. The experts from the aluminium sector frankly did not pay much attention to the actual administrative burden either. However, the need for an effective and efficient monitoring agency was highlighted (Appendix E.1.1 and E.1.2). In line with the policy and societal perspective, the aluminium sector also believes that the burden can be overcome, partly due to the fact that they already need to declare the goods, plus have relevant experience from the trading in emission certificates in the EU ETS (Appendix E.1.2). That is also the view of the scientists involved, who also pointed out the acceptability of the burden is determined by the extent to which it is perceived as one by the companies involved. When the EU assists and is accommodating in the pilot phase in the declaration of the carbon content of the aluminium, the sector is more likely to accept it.

Concluding, the administrative burden is not perceived as highly substantial by most actors, although the need for a (longer) proposed pilot phase is highlighted both in literature and the interviews. The scope and coverage of the CBAM are however vital in that perception; when CBAM is expanded to more sectors and trade flows, the administrative burden can still be overcome, but only with more help from the EU and the required infrastructure needed for safe data processing.

5.3. Foreign adoption of policy instruments

A third of the objectives of CBAM is to stimulate non-EU countries from outside the EU27 to adopt similar carbon pricing instruments, this theme is derived from that objective. It is well-founded in literature and also addresses the knowledge gap in this research, as can be seen in chapter 1.

Best practice: GDPR

Stimulating non-EU countries to adopt carbon pricing mechanisms is one of the most sought-after effects of the CBAM, as that is the ultimate objective of CBAM for the EC. The EU as a front-runner of the fighting climate change envisions that other countries start adopting decarbonisation PIs similar to the EU ETS, a carbon tax or a CBAM (Appendix E.3.3). The likelihood of CBAM actually stimulating the adopting of such policies in non-EU countries is small, as it is inherently surrounded by big uncertainties due to the many factors of influence. When looking at other sectors, the only comparison that could be used as a precedent to CBAM is the implementation of the General Data Protection Regulation (GDPR) in 2018, even though it is a totally different field than the implementation of REPIs. Since the implementation, a fair amount of non-EU countries have adopted the standards of the GDPR into their own countries, with the objective to allow the companies based & operating in their country to work with one standard of privacy regulations, instead of multiple ones (Mike Woodward, 2021). This is especially true for countries of which the EU is a major trading partner. The analogy of the GDPR is thus potentially highly insightful for assessing the impact of CBAM in the decarbonisation policies of non-EU countries. It is possible and could even be much quicker than expected (Mike Woodward, 2021). However, a major point of influence is the nature of the policy instrument: whereas the GDPR focuses on a data protection standards – which entails a one time investment and very low apex for companies raising their standards – the CBAM focuses on paying a tariff per unit imported. The apex of the CBAM are therefore much larger, next to the increased transaction cost as explained in section 5.2. It is questionable if those increased costs, both fixed and variable costs, can be as easily overcome via a new policy instrument – as happened with the GDPR standards.

Limited power of CBAM

Similarly, the power CBAM can have on non-EU countries adopting carbon policies should not be overestimated, since there are more influential factors in the system. Examples of such factors are the gas price crisis in the EU and the energy-security-crisis in China (Appendix E.4.3). Any effect that would occur after implementation of the CBAM cannot be fully assigned to CBAM. One exception is the proposal of a CBAM in the UK, which is a rather special example because of the Brexit. All EU policy instruments that previously were in effect in the UK are now being revised (Climate Exchange, 2021). The aluminium sector also emphasised the possibilities China has to avoid having to pay the CBAM tariffs via *resource shuffling*. That was also identified by both the policymakers themselves and the scientists as a major risk and likely barrier to further adoption of carbon pricing instruments in non-EU countries (Appendix E.1.1, E.2 and E.3.1). Logically, countries that are closer to the EU, with larger trade rates and of which the EU is one of the major export destinations, are more dependent on the EU. Therefore, they are more affected by the CBAM, and thus more likely to adopt carbon pricing instruments (Appendix E.3.2 and E.4.1). The last factor indicating whether REPIs will be adopted by non-EU countries because of CBAM is the usage of the revenues generated by the CBAM (Appendix E.4.2). It is much more likely for non-EU countries to adopt such instruments, when the tariffs they pay when exporting to the EU are returned to those same countries via investment funds and development programs. This is particularly important for developing countries. At the same time, those developing countries would perceive the CBAM as a PI that is just.

Concluding, two major factors can be identified regarding the adoption of PIs in non-EU countries: (i) the correct use of the revenue generated by CBAM strongly influences the perceived justness of CBAM by affected countries, and (ii) the power CBAM can have on non-Eu countries adopting carbon policies should not be overestimated. The analogy of the GDPR is potentially useful here. Nonetheless, no solid proof that non-EU countries will actually adopt carbon pricing PIs because of CBAM was found, despite the promising potential of CBAM causing such policy adoptions found in both in the interviews and in literature.

5.4. Competitive position of the German aluminium sector

Another objective of CBAM is to protect the competitive position of the aluminium sector in the EU, despite the rising carbon prices and corresponding increased marginal costs of producing aluminium in the EU in comparison to producing it outside the EU. This fourth theme examines this phenomenon in more depth. Central elements in the theme are the economic factors influencing the competitive position of the aluminium sector, especially the position of the Germany sector.

Major fear of policymakers

From a policy perspective, there is a lot of fear that the EU aluminium sector loses (part of) its competitive position. It is one of the major rationales for CBAM, since the phase out of free allocations in the EU ETS leads to higher marginal costs per tonne of aluminium in the EU (Appendix E.2). The consequent loss of jobs and growth in the respective countries is a well-feared risk by the EU and its members states. Many of the governmental documents researched dive into the risk, since it is a straightforward argument used by politicians, compared to less quantitative rationales like environmental loss or decreased geopolitical powers (Gläser et al., 2021). Governments of EU Member States favour aiming at a level playing field between the EU Member States and non-EU countries (Appendix E.2). I.e., the need for a level playing field when carbon costs increase in the EU with rising EU ETS prices and phasing out of the free allocations.

There is a lot of critique on the proposal of CBAM from non-EU governments, while the EU members states strongly advocate for protecting the EU aluminium sector from further increased prices. Actual observations of reduced competitiveness of the CBAM sectors vary; in some countries it is observed, in some it is not. A possible explanation is that reduced competitiveness can be caused by many different factors (Eicke et al., 2021). Since the proposal of CBAM contains a phase out of the free allocations in the EU ETS for the aluminium sector, national compensation schemes have been mentioned for the aluminium sector in particular (Appendix E.1.1). Trade partners of the EU also criticise the proposal of CBAM because of the alleged protectionist nature of the instrument, brought up the US, China and other trading partners (Appendix E.1.3 and E.2).

Strong stance of the aluminium sector

Logically, an even bigger emphasis on maintaining the competitive position of the aluminium sector is expressed by the businesses. In comparison to the policy perspective, it is added that even with CBAM on direct emissions and only imports, a loss of competitive advantage will still be caused by CBAM. Because the marginal costs of aluminium are higher when competing on the global market of aluminium (Gläser et al., 2021). When CBAM comes into effect in 2026, aluminium producers from non-EU countries do not have to pay for their carbon content on the global aluminium market. At the same time, the marginal costs of producing aluminium in the EU still have risen, due to the expected higher prices in the EU ETS. The EU needs to decide on the consequent trade-off between creating a fair level playing field, or designing a more extensive first phase of CBAM (Appendix E.4.2).

Most likely, the aluminium companies would also prefer a less extensive first phase of the CBAM, where it only applies to imports (Appendix E.1.1 and E.1.2). Experts added that the aluminium sector prefers compensation for the indirect emissions over being included in the CBAM, which is something the policymakers acknowledge but do not act on (Appendix E.1.3 and E.2). The reason is that indirect emissions are included in the CBAM in the future, thus setting up an extra mechanism for compensation of the indirect emissions would primarily benefit the aluminium sector, but not the other CBAM sectors (Dumitru et al., 2021). That angle of the aluminium sector was confirmed by the aluminium experts interviewed, who strongly emphasised losing their competitive advantage (Appendix E.1.2). To ensure that the aluminium sector becomes more involved with CBAM, this needs to be taken into account. A potential solution to that would be to shift to much more aluminium production from scrap via recycling, but the current volume in the market is not sufficient to be able to fully supply the EU market (Appendix E.1.1). Moreover, such a rapid shift to recycled aluminium requires extensive investment in recycling capacity and corresponding aid from the EU.

It is important to take the bias of the aluminium sector into account when interpreting these strong viewpoints, leading to potential exaggeration of losing competitive advantages as a result from just the exports. The aluminium sector thinks very economically, and if the competitive disadvantage of the non-EU competitors would be larger than the disadvantage of the EU aluminium sector, they would be more than happy to accept CBAM as a new PI (Appendix E.3.1). However, China is expected to have ample opportunity to compensate for the loss of competitiveness, via for example resource shuffling (Appendix E.3.3). A shift in the value chain of aluminium as a result from CBAM is also to be expected: aluminium bulk has very small margins, making bulk aluminium production in the EU not profitable any more (Appendix E.4.2 and E.4.3). Thus, the EU aluminium sector will most likely move to more high-end products that inherently have higher margins, by phasing out the production of raw aluminium.

In conclusion, in the debate around CBAM there is a strong emphasis on the potential loss in competitive advantage of the aluminium sector in the EU. All three perspectives accord similar viewpoints, although the extent of the loss is still disputed over. The EU needs to be careful to not fully follow the emphasised loss of competitive advantage, and it needs to accommodate for the risk of carbon leakage as well, which will be addressed in the last theme.

5.5. Economic and geopolitical consequences

The next theme is the economic and geopolitical consequences of CBAM, seen in the bigger picture of the energy transition. The theme was found in the literature on the geopolitics of the energy transition, and more specifically the winners and losers of the transition towards a fully RE based energy system (chapter 3.4.1). Both the economic and geopolitical consequences will be discussed from each perspective.

Economic consequences

Regarding the economic consequences, several expectations from the policy perspective have already been highlighted in the previous sections. Loss of the competitive position of the aluminium sector is one (section 5.4), but decreased margins and increased prices as a result from the administrative burden is another (section 5.2). A major risk is carbon leakage, as outlined in chapter 4. The German government did not assess it as a serious direct problem on the short term, but potentially devastating on the longer term (German Federal Government, 2021). With projected prices of a tonne of CO_2 between 72 and 182 euros, the added costs for the aluminium sector can be devastating as well. The aluminium sector is asking for more compensation for that rise in carbon prices (Appendix E.1.2). On the other hand, CBAM has the potential to mitigate that effect and create a level playing field, be it at a higher price of CO_2 (Appendix E.2). Attention has also been paid to the opportunity window of reinforcing the simultaneous transition towards a more circular economy, which the aluminium sector is very suitable for (Rijksoverheid, 2021). As stated in chapter 4, almost all aluminium can be recycled (Appendix E.3.1). This is in addition to the impact of CBAM has as expected by the EC, such as increased employment rates of about 0.45% when the revenues of CBAM are reused properly (European Commission, 2021c).

The loss of a competitive position of the aluminium sector is emphasised by more societal actors, while more concrete expectations regarding price development of carbon permits are added (Gläser et al., 2021; Eicke et al., 2021). Namely, the price of emission allowances is expected to keep increasing in the long term. Moreover, the overall economic impact on growth rates is rather small, with approximately 0.22% reduction in the growth when the climate ambitions of the EU are accompanied by the CBAM (Dumitru et al., 2021). Also, several non-EU countries would be vulnerable to CBAM. These countries are all highly dependent on the EU as a destination of exports, with the UK, Serbia and Mozambique as the most exposed ones (Dumitru et al., 2021). China, on the other hand, is one of the largest trading partners of the EU, but has limited dependency on the EU as a destination of export (Dumitru et al., 2021; Kardish, Li, et al., 2021). This distinction suggests a factor of influence on the vulnerability of a country to the consequences CBAM.

Geopolitical consequences

The geopolitical consequences are mostly related to the risk of retaliation measures by the major trading partners of the EU. Shortly after the announcement of the 'Fit for 55' package in July 2021 both China and the USA announced to counter CBAM with equal measures, leading to similar disputes as the ones around import tariff in recent years (Orange Wang, 2021). When such disputes escalate into trade wars, the *Dirty Nationalism* as explained in chapter 3.4.1 becomes much more realistic. Nonetheless, researched societal actors do not dub a trade being extremely likely (Dumitru et al., 2021). The governments of the EU Member States in particular will try to prevent that from happening, with Germany at the forefront due to its complex relationship with China (German Federal Government, 2021; Politico, 2021). For the aluminium sector itself, increasing geopolitical tensions between Germany and China would be detrimental, as both CBAM and the increased tensions hinder the trade of aluminium. The costs of for example the German car industry could increase dramatically. Lastly, aluminium is considered one of the critical materials in the energy transition, which gives the sector a solid position for any future negotiations on decarbonisation efforts (Appendix E.3.2 and E.4.3).

The experts provided expected effects, described in more detail than literature and policy documents did. First, of the CBAM sectors, the aluminium sector is the pre-eminent one that can benefit from an increasing electrification of the energy mix via RES, because a large part of the production process is (already) powered by electricity (Appendix E.2). Since the transition becomes cheaper and provides the sector with extra leverage in negotiations, the sector would become a winner of the energy transition – both economically and geopolitically. Similar to the results in section 5.4, another expectation was the neighbours of the EU being extra affected by CBAM. Because generally speaking, neighbours of the EU are more dependent on the EU as an export destination than countries who are not – for example China and Australia (Appendix E.4.1). China will be mildly affected by CBAM, in economic and geopolitical sense (Appendix E.3.1 and E.1.1). Partly due to the possibility of resource shuffling, but also because China is less dependent on the EU – in contrast to the EU's direct neighbours (Appendix E.1.2 and E.3.3). The experts also emphasise the unique character of the aluminium sector, due to its low amount of scope 1 emissions – that are included in CBAM as proposed – and large amount of scope 2 emissions – which are not included in CBAM. It makes the impact of CBAM smaller compared to the other sectors, economically and geopolitically.

Concluding on the economic and geopolitical consequences in the broader context of the energy transition in the aluminium sector, several winners and losers can be identified. Starting with the EU Member States and Germany in particular: most EU Member States have the potential to become winners, when they incorporate RE in time – both in the aluminium sector and in their energy mix as a whole. Shifting in the short-to-medium term to more electricity based industry, such as the hydro power-based production of aluminium in Norway, provides a solid base to building a more robust and resilient aluminium sector in the EU. Regulations such as CBAM add to this trend and push the EU Member States to a bigger advantage. In contrast, direct neighbours of the EU are more likely to experience negative effects from CBAM, especially if they export many goods from one of the CBAM sectors to the EU – such as Turkey or Ukraine. Other non-EU countries that are not a neighbour of the EU, like Mozambique and Guinea, are also more likely to lose an advantage due to CBAM. That is only those countries that heavily rely on the EU as an export destination also. Lastly, countries like China, Australia and Japan are likely to be winners from the implementation of CBAM, since they are sufficiently independent of the EU. The economic consequences are manageable when the loss of competitive advantage of the German aluminium sector can be mitigated, seen from the policy and societal perspective. The abeyance of the geopolitical consequences is serious, but no hard claims on the expected outcome can be made. The only exception is that the major trading partners will install counter-tariffs, but to what extent is very uncertain. So the two dominant factors in determining whether a country is likely to become a winner or a loser after implementation of CBAM are: (i) the dependency on the EU as export destination, and (ii) the geographical closeness to the EU27.

5.6. Risks of CBAM

The sixth theme concerns the three main risks of CBAM: *resource shuffling*, *risk of retaliation measures* and *carbon leakage*. This theme stems from the literature on CBAM and other REPIs as discussed in chapter 3, as well as the objectives of CBAM – i.e., preventing *carbon leakage*. Each of the risks will be addressed.

Carbon leakage

Preventing carbon leakage is one of the objectives of CBAM, but the question still remains if CBAM is able to do so. The EC definitely agrees with that, while national governments are less convinced of the effectiveness of CBAM in that (European Commission, 2021b). Companies in the sector however, provide quite subjective insights into the risk of carbon leakage. It makes sense that an aluminium producer will always (over-)emphasise the effect of carbon leakage if it concerns their sector (Appenddix E.1.1). Aluminium analysts point to proof of carbon leakage in different times, such as the relocation of part of the industry to non-EU countries since 2000, which was because of cheaper labour costs (European Aluminium, 2021). Carbon leakage is not a phenomenon that has indisputable proof, mainly caused by the immense complexity of the systems studied (Eicke et al., 2021). However, the fact that it might be thickened does not mean that the risk should be ignored.

Many of the above-mentioned driving factors for carbon leakage were brought forward by the experts as well, or overlap with some factors brought forward in the section on CBAM's risks in chapter 3. Interviewed experts from the aluminium sector confirm the expectation from the societal perspective that any comparable relocation of facilities in the aluminium sector will be brought forward as proof of carbon leakage (Appendix E.1.1 and E.1.2). Namely, 30% of the facilities that used to be part of the value chain of aluminium in 2003 – smelters, extrusion, alumina refineries, recycling factories, etc. – has relocated from a country in the EU to a country in the developing world. That is despite or maybe because of the implementation of the EU ETS in 2005 (Appendix E.1.1 and E.1.2) (European Aluminium, 2021). A correlation that is surprising. However, this correlation should be interpreted critically, since the shift was mainly due to the lower incomes in the developing countries, and cannot be solely assigned to the introduction of the EU ETS. At the same time, the influence of the EU ETS should not be overlooked either. Carbon leakage is not a phenomenon that can be studied in isolation; many factors can drive carbon leakage, because it is the result of the interaction between those factors, as well as the unique context at that time (Appendix E.4.3). Examples of such factors in the current energy system are the gas price crisis in Europe, as well as the energy crisis in China. Interestingly, it actually does not matter for the actors whether carbon leakage is an actual, existing phenomenon: once it is perceived as a risk and therefore companies start considering relocating, the problem becomes real (Appendix E.4.1). This means that the discussion whether carbon leakage is a problematic risk or not is less relevant; it only matters if affected companies *perceive* the risk as problematic. There are ample solutions to research whether carbon leakage is perceived as a problematic risk by companies in CBAM sectors, which do not need to be explained here. Surveys or interviews are just two of them. Regarding carbon leakage, it can be concluded that all experts interviewed stated that carbon leakage is not indisputable and should not be underestimated. Especially the extent to which carbon leakage is perceived is important and vital for determining the chance of carbon leakage occurring after CBAM.

Retaliation measures

The *risk of retaliation measures* is a much more tangible effect of CBAM, partly because both China and the USA have announced countering CBAM with their own measures (Orange Wang, 2021; Mullen, 2021). Moreover, recent experiences made it very real for all actors involved that trade wars are a realistic risk (Appendix E.2 and E.4.3). Both the EU and non-EU governments are still reluctant to let the situation escalate any further before the negotiation of CBAM are finished, the chance of a trade war surrounding CBAM is therefore very small in the short term. The national governments of the EU Member States are not as expressive as with other issues, since countering tariffs in a trade war are best done by the EU as a whole (Appendix E.3.1 and E.3.3). The extent of the measures determines the impact of the announced retaliation measures (Erixon, 2021).

Tariff wars as a result from countering retaliation measures were also perceived as a risk with high impact by the experts. Despite the relatively small likelihood of a tariff war actually unfolding, its impact can be disastrous for both the EU and China (Appendix E.3.3). Moreover, the likelihood of a trade war emerging is smaller than compared to five years ago, with bigger tensions between the current global geopolitical powers: the USA, the EU, Russia and China (Appendix E.3.2). Today, there is more consensus on combating climate change, thus a full and extensive trade war is less likely than five years ago. Concluding, the risk of retaliation measures is quite small, but its impact would be immense.

Resource shuffling

Thirdly, *resource shuffling* is not a very realistic risk, apart from the major aluminium producing countries. Few countries are sufficiently independent to do so, while the current share of the energy mix being RE also determines the possibilities a country has for resource shuffling. China is one of the countries that is able to do so, especially in the aluminium sector; a current share of 10% of the aluminium is produced with RE, while less than that of the county's aluminium production is exported to the EU, as already explained in more detail in chapter 4. Russia also has the potential, but currently does not have sufficient RES in their energy mix to do so. Governments of EU members states do not explicitly address this risk, mainly due to the strategic character of the risk. National governments of other countries do not so either, because of the same sensitivity of the information exposed.

Businesses and sector analysts, on the other hand, explicitly address resource shuffling and expect it to happen with near certainty. The little enforcement measures that are possible to prevent resource shuffling also increase the chance of retaliation measures, thus are not favourable (Appendix E.1.3). Many experts indicated at the high chance of China and Russia shuffling resources in the aluminium sector, because of the ease of avoiding CBAM and the lack of enforcement methods the EU has to counter the resource shuffling. Namely, the EC cannot really do anything to prevent resource shuffling, apart from asking (Appendix E.2). Only imposing more import tariffs on those countries could help, but as discussed that is something all actors are eager to prevent. Other methods to enforce the CBAM are also absent for the EC, meaning that the insights from literature on enforcement – see chapter 3.4.2 – could prove very valuable when taken into consideration.

5.7. Other themes discussed

Next to the six themes as explained in detail above, the expectations of the experts regarding strategic behaviour between EU Member States were also discussed, as well as possible strategies for the EC to implement a more effective CBAM. The interviews were a unique opportunity to dive into the different perspectives on those two matters. Again the three perspectives of policy, society and experts will be used.

Strategic behaviour between actors is a common phenomenon with large new policy instruments being implemented (Wegner et al., 2017; Hourcade et al., 2007; Enker & Morrison, 2020). This research will not go into depth of what strategic behaviour is, but it is interesting to assess whether strategic behaviour can be expected from EU Member States in the coming implementation stage of CBAM. All experts agree that some form of strategic behaviour can be expected from the Member States, although the policy officer is much more positive than the aluminium sector (Appendix E.2, E.1.1 E.4.1). Mild strategic behaviour is more likely, since all Member States are being protected by CBAM, but it will mostly be about the nuances in the negotiation (Appendix E.2). Potential disputes will be about what sectors to include and the tariff design (Appendix E.4.3).

Moreover, there is a similarity between the risk of strategic behaviour and the expected impact of CBAM on countries. As we recall from section 5.5, the dependency on the EU as a trading partner determines the expected impact. Similarly, the dependency of an EU Member State on heavily affected countries, in the trade in CBAM sectors, determines the likeliness of strategic behaviour by that Member State. Evidently, that dependency is one of the factors determining the likeliness of strategic behaviour. In potential disputes of strategic behaviour between EU Member States, the aluminium sector itself again takes the likeliness more seriously, while other types of actors are more nuanced in their expectations, very similar to the division of perspective on the other three risks as explained in section 5.6.

Lastly, the experts gave their views on the future implementation of CBAM and what strategies or elements the EU should look at into more detail. All experts emphasised that the aluminium sector is a stranger in the midst of the CBAM sectors, since the majority of its emissions are in scope 2 – the indirect emissions – which are not included in CBAM. Moreover, the analysts and the scientists emphasise the potential underestimation of current dominant factors, such as the energy crises in Europe and China (Appendix E.3.3 and E.4.3). Also, avoiding more geopolitical tensions between the EU and its trading partners is essential for the success of CBAM, since such tensions are dominant in influencing the acceptance of new PIs (Appendix E.3.1 and E.4.3). Not surprisingly, the aluminium sector advocated to exclude the aluminium sector from CBAM, at least for now until the indirect emissions are included as well. The business perspective in that is fairly strong, so the bias of the sector should be considered when using these insights.

5.8. Identification of factors driving the impact

In the previous lists of impact variables from chapter 3.2.6, the rest of the literature study and the case study in chapter 4, many factors are identified that determine and drive the impact a REPI like CBAM has on the system it is implemented in. Below an updated list of impact factors can be found, which comprises the most important factors, which can be used in further research and other analyses. Per factor it is indicated what part of the analysis the factor stems from, thus where the detailed rationale for the factor can be found.

1. Efficiency & Effectiveness (3.2.6)
2. Carbon emissions – absolute and the type (3.2.6)
3. Government expenditures on policy measures (3.2.6)
4. Trade rates (3.2.6 & 3.3.1)
5. Elasticity of prices – of certificates, product and average in the sector (3.2.6, 3.3.2 & 4.3.1)

6. Import / export dependency (3.2.6 & 4.3.1)
7. Risk of carbon leakage (3.2.7)
8. Cascading protectionism (3.2.3)
9. Energy security (3.4.1)
10. Flexibility (3.2.2)
11. Degree of a tailor-made PI (3.2.2)
12. Usage revenue (3.2.2)
13. Structure of the performance evaluation (3.2.4)
14. Share of RE in the energy mix (3.2.3)

5.9. Sectional conclusion

This section lists the main conclusions from the six themes. These conclusions are:

1. A combination of PIs is preferable in decarbonisation policy, but only if the second one is designed to be tailored and complementary to the first PI – where one is the carrot and one is the stick.
2. The administrative burden for companies is quite large, but manageable for aluminium companies. The pilot phase as proposed is required to ensure a smooth process of implementation.
3. There is no observable proof of carbon pricing PIs being adopted by non-EU countries; only that CBAM has a promising potential to do that, theoretically.
4. There is consensus that the German aluminium sector will lose on its competitive advantage as a result from CBAM, but the extent is unclear and depends on the negotiations of the EP and the Council. It is crystal clear however that carbon leakage needs to be accounted for more thoroughly.
5. Two factors determines whether the aluminium sector in countries can be considered a winner or loser of CBAM being implemented: (i) the dependency of a non-EU country on the EU as an export destination in the CBAM sectors; (ii) the geographical closeness to the EU27. The more of both, the more likely the chance of being on the losing side of the implementation of CBAM.
6. Carbon leakage and retaliation are two realistic risks that need to be accounted for, while resource shuffling is a risk that can hardly be tackled and is thus better to set aside and focus on the other two.

6
Discussion

This chapter provides a synthesis and discussion on the results of this research. It is structured as follows. First, the sub-research questions in this research are answered, by interpreting the results from chapter 5. Afterwards, the limitations of the research and the research design are discussed.

6.1. Answers to the sub-questions

In table 6.1 the sub-questions are revisited. Afterwards, the answer per sub-question will be given.

Table 6.1: The sub-questions in this research.

Question	**Chapter**
1. What is the Carbon Border Adjustment Mechanism and what are its objectives?	3 & 4
2. What theoretical issues and challenges of a renewable energy policy instrument should be taken into account when implementing the Carbon Border Adjustment Mechanism?	3
3. How do domestic policy instruments affect decarbonisation efforts in non-EU countries?	3 & 5
4. How are the aluminium trade flows between Germany and China affected by the implementation of the Carbon Border Adjustment Mechanism?	4 & 5
5. How are economic and geopolitical dynamics between two countries affected by a new renewable energy policy instrument in one of those countries?	5

Question 1—What is the Carbon Border Adjustment Mechanism and what are its objectives?

The Carbon Border Adjustment Mechanism (CBAM) is a policy instrument to be implemented in the EU in 2023. It is an addition to the EU ETS and companies from non-EEA (European Economic Area) will have to pay a tariff – depending on the carbon content of the good – when exporting the goods to the EU27. It serves four main objectives:

1. to limit the effects of carbon leakage.
2. to protect domestic industries against reduced competitiveness.
3. to incentivise foreign trade partners and foreign producers to adopt measures comparably to the EU's.
4. to yield revenue that can be used to further accelerate decarbonisation in the EU and its trading partners.

While defining CBAM with the above objectives followed from the literature studied for this research. The analysis from chapter 4 shows the uncertain elements of CBAM and concludes that CBAM is not set into stone until the negotiations of the EC, EP and Council have finished. When those negotiations have finished, a detailed picture of the instrument can be drawn; its impact is so far surrounded by uncertainty. Nonetheless, its compatibility with the EU ETS is very promising, as well as its ability to create the level playing field as intended. The literature study in chapter 3.2.4 on CBAM in theory showed that all previous attempts at implementing a CBAM as such a large scale have failed, but that CBAM in its current form has sufficient momentum. The version of CBAM that is proposed to far is a limited version. Excluding the export rebates from the scope of CBAM is the major constraint and an example of that limitation of CBAM. The effectiveness of CBAM in the CBAM sectors is for these reasons limited, especially in protecting domestic industries and preventing carbon leakage. After the start in 2023, companies in the sectors of Iron & Steel, Aluminium, Cement, Fertilisers and Electricity first do not have to pay the tariffs for 3 pilot years, this allows the companies and countries to adjust their business and policies to CBAM.

Question 2—What theoretical issues and challenges of a renewable energy policy instrument should be taken into account when implementing the Carbon Border Adjustment Mechanism?

By studying existing Renewable Energy Policy instruments (REPIs), best practices and insightful challenges were identified from theory. First, CBAM needs to be flexible to ensure an as effective policy instrument as possible. CBAM would be considered flexible when it can easily be implemented in the other sectors and scopes than the ones proposed. Quick and cheap extensions of CBAM to a bigger scope later, by also including for example export rebates and the petroleum industry, would make CBAM very flexible. Obviously, it is important the same level of effectiveness is maintained with a potential extension in scope of CBAM. Supportive instruments – e.g., a market auction price – can help improve the flexibility and effectiveness of CBAM in reducing the carbon emissions in the CBAM sectors. Secondly, there is a risk of cascading protectionism via countries countering the CBAM with their= own policy instruments. Installing new import tariffs on each other's main export products can be the result, commonly known as a tariff war.

The third main issue is that sharing information on the exact content of materials is highly complex and sensitive. Both the second and third issue can be mitigated via the installation of an independent authority responsible for monitoring and enforcing CBAM. Chapter 3.3 found that such an authority could tackle the problem of possible discriminating effects, which is one of the root causes of a trade war. Namely, the perception of discriminating effects causes inequality, which in turn increases the risk of a trade war.

Lastly, two issues related to the implementation are the use of revenue and the performance evaluation of CBAM. In line with the objectives, the revenue generated by CBAM could be used for three options: (i) Flow back into the affected sectors via innovation subsidies; (ii) Invest in upgrading the current infrastructure to make it more future-proof, as well as suitable for renewable energy; (iii) Help developing countries to reduce their carbon emissions as well. Regarding the performance evaluation, an ex-post chosen evaluation method does not work effectively, thus the evaluation should be designed in synchronisation with the PI itself.

Question 3—How do domestic policy instruments affect decarbonisation efforts in non-EU countries?

In general, decarbonisation efforts in foreign countries are not affected by domestic policy instruments (PIs), unless the domestic PI has a direct effect on the foreign countries. Other factors, such as energy prices and geopolitical tensions, have a stronger influence. This research showed that domestic PIs can serve as a precedent for those foreign countries. The strength of PIs in driving decarbonisation in foreign countries should however not be overestimated, even in the case of a direct effect. Decarbonisation efforts are the result of a wide variety of factors, of which existing PIs are one. Some other examples of those factors are the aforementioned energy prices, the dominant view in the governments and availability of low-cost renewable energy technologies. Nevertheless, foreign countries can learn greatly from the teething pains of implementing a new PI by .

When applying this theoretical conclusion to the case of CBAM, it can be concluded that CBAM certainly has the potential to affect the decarbonisation in non-EU countries. However, the extent to which CBAM has an impact in those non-EU regions simply cannot be determined without making assumptions. Even more so, the power of CBAM in affecting decarbonisation efforts in non-EU countries should not be overestimated at all. Other, more contextual factors can play a more important role, such as the aforementioned geopolitical tensions and energy crises. The implementation of CBAM can play a role in decarbonisation efforts in for example the neighbouring countries of the EU. Because CBAM is showing to have limited influence on decarbonisation efforts in non-EU countries, the conclusion can be extrapolated that decarbonisation efforts in each country are still a trade off that is mostly economics based.

Question 4—How are the aluminium trade flows between Germany and China affected by the implementation of the Carbon Border Adjustment Mechanism?

The aluminium trade flows between Germany and China are only mildly affected by CBAM, because of several reasons. First and foremost, chapter 5 shows that the aluminium sector is only partly affected by CBAM, since the majority of its carbon emitted during production is indirect, because the carbon is emitted during the production of electricity needed for aluminium smelting. Also, China only exports a minor part of its total aluminium production to the EU. The share of aluminium exported from China to the EU is smaller than the share of aluminium production in China powered by renewable energy. Thus, China has potential for resource shuffling, at least in the short term until the ratio between the exports to the EU and RE produced aluminium changes. In the longer term, the German car industry could be more affected by CBAM, which will spark increasing tensions between China and Germany. A potential result of that is carbon leakage, but also a change in the value chain of aluminium could be caused. The margins in bulk trade would not be profitable any more, causing the EU aluminium sector to limit itself to producing high-end aluminium products. In the process, it can be concluded that it is likely that the German aluminium industry will lose some of its competitive advantage.

Question 5—How are economic and geopolitical dynamics between two countries affected by a new renewable energy policy instrument in one of those countries?

A new REPI in a country or union definitely changes the dynamics between that country and foreign countries. It however greatly depends on the affected sectors and the country specific economic and geopolitical position. The main factors that determine the extent to which the dynamics change, both in terms of economics and geopolitics, are:

- The dependency of both countries on fossil fuels.
- The nature and size of the affected sectors.
- The interdependency between the two countries in the affected sectors.
- The extent to which one of the countries gains an advantage over the other.
- The commonalities in terms of their long-term goals.

This means that using these five factors, changing dynamics can be assessed, especially the extent to which the dynamics are influenced. Amongst these five factors, the nature of the affected sectors and the interdependency are most influential, because these two factors are the root of the other factors as well.

6.2. Policy considerations

Now that the sub-research questions have been answered, considerations for policy and society can be identified. Multiple considerations can be taken from this research, in order to implement a CBAM that is more robust, resilient and effective. The policy advice provides a number of policies that can be implemented by the EC. The decision which policy considerations are desirable to implement lies with the decision makers in the EC.

The first policy to consider is to exclude aluminium for now from the CBAM sector, and when desired to choose a substitute sector from the ones that were excluded from the final proposal of CBAM in the *Fit for 55* proposal in July 2021. When the chosen scope and coverage – only direct emissions, only imports – is not expanded (including respectively indirect emissions and exports) the aluminium sector does not provide sufficient benefit. This benefit is neither in terms of (i) reduction in emissions, (ii) acceptability of the CBAM sectors nor (iii) prevention of carbon leakage. Decision makers will have to choose which of the three options is best to still ensure CBAM achieving its targets. The added value of including the aluminium sector in the CBAM sectors is limited, due to the vast majority of the emissions from the aluminium sector being indirect. The *Fit for 55* proposal also included a type of compensation scheme for the just aluminium sector, which is even more proof of the incompatibility of the aluminium sector in CBAM. Including the aluminium sector in a later stage, when indirect emissions are also included, is something to consider for the decision makers.

Next, the extent of which CBAM affects the phenomenon of carbon leakage is not to be overestimated by the decision makers. Hardly any empirical evidence of carbon leakage due to a policy instrument has been brought forward, both in- and outside the aluminium sector. Overestimating the power of CBAM in preventing carbon leakage is risky, since other factors have a much higher potential impact than CBAM in its recently proposed form. This is even more so in the aluminium sector, since CBAM has a limited effect on the aluminium sector compared to the other CBAM sectors. Contextual factors such as rising geopolitical tensions, the gas price crisis in Europe or the energy crisis in China can change rapidly in the short term and belabour the impact of CBAM on carbon leakage in the aluminium sector.

The third policy to consider for decision makers is the installation of an independent monitoring and enforcement authority. This authority could be responsible to the two mentioned elements. (i) For monitoring the expected risks as outlined in chapter 5.6, as well as the performance of the impact CBAM has in the sectors affected. Chapter 3.3 provides a set of handles to monitor the performance of CBAM, based upon literature. (ii) For ensuring the enforcement of CBAM, to mitigate those same risks and ensure a smooth implementation. During the pilot phase of the administrative work, the enforcement can already start, to be fully rolled out after 2026. Decision makers should decide on the exact responsibilities of this authority, but it would certainly help in mitigating the risks identified, as well as to achieve CBAM's objectives.

Moreover, the usage of the revenue generated with the CBAM should be determined prior to implementation, to prevent the affected (non-EU) countries perceiving the CBAM as unjust. As stated by many of the experts interviewed, the revenues should flow back to the countries paying the tariffs in the form of development programmes, or to the affected sectors in the form of decarbonisation stimulus. The fifth and last policy consideration is the usage of the list of relevant factors to determine the influence CBAM has, as identified in chapter 5.8. Taking these into consideration in policymaking could prove very valuable.

6.3. Limitations of the research

Several limitations to this research can be identified. Starting with the system researched. Typically, when researching a new PI that is not yet implemented, nor has a precedent, the research comes with a vast amount of uncertainty. This research has tried to take away part of that uncertainty by combining different perspectives and backgrounds from theory. The immense uncertainties and ever-changing influence of different factors made it difficult to isolate the system. That is rather inevitable with this type of research. Nevertheless, the expectations regarding the impact of CBAM have been narrowed down to a great extent and useful considerations are the result of the research.

Secondly, data collection via conducting interviews for the case study formed a limitation. As explained in chapter 2 and in appendix D a selection of 11 interviewees has been formed, with one to four experts per background-group being interviewed. This was due to the willingness of potential interviewees to participate, as well as time restrictions in a master thesis. They often perceived their knowledge of either CBAM, REPIs, the aluminium sector, Germany or China – and often a combination of these five – insufficient to feel comfortable enough to be one of the experts in this research. The amount of experts interviewed was still above the minimum (Yin, 1984; Auerbach & Silverstein, 2003). Additionally, the bias in interpretation of the interviews could not be fully ruled out, due to the individual nature of this master thesis. Ideally, the interviews and the interpretation would be conducted by multiple investigators with different backgrounds.

Thirdly, the selection of interviewees was also not as specified for the case of the dynamics in the trade flows between China and Germany. As can be seen in table E.1 only one of the experts had a Chinese perspective and none of the scientists or analysts were specialised in economics. However, the latter was partly covered by the knowledge of the analysts in the geopolitical field, who also look at trade flows, the scientist with a background in energy policy and by the two experts from the aluminium sector. Unfortunately, the Chinese perspective was much harder to ensure due to language, geographical and cultural differences between the researcher and the potential interviews with a Chinese perspective. The results of this research would be better validated with a group of experts who have a more balanced background between the different research and geographical areas.

Fourth and last, some researched areas were not in line with the background of the researcher. Despite the multidisciplinary background of the researcher, the experience in both IR and economics was limited and thus not ideal. That might have resulted in slightly different focuses in each part of the research. To ensure having a complete overview of the relevant topics of IR and economics, the literature reviewed for the literature study focused mainly on the general aspects in those two fields; therefore mainly other literature reviews provided the required overview and served as starting point for the rest of the research.

7

Conclusion

In this last chapter, an answer to the main research question is given. Afterwards, a reflection on the research and its results will be conducted. The chapter concludes with the recommendations for further research.

7.1. Conclusion on the main research question

In this section, we answer the main research question. This research has aimed at providing more insight into the expected consequences of new policy instruments such as CBAM. The main research question has been formulated as follows:

What influence does the Carbon Border Adjustment Mechanism have on decarbonisation in the aluminium sector, given the economic and geopolitical dynamics between Germany and China?

To provide an answer, first the dynamics of the aluminium trade between Germany and China were analysed. These dynamics can be described as follows. The dependency of the German car-industry on Chinese aluminium production is significant, but the volume of aluminium transport from Germany to China is limited and thus substitutable. In both Germany and China, aluminium products from the total value chain are produced, apart from bauxite mining. Low-end aluminium products are more vulnerable to geopolitical tensions between the two countries, compared to high-end products. Geopolitical tensions between countries – who are both part of the value chain of aluminium – always cause a rise in prices of the aluminium. Low-end products, that have lower margins, are more vulnerable to those increased prices, compared to more high-end products. Moreover, Germany is also considered to be the weak-spot of the EU, geopolitically, in its relation with China. That is mainly due to the dependency of Germany on China in their most important sectors, of which the car-industry is logically the most prominent one. Therefore, a CBAM that does not strongly frustrate China is of great importance to Germany.

Given these dynamics between Germany and China, the expected consequences of CBAM were studied along six themes: (i) compatibility of the policy instrument; (ii) administrative work needed; (iii) stimulation of decarbonisation in foreign countries; (iv) competitive position of the German aluminium sector; (v) economic and geopolitical winners and losers; (vi) major risks of CBAM. Taking three perspectives – policy, society and experts – ensured a more balanced view on the influence of CBAM on decarbonisation in the aluminium sector. This led to a set of four main factors, which significantly overlap with the six themes identified. These four factors help in assessing the influence of CBAM and making CBAM more effective in achieving its objectives. These factors are:

- **Tailor-made**
  The more specified CBAM is in addition to the EU ETS, the more CBAM accelerates the decarbonisation in the (world-wide) aluminium sector.
- **Manageability**
  The work is expected to be manageable for aluminium companies from both the EU and non-EU countries. That should be in addition to the current declarations that are already being carried out by the sector when importing aluminium into the EU.

- **Export dependency**
  The more dependent the aluminium sector in a non-EU country is on the EU as export destination, the more CBAM will affect the aluminium trade between that specific non-EU country and the EU.

- **Geographical closeness**
  The closer the non-EU country is to the EU, the larger the impact of CBAM will be on that specific country.

These four determine the consequences of CBAM for any particular non-EU country. A more granular representation of these four main factors can be found in chapter 5.8.

Moreover, three conclusions can be drawn regarding the major risks of CBAM and its corresponding objectives, as identified in chapter 1.1.2.

- CBAM will have **a minor effect on carbon leakage** in the aluminium sector.
  Other factors will have a more significant direct impact on carbon leakage, because the majority of the emissions in the aluminium sector is indirect.

- The German aluminium sector will **lose part of its competitive position**.
  Mainly due to the lack of export rebates in the CBAM, but also due to resource shuffling and higher overall prices.

- **Carbon leakage & retaliation measures** are serious risks, resource shuffling is less important.
  Of the three major risks, resource shuffling can also be substantial, but is much less influential and does not have a comparable impact to the other two risks. Both carbon leakage and retaliation measures should be taken into account by the EC when continuing with the implementation of CBAM.

For the case of the German-Chinese aluminium trade, CBAM will have the following effects, which are surrounded by uncertainty. First, a switch to high-end aluminium products produced in Germany can be expected on the long-term. The same goes for the production of aluminium products in other EU countries. That is with one major assumption made, namely that EU Member States are still keen on producing products from the value chain. If so, high-end products are going to be the best option in terms of viability. On the short-term however, resource shuffling in China can be expected, because the amount of the aluminium produced with energy from RES is higher than the amount of aluminium shipped to the EU. Moreover, there is a small chance of carbon leakage in all CBAM sectors, although the chance is expected to be highest in the aluminium sector. That is because CBAM protects the EU aluminium sector the least of the proposed CBAM sectors. Fourth, it is likely that (the major) trading partners of the EU will react to CBAM with counteracting measures of retaliation. Those measures have already been announced by the major trading partners of the EU, including China. Sectoral based agreements on the volumes traded under CBAM could mitigate that effect and prevent a potential trade war between the EU and its trading partners.

This research has provided an overview of the more relevant fields of study that need to be considered in order to research a CBAM. Using insights from both economic and geopolitics, influential factors from both fields are analysed and brought together. From the economic perspective, insights from comparable policy instruments like a carbon tax and cap-and-trade system are used to come to a set of factors that determine the influence a CBAM can have. Similarly, implementation challenges regarding international relations and geopolitics are identified. Secondly, this research has extended the knowledge on the impact of domestic policy instruments on decarbonisation in foreign countries. Via a case study – taking multiple different perspectives into consideration – that specific relation between policy efforts in two different countries with separate governmental bodies was researched, which provided a balanced view on the relation. To enable assessing that impact, a unique set of impact variables was drawn up, which can be used in assessing any policy instruments that aims at an energy system that is more renewable energy based. Five categories of these impact variables were identified, which cover the fields of economics, geopolitics and sustainability.

To conclude, assessing the impact of CBAM on a specific sector from an economic and geopolitical perspective has proved to be a highly complex process, where each factor is met with a lot of uncertainty. This resulted in scattered information from a broad range of perspectives and fields of study. This makes it really hard to structure the system CBAM will be implemented in, and isolating factors of influence on CBAM is very difficult. The interdependencies between the factors and the policy instruments complicated the situation even more. However, a set of factors that can be used and applied for future policymaking is identified, backed by the balanced views of the different perspectives on CBAM. This led to a set of policy considerations that decision makers can use in the future implementation of CBAM, as well as in other future implementation processes of renewable energy policy instruments.

7.2. Reflection on the results from literature

By combining the insights from different perspectives, this research has made it easier to grasp the variety of themes related to CBAM. Besides the strength of using a broad range of themes for insights into CBAM, it can also be a pitfall and divert the attention away from the most relevant themes. With the conclusions in mind, it would have been valuable to research a more tangible and isolated scope. The main themes discussed in theory – REPIs, IR, geopolitics and enforcement – have proven valuable. Each of the fields is a complex theme on its own as well. A more scoped theoretical framework of the research would prove more tangible, but less insightful, because of the variety of factors that are of influence on the impact of CBAM. Therefore, due to the multifaceted character of CBAM, that range of themes was necessary. Several renewable energy policy instruments (REPIs) were discussed from a theoretical perspective, to distinguish insights for the influence CBAM might have on decarbonisation efforts. These insights led to the range of factors, which remains very broad. A more scoped set of insights might prove more valuable and accurate to future use of the results. The exploratory comparison between a carbon tax, a cap-and-trade system and CBAM serves as an excellent starting point for further analysis.

Despite this being a qualitative study, an attempt has been made to include economic factors as well, without going into details of scenarios for import rates and gain & loss in GDP. Loss of competitiveness of industries both inside and outside the EU is a very important point of discussion for governments when implementing carbon pricing instruments, this research adds to that point of discussion by providing insights in the consequences for specific trade flows. The nature of CBAM as a new REPI – directly impacting countries it is not implemented in – makes a large difference for the impact of the REPI for trade flows.

A third result was that the literature study presented relevant information on International Relations (IR). The importance of energy security in the implementation phase of CBAM is identified. The extensive body of literature already available on IR was not all relevant to this research, and the concise and specific overview of IR proved valuable to this research by emphasising the importance of energy security. Energy security might otherwise have been missed by policymakers of CBAM. Broadening the perspective on CBAM and its effects with insights from IR could have been partly covered by the geopolitics study in section 3.4.1 and 4.3.2, but for reasons of completeness it proved valuable to take the full perspective of IR. The mismatch between the two perspectives of RE and IR still remained before this research and is now further confirmed. It is extremely complex to conclude with solid statements when combining those two perspectives. In contrast to IR, this research does provide an extension of the geopolitics of renewable energy, with new insights regarding the geopolitical consequences of a new REPI.

Lastly, the enforcement challenges of CBAM were shortly addressed. This research provides insights in potential enforcement issues and practicalities of CBAM, via the literature study in chapter 3.4.2 and via the case study in chapter 4 and 5. The results showed that those issues are not to be overlooked in the implementation of CBAM, partly due to the unpopularity of the instrument amongst many of the actors. The implications of this research for the literature on enforcement were therefore limited.

7.3. Reflection on the results of the case study

The results from literature in chapter 3 were used as input for both the case study in chapter 4 and the results in chapter 5. The case study has implications for the implementation of CBAM, the aluminium sector and the dynamics between Germany and China. For CBAM, more insight is gained in the specific consequences for one of the CBAM sectors, which provides policymakers with starting points for the further negotiations. However, it was not possible to provide a more tangible starting point in the form of quantitative data of impacts for specific sectors due to the nature of the research. The data collected via the interviews does give insight into possible impacts of CBAM, but quantifying that was evidently impossible. Through that, an increased level of detail could prove valuable for research on CBAM and is lost via generalisation of the data from the interviews. That generalisation is already partly covered in the research of for example Eicke et al. and Evans et al. (2021; 2021).

This research also has implications for the expected interaction between CBAM and the EU ETS. As explained in chapter 5.1 most PIs prove to be more effective when combined. However, this conclusion will need to be further tested in quantitative studies, as well as in case studies on other CBAM sectors. A broader view on the inclusion of the aluminium sector into CBAM was provided. There is incomprehension in the sector for its inclusion in CBAM – the sector does not understand why they are included – despite the abundance of explanation of the EC on why they are. The inclusion of aluminium sector in CBAM and research on its consequent dynamics confirms some opinions of the sector, but places them in a broader perspective. Again, the qualitative nature of this research does not provide hard facts that the sector could use for a stronger lobby for the sector. The same holds for the implications for the dynamics between Germany and China. Concrete and specific consequences for the dynamics between the two countries could not be identified, which is mostly due to the vast uncertainty around CBAM, but the qualitative nature of the research certainly does not help in reducing that uncertainty. Moreover, as touched upon by some interviewed experts, CBAM could only mildly influence these dynamics (Appendix E.4.2 and E.4.3). The huge lack of data regarding the specific trade volumes, production locations and wide range of products that are part of the value chain of aluminium did not make it more doable to identify specific consequences for the dynamics either. For example, only generalised data about the total aluminium imports from China into the EU was available, which decreases the value of the results for the German and Chinese government. It proved much more challenging to include the Chinese and German perspective equally in the case study. Access to experts with the Chinese perspective was hard due to cultural and language barriers in the network of the researcher. Similarly, the language barriers greatly hindered data collection from Chinese policy documents and businesses was impossible and only partly covered by the English documents and experts interviewed.

Reflecting on the selection criteria for a case, as stated in chapter 2.2, is necessary. Both from the perspective of the aluminium sector itself, and from societal actors like analysts and scientists, the inclusion of aluminium as a CBAM sector proved to be debatable at the least; the decision of the EC is deemed incomprehensible. This also has an effect for the selection of the German-Chinese aluminium sector as a case study in this research as well. Four criteria were used: *typical, critical, combination and convenience*. Because the aluminium sector proved to be a mismatch with CBAM, the criteria need to be altered. Here, one criterion needs to be replaced by a new one: *generalisable*, instead of *convenience*. Convenience has proven to be a less important criterion for case selection, because in hindsight the sectors were not really distinguishable for the selection of the case, plus neither of the CBAM sectors significantly met the criterion. Still, it is important to emphasise that convenience can be of influence on the selection of the case, but not as one of the four main criteria.

Then the criterion substituting the *convenience* criterion: as explained in chapter 4.1 the aluminium sector is particularly different from the other four CBAM sectors and thus not *generalisable* to the other CBAM sectors. The value of the research could have been increased with including at least one of the other CBAM sectors, next to aluminium. It needs to be noted that a comparative case study of the five CBAM sectors was not possible within the time restrictions of this research.

In line with the enforcement challenges from literature as discussed above in section 7.2, this research provides new insights regarding the enforcement possibilities. The new insights regarding enforcement are also rather straightforward, which is sensible because of the uncertainty of the ongoing negotiations in the EP and the Council. That uncertainty also made it challenging to ensure the practicality and tangibility of the results. Both the enforcement and practicality issues are addressed.

The conclusions have been drawn specifically for the case itself. There are multiple considerations for future research on CBAM and other REPI that are to be implemented. The geopolitical and economic perspective in this research made it more difficult to grasp the complexity of the system researched. First, the context of the REPI is essential in researching new REPIs. This research has taken many factors and perspectives from this complex context. Factors that are more temporary, which are less predictable, play an important role in the implementation of a REPI such as CBAM. During the research, both energy crises relevant to CBAM and the aluminium trade between Germany and China became increasingly influential. Both crises worsened, decreasing the influence CBAM can have.

Researching the impact of domestic policy instruments on the decarbonisation in foreign countries also provided contributions to society as a whole. First, despite the large uncertainty surrounding CBAM, part of the uncertainty is taken away by providing factors to assess the impact CBAM has in a specific sector, both domestically and in foreign countries. The expectations from different perspectives were combined to provide a full and balanced overview of business, science and policy.

Also, this research provides factors of importance for both the aluminium sector and policymakers to ensure a more effective CBAM. An analysis of the aluminium sector, its value chain and the trade flows around the world provides a more balanced view than just the analysts from the sector itself have produced so far. It considers the different viewpoints of the actors and concludes on the suitability of the aluminium sector to be included in CBAM in its proposed form. This is especially valuable for the EP & the Council in its negotiations of the detailed implementation of CBAM, as well as to know better what to expect from CBAM as formulated in the 'Fit for 55' proposal. Allowing policymakers to better specify the proposal of CBAM will help in achieving a more efficient and effective EU Green Deal, for the EU, the Member States and their partners.

Thirdly, three concrete policy options were presented, which can be used in the further implementation of CBAM, both for the period until its expected start in 2023, as well as the period of its implementation. These policy options are:

- Excluding aluminium from the first group of sectors CBAM is implemented in.
- The likelihood of carbon leakage in the EU aluminium sector is not to be overestimated.
- Installation of an independent monitoring and enforcement authority.

7.4. Recommendations for future research

Following the conclusions as explained above, several directions for further research can be identified. Below the main recommendations for future research are outlined, but more detailed recommendations for the aluminium sector are possible too. The first recommendation is to investigate further what the impacts are for the other four CBAM sectors, using the factors and methodologies identified in this research. All other four CBAM sectors are likely to be affected more by CBAM, because there the emissions are mostly direct. That brings us to the second recommendation, namely to investigate what the influence of CBAM would be on foreign countries with a different scope of CBAM. In other words, what would the influence of CBAM be when indirect emissions are also included in the first phase starting in 2023. The same holds for including the exports in the CBAM, as well as choosing a different geographical scope or application sectors. Furthermore, it is possible to use the identified factors in this research to further quantify the influence of CBAM on the aluminium sector of Germany and China. Lastly, it is recommended to test the applicability on non-energy sectors, on sectors where the economic and geopolitical characteristics play an important role as well. Examples of these sectors are transport, logistics and the diffusion of technology.

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Appendices

A

Impact variables

A.1. Impact variables from theory

This part follows the structure of the list of impact variables from theory. Two categories are left out of this review, because of their limited relevance to this research, namely 'technology' and 'innovation'.

Overview impact variables from theory

An overview of the impact variables derived from comparable renewable energy policy instruments is given below:

1. (Neo-)Classical Economics:
    - Efficiency (Y. Li & Su, 2017; Ockwell, 2008)
    - Effectiveness (Azhgaliyeva et al., 2018; Y. Li & Su, 2017; Condon & Ignaciuk, 2013)
2. Environment:
    - Total carbon emissions (absolute): regional vs global (Banerjee, 2021; K. Zhang et al., 2020; Condon & Ignaciuk, 2013)
    - "Exported emissions" (Banerjee, 2021)
3. Mitigation costs: (Y. Li & Su, 2017; Bistline et al., 2020)
    - Policy changes (Azhgaliyeva et al., 2018)
    - Policy implementation (Azhgaliyeva et al., 2018)
    - Abatement costs (Banerjee, 2021)
    - Government expenditures on policy measures (K. Zhang et al., 2020; Y. Li & Su, 2017)
4. Technology:
    - Availability of (low-cost) fuel (Marbe & Harvey, 2006)
    - Power-to-heat ratio (Marbe & Harvey, 2006)
    - Levelized Cost Of Electricity (Marbe & Harvey, 2006)
5. Competitiveness companies: (Fouré et al., 2016)
    - Trade rates (Dong & Walley, 2012; K. Zhang et al., 2020; Condon & Ignaciuk, 2013)
    - Investment rates (K. Zhang et al., 2020; Shi et al., 2019)
    - Dependency on financial support (Thapar et al., 2016)
    - Prices (elasticity as well) (Banerjee, 2021; Bistline et al., 2020)
    - Tax share in the price (Shi et al., 2019)
    - Size of the annual demand (Shi et al., 2019; Marbe & Harvey, 2006)
6. (Geo)politics:
    - Risk of retaliation (Fouré et al., 2016)
    - GDP & welfare losses / wins (Bistline et al., 2020)
    - Import / export dependency (Banerjee, 2021)
    - Human capital development (Sodiq et al., 2019)
    - Social justice (Sodiq et al., 2019)
7. Corporate Social Responsibility:
    - Race-to-the-bottom (Luxmore, Hull, & Tang, 2018; Taebi & Safari, 2017; Rose, 2020)

8. (Soft) Innovation:
   - RE innovation (measured in patent data (p. 240), can be problematic) (Pitelis, 2018)
   - Learning and network effects (Shum, 2013)

Neoclassical economics

This first category of impact variables is the ones which are used most often in impact assessments, usually more quantitative studies. These two are *efficiency* and *effectiveness*. In generic terms, efficiency is the rate in which a certain amount of input - whether that be money, energy or time or something else - is converted into a particular amount of output - which could be the same concepts as with the input - during a process (Cambridge English Dictionary, n.d.). In terms of the efficiency of policy instruments, an example could be the return rate of money into an X amount of CO_2 emission reduction. In energy-related literature, often the term energy efficiency is used, to express the amount of energy that is wasted by using it (Ockwell, 2008). Li & Su use the term similarly to Ockwell, related to energy efficiency (Y. Li & Su, 2017; Ockwell, 2008). It is a highly rational and quantitative variable, stemming from the theory of Neo-Classical Economics (Ockwell, 2008).

Correspondingly, *effectiveness* is a second widely used variable in impact assessments. It too is highly rational and quantitative, since effectiveness means the extent to which the measures taken have the desired effect (Azhgaliyeva et al., 2018). Azhgaliyeva et al. have focused their whole research on the effectiveness of policy instruments, more specifically those related to increasing the uptake of renewable energy (2018). Often these two are taken together; in economic studies, as well as in impact assessments of renewable energy (RE) policy instruments (Y. Li & Su, 2017; Condon & Ignaciuk, 2013). Yet, these two have been researched over and over, thus it is enriching to look more in detail to other impact variables in research on RE policy instruments.

Environment

A second category of impact variables used is the ones concerning the environment, mostly emission-related. The first one, universally used in all research regarding reducing CO_2 emissions, is the total carbon emissions, measured in tons (T), kilotons (KT) or megatons (MT) (K. Zhang et al., 2020). Depending on the research and the case study, these concern the absolute emissions of either countries, regions or the total carbon emissions globally (K. Zhang et al., 2020). Next to these predominantly direct emissions, the "exported emissions" also need to be taken into account when assessing the impact (Banerjee, 2021). These exported emissions come into play when a country does have a carbon restricting policy instrument in place, while still having to pay the border taxes when exporting products to the BCA-implementing country (Banerjee, 2021).

Mitigation costs

In this third section of variables, the costs related to any mitigation or abatement efforts are included (Y. Li & Su, 2017; Bistline et al., 2020). Four different terms have been proposed by different researchers. The impact for "policy changes" or "policy implementation" for example mean the costs of the actual process of making the changes in policy, or implementing it (Azhgaliyeva et al., 2018). This could include costs for providing subsidies (Azhgaliyeva et al., 2018), however a clear distinction is lacking. Others call it simply the "abatement costs" or "government expenditures on policy measures - much broader terms - what implies that those subsidy costs are by definition also included (K. Zhang et al., 2020; Y. Li & Su, 2017).

Competitiveness companies

The next category is highly related to one of the main objectives of a BCA: the competitiveness of the companies. One of the objectives of a BCA is to level the playing field, which is all about protecting the competitiveness of the emitting companies (Fouré et al., 2016). Naturally, the majority of these companies are in the energy intensive sectors. Despite some of them being fairly economical, they are still highly relevant as a result of their strong ties to the BCA objective.

Starting with the trade rate, which are about the rates in the current situation: those not linked to the BCA (Dong & Walley, 2012; K. Zhang et al., 2020; Condon & Ignaciuk, 2013). Also the investment rates need to be taken into account, because these need to be carefully monitored when introducing new technology on a large scale, as with new policy instruments (K. Zhang et al., 2020; Shi et al., 2019). The better the rates are, to more project depend on financial support from governmental bodies: a third variable mentioned in previous literature (Thapar et al., 2016).

Furthermore, market dynamics need to be monitored and taken into account when assessing the impact of a policy instrument as well. Prices and their elasticity (Banerjee, 2021; Bistline et al., 2020), and the tax share in those products prices alike (Shi et al., 2019). Lastly, the size of the annual demand of the sector and the scoped trading partners need to be adjusted for (Shi et al., 2019; Marbe & Harvey, 2006).

Politics

One of the major risks of a BCA is the risk of retaliation of countries being inflicted on, related to the political variables (Fouré et al., 2016). Each country and region will want to protect their citizens and their GDP, by preventing any welfare losses (Bistline et al., 2020). This very practical variable is of vital importance to government, their re-election depends on it. A variable that is less in sight of a country's inhabitants is the import / export dependency of the country, as well as its companies (Banerjee, 2021). Being a major EU-exporter would mean larger costs and vice versa.

A last set of variables linked to the political dimension is human capital development of the instrument posed on both the implementing country, as well as the country that the mechanism is posed upon (Sodiq et al., 2019). Sodiq et al. also highlight the need for an assessment of social justice, although that might be lower on the agenda of some countries (2019).

Technology

The *technology* category is less relevant for this study, since this study focuses more on the non-economical impacts. Moreover, these impacts strongly depend on the type of technology address in the policy instrument. However, the technology related impact still need to be shortly elaborated on. The availability of a (low-cost) fuel to actually produce the energy is a first (Marbe & Harvey, 2006). Also the power-to-heat ratio is important, but again that ratio strongly depends on the technology used, thus more generalised statement cannot be made (Marbe & Harvey, 2006). The same holds for the third, the levelized cost of electricity – the LCOE – of the specific technology (Marbe & Harvey, 2006). It can be concluded that these three technology variables are less relevant for this research since they are too specific and technology dependent for this research that focuses on the larger picture of all RE technologies.

(Soft) Innovation

The innovation dimension of variables is a softer means of innovation compared to the rather 'hard' technical innovation in the *technology* dimension, and also less relevant for this research. Innovation is often driven by universities and companies, something that can be measured via the patent data of a country (Pitelis, 2018). However, including this could be problematic at the same time, as a whole new dimension opens up and is only visible on the long term (Pitelis, 2018). Lastly is the learning and network effects, a variable that will only be visible on the long term, long after implementation of a BCA (Shum, 2013).

Non-energy insights

Next to renewable energy policy instruments used for carbon emission reduction, other concepts can provide valuable insights into assessing the impact of CBAM as well, such as Corporate Social Responsibility (CSR) and soft law. The aim of briefly addressing these theories is to gain insights from similar phenomena and look at possibilities of enforcing guidelines. Despite the rather different nature of the objective – reducing the social and societal impact corporations have versus reducing the emissions of companies and countries – CSR and its 'race-to-the-bottom' show similarities with the risk of carbon leakage and reduced competitiveness. In CSR literature the issue of the 'race-to-the-bottom' has often been identified (Luxmore et al., 2018; Taebi & Safari, 2017; Rose, 2020). It is described as 'a rush to reduce environmental and other regulations to attract and retain predatory Multi-National Enterprises' (Luxmore et al., 2018). In other words, both developed and developing countries try to delay their adoption of environmental and social regulations needed for a more just and environmental friendly society on Earth, in order to maintain their attractive business environment for corporations to settle in. With a continuous delay, a 'race-to-the-bottom' has emerged where countries are waiting on each other before adopting the required regulations, such as regulation aimed at reducing carbon emissions (Taebi & Safari, 2017).

Until recently however, CSR was an optional objective for corporations subjective to 'soft law'. Soft law is 'a quasi-legal instrument that aims to institutionalize a social norm without exerting legally-binding force' (Taebi & Safari, 2017). For regulators it was difficult to enforce the regulations, since no existing legally-binding instruments were in place. Therefore, other strategies needed to be invented, to penalise voluntary rules, despite a recent change in CSR being subjective to 'hard law' rather than soft law with the introduction of the EU Directive on CSR (Rose, 2020). Still, for other concepts outside CSR, such as CBAM, a penalisation of voluntary rules would be highly valuable. Such a penalisation is highly relevant for this research as well, as it could greatly influence the impact of CBAM and its successful implementation.

A.2. Factors for impact after the analysis

After and during the analysis, a list of factors of impact has been constructed. The summarised version of that list – that only includes the most important ones, and no merged factors – can be found in chapter 5.8. Here the full list is displayed, below:

- Neo-Classical Economics:
  - Efficiency
  - Effectiveness
- Environment:
  - Total carbon emissions (absolute): regional vs global
  - "Exported emissions"
- Mitigation costs:
  - Policy changes
  - Policy implementation
  - Abatement costs
  - Government expenditures on policy measures
- Technology:
  - Availability of (low-cost) fuel
  - Power-to-heat ratio
  - Levelized Cost Of Electricity
- Competitiveness companies:
  - Trade rates
  - Investment rates
  - Dependency on financial support
  - Prices (elasticity as well)
  - Tax share in the price
  - Size of the annual demand
- (Geo)politics:
  - GDP & welfare losses / wins
  - Import / export dependency
  - Human capital development
  - Social justice
  - Risk of carbon leakage
  - Cascading protectionism
  - Energy security
  - Degree of multilateral cooperation
  - Leverage currently present between the researched countries
  - Degree of "weak spot"
- Corporate Social Responsibility:
  - Degree of characteristics of a Race-to-the-bottom
- (Soft) Innovation:
  - RE innovation (measured in patent data (p. 240), can be problematic)
  - Learning and network effects
- Form of the PI
  - Flexibility
  - Degree of Tailor-made
  - Usage revenue
  - Structure of the performance evaluation
- Market dynamics
  - Market stability (also expected stability after implementation of the PI)
  - Share of RE in the energy mix
  - Energy prices

  - Current push for decarbonisation present in the sector
- Enforcement
  - Degree of enforcement transparency
- Case specific
  - Case vulnerability
  - Type of emissions
  - Main locations of the emissions
  - Production capacity of the sector

The list can be used as output of the research.

B

System analysis

This appendix provides further information on the system analysis and the actor analysis conducted for this research. It starts with the system analysis by discussing and explaining two major techniques of system analysis: a causal relations diagram and a system diagram. Then the actor analysis is explained, of which the Power-Interest Grid is a part.

B.1. System analysis

Performance criteria

These performance criteria are mainly taken from the literature review on impact assessment, which can be found in chapter 3.2.6. Also,

1. **Abatement costs**
2. **Trade rates**
3. **Investment rates**
4. **Efficiency**
5. **Effectiveness**
6. **GDP & welfare losses**
7. **Human capital development**
8. **Risk of retaliation**

Causal relations diagram

The causal relations diagram – also called a causal map – is a method for identifying the factors of influence in a system and map them with their mutual relations (Enserink et al., 2010). Below the causal relations diagram can be found. Four types of factors are identified, which is not a part of the process of making a causal map, but allows for easier construction of the system diagram – discussed and found in the next paragraph. In this map the colours of the factors (the ovals) do not have function yet, and can therefore be ignored. The colours of the arrows however do have a function: they indicate if the relation is positive or negative, respectively green and red. A positive relation indicates that when factor A is higher or larger, factor B – at the end of the arrow – also increases (Enserink et al., 2010). The same holds for when factor A decreases; then factor B also decreases. A negative relation means the opposite: an increase in factor A leads to a decrease in factor B and vice versa (Enserink et al., 2010). A green arrow means a strengthening relation, and a red arrow a weakening relation.

System diagram

A new step in analysing the system the case is placed in, after mapping the causal relations, is a system diagram. Several categories of elements can be identified in the diagram. These are:

- **Means of the problem owner**. These are the orange rectangles on the left side of the diagram. In this case there is no real problem owner, as all actors are relatively equally affected by the problem as defined in chapter 1.1.3, but since Germany is one of the EU Member States that needs to deal with CBAM

Figure B.1: The causal relations diagram of the case of the dynamics of the German-Chinese aluminium trade.

in the case of the aluminium trade between Germany and China, this system diagram is constructed from the perspective of the German national government. The means of the problem owner are the actions the actor can do to influence the factors in the system, all in order to improve the performance of the system on the criteria set.

- **Criteria**. These are the blue rectangles on the right side of the diagram. These can be seen as the key performance indicators the performance of the system is test on. The criteria are taken from both literature and interviews and are argued for in chapter 4.
- **External drivers**. These are the light green ovals at the top of the diagram. These are factors that cannot be influenced by the factors in the system, as well as by the problem owner. They can be altered by other actors in the system, such as China in this case, but cannot directly be changed by the problem owner.
- **Factors**. These are the white ovals in the centre of the diagram, and these are the once that are changed by both the means of the problem owner and the external drivers. They in turn adjust the performance of the system on specific criteria.

B.2. Actor analysis

Power-Interest Grid

Identify the key players and other actors involved in the system.

In figure B.3 the Power-Interest Grid can be found.

Key players

As explained in more detail in chapter 4, the key players in the case are the following ones, which were identified by constructing the Power-Interest Grid in figure B.3.

Full list of actors involved

Below a full list of the actors identified in the case can be found. This the same group as the ones that can be seen in the Power-Interest Grid in figure B.3.

- European Commission
- WTO
- National Government of Germany
- National Government of China
- Producers of aluminium in Germany

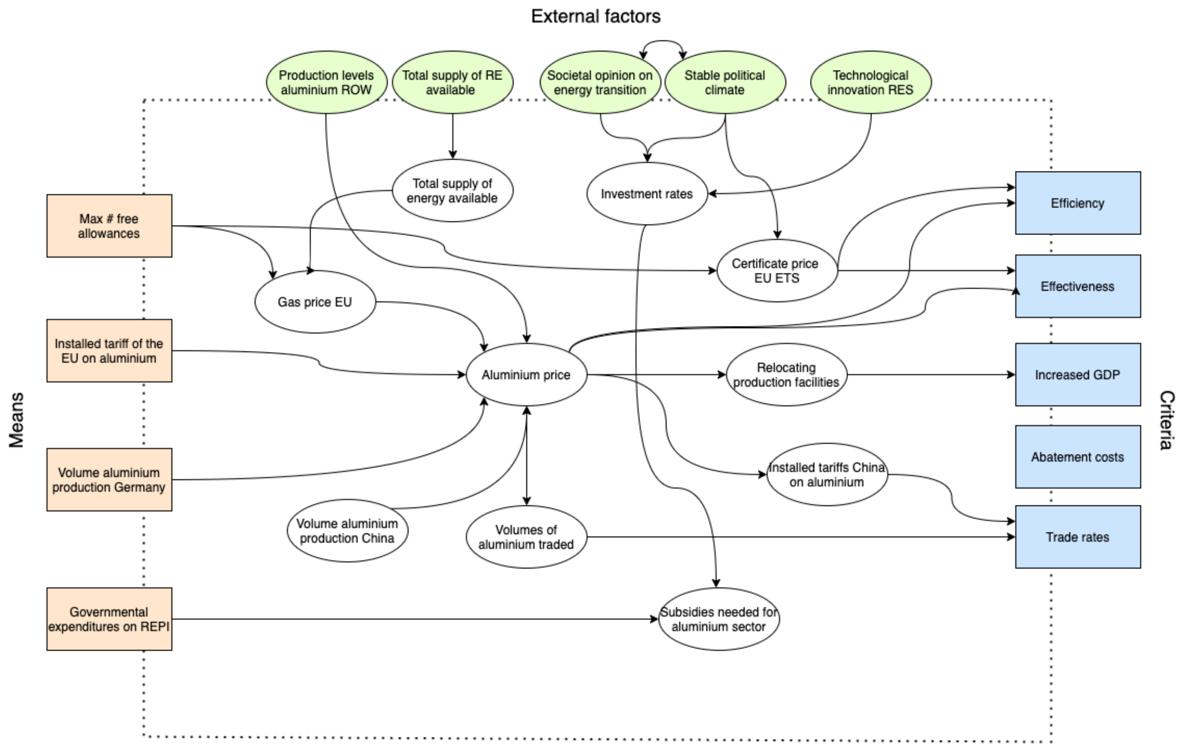

Figure B.2: The system diagram of the case of the dynamics of the German-Chinese aluminium trade.

- Producers of aluminium in China
- Council of Europe
- European Parliament
- DG CLIMA
- DG TAXUD
- DG TRADE
- Member States of EU27
- other European countries
- Developing countries ROW
- Developed countries ROW
- Manufacturers of the final products of aluminium
- Customers of the final product of aluminium
- Analysts of the aluminium sector
- Civil society groups
- Trade associations
- Interest groups of aluminium producers
- Companies that transport aluminium
- Environmental interest groups

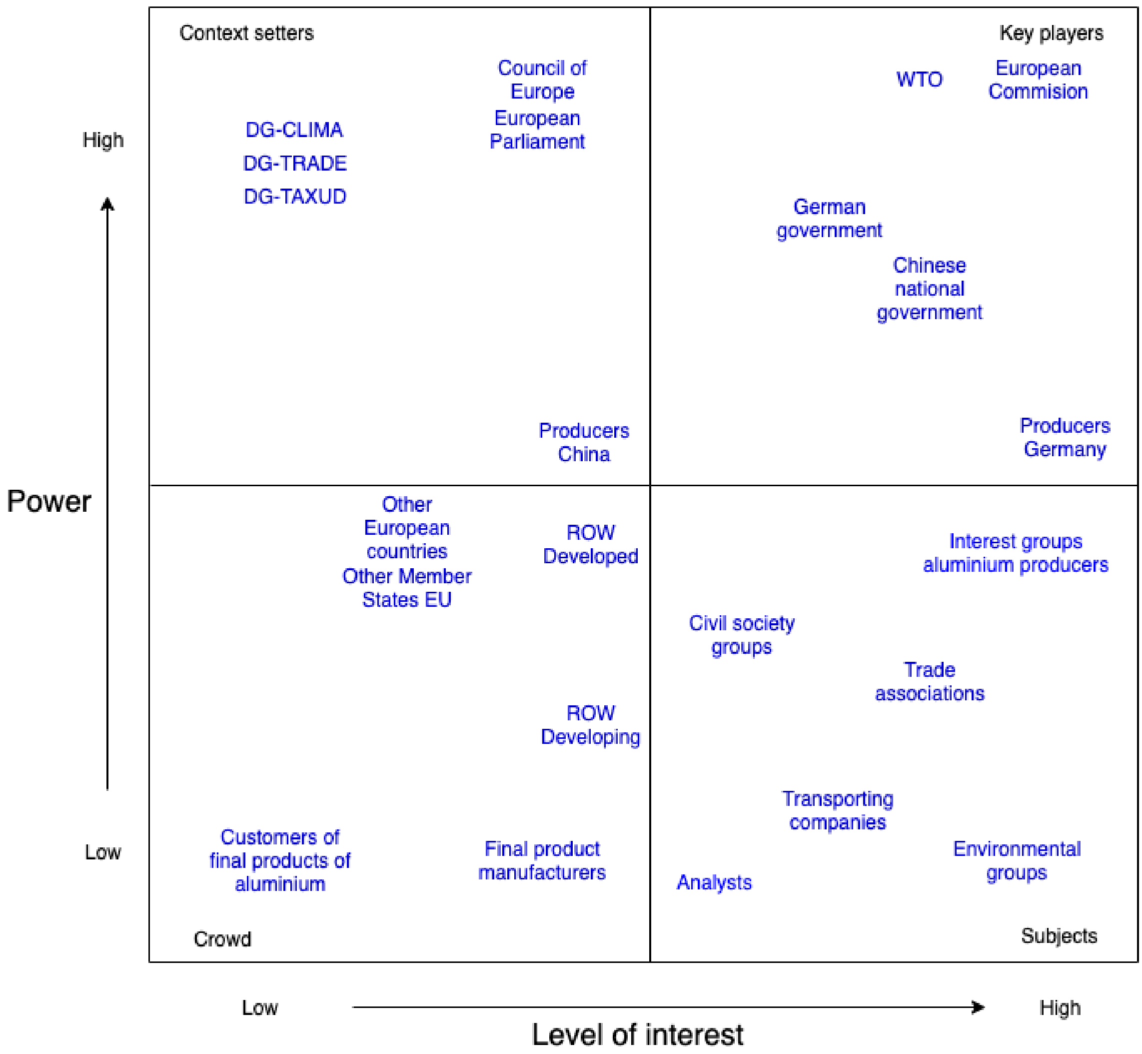

Figure B.3: The Power-Interest grid of the case.

C

Background information on the case

C.1. Introduction

Two reasons why the emissions of carbon of countries without CO_2 regulation would increase as a result from carbon leakage: no abatement measures are adopted in the unregulated country leading to a lacking incentive to decrease the companies carbon emissions (Fouré et al., 2016). Secondly, the unregulated country could even increase the activities of their carbon emitting industry due to the emerged competitive advantage over regions with abatement measures in force (Bellora & Fontagné, 2020; Antimiani et al., 2013).

Intro to CBAM

With far-reaching consequences for many sectors and trading partners, the European Commission decided to organise feedback sessions with each of those sectors and trading partners, allowing them to influence the implementation of the mechanism (Dybka et al., 2021). These consultations were held over the course of July until October. The included trading partners that were consulted are: India, Japan, Mexico, South-Korea, Russia, South Africa, Ukraine and the US (Dybka et al., 2021). Also, different types of organisations have participated, roughly categorised in three categories (Marcu et al., 2020).

The first category of organisations are think tanks, academia and environmental organisations (Marcu et al., 2020). In general, they were quite enthusiastic about an implementation of the CBAM, although a minority of them was more nuanced concerning the motives for implementing the CBAM. Secondly, governments and governmental bodies, for example of the mentioned countries (Marcu et al., 2020). It makes sense that the second category of participants of the feedback sessions were more opposed to the regulation, since the position of companies in their countries will likely deteriorate. Thirdly are businesses (Marcu et al., 2020). They had a *wait and see strategy*, since their new position heavily depends on the exact execution of the mechanisms, varying per sector and the degree of trade with partners from outside the EU.

After the feedback sessions, the EC has been outreaching its activities around the CBAM, by involving the different related Directive-Generals (DGs) and EU delegations of the European External Action Service (EEAS) (Ireland, 2021). As with previous attempts of implementing a CBAM, the involved DGs are the designing DG TAXUD, together with the DG CLIMA and the DG TRADE. This period ended with an EC Conference and plenary sitting specifically on the CBAM on February 15, 2021 (Jadot et al., 2021). Among its conclusions was a summary of the objectives and criteria to be met in order to meet those objectives. These will be further discussed in the next paragraph.

CBAM objectives

The first of these four main objectives is to limit emissions leakage as explained in section 1.1, thus it needs no further explanation of the risk and of leakage and its corresponding objective. Secondly, the CBAM aims to protect against reduced competitiveness of domestic industries (Marcu et al., 2020). When the carbon price in the EU ETS would rise significantly, the prices of products produced by domestic industries would rise as well. Consequently the position of competitiveness of industries in the EU weakens in relation to those industries in countries without such policy instruments reducing carbon emission (Evans et al., 2021).

Incentivising foreign trade partners and foreign producers to adopt measures comparably to the EU's is the third objective of the CBAM (Marcu et al., 2020). The 'simplest' solution for countries heavily affected by the CBAM would be to adopt policy instruments comparable to the EU ETS - such as a cap-and-trade system, domestic carbon adjustments or a carbon tax (Bellora & Fontagné, 2020). However, implementing these policy instruments costs a lot of time and effort, and often democratic restrictions are in place. Nonetheless, incentivising countries to adopt renewable energy policy instruments is one of the objectives of the CBAM.

Lastly, the fourth objective of the CBAM is yielding revenue that can be used to fund investment in the innovation of clean technology, to modernise the current infrastructure and to finance international climate measures (Marcu et al., 2020). By also spending the revenues from the CBAM on projects reducing greenhouse gas emissions, the CBAM serves a 'double' value. That value would even more larger if the revenue collected under the CBAM would go to the EU's budget for countries most vulnerable to climate change, as part of the development aid budget. Next to four main objectives above, the EP has formulated one extra objective, which is in essence the rephrased mission of the CBAM: enhancing the climate action of the European Union (Jadot et al., 2021).

The pros and cons identified (ESG Enterprise, 2021):

- Pros
  - Generate revenue to be used for measures mitigating climate change, especially in developing countries with less means to adopt more strict climate policies.
  - Reduce the risk of carbon leakage.
- Cons
  - It can hinder the development of developing countries via the extra costs.
  - WTO compatibility

C.2. Trade flows of CBAM sectors

Aluminium

In C.2 an overview of the trade flows of Iron & Steel into the EU can be found, with the width of the lines into the EU displaying the volume of the flows. As discussed in chapter 4.1 as well, Russia and China both export a large share of the total export into the EU, with around 14% of all Iron & Steel.

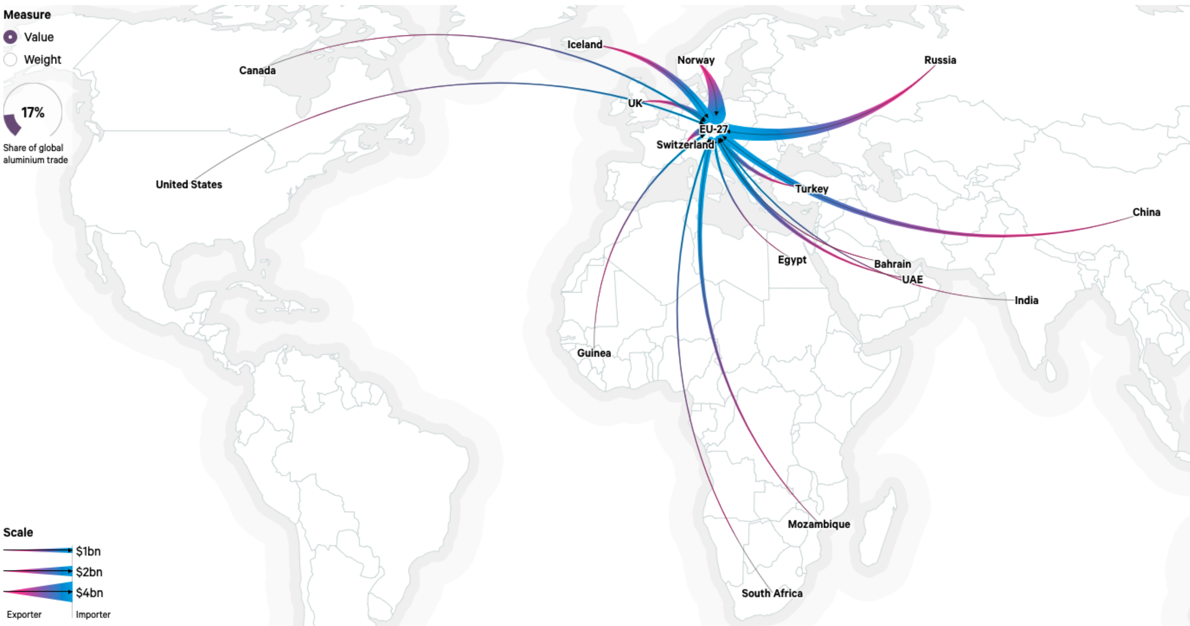

Figure C.1: The trade flows of Aluminium imported into the EU.

Source: *(Kardish, Mäder, et al., 2021)*

Iron & Steel

In C.2 an overview of the trade flows of Aluminium into the EU can be found, with the width of the lines into the EU displaying the volume of the flows.

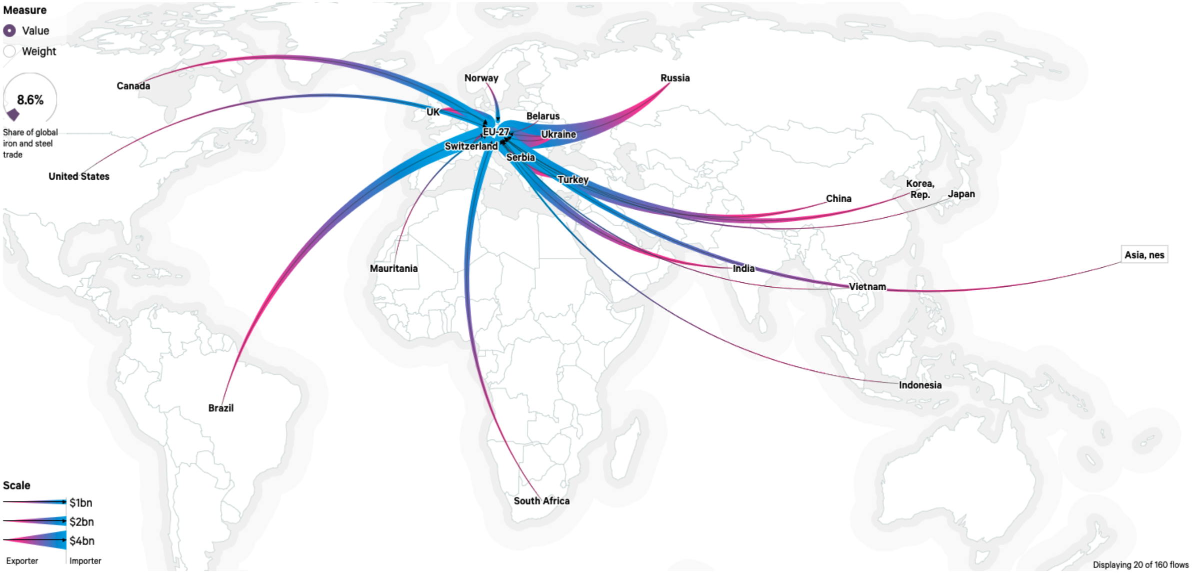

Figure C.2: The trade flows of Steel & Iron imported into the EU.

Source: *(Kardish, Mäder, et al., 2021)*

Cement

In C.2 an overview of the trade flows of Cement into the EU can be found, with the width of the lines into the EU displaying the volume of the flows. As discussed in chapter 4.1 as well, Turkey is responsible for the largest share of cement exported into the EU, around 30% of the total.

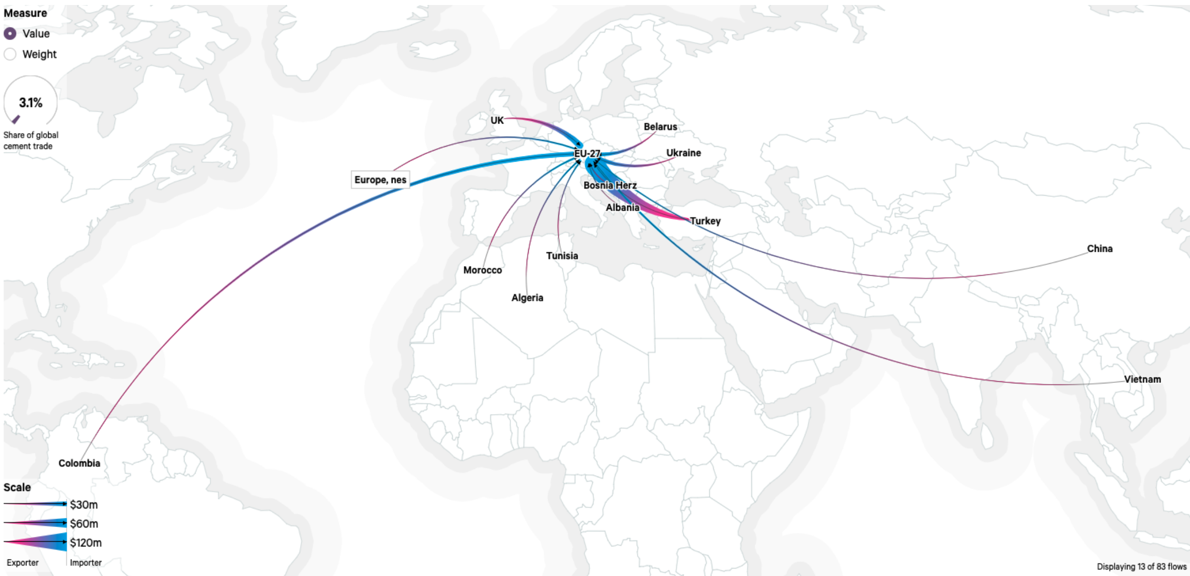

Figure C.3: The trade flows of Cement imported into the EU.

Source: *(Kardish, Mäder, et al., 2021)*

Fertilizers

In C.4 an overview of the trade flows of fertilizers into the EU can be found, with the width of the lines into the EU displaying the volume of the flows. As discussed in chapter 4.1 as well, Russia exports by far the most fertilizers into the EU with around 30% of all fertilizers exported to the EU.

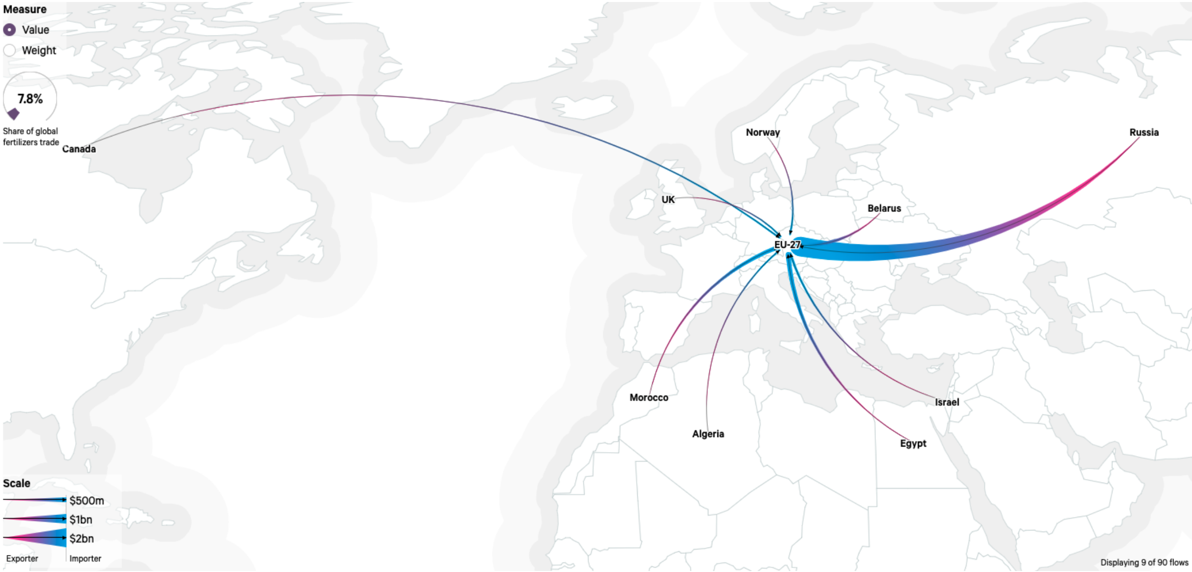

Figure C.4: The trade flows of Fertilizers imported into the EU.

Source: *(Kardish, Mäder, et al., 2021)*

D

Interview approach

In this appendix the approach for each of the interviews is explained further. It starts with an explanation of the selection of interviewees, and the second section entails the questions asked during the interview. The latter part starts with a list of the 6 main questions. Then the three extra questions that were asked when possible and relevant are listed, and lastly a list of the follow-up questions can be found.

D.1. Selection of interviewees

For the selection of the interviewees 33 people were contacted from the various backgrounds as explained in chapter 2.2. Via LinkedIn and basic Google searches the interviewees were found and selected using the following criteria:

- Is the person an expert in the field of renewable energy policy?
- Is the person part of a company active in the aluminium sector?
- Is the person part of a think tank specialising in energy?
- Is the person a policy officer with a focus on energy policy and renewable energy policy instruments?
- Does the person know something about geopolitics? Preferably in the energy transition?

As said, 33 people were contacted. Many of them did not reply at all, or quickly denied the request. As stated in chapter 6 as well, the most common reason for denying the request was that the person perceived their knowledge of one of the aspects of the research insufficient to actually participate in the interview. Out of these 33, 13 people agreed to do an interview. Eventually 1 of those 13 actually were able to plan the interview well in the timespan of this research. The remaining 2 people confirmed that they wanted to participate, but never replied to the reminder any more.

D.2. Central themes in the interviews

Six central themes were identified to be addressed in the interviews. These are both derived from the literature research in chapter 3, as well as linkages to the different objectives of CBAM. These themes are also used to structure the result section of the research. The themes are outlined in the next six subsections. Afterwards, questions were formulated along the six themes.

Theme 1: Combining policy instruments

Policy instruments work more effective towards their objectives when combined with other policy instruments.

- The working of different PIs is definitely improved by implementation a mix of them. However, they are still separate instruments, so it is hard to distinguish the working of both, apart from the EU ETS price. Decarbonisation efforts globally will probably be increased. Still, CBAM is aimed at reinforcing the working of the EU ETS, so it makes sense.

- In other situations a border adjustment might not be as reinforcing as CBAM.

Theme 2: Administrative burden

A huge administrative burden for the companies in the CBAM sectors can be expected.

- It is a very large administrative burden for many companies, which will definitely annoy them. CBAM might even be too much extra work for them to be 'satisfied' with it, foreign companies will definitely not like the EU for it.
- However, the trial period of just doing the administrative work, and not paying, can allow companies to get used to it over the years. Although the period might still be too short for the companies really to get used to them.

Theme 3: Foreign countries adopting REPIs

One of the objectives of CBAM is to stimulate foreign countries to also adopt PIs comparable to CBAM.

- 50/50, so hard to say. As with GDPR, the EU is setting an example and countries definitely follow the standards, but this might be the last push over the edge, meaning that some (more powerful) countries will counter the measure with their own measures.

Theme 4: Competitive position of the CBAM sectors

A second major objective of CBAM, a large part of the rationale in fact, is to protect the competitive position of the CBAM sectors in the EU. Specifically, the interviews will be focusing on the competitive position of the EU aluminium sector.

- Outside, yes, if they import to the EU.
- In the EU, their position is the same, at least that is how it is meant. Carbon leakage could occur, but the chances are much lower with CBAM in place.

Theme 5: Economic and geopolitical consequences – winners or losers

In geopolitics, winners and losers are identified as a result from the energy transition towards an energy system fully powered by RES. Can these be identified as well in the case of the aluminium sector?

- Economically, all producers are to some extent the losers, as are the customers. However, foreign producers will be partly affected, due to their mix of export destinations they supply to. Still such a global sector will definitely all lose.
- Geopolitically, countries are more affected than companies. Major aluminium producing countries will in turn lose as well, due to the forced change to more RES. However, some producers will make a disruptive shift, to better distinguish themselves and try to gain an advantage of others. That is quite a risky decision.

Theme 6: Risks of CBAM

Many risks of CBAM have been identified in literature and by analysts, the interviews will dive into the likelihood of these risks.

- There will definitely be countermeasures, but retaliation might be too extreme. A tariff war is on the verge, but can still be prevented through more dialogue.
- Resource shuffling will also happen, but not at a very large scale. Few countries have the power to do so.
- Market deprivation is going to happen as well, although it is very indirect. Part of the first answer.
- Carbon leakage not so much. Incidentally it will happen though.

These themes in turn were the input for the questions of the interviews.

D.3. Interview guide and questions

Each of the interviews was conducted semi-structured, as explained in chapter 2. This means that the same list of questions is used in each of the interviews, while there was still room for follow up questions wherever possible and relevant.

Main questions

Six main questions were asked during each of the interview.

Question 1

It is often mentioned that policy instruments work best in a mix of policy instruments. Do you think CBAM will amplify the operation of the EU ETS, and why?

Question 2

To what extent do you think the CBAM is putting an administrative burden on companies and will that hinder trading activities?

Question 3

One of the main goals of CBAM is stimulating foreign countries to also adopt similar policy instruments to an ETS or carbon tax. What do you think the chances are of that happening?

Question 4

Do you think industrial clusters of for example aluminium will lose their competitive position? Both in the EU, as well as outside of it? Why?

Question 5

To what extent do you think there are winners and losers in the aluminium sector, as a result from the increasing share of renewables in the energy supply? Economically and geopolitically? Is there a difference between (types of) countries in their possible opposition of CBAM?

Question 6

To what extent do you think the expected risks of CBAM will occur? That is about three main risks:

1. Carbon leakage
2. Risk of retaliation
3. Resource shuffling

Extra questions

Three extra questions were asked, with three different themes. These questions were asked when the interview was coming to an end, to ask the interviewee about their personal opinion. In order of importance and frequency of asking in each of the interview, these questions are:

1. What should the EU do to implement the CBAM successfully?
2. Do you think actors and countries will *behave strategically* when it comes to CBAM and why? That is, during the negotiation phase, the implementation phase and once installed?
3. Are the extremely high gas prices present in Europe of influence on decarbonisation and CBAM? That is, during the time of the interviews in October and November 2021?

Follow up questions

A large set of follow up questions was set up, to allow for more detailed questions once relevant in the interview. They are categorised into three categories: general, case and CBAM questions.

General questions

These general questions were asked as a mere introduction in the interview, to get on the same page regarding background of the interviewee and interviewer, plus to loosen up the interviewee when needed.

1. What is the organisation you work for?
2. What type of organisation is it?
3. What is your role in that organisation?
4. What is your expertise?
5. To what extent is your organisation involved in CBAM?

Case questions

These questions were aimed at discovering more detailed information on the case of dynamics in the German-Chinese aluminium trade. These were specifically used during the interviews with people from the aluminium sector, as well as the interviews with China experts.

1. What place does the organisation have in the value chain of aluminium?
2. When business / producers:
    (a) Who are you competitors?
    (b) Where does your supply come from?
    (c) Who are your targeted customers?
3. When analysts:
    (a) What part of the value chain of aluminium do you think is most vulnerable to the CBAM?
    (b) What is the role of Germany in the value chain?
    (c) How would you describe the economic and political relation between Germany and China?
        i. What factors play a role?
        ii. What major events have led to this situation?
        iii. What other countries have a significant influence on their relation?
    (d) How do you think their relation will evolve, if there is NO implemtation of CBAM?
    (e) How do you think their relation will evolve, if CBAM is implemented?
4. When scientists or analysts:
    (a) What part of the value chain of aluminium do you think is most vulnerable to the CBAM?
    (b) What is the role of Germany in the value chain?
    (c) How would you describe the economic and political relation between Germany and China?
        i. What factors play a role?
        ii. What major events have led to this situation?
        iii. What other countries have a significant influence on their relation?
    (d) How do you think their relation will evolve, if there is NO implemtation of CBAM?
    (e) How do you think their relation will evolve, if CBAM is implemented?

CBAM questions

1. What do you know about the Carbon Border Adjustment Mechanism?
2. What do you know about the EU ETS?
3. Do you think carbon leakage is a realistic consequence of the EU ETS price that keeps increasing?
4. How do you think your organisation will be affected by the CBAM?
5. Will there be directly increased costs in your organisation?
6. What role can an EU member-state play in the forming of the CBAM?
7. Do you agree with the European Commission with the fact that CBAM does not violate WTO Law?
8. Do you think the CBAM is an effective policy instrument, and why?
9. Is there a difference between (types of) countries in their possible opposition of CBAM?

E
Interviews

This appendix entails the summaries of each of the interviews. The appendix is structured along the four groups of actors interviewed: Aluminium sector; Policy makers; Scientists; Analysts. Some of the interviews were recorded and transcribed. However, not all interviewees gave permissions to do so. Therefore, to maintain the consistency in the interviews, a summary of each interview has been made with the important insights and quotes where possible. A second reason to do so is the limited added value of adding the full transcript of each interview, due to their extensive length of roughly 10 pages, most even more. The transcripts are available upon request at the author.

Table E.1: Overview of the interviewees and their role & perspective.

Group	**Interviewee**	**Role**
Aluminium sector	Emanuele Manigrassi	*Public Affairs Manager* *European Aluminium*
	Anonymous	*Board Member Sustainability* *European Aluminium producer*
	Cilian O'Donoghue	*Director Energy & Climate Change* *Eurometaux*
	Anonymous	*Industry analyst with focus on Steel* *German think tank for the metal sector*
Policymakers	Anonymous	*Policy Officer* *EC – DG-CLIMA*
Scientists	Benjamin Silvester	*PhD IR & Energy System Transitions* *University of Stavanger*
	Oluf Langhelle	*Professor Energy Policy* *University of Stavanger*
	Anonymous	*Researcher European Studies* *A Chinese University*
Analysts	Sarah Jackson	*Policy analyst* *E3G*
	Lina Li	*Senior Manager Carbon Market & Pricing* *Adelphi; ICAP*
	Coby van der Linde	*Director* *CIEP*

In table E.1 an overview of the interviewees with their roles, and the perspective the interview is placed in can be found.

E.1. Aluminium sector

E.1.1. Representative interest group of aluminium

This interview was conducted with Emanuele Manigrassi of the European Aluminium Association. The interview was conducted in English.

Q1: Combining policy instruments The working of policy instruments is not the expertise of the interviewee, thus he did not feel that it was his position to answer this question.

Q2: Administrative burden

- More paperwork is evidently bringing in extra costs, but most of the aluminium transporters already have to declare their goods, so in that sense it does not mean so much extra work.
- More important is the need for a monitoring agency of the EU, that will also costs quite a lot.

Q3: Stimulating foreign countries

- Hard to say, since the policy instrument is not tested at all.
- However, we see that some countries are already setting up similar systems to the ETS, or a carbon tax, but it is unclear if that is directly related to the CBAM.

Q4: Changing competitive advantages

- There are definitely changes, but not in the right direction for the aluminium sector. Exports are affected, which even mean losing on their competitive position.
- Aluminium is less affected by CBAM than the other CBAM sectors.
- If a shift to using more recycled aluminium is possible, only 5% of the electricity needs to be used, making it much easier for the sector to gain an advantage.
- The price of aluminium is set globally, so the EU sector will lose position due to higher prices here.
- The aluminium sector in the EU also loses position because they compete with the steel sector as well, especially the international market.

Q5: Winners and losers, from economical and geopolitical perspective

- Aluminium is quite a different sector than the other CBAM sectors, making it strange that they are included. In that sense, the EU aluminium sectors is certainly not winning.
- However, the EC is proactive in helping the aluminium sector deal with the new instrument.
- In the energy transition as a whole, aluminium will keep playing an important role, as it is one of critical materials required for many of the RE technologies – solar, batteries, etc.
- The EU loses leverage and position in general, because they do not fully help their industry. Export rebates are not included in CBAM.
- The EU will always need to import aluminium as well, as the production in the EU is not high enough, and recycling everything we have now is not sufficient either.

Q6: Expected risks actually occurring

- Carbon leakage is a real risk, it has already happened since 2003: 30% of the primary aluminium production facilities have left the EU. That is even with the current ETS scheme in place, as a measure to prevent carbon leakage.
- Resource shuffling in China is a risk that is highly anticipated on, because they have sufficient capacity to 'produce' the aluminium meant for the EU market with RE, and the rest will be ceteris paribus in that situation.

Ending questions

- The Commission should not have included the aluminium sector in the CBAM, because its effect is minimal until the indirect emissions are included as well. And in that situation a lot needs to change for the aluminium sector to be on board as well.
- Member states of the EU will definitely try to gain as much for their CBAM sectors, compared to foreign countries.

E.1.2. Aluminium producer

Before participating in the interview, the interviewee required the researcher to process the information from the interview anonymously. Therefore, the interview was not recorded and thus no transcript was constructed. During the interview, notes were made and those were processed into a display of the insights from the interview that was consistent with the other interview; namely by structuring the answers along the questions asked.

The interviewee is Head of Sustainability at a large European aluminium producer.

Notes interview
Q1: Combining policy instruments Since the interviewee does not have a background in policy evaluation, nor is active in that field, the question was irrelevant to ask.

Q2: Administrative burden

- Surely it will mean extra work, but it is a good exercise for the affected sectors. It is a challenge to become comfortable with the new data and processing that new data.
- Who will check it the tasks performed by the companies? A regulatory agency should be appointed to do so.
- An example: Audit certification on site at smelters and rolling companies is now being done. With all that, including an audit of the audit, many actors were still able to manipulate the data. It is quite vulnerable and a lot of work to do it properly.

Q3: Stimulating foreign countries

- With smelters: doesn't make much of a difference. Not so much of influence.
- Recycling the capacities used would be good, much less emissions with recycled aluminium and it is also cheaper to export as well.
- A lot of worries on what china will do, as many companies and organisations have no clue.

Q4: Changing competitive advantages

- For smelters there could be large damages done to their competitive position, compared to smelters outside the EU.

Q5: Winners and losers, from economical and geopolitical perspective

- The aluminium sector is less exposed to the CBAM, thus less of a loser. Mainly because indirect emissions not included due to indirect compensation.
- Costs of CO_2 are included in the marginal costs of electricity, so that makes the aluminium sector also less vulnerable.

Q6: Expected risks actually occurring

- When free allowances are phased out, CBAM is not enough to prevent carbon leakage.
- Best *for the aluminium sector* to use the revenues generated from CBAM for recycling aluminium.
- Recycling aluminium could lead to a 50% decrease of the total emissions, plus it would be in line with circular economy packages.
- Risk of aluminium production in China: resource shuffling. 10% of the production is now produced with hydro power, which is sufficient to use just for Europe, to avoid having to pay the CBAM tariffs.
- Calculation of carbon content becomes more complex more down the value chain.
- Another issue: exports are not included in CBAM, making it not fair to EU aluminium producers in their competition for non-EU markets.

Ending questions

- Keep the free allowances until we know that CBAM works, so that means at least until the pilot phase with just doing the administrative work.
- Full value chain inclusion in the CBAM, as now only a large part of the value chain is included in CBAM. E.g. the wheels in the automotive industry are not included, while they should be.
- A more gradual phase in of CBAM, we have to know it works before we move on with a larger implementation.

The interviewee wanted to add two more small points which address the actual need for a CBAM. First, since only scope 1 emissions are included and the smelters in Europe are all quite new and have thus very small scope 1 emissions, the eventual impact is much less than with older smelters in foreign countries. Secondly, monitoring the scope 2 emissions needs to be included in the administrative pilot phase, so see what the impact would be.

E.1.3. Director metal industry associations

The interview was with Cilian O'Donoghue, Director Energy & Climate Change at Eurometaux, the metal industry association in Europe. It was conducted in English.

Notes interview

Q1: Combining policy instruments

- CBAM will not necessarily amplify the EU ETS, since it does not prevent carbon leakage, as it is designed. Especially not in aluminium sector.
- When properly designed, tailor-made for each other policy instruments in general will strengthen the effect of one another, but only then.

Q2: Administrative burden

- Burden is quite significant.
- An authority could take some of that away, but that really depends on the exact responsibilities that authority has.

Q3: Stimulating foreign countries

- Time will tell.
- Quite sceptical, you can't be too confident, because see what happened with the aviation and maritime sector.
- The CBAM we have now in negotiations is going to have an adverse effect even, because the sector loses competitiveness and therefore loses the ability to innovate.

Q4: Changing competitive advantages

- Cost compensation is needed to cover the lost advantage. With the removal of the free allocations, and CBAM, compensation is needed.
- The aluminium sector is already losing, and they would further lose it with CBAM.

Q5: Winners and losers, from economical and geopolitical perspective

- Consumer will lose to some extent as well, due to less innovation.
- Aluminium is a loser economically, because it is included, hardly anyone knows why. Its competitiveness with steel was a factor.

Q6: Expected risks actually occurring

- Carbon leakage is a reality in the aluminium sector. When looking at several sectors, carbon leakage is more debatable. Aluminium sector is probably the most exposed sector for carbon leakage.
- CBAM won't really prevent carbon leakage. For three reasons:
  - It's a replacement of the free allocations, which are not sufficient.
  - Exports are not included.
  - CBAM can easily be circumvented.
- Since CBAM can easily be circumvented, resource shuffling is a very realistic risk. It is however possible to be more strict on that, but legislation needs to be changed then. Resource shuffling is extremely likely.
- Many countries will be able to "do" resource shuffling.
- Maybe some retaliation measures. In Europe we need to be prepared.

Ending questions

- Free allocations should remain until proven that CBAM levels the playing field in the global market of aluminium, and also Iron & Steel.

- More gradual implementation. Grade system for indirect cost compensation.
- The Commission first would need to see what the actual responses are from other countries on the actual proposal after negotiations, before actually implementing CBAM at all.
- 5 points of advice to the Commission
- Some form of strategic behaviour, but only "natural".
- Production flows of aluminium between China and Germany will not change.

E.1.4. Industry analyst with a focus on the steel sector

The interview was with an industry analyst from a German think tank focused on energy and more specifically the metal sector. The interviewee preferred to have the results be processed anonymously. The interview was conducted in English and the main insights can be found below.

Q1: Combining policy instruments

- For the combination of CBAM and the EU ETS it is not very effective in preventing carbon leakage, but theoretically it could make sense. However, I am not an expert in the field of policy instruments and can only look at this specific situation.

Q2: Administrative burden

- Actually measuring the carbon footprint of products is going to be a large hassle, also for the companies. It depends on that to determine to what extent it is a real burden for the companies.
- It is very wise move of the EU to first do the pilot phase, but that phase should be extended.

Q3: Stimulating foreign countries

- It is not very likely that CBAM will be the main cause of that foreign countries adopting similar policies, but it might as well be the spark. Not very likely though.

Q4: Changing competitive advantages

- Aluminium and steel in the EU will lose some competitive advantage.

Q5: Winners and losers, from economical and geopolitical perspective

- CBAM might be able to keep the carbon price high, but it cannot make the business case of the new renewable energy technologies much better. To do so, a new PI with different objectives will need to be designed.
- Other countries from outside the EU might win, because they have the possibility for resource shuffling.
- Non-EU countries will probably also move to sectoral based agreements for the CBAM sectors, to prevent having to pay large amounts of money due to CBAM.
- From a geopolitics perspective, when the major players in the CBAM sectors make sectoral based agreements, large geopolitical conflicts can be prevented.

Q6: Expected risks actually occurring

- Resource shuffling is possible in several countries, especially the countries that have a vast potential for RE production, like China, Russia and the USA. It is also something that the EU cannot really do a lot about. Take practices from tax evasion is best, but it is also a really different phenomenon.
- Carbon leakage cannot really be prevented by CBAM, not in the aluminium sector, not in the steel sector.
- Trading disputes might be the gun that never shoots and always is looming over the sectors. However, that really depends. With large sectoral based agreements, it could be mitigated or even prevented. Most risks are China, the US and Russia for the EU, the rest is much less significant.

Ending questions

- Not so much strategic behaviour, I am not an expert in that.
- However, both the cement the power sector are most exposed to CBAM, at first, since they are most regional. The aluminium and fertilizers sectors will need sectoral agreements to really cope with CBAM, and the issue of export rebates is much more important for those two. Lastly, steel is affected a lot, but fairly. It can win a lot by making much more secondary steel.

E.2. Policymakers

This interview is with a Policy Officer of the European Union at DG-CLIMA, who worked on the proposal of CBAM. The interview was conducted in Dutch, translated to English and the main insights can be found below.

Q1: Combining policy instruments

- CBAM is designed as an addition to the EU ETS, and the EC expects it to be complementary and indeed strengthen the ETS.

Q2: Administrative burden

- The EC thinks that it is not too much, as it is mainly first getting used to it, and it is a minor addition to the companies already having to declare goods they export to the EU.
- Also, the EC does not 'care' that much about it, whether it is too much of a burden.

Q3: Stimulating foreign countries

- It is designed to do so, and thus we expect that as well. Maybe not as quick as we hope.
- If countries can avoid paying CBAM costs with resource shuffling, the CBAM will not be effective in stimulating foreign countries to adopt carbon pricing instruments.

Q4: Changing competitive advantages

- The EU aluminium sector thinks that the compensation for their indirect emissions is much better for their competitive advantage than the CBAM. T
- The EC acknowledges that, until indirect emissions are included in CBAM as well.
- The consequences for the aluminium sector are particularly smaller than for the other CBAM sectors.

Q5: Winners and losers, from economical and geopolitical perspective

- If the CBAM pushes the aluminium sector towards a more decarbonised production, they can gain an advantage over their competitors, and the EU aluminium sector can become a winner economically.

Q6: Expected risks actually occurring

- Resource shuffling is a real risk, the EC cannot do anything about it.
- Countermeasures are a realistic threat as well, but a trade war might be too much. Both China and the EU have a lot to lose in that, and probably both will back out before that happens.
- Carbon leakage is a difficult problem and hard to predict if it will happen. Our previous experience has not brought us a lot, since the price of carbon was always very low. But, it sounds like a lot of fuss and not too much actually happening.

Ending questions

- Member states are in general positive about CBAM, but some strategic behaviour will probably occur. Fear of the CBAM getting hijacked by such behaviour. For example, Germany and France are opposed to some extent. Most in favour of CBAM though, only the UK would probably have been a strong opposer.
- Due to the extensive amount of consultation meetings with all actors the current proposal of CBAM is strong. Until the negotiations are over, we don't have a lot to add yet to what has already been proposed.

E.3. Scientists

Of the eight interviews conducted, three were with scientists.

E.3.1. PhD International relations & Energy System Transition

This interview was with Benjamin Silvester, a PhD at the University of Stavanger in the field of Political Science and Energy System Transitions. The interview was conducted in English.

Q1: Combining policy instruments

- Policy instruments are easier to implement when a precedent is set.

- CBAM is too massive to be a really efficient policy instrument. That is simply not possible. The same happened with the requirement of the EU having an interconnection level of 15%; extremely inefficient but it still gets the job done, thus it is still effective.
- Similar instruments do amplify the working of each other, but the extent to which they do still depends on the inter-compatibility.

Q2: Administrative burden

- Doing all the administrative work for CBAM is incredibly inconvenient for the industry.
- The question is however if the burden is acceptable. If it is, it is fine, otherwise obviously not.

Q3: Stimulating foreign countries

- To a extent it will certainly help in stimulating foreign countries to adopt RE policy. However, it depends again. Mostly on the share of the EU of their total export destinations, in terms of volume, as well as the size of the CBAM sectors in that particular country. Turkey will be more affected by CBAM than Australia is, for example.
- The extent to which it will help cannot be determined however.
- It would help greatly however if the revenues generated by CBAM would flow back to the affected countries, that could really make a difference.

Q4: Changing competitive advantages

- There will definitely be changed competitive advantages, but probably not that much in the aluminium sector. Only direct emissions are included, and mostly electricity prices influence the price of aluminium. Since those will be less affected just by CBAM, compared to other sectors and prices, the aluminium sector is less influenced.
- Companies are willing to take a disadvantage, when the disadvantage of their competitors is greater.

Q5: Winners and losers, from economical and geopolitical perspective

- Petroleum industry is probably going to be the loser, but they still try their best to converge themselves to be more of a winner. For example, the Norwegian petroleum industry wants electric cars to become the dominant car-type, because then they can provide the electricity needed via their fossil energy sources.
- For both this and the loss of competitive advantage, it is really valuable to look at the effect the EU ETS had at the time, that could provide a lot of interesting insights.

Q6: Expected risks actually occurring

- Carbon leakage is a highly uncertain phenomenon, no one knows the extent to which that happens and will be happening, since it often is a combination of drivers of the leakage. One driver cannot be isolated and the cause of the leakage can not be assigned to just one driver.
- Personally, I think that carbon leakage is also not that likely from just CBAM, a lot more needs to happen before the European industry is going to relocate. Often the phenomenon is a bit exaggerated in my opinion.

Ending questions

- Member States will definitely behave strategically, but that still depends on the eventual design of CBAM which countries will do that most strongly.
- If the geopolitical conflict between China and Taiwan really kicks off in the coming years, that could have a massive effect on energy relations worldwide.
- The line of first an ETS, now CBAM: it is a slippery slope. Which means that companies and the sector might be reluctant at the start of a new policy direction, because they fear that it only gets worse for them. More and more stringent PIs.
- Gas price crisis surely has a large influence, but not so much on the aluminium sector.

E.3.2. Professor in Environmental and Energy Policy

This interview was with Oluf Langhelle, Professor of Environmental and Energy Policy at the University of Stavanger. The interview was conducted in English.

Q1: Combining policy instruments

- The "carrot and stick" analogy. Policy mixes work when there is both of them.
- Example of the waste collection of Norway, similar to what now is happening around the ETS. A voluntary instrument, which was not meant as one, but all the exemptions made the instrument a voluntary one. Once taxation was added to it, it worked much beter.
- Carrot and stick: usually it does not matter which one to start with, as long as you do it. Both can initiate the need for the other, as long as the mission is the same.

Q2: Administrative burden

- Of course it will cost the companies money and time, but not too much. Most of those companies would want the market to solve these kind of things, or for these type of instruments to be voluntary. That is however not possible anymore.
- It is however very wise to first do such an extensive instrument first on paper.

Q3: Stimulating foreign countries

- CBAM is now much more justified from an environmental perspective, maybe not so much from other perspectives, but that is less of my expertise.
- Stimulating other countries will be possible, but not as much as hoped. Foreign countries still have many doubts, and will use that as leverage to not directly impose new policies.
- More renewable energy is required in each of the sectors, and this might just be the last push needed for the sectors to start the disruptive innovations in their businesses. However, it is far from certain, maybe even hardly likely that it will happen. The potential is there though. The EU is a huge market, and many countries will always be trading with the EU.

Q4: Changing competitive advantages

- There is a precedent with the agricultural market around 2000. The regulation was never in place, because the lobby of the sector – afraid to lose too much of their competitive position – was too strong and no deal was made. A case is needed that sets the precedent for other sectors, and CBAM may be that spark.

Q5: Winners and losers, from economical and geopolitical perspective

- The Norwegian aluminium industry is definitely more at an advantage over other countries producing aluminium.
- However, once the aluminium industry starts to focus on more recycled aluminium, it becomes much harder for Norway.
- The debate around CBAM is not so much an environmental debate, but more of a debate on economics and geopolitics.
- European industries will not be so much the losers of this transition, maybe only in the short term with reduced export competitiveness. However, in the long term we will be fine.

Q6: Expected risks actually occurring

- Trade wars are possible, but it is less likely than when CBAM would have been implemented 5 years ago. Now the world is much less divided on whether climate change is happening.
- Resource shuffling is a possibility, a huge one, but eventually there will be change in the sectors in other countries. The question however is how rapid that change will be on our doorstep.
- Carbon leakage from this type of instrument is often exaggerated, at least in my head looking at it from a Norwegian perspective. Many facilities have already moved to lower income countries, because of the income, and not because of these instruments. There has not been a precedent that shows carbon leakage originating in environmental reasons.

Ending questions

- Strategic behaviour between Member States of the EU will definitely happen, because not all countries are on the same page when it comes to environmental issues, such as Poland for example.

E.3.3. Researcher European Studies from a Chinese perspective

The interview was conducted with a researcher in European Studies at a Chinese university, with a focus on EU trade policy. The language was English, and the interviewee wished to remain anonymous.

Q1: Combining policy instruments

- It makes sense that a combination of policy works best, but only if they are tailored together.

Q2: Administrative burden

- For China that is not so much of a problem, as they just see it as one of the problems to deal with. The bigger problem for them is that actual mechanism.

Q3: Stimulating foreign countries

- China would just cut off the electricity of some companies if they have insufficient. That has caused the current energy crisis as well.
- China will be influenced by CBAM, but it is definitely not a real driver. China is under the influence of much larger forces, such as the energy crisis.

Q4: Changing competitive advantages

- It is actually quite likely that the EU industry is gaining an advantage over Chinese aluminium producers. Still, the Chinese industry as a whole has some possibilities to overcome CBAM when they work together.
- Energy is increasingly important, also in China, and China is realizing that. Also as a means to achieve more geopolitical goals.

Q5: Winners and losers, from economical and geopolitical perspective

- China is realizing that energy can be used as a means to achieve more geopolitical goals.
- A systemic rivalry is created between China and other geopolitical powers in the world (Russia, USA, EU)
- China will probably be a winner, as there is still a lot of low hanging fruit and it is still really focusing on (economic) growth. It will cease any opportunity.
- China is gaining an advantage in many sectors, as the quality of their products increases as well.
- China is trying to become more and more independent, to be able to rid itself from other countries in the future crises to come.

Q6: Expected risks actually occurring

- China will definitely pose countermeasures, as they have done in other situations as well.
- However, China does not benefit from a trade war either, so it will try to prevent that as well. Their patience and stubbornness might be stronger.
- China will move to other sectors and industries well, as their leverage is a bit larger.

Ending questions

- Current Chinese energy crisis is caused by high prices and outages.
- The energy crisis in China can have far-reaching consequences for the introduction of CBAM.

E.4. Analysts

E.4.1. Analyst with a geopolitical perspective

This interview was with Sarah Jackson, an analyst at the think tank on climate policy E3, who has a focus on geopolitics in the EU USA relationship.

Q1: Combining policy instruments

- For the affected sectors, it is not so much about the two instruments strengthening each other, but more about how the new instrument will compensate for the losses of the first one: how are the free allocations compensated for.

Q2: Administrative burden

- A wise move of the EU, because the companies are certainly not happy about it.

Q3: Stimulating foreign countries

- In nearby countries it might, for the rest it is mainly for the public, an extra argument for pushing through CBAM.

Q4: Changing competitive advantages

- Nearby countries, of which the EU is the major destination of exports of in the CBAM sectors, are losing the most, while other countries like China and the US less rely on the EU as a market. Probably the same will happen for aluminium.

Q5: Winners and losers, from economical and geopolitical perspective

- Nearby countries to the EU are the biggest losers of the transition, globally operating companies from countries that hardly rely on the EU as destination for exports win. Both in economics and geopolitics.

Q6: Expected risks actually occurring

- Doesn't matter if carbon leakage is real or not, if the companies perceive it as an actual risk, it is an actual risk. Simply because they would relocate if they think the risk is real.
- The same goes for the EU, doesn't matter if history hasn't proven carbon leakage, it could still occur and thus is a significant risk for the EC.
- Trade war is likely, at least the US is certainly going to react with sanctions. If some partners don't like it, they can easily group together and push the EU back into its former position of not having CBAM.
- Similar thing happened with the 2012 aviation crisis between Boeing and Airbus.

Ending questions

- It will be interesting to see what the effects of CBAM are on the forming of the climate club, something Germany has wanted for quite some time. What interaction will follow from it, that will be interesting to see.
- Main point for CBAM to be a success is that all foreign countries, developing countries especially, view CBAM as a unilateral instrument. That would make it more equal and therefore easier to accept for those countries.

E.4.2. Analyst with a Chinese-German perspective

The interview was with Lina Li, Senior Manager at the Adelphi Institute. Her expertise is emissions trading and market mechanisms. With here partly Chinese, partly German education, she keeps a balanced opinion between the two perspectives. The interview was conducted in English and the main insights are listed below.

Q1: Combining policy instruments

- Combining instruments is very good, but only as long as they are in line with each other, or targeting different elements of the same objective (carrot & stick approach).

Q2: Administrative burden

- The proposed gradual approach is very important and wise of the EU.
- There is still a loophole for companies, because companies can still choose not to declare the goods they import, and thus avoid CBAM in the first phase. There needs to be an enforcement measure into place in the first phase as well.
- There might be a lack of capacity to cope with CBAM at the companies, because it is definitely imposing quite a lot of work on them.
- The effectiveness of CBAM also surely depends on the user-friendliness of the measure. A quality helpdesk would certainly help in that, to help take away part of the burden.

Q3: Stimulating foreign countries

- CBAM is definitely going to help. Definitely. With CBAM, there is much more momentum. Other countries see this as a new sign that more decarbonisation policies are possible and needed.

Q4: Changing competitive advantages

- The aluminium is the second most affected sector of the CBAM sectors.

Q5: Winners and losers, from economical and geopolitical perspective

- The aluminium sector of China won't be a loser, but it is hard to say if the EU aluminium sector will be a loser – economically.
- CBAM is a unilateral measure, so we cannot point at any of the trade partners of the EU being much more affected, while the design is not yet final.

Q6: Expected risks actually occurring

- There will be talks about CBAM being a protectionist measure, but as long as the EU makes sure that it is in line with WTO Law, nobody really can anything about it. Apart from installing their own measures to counter CBAM, but then again that needs to be tested by the WTO.
- Any bilateral conflicts between the EU and just one country can pretty easily be solved by also looking at other products that are important in the trade between the two. However, when looking at multilateral conflicts, it is much harder.
- Maybe one of the biggest risks is then that non-EU countries start forming alliances against the EU, but a lot needs to happen before that would become a reality.

Ending questions

- There are still so many details left out, and that does not improve at all the coping of the companies.
- The EU could and maybe should expand the three-year pilot phase, as we don't know for sure the infrastructure of CBAM is in place in time, before 2026.
- Also, the use of the revenue of the CBAM needs to be sorted out as well, as the EU is required to define that, if non-EU countries are going to accept the measure.

E.4.3. Director of an International Energy Think Tank

This interview was with Coby van der Linde, Director of Clingendael International Energy Program (CIEP). Her expertise is geopolitics of the energy system. Previously she had a focus on the petroleum industry, but she is doing many different things and focusing more on RE. The interview was in Dutch and translated to English. The main insights relevant for this research are listed below. She was accompanied by one of the other employees of CIEP.

Q1: Combining policy instruments

- If the instruments are not too generic, and the instruments are designed for each other, they certainly amplify each other.

Q2: Administrative burden

- Hard to say, but it will not be a decisive factor. Not the most influential factor.

Q3: Stimulating foreign countries

- The objective could be reached, but such an effect cannot at all be attributed to CBAM only. CBAM can hardly be isolated, and thus its effects are hard to measure.

Q4: Changing competitive advantages

- The aluminium sector is not so much influenced by the CBAM, because of CBAM only including scope 1 emissions. Also, other factors are more important in the changes in the sector.
- Countries who produce more raw aluminium, the cheaper blocks of aluminium, will gain over the countries with more semi-fabricated products in their production facilities. The EU aluminium industry is therefore likely to move to the high-end products, where the margins are larger.

Q5: Winners and losers, from economical and geopolitical perspective

- China seems to be a winner in the system, since they can pretty easily cope with CBAM, as they can shuffle the resources used for the production of aluminium with a destination in the EU. Both economically and geopolitically, China is gaining an advantage in comparison to the last years.

- If countries are able to produce the aluminium with RE, they can become winners. If not, they become the losers.
- The USA will like it not that much when a climate tariff is posed on them from their 'ally' – the EU – while they are also rivalling with China.
- The EU Iron & Steel industry thought they would become economic losers of the CBAM compared to the aluminium sector, since they compete. That possible has contributed to the aluminium sector being one of the CBAM sectors.

Q6: Expected risks actually occurring

- Carbon leakage is a realistic risk, it happened several times in the past, for example in the '90s as well. But usually because of actual raised prices, and not this type of indirect causalities.
- CBAM will probably only have a minor effect on carbon leakage. Other factors are stronger.

Ending questions

- The Chinese energy crisis is a major factor in the system, as is the gas price crisis in the EU.
- The Chinese energy crisis is mostly caused by prices that are frozen for a long time.
- The system cannot be sufficiently isolated to do proper research.
- A product passport will be needed to eventually monitor the scope 2 emissions of each product.