İSTANBUL TİCARET UNIVERSITY
INSTITUTE OF GRADUATE SCHOOL
DEPARTMENT OF INTERNATIONAL TRADE
DOCTORATE OF INTERNATIONAL TRADE PROGRAMME

POTENTIAL ECONOMIC EFFECTS OF THE CARBON BORDER ADJUSTMENT MECHANISM ON GERMANY AND TÜRKİYE

Ph.D. Thesis

Pauline Sophie SEYFERT

İSTANBUL, 2025

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Ph.D. Thesis

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İSTANBUL, 2025

APPROVAL PAGE

ETHICS STATEMENT

I, Pauline Sophie SEYFERT, certify that,

- I am the sole author of this thesis and that I have fully acknowledged and documented in my thesis all sources of ideas and words, including digital resources, which have been produced or published by another person or institution;
- This thesis contains no material that has been submitted or accepted for a degree or diploma in any other educational institution;
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Pauline Sophie SEYFERT

ABSTRACT

Over centuries Turkish-German economic relations have progressed favorably and have steadily been expanding. Today, Germany is one of Türkiye's key partners in trade and primary export destination. Recently implemented environmental trade policies, such as the Carbon Border Adjustment Mechanism (CBAM), potentially affect the trade development of both countries mutually. The CBAM is a leading example of green trade policy and serves as a carbon taxation instrument linking the emission footprint of goods imported to the European Union to an emission cost, potentially putting strain on trade ties. Notions such as Pigouvian taxation form the underlying theoretical framework. The CBAM encompasses the aluminum, cement, electricity, fertilizers, hydrogen as well as iron and steel sectors. This thesis focuses on the CBAM's potential economic effects on trade relations between Türkiye and Germany, while addressing specifically cost effects on Turkish exports to Germany in the iron and steel and aluminum sectors. These two sectors stand for a significant economic value in bilateral trade among the CBAM-relevant sectors. The total added cost on a four-digit Combined Nomenclature (CN) code basis is determined regarding the iron and steel and aluminum sectors from 2019 to 2024 on a yearly basis. Moreover, the sectoral distribution of additional cost relative to Turkish export trade volumes to Germany is assessed. Based on the findings, the CBAM is set to impact the iron and steel sector most. The potential costs are determined according to the two individual scenarios each using the CN code-based emission intensity data and the carbon pricing levels as well as export trade flows. For Turkish exporters, the cost effects may result in reduced price competitiveness and lower trade volumes. German importers may encounter higher product prices and supply chain risks arising from the reduced availability of competitive goods and suppliers from Türkiye. These risks call for policy measures to safeguard and strengthen the corresponding bilateral trade ties.

Keywords: Türkiye–Germany Trade Relations, Sustainable Trade, Environmental Trade Policy, Carbon Border Adjustment Mechanism (CBAM), Emission Trading System

ÖZET

Türkiye-Almanya ekonomik ilişkileri yüzyıllar boyunca olumlu yönde ilerlemiş ve istikrarlı bir şekilde genişlemiştir. Günümüzde Almanya, Türkiye'nin dış ticaretteki en önemli ortaklarından biri ve ihracat destinasyonudur. Yakın dönemde uygulamaya konulan Sınırda Karbon Düzenleme Mekanizması (Carbon Border Adjustment Mechanism – CBAM) gibi çevresel ticaret politikaları, iki ülke arasındaki ticari gelişmeleri karşılıklı olarak etkileme potansiyeline sahiptir. Yeşil ticaret politikasının önemli bir örneği olan CBAM, Avrupa Birliği'ne ithal edilen malların emisyon ayak izini bir maliyete bağlayan karbon vergilendirme aracidir. Bu durum, AB ve Türkiye arasindaki ticari iliskiler üzerinde baskı oluşturma potansiyeli vardir. Pigoucu vergilendirme gibi kavramlar, temel teorik çerçeveyi oluşturmaktadır. CBAM; alüminyum, çimento, elektrik, gübre, hidrojen ile demir-çelik sektörlerini kapsamaktadır. Bu tez, CBAM'ın Türkiye ve Almanya arasındaki ticari ilişkilere yönelik olası ekonomik etkilerini ele almakta, özellikle Türkiye'nin Almanya'ya yaptığı demir-çelik ve alüminyum ihracatındaki maliyet etkilerine odaklanmaktadır. Bu iki sektör, CBAM kapsamındaki sektörler arasında ikili ticarette önemli bir ekonomik değere sahiptir. Demir-çelik ve alüminyum sektörlerinde dört haneli Kombine Nomanklatür (CN) kodu bazında toplam ek maliyetler 2019–2024 yılları için yıllık olarak hesaplanmıştır. Ayrıca, ek maliyetlerin Türkiye'nin Almanya'ya ihracat hacimleri içindeki sektörel dağılımı incelenmiştir. Bulgulara göre, CBAM'dan en fazla etkilenecek sektörün demir-çelik olduğu görülmektedir. Potansiyel maliyetler, CN kodu bazlı emisyon yoğunluğu verileri, karbon fiyatlama düzeyleri ve ihracat ticaret akışları kullanılarak iki farklı senaryo çerçevesinde belirlenmiştir. Türk ihracatçılar açısından maliyet etkileri olacagi ön görülmektedir. Bu etkilerin basinda, fiyat rekabetçiliğinde azalma ve ticaret hacminde düşüş ön görülmektedir. Alman ithalatçılar ise Türkiye'den rekabetçi ürün ve tedarikçilerin azalmasına bağlı olarak artan ürün fiyatları ve tedarik zinciri riskleriyle karşı karşıya kalabilir. Bu riskler, ilgili ikili ticari ilişkilerin korunması ve güçlendirilmesine yönelik politika tedbirlerini gerekli kılmaktadır.

Anahtar Kelimeler: Türkiye-Almanya Ticaret İlişkileri, Sürdürülebilir Ticaret, Çevresel Ticaret Politikası, Sınırda Karbon Düzenleme Mekanizması (SKDM), Emisyon Ticareti Sistemi

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LIST OF ABBREVIATIONS

BEC	Broad Economic Categories Classification
BECV	Verordnung über Maßnahmen zur Vermeidung von Carbon-Leakage durch den nationalen Brennstoffemissionshandel
BEHG	Brennstoffemissionshandelsgesetz
bpb	Federal Agency for Civic Education
CBAM	Carbon Boarder Adjustment Mechanism
CBDR	Common But Differentiated Responsibilities
CCACB	Climate Change and Adaptation Coordination Board
CCASAP	Climate Change Adaptation Strategy and Action Plan
CCMSAP	Climate Change Mitigation Strategy and Action Plan
CH_4	Methane
CN	Combined Nomenclature
COP	Conference of the Parties
CO_2	Carbon Dioxide
CO_2eq	Carbon Dioxide Equivalent
DAAD	German Academic Exchange Service
Destatis	Federal Statistical Office
EBRD	European Bank for Reconstruction and Development
EEX	European Energy Exchange
EU	European Union
EU-27	The 27 member states of the European Union
ETS	Emissions Trading System
ETS2	Emissions Trading System 2
EUR	Euro
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
HS	Harmonized System
HFCs	Hydrofluorocarbons
ICE	Intercontinental Exchange
INDC	Intended Nationally Determined Contribution
KSG	Bundes-Klimaschutzgesetz
kWh	Kilowatt-Hour

LDCs	Least Developed Countries
LULUCF	Land Use, Land Use Change and Forestry
MDGs	Millennium Development Goals
Mio.	Million
MNPP	Marginal Net Private Profit
MPC	Marginal Private Cost
MSB	Marginal Social Benefit
MSC	Marginal Social Cost
MTP	Medium-Term Program
MW	Megawatt
NDCs	Nationally Determined Contributions
N2O	Nitrous Oxide
PFCs	Perfluorocarbons
R&D	Research and Development
SDGs	Sustainable Development Goals
SDSN	Sustainable Development Solutions Network
SF6	Sulphur Hexafluoride
t	(Pigouvian) taxation or negative externalities
tCO_2e/t	Tonne CO_2e/Tonne Goods
TL	Turkish Lira
TOE	Ton of Oil Equivalent
TURKSTAT	Turkish Statistical Institute
UK	United Kingdom
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
US	United States of America
USD	United States Dollars
WBCSD	World Business Council for Sustainable Development
WTO	World Trade Organization

INTRODUCTION

Climate change and the connected implications for the planet and humanity have led to the development of precautionary measures on a global scale. Part of that is the introduction of international treaties and policy efforts to increase climate action and ultimately counteract climate change. In this context the Paris Climate Agreement determining climate neutrality by 2050 is by far the best-known and most recent one of its kind. Furthermore, climate action affects national and international economic policy in many areas, such as industrial policy in connection with the green transformation of the industry or foreign trade policy in the course of economic instruments such as a carbon tax on imports. As a result, simultaneously multilateral and bilateral economic relations are ultimately affected by climate policy, may be put to the test and may have to adapt to new surrounding and updated requirements.

In the context of this thesis Turkish-German historical and economic relations are further assessed. Over the past 30 years Turkish-German trade relations have been expanding, considering bilateral trade ties. Moreover, Germany and Türkiye have established a Joint Economic and Trade Commission in 2018 as well as the German-Turkish Energy Forum, as an exchange forum for governmental representatives and the private sector from both sides (Federal Foreign Office, 2024b). According to Turkish Statistical Institute (TURKSTAT) (2025c), in 2024 on the basis of Turkish export trade volumes Germany was the country's leading export destination and Germany's export trade with Türkiye made up for the third largest share in Türkiye's total import volume. Germany is Türkiye's overall third most important trade partner country, following Russia and China in first and second place respectively in 2024. On the other hand, in the context of export trade Germany ranks before the United Kingdom (UK) and the United States (US) the same year.

Considering the German trade statistics, overall Turkish exports rank 14th in the international comparison and Türkiye's import volumes to Germany value the country as 16th largest in 2024 (Federal Statistical Office (Destatis), 2025a). Measured by turnover referring to Turkish-German total exports plus imports, Türkiye is Germany's 14th largest partner in trade in global comparison. Moreover, measured by the individual foreign bilateral trade balance which means calculating exports minus imports, Türkiye reaches

21st places with a positive result amongst the international ranking in 2024. When considering the trade balance's development over the past two decades imports from Germany have been mostly exceeding exports from Türkiye, causing a trade deficit from a Turkish perspective (TURKSTAT, 2025c). The categories with the overall highest trade volumes are "Vehicles other than railway or tramway rolling-stock, parts thereof", "Boilers, machineries and mechanical appliances, parts thereof" and "Knitted and crocheted goods and articles thereof" (TURKSTAT, 2025f). In 2024, overall Turkish export trade amounted to 18,4 billion USD and imports from Germany reached 25,1 billion USD, accounting for a trade total of 43,5 billion USD (TURKSTAT, 2025c). Considering the export categories on the basis of the relevant CN codes under the CBAM for the sectors aluminum, iron and steel, fertilizer and cement the corresponding export results from Türkiye to Germany amount to a total of 1,6 billion USD. Moreover, in relation to the total trade activities between the two countries its proportion accounts for 3,7 percent. Furthermore, regarding the sole overall export trade volume to Germany its share results in 8,7 percent.

According to the export ranking in goods and services from 2024, Germany ranks third and Türkiye 24th in the global comparison (World Bank, 2025a). Germany achieved an export result in goods and services of 1,9 trillion in 2022, of about two trillion USD in 2023 and 1,9 trillion in 2024, indicating a slight stagnation tendency in export trade over the past few years. The majority of German foreign trade activity accounting for approximately two-thirds of the total volume is occurring inside of Europe (Federal Agency for Civic Education (bpb), 2024). In 2022, Türkiye's export trade encompassing services and goods amounted to 346,6 billion USD (World Bank, 2025a). The following year the result further increases to 357,6 billion USD and to 372,8 billion USD in 2024, reaching a historical all-time-high for Türkiye.

The ties between the two countries are forged through the different dimensions of society, politics, and economy (Bedir et al., 2022). A historical review of the economic-political relationship between Germany and Türkiye showcases the centuries-old relations between the two countries. The ties between Türkiye and Germany historically started back in the 11th century (Konukman, 2023). A joint agreement on the exchange of goods and friendship was put into place by the Ottoman Empire and the Kingdom of Prussia in year 1761 (Republic of Türkiye Ministry of Foreign Affairs, 2023). In 1961, the two

countries signed a bilateral agreement on sending laborers from Türkiye to Germany, resulting in many Turkish people's migration to Germany (Akgündüz, 1993; Baş, 2021; Dernbach, 2021; Federal Foreign Office, 2021; Republic of Türkiye Ministry of Foreign Affairs, 2023).

On March 1995, the enforcement of the Customs Union was concluded and went into effect at the start of 1996, in accordance with the with the Decision No. 1/95 by the European Council-Türkiye Association Council (Başlar, 2004; European Union EUR-Lex, 1995; Karatas, 2016; Republic of Türkiye Ministry of Foreign Affairs - Directorate of EU Affairs, 2024a; Tekce, 2016). The Customs Union forms the base for the ties between Türkiye and the EU economically, in particular regarding the exchange of goods (Selcuki & Tulan, 2021). Hence, also Turkish-German trade relations benefit from the introduction of the Customs Union. The history of Turkish-German ties is extensive and regardless of governmental discrepancies in recent years, Turkish-German ties continue to be persistent (Hermann, 2023). According to Aya and Atun (2013), the Federal Foreign Office (2024b), the Republic of Türkiye Ministry of Foreign Affairs (2023) and Szabo (2018), about three million (Mio.) people with Turkish roots live in Germany today, holding a crucial position in the context of the countries' ties.

In the context of climate action, the goal of the European Union (EU) is to support the protection of climate by implementing the European Green Deal (Şahin et al., 2021). The European Green Deal aims to achieve net zero emissions in the EU by mid-century, to support the protection of the climate and to separate the expansion of the economy from the consumption of resources as well as to define the course for a sustainable transformation (European Council - Council of the European Union, 2024a; Fetting, 2020; Şahin et al., 2021). Furthermore, the policy package aims to encourage the actions necessary to create a net zero emissions and more sustainable surrounding while endorsing fair and competitive conditions along with the climate neutrality goal by 2050 (Şahin et al., 2021).

Beyond the transition internally in the EU the European Green Deal intends to lower the carbon footprint and hinder the migration of greenhouse gas emissions to third countries by moving their manufacturing facilities accordingly, the so-called "carbon leakage", in the global context (European Bank for Reconstruction and Development et al., 2023, p.

7; European Commission - Directorate-General for Taxation and Customs Union, 2024; Şahin et al., 2021).

A related tool from the policy package is the Carbon Border Adjustment Mechanism (CBAM), a component of the so-called “Fit-for-55” bundle (Dröge, 2021). It connects the generated carbon footprint from manufacturing processes of EU import goods which are elevated emitters to a corresponding emissions cost (European Commission - Directorate-General for Taxation and Customs Union, 2024). Simultaneously, the CBAM is supposed to encourage the transformation of the manufacturing sector to become greener in foreign countries.

The initiation of the instrument will be conducted bit by bit in a row with the dismissal of released quotas under the EU’s Emissions Trading System (ETS) to additionally foster the low-carbon transformation of national manufacturing (European Bank for Reconstruction and Development et al., 2023; European Commission - Directorate-General for Taxation and Customs Union, 2024). With the *Directive 2003/87/EC* the EU implemented a scheme for the exchange of carbon permits, the so-called EU ETS with the goal to facilitate the abatement of polluting emissions (European Union EUR-Lex, 2003*,* (Article 1)). According to the European Environment Agency (2024), the EU ETS has substantially contributed to the reduction of emissions by greenhouse gases following its implementation in the year 2005. Developments such as a price tag on carbon emissions, shifts in cost for petrol as well as legislation regarding climate action, e.g., facilitation of renewables, made abatement of greenhouse gases in the context of fixed setups gain momentum as well as greatly advanced the environmental protection targets of the EU. Especially in 2023, greenhouse gas emissions that year dropped most ever following its introduction.

The CBAM encompasses first off, the following high-emitting industries: aluminum, cement, electricity, fertilizers, hydrogen as well as iron and steel (Council of the European Union, 2022; European Bank for Reconstruction and Development et al., 2023; European Commission - Directorate-General for Taxation and Customs Union, 2024; European Union, 2024; German Chamber of Commerce and Industry (DIHK), 2024; European Union EUR-Lex, 2023a, (Annex I & Annex II)). Scholars note that the ties between Türkiye, European countries and the EU may be endangered in the context of this

instrument and underlines the necessity of its assessment (Şahin et al., 2021). Furthermore, the CBAM's impact from an expense perspective may lead to implication regarding the total export trading activity from Türkiye to the European market (European Bank for Reconstruction and Development et al., 2023).

In respect to climate action and sustainability efforts the Sustainable Development Goals (SDGs) play a crucial role and can be connected to the European Green Deal and the CBAM. The total of 17 SDGs is coupled with a sum of 169 objectives together in combination emphasize the scope and aspiration of the set out global development framework with a focus on sustainability (United Nations Department of Economic and Social Affairs, 2015). In terms of the European Green Deal a connection to all 17 SDGs is found, according to the Sustainable Development Solutions Network (SDSN) Europe (2022). Although it must be noted that not all SDGs relate to the various policies under the Green Deal equally. As the CBAM is linked to the "Fit for 55" policy package the most relevant SDGs corresponding to that set of policy measures are considered in connection with the CBAM (SDSN Europe, 2022, p. 29).

Furthermore, in the context of economic tools for the protection of the environment and reduction of pollution the conceptual framework of Pigouvian taxation is often mentioned. Moreover, Carbon Dioxide (CO_2) taxation is substantially grounded on the conceptual framework established by Arthur Cecil Pigou (Kawecka-Wyrzykowska, 2024; Pigou, 1920). The scholar was the one initially introducing the notion which demonstrates that taxation may be applied to lower exterior adverse consequences due to actions of bodies. Moreover, the economist proposes applying a carbon levy to discourage polluting activities equivalent to the inclined harm (Aristei, 2021; Pigou, 1920). In the context of Pigouvian tax the governmental body takes advantage of the income due to the carbon levy (Aristei, 2021).

Both Germany and Türkiye have established climate policies and decarbonization strategies nationally. On December 12, 2015, Türkiye approved the Paris Agreement which was then sealed on April 22 of 2016 while giving importance to Türkiye's status as an emerging economy (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021; Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2023a). The Paris Agreement was later ratified and issued with the

Official Gazette 31621 on October 7th, 2021. Türkiye declared its objective for climate neutrality until 2053 in September 2021 commencing the local transformation process (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021). The country's goal is to proceed along the course of sustainable economic growth by means of taking into account national strategic development pathways as well as progress abroad (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2023a). Germany and the EU signed the Paris Agreement on April 22, 2016, and ratified it on October 5 the same year (*Paris Agreement, CHAPTER XXVII, 7.d*.). According to the climate protection legislation *Bundes-Klimaschutzgesetz* by the Federal German Government, Germany must achieve net zero by 2045 (Federal Government, 2022). Until 2030 the country must lower its carbon emissions by 65 percent compared to the values from the year 1990. Moreover, the target for 2040 even calls for a decrease of at least 88 percent of greenhouse gases. The targeted net zero levels until 2045 refer to the symmetry of emitted carbon emissions as well as their compensation.

As part of this thesis an assessment on the potential economic effects against the backdrop of trade relations between Germany and Türkiye is conducted. The examination focuses on the potential cost effects of the CBAM regulation on Turkish export trade to Germany. In particular, the potential cost effects for the iron and steel as well as aluminum sectors are assessed. The research question is as follows: What are the potential economic effects for exported goods from Türkiye to Germany on a sectoral basis?

The total additional cost on a four-digit CN code basis is calculated for the iron and steel as well as aluminum sectors annually for the period 2019 to 2024. Furthermore, the relative shares of the additional cost in relation to the overall Turkish export trade volume to Germany is examined. The research results are intended to enable the private and public sector to identify individual risks and develop as well as carry out corresponding risk management measures.

The thesis is structured in a number of different parts. The initial chapter of the literature research will focus on a historical review of the economic-political relationship between Türkiye and Germany. In this context, the historical development of relations and their course overtime during different centuries are of particular interest. In the following chapter environmental policy approaches in connection with green trade, decarbonization

and the CBAM are depicted. On the side of the EU, the European Green Deal, the EU ETS and the CBAM are showcased. The chapter is complemented by the Sustainable Development Goals and the conceptual framework of Pigouvian taxation as an economic instrument in the context of environmental policy. Furthermore, in the next chapter decarbonization strategies and climate policy in Germany and Türkiye are portrayed. In the following chapter, the potential effect of the CBAM on trade between Germany and Türkiye is further assessed. The chapter covers the development of trade with world, both, from the perspective of Türkiye and Germany. Moreover, the Turkish-German trade relationship is outlined. In addition, the trade ties in the context of the CBAM related sectors are assessed in more detail with a focus on the iron and steel, aluminum, fertilizer and cement sectors for the time period 2014 to 2024. Thereafter, the potential effects of the CBAM on Turkish exports to Germany is examined centered around the iron and steel as well as aluminum industries as the fertilizer and cement sectors only account for negligible export amounts to Germany between 2014 to 2024. Based on the findings a conclusion is drawn and derived from this, policy recommendations are provided.

The findings clearly show that Turkish-German trade relations will be affected by the CBAM regulation. Critical in this context is the increase of costs for exported goods in the aluminum and iron and steel sectors. In particular, the iron and steel sector will relatively be most impacted in comparison to the aluminum sector. This development can cause a loss of price competitiveness and a decline of exports from the perspective of Turkish exporters. On the other hand, German importers may face increased product prices as well as supply chain risks due to lower availability of competitive products and suppliers from Türkiye. These potential risks demand policy measures to protect and further facilitate trade relations between the two countries.

1. HISTORICAL REVIEW OF ECONOMIC-POLITICAL RELATIONSHIP BETWEEN GERMANY AND TÜRKİYE

The chapter on the historical review of economic-political relationship between Germany and Türkiye showcases the centuries-old relations between the two countries. The different periods of the bilateral relations among Türkiye and Germany span several eras, times of upswing and downturn, success stories but also lost battles and conflict.

The ties between the two countries are forged through the different dimensions of society, politics, and economy (Bedir et al., 2022). According to Paul and Schmidt (2017, p. 1), "Germany and Turkey have had close relations since the Ottoman times, being intertwined by multiple historical, economic, cultural, and societal ties.". The Republic of Türkiye Ministry of Foreign Affairs (2023) underlines, "Germany is one of Türkiye's most important allies in Europe.". The two countries have been upholding well-established connections with one another in various manners, e.g., in regard to politics, society, defense as well as trade (Republic of Türkiye Ministry of Foreign Affairs, 2023). Consistently, leading representatives get together and exchanges also at lower levels are conducted.

Furthermore, the Federal Foreign Office (2024b) emphasizes that "Germany and Turkey are linked by especially wide-ranging and close relations...". Arim (2001) emphasizes that the ties between the two countries are "complex" (p. 125), stating that each issue needs to be addressed in the context of the relationship's entirety. During the past years the relationship has dangled amongst disagreement and disparity as well as conjunction and accord (Bedir et al., 2022). Although, as stated by Istikbal (2021), "...close economic relations between Turkey and Germany are based on solid ground...". Istikbal (2021) emphasizes that these ties develop apart from challenges in politics within Turkish-German relations.

As stated by academia, the relations between Türkiye and Germany historically started back in the 11th century (Konukman, 2023). Interactions between the Germans and the Turks involved both connections and conflicts driven by various motives and commencing during this comparatively early period. Önsoy (2016) contradicts this statement, noting that the bilateral ties found their beginning at the closing of the 16th century, but over time evolved at low pace. The scholar states that the German side did

not start to truly make advances toward the Ottomans prior to the early 19th century. The reason is that concerns by the German were advocated for by the Austrians, French and Prussians at the level of the Ottoman Empire for an extended period, as mentioned by Önsoy (1972).

Konukman (2023) notes that political power dynamics and factors of religion played a significant role, frequently emerging as part of the bilateral ties. Nonetheless, situating the amplification and expansion of relations during the medieval period as well as the initial modern era seems more convincing. Also, Baş (2021) claims that historically Turkish people have been present in Germany and the previously little German regions since the initial modern era. According to Konukman (2023), the corresponding time period in addition aligns with the growing political ambitions of the Ottoman Empire concerning European domains. Therefore, against this background a magnitude of connection to Europe by the Ottoman, particularly regarding Central European domains, may more likely go back to the 1500s.

Baş (2021) adds that during the 1500s and 1600s the German-Turkish relations were reduced to links in war situations. Furthermore, it is emphasized that it is indisputable that these interactions were generally of militaristic kind (Konukman, 2023). For example, historical records show that Ottoman military forces surrounded Vienna in both 1529 and 1683 throughout the 16th and 17th centuries. Although they eventually retreated, in particular following the latter siege, it took them time up until the 18th century. Scholars Aya und Atun (2013) note that it is believed that the German military first battled against the Turks throughout the second battle of Vienna in the year 1683. A time when Europe was marked by warfare and investigations motivated by religion.

In the following subchapter Turkish-German relations between the 18th and 19th century are further elaborated on.

1.1 Turkish-German Relations Between 18th and 19th Century

In 1761, the relationship between the Kingdom of Prussia and the Ottoman Empire commenced (Aya und Atun, 2013). A joint agreement on the exchange of goods and friendship was put into place by the Ottoman Empire and the Kingdom of Prussia in the year 1761 (Republic of Türkiye Ministry of Foreign Affairs, 2023). Followed by the

treaty the Ottoman Empire assigned their first ambassador to Prussia in due course. Konukman (2023) writes about a turning point in the relationship between Germans and Turks during the 18th century, emphasizing that these improved for the better. Baş (2021) notes that in particular during the 18th century, the ties between the Ottoman Empire and Prussia developed into a relationship with a cooperative character. In addition, Ottoman aspiration to further enlarge territories in EU by using armed forces diminished. In a similar manner, Kingdom of Prussia as well did not hold regional ambitions towards the Ottomans neither (Konukman, 2023). According to Türk (2019) the developments marked the initiation of diplomatic ties between the two parties. In the beginning war captives of Turkish or Muslim origin were brought to Germany, out of which the greater part integrated into the country. In consequence, the heads of state at the time, initiated ties of diplomacy (Baş, 2021).

Overall, bilateral ties did not see a significant improvement before the late 1880s (Önsoy, 2016). This was also due to the growing investment activities of German companies as well as significant assistance in regard to the army necessitating an increasingly active advocacy for German concerns within the area. Nonetheless, Bismarck, also later Chancellor of the German Empire, maintained a careful approach striving to prevent whichever forthright interference. German emperor Wilhelm II, on the other hand, seemed to seek closer ties with the Ottomans. In 1898, while traveling through the Ottoman Empire, Emperor Wilhelm II affirmed himself to be an ally and friend of the Islamic religion and the Turkish people (Baş, 2021; Reyhan, 2005; Schaper, 2019). This was the second occasion on that the emperor journeyed to Constantinople (Reyhan, 2005). During his speech the German emperor emphasized: “May the Sultan and the 300 million Mohammedans who, scattered across the earth, worship their caliph in him, be assured that the German Kaiser will always be their friend.” [Translation into English] (Schaper 2019). The emperor’s words led to astonishment in the international context not long after, labeling one more climax in the ties between the two countries (Baş, 2021). Moreover, the increasingly cordial relationship in addition led to a rise in business collaboration. Götting (2014) notes that following his journey in 1898 to the Ottoman Empire the Emperor considers himself guarding the followers of Islam.

In 1888 the German emperor Wilhelm II was enthroned also signaling the start for a new era for the ties between the two empires (Önsoy, 2016). Wilhelm II, opposing the political

approach by Bismarck of conflict resolution and diplomacy, the emperor rather adopted an assertive and imperialistic political agenda. Both internationally the colonization and domestically the industrial development were high up on his political agenda, leading to an increasing demand for resources. The German Empire, feeling it had no suitable role as part of the current world order of colonial powers at the time, shifted its focus to the Ottoman Empire. For the purpose of racing against the other major nations, the emperor had been advocating an imperialistic colonist strategic approach from the 90s of the 19th century on, and his strategy regarding the Orient was founded on these geopolitical concepts (Götting, 2014). Furthermore, a number of scholars created schemes depicting a vast economic region spanning from the Persian Gulf to the North Sea, which was to serve as the foundation for the later declaration of global dominance. Moreover, the idea of German colonialism in Mesopotamia and the extraction of its natural resources, particularly coal and oil, was supported by other individuals. The Ottoman Empire, which spanned three continents and had historically hostile relations with Great Britain, France and Russia, offered an alternative for the German Empire, which had not been very successful in the course of the imperialist world order (Reyhan, 2005).

Various landmarks characterize the close German-Turkish cooperation. Together the Empires invested in projects such as the train line between Istanbul and Baghdad (Republic of Türkiye Ministry of Foreign Affairs, 2023). Konukman (2023) emphasizes that the partnership between Prussia and the Ottoman Empire was manifested by the railway project, referring to it as an additional crucial moment in bilateral relations adding an economic dimension to the ties. With the license to build the railway came the starting point for an operation classified among the major projects during the 1800s and 1900s. Simultaneously, this led to a substantial expansion of leverage by the German Empire within the Ottoman Empire (Önsoy, 2016). By the end of the 1880s, the German empire started to be interested in railway licenses in the Ottoman Empire. The license for the Anatolian railway project was received by the Deutsche Bank which, again, represents a defining moment in the relationship of the two parties. The railway line connecting Istanbul and Ankara was the first to be awarded to Deutsche Bank. For this reason, they established the so-called "Anatolian Railway Company" (Önsoy, 2016, p. 224). Furthermore, during the German emperor’s stopover in Constantinople while journeying eastward in 1898, the parties reached an agreement regarding the building of the Baghdad

Railway which would establish a railway link towards the Iranian Gulf (Reyhan, 2005; Schaper, 2019). Moreover, other additional commercial initiatives of significant size are said to have been concluded during the emperor's stay (Schaper, 2019). Reyhan (2005) notes that the emperor also conducted the opening of a Protestant church.

During the 19th century a company of German officers arrived in Istanbul with the aim to provide training to the military of the Ottoman Empire, including Helmuth von Moltke who remained on-site for the period between 1835 to 1839 (Önsoy, 2016). Reyhan (2005) notes that the provided military support in this context lacked effectiveness. The growing ties were succeeded by intensifying collaboration regarding the armed forces in the course of the rules of Mahmud II as well as Abdülhamid II (Republic of Türkiye Ministry of Foreign Affairs, 2023). In particular throughout the rule of Abdülhamid II and the amplification of diplomatic ties between the Ottoman Empire and Prussia in the 80s of the 19th century, the military order of Prussia exerted a stronger influence on the education of the Ottoman troops (Kurşun Tükenmez, 2023). In consequence, the Ottoman army academy was reformed consistent with the Prussian example.

The sent military officers Moltke, Kaehler as well as Goltz Pasha also shaped this process when present in the Ottoman Empire (Kurşun Tükenmez, 2023). Examples of adaptations include the addition of the German language to the program of study and the importing of learning utensils, firearms, among others, being brought directly from the German Empire to the Ottoman Empire. Also, Konukman (2023) notes that the partnership between the two empires was not solely focused on synergies in the commercial sense, apart from it potential also laid in the context of the armed forces. Against this background, the scholar refers to the so-called "Brotherhood in Arms" ("Waffenbrüderschaft") [Translation into English] between the two allies starting to pick up speed during the latter part of the 19th century (Konukman, 2023, p. 12). This partnership drew the Ottoman Empire and German Empire nearer to one another marking the start of an alliance in the early 20th century. In the following subchapter Turkish-German relations throughout the first half of the 20th century are summarized.

1.2 Turkish-German Relations Throughout First Half of the 20th Century

In times of World War I, the Ottoman Empire and the German Empire became allies (Götting, 2014; Konukman, 2023; Kreiser, 2013; Republic of Türkiye Ministry of Foreign

Affairs, 2023). The alliance treaty was signed by the two parties on August 2, 1914 (Alkan, 2014; Götting, 2014; Kreiser, 2013; Reyhan, 2005). The treaty was concluded although previously the allies had not decided on shared military objectives yet (Götting, 2014).

With the treaty, besides the supply of armed forces, the German Empire demanded the Ottoman Empire to augment its political leverage in the role of a Muslim sovereignty in Asia and therefore to eventually reach the areas in the hands of the countries of the Entente but populated by Muslims (Götting, 2014). According to Kreiser (2013), regardless of the second thoughts that had arisen on the Ottoman side from within the cabinet, which included advocates for closer connection with France as well, the treaty was concluded. The Ottoman Empire proclaimed a state of "armed neutrality" (“bewaffnete Neutralität”) [Translation into English] in public the following day after settling the treaty with the German Empire which triggered a reaction on the part of the Allies (Götting, 2014; Kreiser, 2013). Great Britain did not surrender the two battleships whose construction had been completed, and costs had been covered in advance by the Ottomans, as stated by Kreiser (2013).

Also, from the social perspective, there were a number of developments. Baş (2021) states that in the year 1912, approximately a number of 1.350 Turkish people was residing in the German Empire’s capital. The majority of these people was employed in tobacco companies or in one of the major manufacturing firms such as AEG. Moreover, collaboration in academics started to increase with e.g., 13.000 students and apprentices traveling to the German Empire for studying and obtaining technical expertise or 750 Turkish adolescents arriving in the German capital to begin a traineeship following an additional deal regarding trainings in 1917. Despite Turks coming to Germany for educational purposes, on the other side also German adolescents went to the Ottoman Empire for the same goals.

Following the Balkan Wars, the Ottoman Empire once more turned to the German Empire for military assistance in 1913 (Reyhan, 2005). General Otto Liman von Sanders, a cavalry officer, led a group of German military specialists that traveled to the Ottoman Empire. German sway on the Ottomans expanded in all domains hereafter, not only the armed forces (Reyhan, 2005; Werner, 2015). The German Empire engaged in war with

the war declaration to Russia and France respectively on August 1, and August, 3 of 1914 (Hirschfeld, 2021, Kruse, 2013a). Shortly after, the Ottoman Empire entered the war against the Entente at the end of the year 1914, following the bombardements with warships of two harbors in Russia (Alkan, 2014; Baş, 2019; Götting, 2014; Karpat, 2004; Werner, 2015). The Ottoman Empire joined World War I, siding with the German Empire (Alkan, 2014; Karpat, 2004; Konukman, 2023).

At the end of World War in 1918 that caused damage and devastation in a number of respects, the Ottoman Empire was defeated (Alkan, 2014). Also, the German Reich capitulated and lost the war in 1918 (Kruse, 2013b; Hirschfeld, 2021). Moreover, the German emperor Wilhelm II went into exile in the Netherlands the same year. The German Empire and Ottoman Empire collapsed following World War I, but bilateral relations did not crumble (Konukman, 2023; Kruse, 2013b). As mentioned by Güçlü (2002), although the two countries lost in World War I they were no major accusations of the other party.

In this situation the reestablishing of close ties and trust between the Weimar Republic and Türkiye was an uncomplicated undertaking (Güçlü, 2002). Following the conclusion of the Lausanne Peace Treaty in 1923, the trade relations between Türkiye and Germany started to gain more significance. In the year of 1924, a total of 27,4 Mio. Turkish Lira (TL), representing 13 percent of Türkiye's total imports, was coming from Germany. In 1925, this amount then further increased to 31,6 Mio. TL, exceeding the exports coming from Great Britain which had previously traded more than Germany in this regard. Economic relations continued to grow in the 1930s.

On the other hand, with regard to Germany's government in the person of Hitler and his anti-Semitic ideology, Atatürk and his leadership reacted with clear defense and criticism (Güçlü, 2002). Moreover, Atatürk and Türkiye offered skilled and qualified Jewish people in Germany asylum in Türkiye and many representatives of the intellectual and educated classes emigrated (Baş, 2021; Güçlü, 2002; Günhan, 2017; Hermann, 2023; Reisman, 2007). After properly assessing tendencies in the world endangering peace and the cause of World War II, Ataturk expedited activities around collaboration in the region (Republic of Türkiye Ministry of Foreign Affairs, 2022). Türkiye concluded regional agreements in the 1930s, such as the Balkan Entente and the Saadabad Pact. When the

globe was enmeshed in World War II, Türkiye sought to guarantee stability and collaboration simultaneously in the West as well as the East and through different initiatives. Furthermore, Türkiye cleared the path for its intended neutrality stance during World War II.

Starting in 1957, with the so-called "cultural agreement", the cultural dimension has been playing a central role in Turkish-German ties (Hermann, 2023). As part of the treaty, cultural establishments, e.g., the Goethe Institute, the German Archaeological Institute, the German Academic Exchange Service (DAAD) as well as the Orient Institute are established. In addition, lecturers from Germany are posted to Türkiye to teach at institutions of secondary education based in German like the Alman Lisesi or Istanbul Lisesi.

In the following subchapter Turkish-German relations during the second half of the 20th century are further elaborated on.

1.3 Turkish-German Relations During Second Half of the 20th Century

Turkish migration to Germany is a predominant topic in the second half of the 20th century and can be divided into different phases (Aydın, 2016). The different phases of migration from the 1960s onwards are characterized by workforce addition, by emigration for political reasons as well as by reuniting of families, but also by the return to the home country Türkiye.

In 1961, the two countries signed a bilateral agreement on sending laborers from Türkiye to Germany, resulting in many Turkish people's migration to Germany (Akgündüz, 1993; Baş, 2021; Dernbach, 2021; Federal Foreign Office, 2021; Republic of Türkiye Ministry of Foreign Affairs, 2023). According to Akgündüz (1993), the building of the wall separating West and East Germany facilitated the demand for labor force from abroad in Germany in 1961. Furthermore, Germany's labor force was constrained by the large extent of fatalities throughout World War II and the rule of the Nazis (Dinç, 2011). From the 1950s on vast migration for employment commenced, a time the country started to encounter a lack in labor in particular industries, e.g., in mining. Consequently, Germany started to seek labor force form third countries which is referred to as "Gastarbeiter" (Dinç, 2011, p. 255).

The agreement creates a regulatory framework for the migration of workers from Turkey to Germany (Federal Foreign Office, 2021). Originally, a limitation of two years regarding the duration of Turkish laborers remaining in Germany had been implemented but was removed in 1964. In the beginning, the approach for workforce addition in the first stage was meant to work in a revolving manner (Dinç, 2011). Thus, the foreign workers would reside in Germany only for a short period, generally between two and three years, and after going back to their country of origin. From the perspective of the private sector, as untrained labor force got exchanged for already trained personnel. Consequently, the private sector demanded that the residence authorization would be prolonged through regulatory requirements.

Following the conclusion of the agreement, overall, about 876.000 Turks have migrated to Germany under its scope (Federal Foreign Office, 2021). Borchard et al. (2021) notes that in the time frame 1961 to 1973, when hiring was halted, approximately one Mio. Turks had moved to Germany. This also encompassed relatives who had moved to Germany for reasons of reunification following 1964. Overall, women made up approximately one fifth of the Turkish labor force migrating to Germany during that period. Furthermore, locally Turks represented the majority of immigrant groups that had migrated to Germany to work (Akgündüz, 1993). After 1960, also the economic ties between Türkiye and West Germany started to increase with, e.g., funds for investments flowing to Türkiye.

As mentioned by Togan (2011) and the Republic of Türkiye Ministry of Foreign Affairs - Directorate of EU Affairs (2024a), the application for Türkiye to become a member in the the European Economic Community was issued in 1959. At the beginning of the 1960, in 1963, Türkiye and the European Economic Community concluded the so-called Association Agreement, also the Ankara Agreement, which went into effect on December 1, 1964, to facilitate the ties between the two partners, collaboration as well as the integration (Adam & Moutos, 2005; European Commission - Directorate-General for Trade, 2024; European Parliament, n.d.; Karatas, 2016, Özer, 2020). The way for the integration operations was paved by the Association Agreement among Türkiye and the ECC, together with arranging for Türkiye's ultimate complete integration (Adam & Moutos, 2005; European Parliament, n.d.; Özer, 2020). The establishing of a Customs Union was a substantial move in the direction of becoming a complete member of the EU

and part of the integration operations carried out in three steps (Adam & Moutos, 2005; European Parliament, n.d; Özgöker & Bedirhan, 2016).

The first step was the preparatory stage lasting from 1964 to 1970, followed by the conclusion of the so-called Additional Protocol in 1970 (Özer, 2020; Özgöker & Bedirhan, 2016; Republic of Türkiye Ministry of Foreign Affairs - Directorate of EU Affairs, 2024a). Simultaneously to the beginning of the transit term, which lasted from 1973 until 1995, the Additional Protocol went into force, prompting actions like the dismissal of customs tariff and quantity limitations by the ECC whereas Türkiye's process to withdraw trade barriers was step-by-step (Adam & Moutos, 2005; Özgöker & Bedirhan, 2016; Republic of Türkiye Ministry of Foreign Affairs - Directorate of EU Affairs, 2024a). The transit stage persistent for about 22 years, over time resulting in the Customs Union's formation (Adam & Moutos, 2005; Özer, 2020; Özgöker & Bedirhan, 2016).

In retro perspective, starting at the beginning of the 1980s, Türkiye has been following an export expansion agenda, pushing the liberalization for the exchange of goods with other countries forward step-by-step (Tekce, 2016). According to Tekce (2016, p. 399), "In line with this strategy, Turkey has been aiming at integrating its economy with the European Union (then the European Community) since the 1960s.". During the second half of the 80s the country started speeding up its undertakings of adjusting structures such as trading centers and organizations in line with a potential entering the European market.

On March 1995, the enforcement of the Customs Union was concluded and went into effect at the start of 1996, in accordance with the with the Decision No. 1/95 by the European Council-Türkiye Association Council (Başlar, 2004; European Union EUR-Lex, 1995; Karatas, 2016; Republic of Türkiye Ministry of Foreign Affairs - Directorate of EU Affairs, 2024a; Tekce, 2016). Based on Decision No. 1/95 Article 1, hereby, the "final phase of the Customs Union" is enforced (European Union EUR-Lex, 1995). The Union brought Türkiye closer to entering the European Union (EU) as a member country and was even considered the concluding stage (Tekce, 2016). At that point, Türkiye's EU membership was foreseen to happen in a short amount of time following the Customs Union.

The establishing of the Customs Union led to an ease in regard to trade with the EU (Tekce, 2016). The Customs Union forms the base for the ties between Türkiye and the EU economically, in particular regarding the exchange of goods (Selcuki & Tulan, 2021). As part of the treaty, Türkiye adapted its commercial rule sets to the EU's Common Commercial Policy, tariffs and quantity limitations for produced goods were omitted and outward custom duties for imported goods from third-party states were aligned with the EU's specifications (Karatas, 2016; Tekce, 2016; Togan, 2011).

The German economy is the largest in Europe (Selcuki & Tulan, 2021). Having said that, according to Selcuki and Tulan (2021, p. 13), "...the bilateral trade relations between Germany and Turkey cannot be considered separately from the EU-Turkey trade regulatory perspective.". Therefore, it is fundamental that when assessing the Turkish role in the Customs Union to also examine the trading ties between Türkiye and Germany. Witzens (2005) emphasizes that German advocacy for Türkiye becoming a member of the EU has continuously been central among European countries. Turhan (2022) notes that within the EU, the German position is impactful and therefore its course with Türkiye significantly affects the ties between Türkiye and the EU.

In recent times, a number of scholars and key stakeholders have been advocating for the modernization of the Customs Union's framework for reasons of shortcomings and challenges in the context of changed external framework conditions and demands (e.g., Federation of German Industries (BDI), 2017; Dawar et al., 2018; Karatas, 2016; Özekan, 2023; Özer, 2020; Özgöker & Bedirhan, 2016; Slevogt & Seyfert, 2022; Ülgen et al., 2022). In the following subchapter the relationship between Türkiye and Germany in the 21st century is explained.

1.4 Turkish-German Relations in the 21st Century

The history of Turkish-German ties is extensive and regardless of governmental discrepancies in recent years, Turkish-German ties continue to be persistent (Hermann, 2023). High-ranking politicians and governmental officials from both sides regularly visit the other partner country on various occasions such as state visits or joint meetings such as the annual Turkish-German Energy Forum or the yearly Joint Economic and Trade Commission (Federal Ministry of Economic Affairs and Climate Action, 2024; Republic of Türkiye Ministry of Foreign Affairs, 2024; Republic of Türkiye Ministry of Trade,

2024b). Recently, German Federal President Frank-Walter Steinmeier, in late April 2024, and German Chancellor Olaf Scholz, in mid-October 2024, paid individual state visits to Türkiye (Federal Government, 2024a; Federal President, 2024; Presidency of the Republic of Türkiye, 2024a; Zeyrek, 2024). On the other hand, the Turkish President Recep Tayyip Erdoğan last paid a state visit to Germany in the middle of November in 2023 (Presidency of the Republic of Türkiye, 2023a; Republic of Türkiye Ministry of Foreign Affairs, 2024).

As stated by Aya and Atun (2013), the Federal Foreign Office (2024b), the Republic of Türkiye Ministry of Foreign Affairs (2023) and Szabo (2018), about three Mio. people with Turkish roots live in Germany today, holding a crucial position in the context of the countries' ties. Out of the approximately three Mio. people of Turkish origin in Germany's population, about 50 percent possess German nationality (Hermann, 2023). The considerable degree of involvement in the elections in Türkiye by Turkish people living in Germany demonstrates their strong relationship to their home country. In the last presidential elections, held on May 14, 2023, out of the 1,5 Mio. Turks that had been able to attend, half of them participated despite a limited availability of sites to vote.

On the other hand, from the perspective of German tourists Türkiye represents a favored place to go on vacation (Federal Foreign Office, 2024a), Although travel to Türkiye decreased due to the Corona pandemic, the development was restored, and 2019 numbers were regained in 2022 as well as kept increasing in 2023.

Following the destructive earthquake in Türkiye as well as Syria on February 6, 2023, both Germany and the EU are helping in handling the repercussions (Federal Foreign Office, 2024a). At the meeting to gather donations in connection with earthquake relief, which was held in Brussels on March 20, 2023, the most monetary contribution was committed by Germany (Hermann, 2023). In connection with the refugee movements to Türkiye the German authorities provide support in attending to and taking in refugees in Türkiye while reinforcing the organization inside receiving communities as mentioned by the Federal Foreign Office (2024a).

Apart from the preexisting educational and cultural institution established in the context of the cultural agreement following the year 1957 (also see chapter 2.2), the Turkish and German authorities concluded an additional agreement according to which the Turkish-

German University was established in 2008 (Bayar & Bir, 2020; German Academic Exchange Service (DAAD), 2023; German Representations in Türkiye, n.d.). German-Turkish discussion of comprehensive nature to set up a "Turkish-German University" in Türkiye started in the middle of 2006 (DAAD, 2023). The Turkish-German University is governed by Turkish higher education laws since it is a public university (DAAD, 2023; German Representations in Türkiye, n.d.). Both, the Turkish and German president at that time attended the placing of the foundation stone in October of 2010. The first classes commenced on September 16, 2013 (DAAD, 2023; Hermann, 2023; German Representations in Türkiye, n.d.). On April 29, 2014, at this time, German president Joachim Gauck and Turkish president Abdullah Gül officially opened the University during the so-called German-Turkish Year of Science (DAAD, 2023; German Representations in Türkiye, n.d.). Afterwards, in late-January 2020, the, then, chancellor Angela Merkel and Turkish president Recep Tayyip Erdoğan jointly attended the inauguration of the finished university grounds (Bayar & Bir, 2020; DAAD, 2023; German Representations in Türkiye, n.d.).

According to the European Council - Council of the European Union (2024b), Türkiye received the rank as candidate for the EU in December of 1999. Following this development, in October 2005, Türkiye and the EU commenced discussions regarding the EU membership for the country (European Council - Council of the European Union, 2024b; Republic of Türkiye Ministry of Foreign Affairs - Directorate for EU Affairs, 2024b). From an EU perspective, the negotiations halted in June of 2018 based on the EU's assessment on particular domestic political framework conditions in Türkiye that signaled setbacks, in the opinion of the EU (European Council - Council of the European Union, 2024b). The Federal Foreign Office (2024) state that the government of Germany regards the discussions on Türkiye’s membership, that began by 2005, as “open-ended”, and that the country’s candidate status remains.

The partners passed the "Negotiation Framework Document" at the beginning of discussion in 2005, outlining the corresponding rules and proceedings (Republic of Türkiye Ministry of Foreign Affairs - Directorate for EU Affairs, 2024b). Currently, one section is being temporarily halted and additional 16 sections of the framework are discussed in the context of Türkiye’s membership negotiations. In total, the scheme consists of 35 sections to be covered in discussion between the partners.

The next chapter of the thesis assesses environmental policies further elaborating on green trade, decarbonization efforts and the Carbon Border Adjustment Mechanism.

2. ENVIRONMENTAL POLICIES: GREEN TRADE, DECARBONIZATION AND THE CARBON BORDER ADJUSTMENT MECHANISM

In the following chapter different theoretical approaches, schemes and policies in connection with environmental protection, the greening of international trade activities, and the decarbonization of economic operations are outlined and further described. In this context, the EU's instruments such as the European Green Deal, the EU ETS and the linked CBAM are explained. Furthermore, the chapter is concluded with a snapshot of climate and decarbonization in Türkiye and in Germany. The following subchapter provides an in-depth summary of the European Green Deal.

2.1 The European Green Deal

The European Green Deal has its roots in the energy and environmental strategies of the EU which started to be established at the beginning of the 1990s, according to Skjærseth (2021). The corresponding strategies have evolved from isolated and restricted environmental and energy efforts into comprehensive, harmonized approaches designed to meet progressively eager objectives in connection with the environment. Almeida et al. (2023, p. 1) state that the Green Deal was introduced as "world's first public state-led commitment to climate neutrality.". Furthermore, it represents the expansion plan of the EU which was initiated in 2019 (European Council - Council of the European Union, 2025). It consists of a set of policy measures designed to guide the EU through the green transitioning process, with the underlying aim of accomplishing carbon neutrality until 2050.

The United Nations Framework Convention on Climate Change (UNFCCC) was the initial international agreement to directly tackle the change of climate (Maizland, 2023). The treaty was accepted by 197 nations in 1992. With the treaty a yearly platform for global negotiations was created, called the Conference of the Parties (COP), focused on balancing levels of emissions of carbon output in the environment. These gatherings later led to the establishment of the Kyoto Protocol as well as the Paris Agreement.

Concluded in 1997 and enforced in 2005 with the aim to tackle climate change the Kyoto Protocol is an agreement contrasting prior schemes like the UNFCCC as it includes objectives and timings referring to caps for greenhouse gas emissions and corresponding

obligatory periods of achievement (Berrich, 2024; Barret, 1998; Maizland, 2023). Barret (1998) furthers emphasizes that the treaty does not stand for the completion of global collaboration regarding the environmental fight against global warming but rather represents its commencement.

Shislov et al. (2016) notes that it could be challenging to determine a factual, straightforward connection among the Kyoto Protocol and national environmental protection legislation, but the global treaty has potentially amplified political plans both domestically as well as regionally. Nonetheless, the treaty mandated developed nations to cut greenhouse gases by a mean of five percent compared to 1990 results and implemented a scheme to track their development (Maizland, 2023). However, it did not require emerging nations, such as large polluters like China or India, to undertake initiatives. Furthermore, the Kyoto Protocol led to the establishment of proceedings as well as stock of competencies especially regarding supervision, declaration and validation (Shislov et al., 2016) These beneficial factors are applied internationally in the context of various instruments and legislation to counter climate change and e.g. referred to under the transparence aspect as part of the Paris Agreement.

The Paris Agreement was passed by 195 nations at the COP21 in 2015 with the goal of tackling global warming (Aitsi-Selmi et al., 2016; Berrich, 2024; Boone, 2024; Wendler, 2022). Germany and the EU signed the treaty on April 22, 2016, and ratified it on October 5 the same year (*Paris Agreement, CHAPTER XXVII, 7.d.*). Türkiye, on the other hand, also signed on April 22, 2016, but did not ratify the agreement until October 11, 2021. The Agreement symbolizes the first universal and lawfully legitimate climate treaty (Boone, 2024). It officially came into force on November 4, 2016, with a notice for other nations to provide their commitment until late April 2017. The Agreement's main target is to lower general temperature levels globally and restrict emissions with the aim of substantially decrease the danger and effects of global warming. As stated by Berrich (2024) and Maizland (2023) it distinguishes itself through the use of Nationally Determined Contributions (NDCs) that represent a scheme for developing and industrialized nations to determine objectives for emissions abatement. The objectives of the treaty incorporate maintaining a mean of the increase in temperature levels in the world under two degrees Celsius in contrast with results from periods prior to industrialization (*Paris Agreement, Article 2*). In this context, activities for restricting the

threshold to 1,5 degrees Celsius are required. Furthermore, the treaty sought after facilitating competencies to adjust to the negative effects of global warming meanwhile facilitating resilience as well as further development causing less pollution. Moreover, monetary movements should be in line with ways that support small levels of greenhouse gases as well as facilitate growth while considering resilience against climate change.

Ritchie et al. (2020) determined that on average most of the greenhouse gas emitted are originating from the generation of power and heating in the world. Then, industries such as transportation, industrial production, the building sector as well as agriculture rank consecutively. As mentioned by Kalayci and Artekin (2024, p. 3232) the environment's emergency felt by ways of the warming of our climate may result in "many green discourses and policy tools from ecology to economy, from economy to politics.".

Generally, by all means, EU countries joined and approved the numerous climate initiatives such as the United Nations Framework Convention on Climate Change, the Kyoto Protocol as well as the Paris Agreement (Runge-Metzger & Van Ierland, 2019). Moreover, EU countries themselves are responsible for undertaking activities as well as to guarantee the coherence of proceedings at different scales of authority. Meanwhile, the EU focuses its activities and governs fields that it can provide evident additional value.

Originally, as part of the Kyoto Protocol, the EU had dedicated itself to lowering greenhouse gases by eight percent in comparison to the values of 1990 during the initial obligatory phase between 2008 and 2012 (European Union, 2007; Skjærseth, 2021). During the period 2008 to 2012 just nine states which had completely taken part in this stage accounted for moderately greater values as they had dedicated themselves to as part of the Protocol (Shislov et al., 2016).

Ever since, objectives have risen resulting in an aim to cut 20 percent of harmful emissions from 2013 until 2020 as well as, initially, 40 percent less not later than 2030, both in contrast to the rates of 1990 (European Environment Agency, 2021; European Union, 2007; Skjærseth, 2021; United Nations Framework Convention on Climate Change (UNFCCC), 2014). According to the European Environment Agency (2021), the EU accomplished its 2020 greenhouse gas reduction objective, along with raising the percentage in renewable energy sources in energy usage to over 20 percent as well as enhance energy efficiency results as far as 20 percent, too.

In 2023, the European Parliament adapted the so-called "Effort Sharing Regulation" (*Regulation 2018/842*), belonging to the "Fit for 55 in 2030 package", which raises the aimed values for the abatement of emissions to 40 percent from previously 30 percent in comparison to results in 2005 (European Parliament, 2023; European Union EUR-Lex, 2018a). The changes also incline that, occurring for the first time, every EU member state is required to lower their individual emissions levels linked to objectives spanning from ten to 50 percent in accordance with *Annex 1* of the legislation. In addition, EU countries must guarantee that yearly limits in connection with allowed greenhouse gas levels are adhered to each year. The EU's reliance on utilizing strong legislation in tackling global warming is highlighted by the implementation of the Effort Sharing Regulation (Peeters & Athanasiadou, 2020). In contrast to the "Effort Sharing Decision", the legislation particularly refers to its obligatory nature by incorporating the phrase "binding" in the corresponding heading to further emphasize the obligation of EU countries to meet yearly emission abatement objectives, as stated by Peeters and Athanasiadou (2020, p. 210).

Emissions originating from industries not covered by the EU ETS are governed by the Effort Sharing Regulation, so-called "non-ETS sectors" (Runge-Metzger & Van Ierland, 2019, p. 96). Furthermore, these sectors account for approximately 60 percent of the EU's greenhouse gas emissions and primarily arise from dispersed origins such as ground transportation, residential and commercial properties' heat supply, manufacturing of minor and middle magnitude, agriculture, garbage disposal, and goods including fluorinated greenhouse gases, as mentioned by the European Parliament (2023) and Runge-Metzger & Van Ierland (2019). Due to their dispersed characteristics, these emissions are inadequate for becoming part of the EU ETS' scope (Runge-Metzger & Van Ierland, 2019). Among the sectors, ground transportation is the greatest contributor, responsible for over a third of greenhouse gases in the industries outside of the scope of the EU ETS, followed by heat supply of properties as well as agriculture.

Furthermore, in alignment with the Paris Agreement, according to a decision by the European Council, the reduction objectives for the year 2030 were increased valuing at 55 percent (European Commission, 2023a; European Parliament, 2023; Skjærseth, 2021; World Business Council for Sustainable Development (WBCSD, 2021). This decision is also part of the so-called "Fit For 55" bundle by the EU with the goal of reshaping the EU's economy (European Commission, 2023a; WBCSD, 2021, p. 1).

The European Green Deal aims to achieve net zero emissions in the EU by mid-century, to support the protection of the climate and to separate the expansion of the economy from the consumption of resources as well as to define the course for sustainable transformation (European Council - Council of the European Union, 2024a; Fetting, 2020; Şahin et al., 2021). The Green Deal represents a comprehensive and multidimensional policy touching up the environmental, economic, as well as social dimensions (Hajdys, 2024). Although the notion of the European Green Deal was being drafted in late 2019, prior to the COVID-19 crisis, progress in connection with climate action has merely picked up speed since 2023. Several legislative measures under the Green Deal have been implemented, such as the Fit for 55 bundle, which encompasses a number of instructions and laws touching upon the energy and advancing in the direction of net zero. Also, the CBAM is part of the so-called Fit for 55 bundle (European Parliament, 2022). The Green Deal is centered around the agenda that greenhouse gases should be lowered by at least 55 percent until 2030 as well as to accomplish the net-zero target in 2050 (Guzal-Dec, 2022). To reach the determined objectives green transformation efforts should be conducted within a timeframe of 30 years. Moreover, the Green Deal represents a contemporary expansion plan targeting to metamorphose the EU to become an equitable as well as affluent society and to establish an economy which is up-to-date, able to compete as well as utilizes resources efficiently.

Fetting (2020) stresses that the European Green Deal does not represent a legislation instead it is a broad strategic plan sketching the aims and objectives across various domains. Furthermore, the policy package aims to encourage the actions necessary to create a net zero emissions and more sustainable surrounding endorsing fair and competitive conditions along the climate neutrality goal by 2050 (Şahin et al., 2021). Beyond the transition internally in the EU the European Green Deal intends to lower the carbon footprint and hinder the migration of greenhouse gas emissions to third countries by moving their manufacturing facilities accordingly, the so-called “carbon leakage”, globally (European Bank for Reconstruction and Development et al., 2023, p. 7; European Commission - Directorate-General for Taxation and Customs Union, 2024; Şahin et al., 2021).

According to Dr. Ursula von der Leyen, President of the European Commission: “The European Green Deal is our new growth strategy. It will help us cut emissions while

creating jobs." (European Commission, 2019). Furthermore, the European Council - Council of the European Union (2024a) emphasizes that "It [the European Green Deal] supports the transformation of the EU into a fair and prosperous society with a modern and competitive economy.".

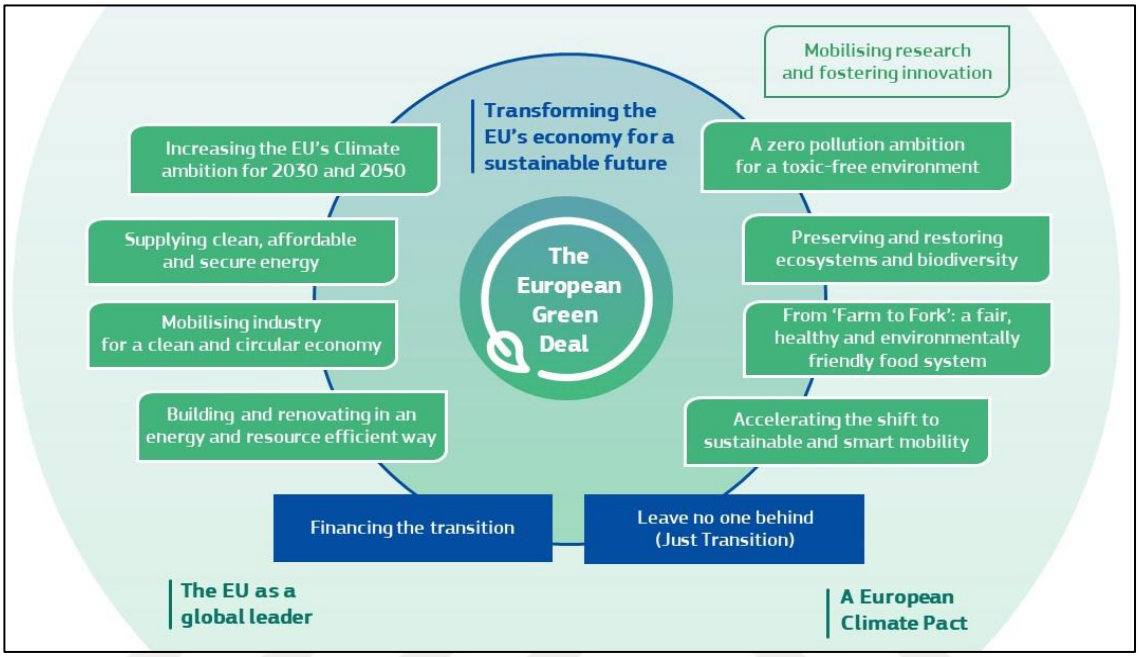


Figure 1. The European Green Deal's Composition

Source: European Union EUR-Lex, 2019b, *Communication COM/2019/640*.

As part of the Green Deal's execution current legislation and criteria is modified and updated framework conditions are established (Fetting, 2020). To ultimately reach net zero by 2050 the plan touches upon the following areas: Carbon reduction in the energy domain, assistance of the industrial sector to emerge as frontrunners as part of the sustainable transformation, improving building structures to increase energy efficiency and establishing more affordable, conscious, and sustainable modes for individual and community transportation (European Commission, 2019). The European Green Deal's initiatives form the groundwork to foster the transition leading to the reorganization of the continent's market (Kalayci & Artekin, 2024).

Figure 1 above describes the miscellaneous components of the European Green Deal. The following initiatives refer to the EU's objective of developing a comprehensive series of profoundly transformational political strategies (European Union EUR-Lex, 2019b). The

heading “Increasing the EU’s Climate Ambition for 2030 and 2050”, refers to boosting greenhouse gas abatement and net-zero objectives, e.g., as seen under the Fit for 55 bundle. Furthermore, the EU focuses on sustainable, inexpensive and guaranteed energy supply, e.g., by focusing on the ramp-up of renewables while transforming, modernizing and decarbonizing its energy system. With the help of the element “Mobilizing industry for a clean and circular economy”, the EU aims to convert their industrial base and corresponding supply chains to accomplish net zero and establish a sustainable closed-loop economic system by 2050. The component “Building and renovating in an energy and resource efficient way” mainly refers to the EU’s efforts to increase efficiency levels of compounds as they account for 40 percent of overall energy consumption and high levels of emissions. Another initiative is around “Accelerating the shift to sustainable and smart mobility” as the transportation sector as a whole stands for 25 percent of greenhouse gases in the EU. The objective is to lower greenhouse gases by 90 percent until 2050 to accomplish net zero and hence, implement various efforts to decarbonize the sector and increase its sustainability.

As part of the initiative “From ‘Farm to Fork’: designing a fair, healthy and environmentally-friendly food system” the EU aims to establish a more sustainable, efficient, equal and robust agri-foods sector, also touching upon the various levels of EU supply chains both domestically and in the context of imports (European Union EUR-Lex, 2019b). In the context of the plan “Preserving and restoring ecosystems and biodiversity” the EU pursues to protect as well as rebuild the ecological system and biodiversity as their state is crucial in impacting the environment as well as in providing basic amenities like pure water, feed or unpolluted air. The final political initiative alludes to “A zero pollution ambition for a toxic-free environment” demanding steps to hinder environmentally harmful activities and repair as well as purify existing damages. The EU aims to implement an array of corresponding strategies and legislation as well as establish measures to improve supervision, documentation, avoidance as well as repair of contamination and environmentally polluting activities.

Beyond the listed initiatives the EU aspires to integrate sustainability aspects in the EU’s entire strategy and plans (European Union EUR-Lex, 2019b). In the context of the action “Pursuing green finance and investment and ensuring a just transition”, the EU acknowledges that to accomplish the wide array of objectives determined by the European

Green Deal, substantial amounts of investment is required. Furthermore, it is necessary to maintain investment streams in the long run and due to the investment volumes demanded both the business world and administrations must contribute, including the setup of investment strategies and monetary funds. The European Commission assumed to accomplish the present agenda of environment- and energy-related objectives until 2030, a yearly sum of 260 billion EUR is necessary equaling approximately 1,5 percent of the GDP in 2018 (European Union EUR-Lex, 2019a; 2019b).

In the context of establishing an equitable and integrated transformational process, the EU implements the "Just Transition Mechanism" (European Union EUR-Lex, 2019b) The instrument concentrates on areas and industries most impacted by the transformational process as rely highly on hydrocarbons or environmentally-unfriendly manufacturing and will provide monetary support through a connected financial tool. Another initiative targets "Greening national budgets and sending the right price signals", referring to the increased application of sustainable monetary allocation instruments to support in diverting government spendings and tax revenue toward climate action. In this context the function of domestic budgetary frameworks throughout the transformation is central. The EU and EU countries are set to collaborate on reviewing and assessing activities in connection to sustainable monetary allocation.

Furthermore, the EU is set to intensify efforts around research and development as well as promote advancements in this context, under the set target of "Mobilising research and fostering innovation", as this is crucial for the success of the Green Deal (European Union EUR-Lex, 2019b). This aspect is also essential in maintaining the competitiveness of the EU in connection with green technological solutions. To facilitate innovative technologies the EU set up Horizon Europe with the aim of financing particular endeavors important in the context of the Green Deal. In another respect, under the plan "Activating education and training", the EU also set out to build a scheme investing in educational activities, developing capabilities and providing know-how in the course of the transformational process. The initiative "A green oath: 'do no harm'" establishes that the EU's regulatory plans, activities and strategies are united to support the accomplishment of a flourishing as well as fair transformation in the direction of an eco-friendly tomorrow.

The EU also has the ambition to take up an international leadership role in the context of climate action and eco-friendly growth in bilateral and multilateral settings, establishing the concept of a "green deal diplomacy" (European Union EUR-Lex, 2019b). In the light of the motto "Time to act - together: a European Climate Pact", among others, the EU prioritizes to build close communication channels with society facilitating knowledge transfer, awareness creation and encouragement as their participation and dedication is fundamental concerning positive outcomes of the Green Deal.

The European Environment Agency regularly publishes a surveillance report in connection to the EU's "8th Environment Action Programme", a scheme for measures on the EU's climate protection regulatory plans leading up to 2030 (European Union EUR-Lex, 2022; European Environment Agency, 2023, p. 6). As part of the report's results the areas, "climate change mitigation", "climate change adaptation", "a regenerative circular economy", "zero pollution and a toxic free environment", "biodiversity and ecosystems", "environmental and climate pressures related to EU production and consumption", "enabling conditions" and "living well, within planetary boundaries" (European Environment Agency, 2023, p. 7-8). In 2023, the overall sentiment in the various areas tends to indicate that the majority of the targets set will not be achieved by 2030 or will only be achieved in part. Only in the subcategories of preventing deaths in babies due to prematurity caused by polluted air, raising spendings on environmental protection, growing the proportion of environmental innovations, expanding employment figures in sectors of environmental products and services, as well as its positive development regarding economic value creation. Also, Lazorčáková (2024) mentions skepticism regarding the fulfillment of the objectives of the Green Deal in time until 2030. Although, the corresponding legislative progresses may be conducted and regulations come into effect, their proper implementation in practice and the delivery of outcomes as well as the need for modifications may lead to delays. The scholar notes a discrepancy between the theoretical and practical enforcement of the objectives of the Green Deal. Thus, when assessing the timely accomplishment of objectives, the theoretical dimension should be considered rather than the practical one. The following subchapter outlines the EU Emissions Trading System.

2.2 The EU Emissions Trading System

With the *Directive 2003/87/EC* the EU introduces a scheme for the exchange of "greenhouse gas emission allowance", the so-called EU Emissions Trading System with the goal to facilitate the abatement of polluting emissions "in a cost-effective and economically efficient manner" (European Union EUR-Lex, 2003, (Article 1)). Following its adoption in the year 2003, the EU ETS was introduced in the year 2005 functioning on separate market windows and currently experiencing stage four which spans from 2021 to 2030 (European Commission - Directorate-General for Climate Action, 2024c; European Commission - Directorate-General for Climate Action, 2024e). In accordance with the EU's environmental objectives the trading scheme for greenhouse gases has been subject to multiple amendments throughout time. The scheme's scope of validity covers the sum of EU member countries, states of the European Free Trade Association which encompass Lichtenstein, Norway as well as Ireland and, beyond that, in the context of power production the nation Northern Ireland (European Commission - Directorate-General for Climate Action, 2024b). According to the European Commission - Directorate-General for Climate Action (2024c), internationally the EU ETS was the earliest one of its kind and remains in the midst of the biggest emissions trading schemes existing around the world today. Following the implementation of the EU ETS it quickly became popular with legislators and academics due to the fact that it was the first cross-border cap-and-trade system as well as the most comprehensive ETS, covering aviation, globally (Borghesi et al., 2016).

In the context of the Kyoto Protocol signaling the start of global climate collaboration countries adopted various strategies to meet their c pledges and utilize adaption instruments, including procuring units of emission explicitly, encouraging the companies' national emission credits utilization, and promoting national greenhouse gas abatement by means of diverse climate legislation (Barret, 1998; Shislov et al., 2016). Throughout these policies, the EU ETS stands out as the most significant domestic instrument driving the EU greenhouse gas abatement as well as the application of the Protocols credit scheme. The EU ETS has served as the primary catalyst for the exchange of emissions and as the leading underlying factor of inquiries concerning "Certified Emission Reductions" as well as "Emission Reduction Units" (Shislov et al., 2016, p. 18).

According to the European Environment Agency (2024), the EU ETS has substantially contributed to the reduction of emissions by greenhouse gases following its implementation in the year 2005. Developments such as a price tag on carbon emissions, shifts in cost for petrol as well as legislation regarding climate action, e.g., facilitation of renewables, made abatement of greenhouse gases in the context of fixed setups gain momentum as well as greatly advanced the environmental protection targets of the EU. Especially in 2023, greenhouse gas emissions that year dropped most ever following its introduction.

Directive 2003/87/EC stipulates the raise of emission mitigation efforts to assist in the accomplishment of mitigation required to prevent global warming. Furthermore, it supports the realization of the set forth net-zero goals by the EU as well as the environmental aims in line with the *Regulation (EU) 2021/1119* and consequently also the Paris Agreement's ambitions (European Union EUR-Lex, 2003). In addition, the legislation provides conditions to measure as well as follow a more rigorous EU pledge to lower emissions beyond 20 percent, which would be adopted following the acceptance of a global treaty regarding global warming by the EU.

In line with *Directive 2003/87/EC*, the scheme should be enforced in context of the undertakings itemized as part of the Directive's Annexes I and III as well as the emissions stated in Annex II (European Union EUR-Lex, 2003). As stated by the European Commission - Directorate-General for Climate Action (2024b) the EU ETS encompasses emissions linked to particular actions centered around outflows which may be estimated, validated as well as recorded in a particularly precise way. This includes e.g. the emitted CO_2 as a result of the production of power and heat as well as highly power-consuming industrial manufacturing such as in the areas of iron and steel, refineries, cement, other metals, ceramics and chemicals, among others.

In addition, air travel inside the European Economic Area as well as outbound departures to the UK and Switzerland are covered. Also, starting in 2024 the marine transportation sector is affected by the scheme, in particular 50 percent of emitted greenhouse gases of travels departing or arriving beyond EU border, all emitted greenhouse gases of journeys among two harbors in the EU as well as while vessels remain inside of harbors in the EU (European Commission - Directorate-General for Climate Action, 2024b).

In regard to other greenhouse gases N_2O occurring as part of manufacturing processes in connection with acids of different kinds such as adipic, glyoxylic, nitric and glyoxal, and PFCs arising from aluminum manufacturing are affected by the EU ETS. Organizations from the mentioned areas must take part in the EU ETS as it is compulsory EU (European Commission - Directorate-General for Climate Action, 2024b).

Although in particular industries the scheme solely takes into account organizations exceeding a specific magnitude, e.g. in the context of burning feed in plants with "a total rated thermal input" of more than 20 MW (European Commission - Directorate-General for Climate Action, n.d.; European Union EUR-Lex, 2003, (Annex I)). The same can apply for in size rather insignificant installations as long as administrations implement substitute actions for ultimately reducing greenhouse gases (European Commission - Directorate-General for Climate Action, 2024b). Starting in 2024, the scheme additionally obliges facilities burning communal garbage and exceeding a specified amount to track and state emitted greenhouse gases. In total approximately 10.000 facilities as part of the power industry, production sector and aviation carriers running inside the EU as well as journeying to Switzerland or the UK are affected by the EU ETS. Furthermore, the industries reflected under the EU ETS represent about 40 percent of all greenhouse gases emitted within the EU, according to the European Commission - Directorate-General for Climate Action (2024c).

Regarding the historical evolvement of the EU ETS, it can be separated in currently four stages: period one from 2005 to 2007, period two starting in 2008 and ending in 2012 as well as period three from 2013 to 2020 until reaching period four active between 2021 and 2030 (European Commission - Directorate-General for Climate Action, 2024e).

Period one is regarded as the preparation and introductory stage studying and testing what is necessary to operate the system efficiently in period two where it was expected to support the EU's accomplishment in connection with the objectives of the Kyoto Protocol. During period one merely carbon emitted through electricity production as well as manufacturing installations consuming large amounts of electricity were reflected under the EU ETS (European Commission - Directorate-General for Climate Action, 2024e). The EU handed out a major part of carbon permits to organization against any charge. On the other hand, the inclined monetary punishment when violating the rules

amounted to 40 EUR per ton of Carbon Dioxide Equivalent (CO_2eq), as mentioned by the European Commission - Directorate-General for Climate Action (2024e). During stage one the EU effectively implemented an emissions cost, an open market in carbon permits to be exchange throughout the EU as well as the groundwork required for surveilling, declaring and validating carbon levels in in the concerned industries. Due to a lack of dependable empirics regarding levels of emitted greenhouse gases, the ceiling in period one was established by virtue of assumed values. Consequently, the EU had released a number of carbon permits surpassing the actual level of emitted greenhouse gases. This led to an excess of carbon permits available compared to the actual request and the charges for permits dropped to nothing in the year 2007.

During period two the initial dedication phase regarding the Kyoto Protocol commenced with specific greenhouse gas abatement objectives to be accomplished by nations under the EU ETS (European Commission - Directorate-General for Climate Action, 2024e). The EU reduced the limit of carbon permits by 6,5 percent opposed to 2005 and the share in permits without any charge dropped moderately amounting to 90 percent. Moreover, Norway, Liechtenstein as well as Iceland started their participation in the EU ETS. Furthermore, the inclined monetary punishment when violating the rules experienced a raise to 100 EUR per ton of CO_2eq, according to the European Commission - Directorate-General for Climate Action (2024e). The auctioning commenced in a number of states and companies were given permission to purchase global credits amounting to approximately 1,4 billion tons in CO_2eq. Also, starting at the beginning of 2012, the air transport industry became part of the EU ETS with an exception in 2012 for departures heading towards or arriving from nations outside the EU. Due to the access to validated yearly empirics on level of emitted greenhouse gas gathered during period one, the EU lowered the limit for permits during stage two taken into account the factual results. Nonetheless, as a consequence of the financial crash in 2008 levels of greenhouse gases declined further than what was anticipated causing am excess of carbon permits as well as credits imposing a serious burden on emission pricing during period two.

Regarding the auctioning of the carbon allowances, by jurisdiction EU countries have the option to form their own trading exchange as an alternative to the central system (Borghesi, 2016; European Union EUR-Lex, 2023b). Borghesi (2016) emphasizes that when an EU country decides to utilize a separate auction marketplace it must still comply

with the regulatory terms and framework stated in the *Regulation 2023/2830* to guarantee a distinct level of coordination regarding the permits' auction process within the EU. At present, a couple of systems are operating representing the EU ETS.

Firstly, most EU member states participate in the system provided by the European Energy Exchange (EEX) (Borghesi, 2016; European Commission - Directorate-General for Climate Action, 2024f; European Commission - Directorate-General for Climate Action, 2024g). In 2024, the mandate of the EEX was renewed through an official procurement process with a contract extension until the end of 2026 by the EU Commission (European Commission - Directorate-General for Climate Action, 2024g; European Energy Exchange (EEX), 2024). This step was taken due to the implementation of the additional EU ETS, the so-called "ETS2", which will encompass compounds, ground transportation as well as other industries, with corresponding auctions starting in 2027 (European Union EUR-Lex, 2003, Chapter IVa; European Commission - Directorate-General for Climate Action, 2024g; European Energy Exchange (EEX), 2024).

The EEX simultaneously also functions as the allowances' auction marketplace for Germany, as the country withdrew from participating in the central system but instead uses an individual setup (Borghesi, 2016; European Commission - Directorate-General for Climate Action, 2023; European Union EUR-Lex, 2023b). The EEX's mandate in the context of the auction marketplace for Germany was prolonged through an official procurement process in late 2022 and will commence at the beginning of 2024 for a duration of three more years (European Energy Exchange (EEX), 2022; European Commission - Directorate-General for Climate Action, 2023).

Germany has been participating in the EU ETS which was introduced in 2005 (Federal Ministry for Economic Affairs and Climate Action, 2025). As part of the BEHG the German Federal Government decided to establish its own local ETS as well which covers the sectors transport and heating which are currently not covered by the EU ETS at the end of 2019. Firms introducing fuels to the marketplace must follow the requirement of buying carbon permits in accordance with the matching quantity and submit these until September 30th of the consecutive year. During the initial period a scheme with a predetermined cost for the corresponding permits is presented to support the adaptation

process. Simultaneously, a separate marketplace for commercial activities around the carbon permits will be implemented. In 2021, the price for an allowance equals 25 EUR whereas in 2025 the price is set to amount to 55 EUR. Starting in 2026, the cost for permits shall be determined through the marketplace despite though a range between 55 EUR and 65 EUR is intended. In case the ETS setup causes a loss of competitiveness from the perspective of firms in Germany, e.g., through carbon leakage the government fully aims reimbursement. Through the implemented so-called Regulation on Measures to Prevent Carbon Leakage through National Fuel Emissions Trading (*"Verordnung über Maßnahmen zur Vermeidung von Carbon-Leakage durch den nationalen Brennstoffemissionshandel"* (BECV)) [Translation into English] the reimbursement of German firms eligible is given.

The alternative to the EEX is the Intercontinental Exchange (ICE), located in London, which used to represent the EU ETS auction marketplace for the UK until the end of 2020, prior to the establishing of the UK ETS at the beginning of 2021 (Borghesi, 2016; United Kingdom Government, 2024). Out of the UK, only Northern Ireland stayed in the EU ETS in connection with its electricity production, using the EEX in form of an individual separate marketplace like Poland and Germany (European Commission - Directorate-General for Climate Action, 2024f; United Kingdom Government, 2024).

Opposed to the setup in the periods one and two, following an amendment the scheme of the EU ETS significantly transformed (European Commission - Directorate-General for Climate Action, 2024e). The central modifications encompassed a number of different measures. Authorities introduced a sole ceiling for greenhouse gases across the EU instead of the former arrangement where caps were determined on a country basis. Rather than distributing permits against any charge auctions became the standard procedure to assign carbon permits. Furthermore, synchronized guidelines for the distribution of permits against any charge were introduced and additional industries as well as greenhouse gases were integrated according to the European Commission - Directorate-General for Climate Action (2024e).

Together with the amendments to the *Directive 2003/87/EC* in *Directive (EU) 2023/959* in 2023, the EU established an updated EU ETS, the so-called "ETS2" or Emissions Trading System 2, a structure apart from the present greenhouse gas emissions trading

scheme (European Commission - Directorate-General for Climate Action, 2024a; European Union EUR-Lex, 2003, (Chapter IVa), 2023c). The latest design is set to include as well as address emitted greenhouse gases in connection with engine burning inside of houses, as part of overland transportation as well as other areas which mostly encompass minor manufacturing businesses the EU ETS currently not considers. From a structural perspective also the ETS2 represents a "cap and trade" regime same as the current EU ETS, despite that it will encompass upstream greenhouse gases. As mentioned by the European Commission - Directorate-General for Climate Action (2024a) this means that tracking and disclosing levels of greenhouse gases will be mandatory for parties like the providers of petrol as opposed to the final user, e.g., homes or drivers of automobiles.

The framework is planned to be completely running by 2027 (European Commission - Directorate-General for Climate Action, 2024a). The surveillance and disclosing of carbon emissions will commence in 2025. The updated scheme is anticipated to supplement additional legislation introduced by the European Green Deal within the reflected industries. This will support EU members to accomplish greenhouse gas mitigation objectives determined by the EU's Effort Sharing Regulation. Up till now greenhouse gas mitigation within the affected industries lacks jeopardizing the EU's efforts to accomplish the net zero target of 2050. The emissions cost linked to the ETS2 will present a stimulus for the marketplace to attract capital for renovating houses and transport solutions causing less pollution.

The affected parties are expected to be governed as part of the ETS2 implying that it will be compulsory for them to submit adequate carbon permits to make up for the emitted greenhouse gases according to the European Commission - Directorate-General for Climate Action (2024a). The carbon permits will be acquired by the concerned parties through auctioning. The ceiling for emissions determined under the ETS2 is expected to lower greenhouse gases 42 percent until 2030 in comparison to amounts in 2005. The EU will attribute some of the earnings from the auctioning of carbon permits under the ETS2 to the Social Climate Fund which will assist fragile homes as well as tiny businesses. It is further emphasized that EU member countries it will be mandatory to employ the leftover earnings from the trading scheme in the context of environmental protection

activities and community undertakings providing a track record in terms of their reasons of spending.

2.2.1 The Cap System and Pricing of Emissions

As part of the EU ETS a ceiling, a so-called "cap", restricts the amount of carbon emission allowed to be discharged by facilities and organizations annually (European Commission - Directorate-General for Climate Action, 2024d; European Environment Agency, 2024). The quantity of carbon permits released during the course of time in relation to the scheme matches the predetermined cap (European Commission - Directorate-General for Climate Action, 2024d). Every permit allows the discharge of one ton of emissions measured in CO_2eq. In the context of greenhouse gases originating in the sectors aviation, marine transportation, manufacturing of products as well as production of heat and power the underlying estimation models for determining the related limits differ. Prior to the EU ETS, the cap value was determined on an individual country basis with the help of the "national allocation plans" and permits were dispensed in accordance (Borghesi, 2016, p. 2; European Commission - Directorate-General for Climate Action, 2024e).

Cap-and-trade schemes represent the preferred tool for emissions pricing at present (Metcalf & Weisbach, 2009). For example, the EU applies a cap-and-trade scheme, the EU ETS, to amend to the Kyoto Protocol. Also, in the US, e.g., in the US Congress, such schemes are eminently receiving attention. A cap-and-trade scheme depicts an environmental tool with an underlying marketplace approach and falls under the category of mechanisms on the basis of marketable carbon permits (Stavins, 2003). Besides cap-and-trade scheme, there is also there is e.g. also the credit system, working in a way that a company receives credits if its emissions drop below the legal emission maximum determined individually. Goulder and Schein (2013) refer to a cap-and-trade approach as a scheme of marketable carbon permits. Furthermore, connecting a cost to emissions may enable one to accomplish abatement for a discounted price compared to the impact of corresponding legislative frameworks. In the context of cap-and-trade schemes the total permitted amount of pollution is determined, which is distributed between companies in the nature of allowances (Stavins, 2003). These can then be openly traded with other parties. In principle, these allowances may be distributed either by open dispensation or by means of sales transactions conducted by the authorities, such as auction sales.

According to Weitzman and Holtsmark (2018), under a statutory cap-and-trade scheme allowances of carbon limits are distributed to polluters as part of authority while authorizing the domestic exchange of these permits. Overall carbon emissions must match the total amount of distributed permits. Hence, by regulating the total number of allowances distributed, authorities can effectively govern the overall carbon emissions. Economic scholars have been highlighting that cap-and-trade schemes are economical, as they diminish the overall costs of reduction for every determined emissions amount by guaranteeing that each polluter equalizes their marginal costs for reduction of emissions to the equilibrium allowance price.

Opposed to the classic fiscal method in connection with environmental marketplace collapse, systems such as “emissions trading” or “cap-and-trade” are broadly used (Sim & Lin, 2017, p. 158). Despite the fact that academic research did not establish persistent validation of the concept of commissioning a market instrument with power over the carbon price. In their assessment, carbon trading can surpass the Pigouvian approach regarding the national remainder as well as the remainder of the world when foreign trade as well as transnational environmentally harmful effects occur. As a result, adjacent nations are encouraged to adapt their carbon pricing in the absence of a negative rebound effect. Instead of prioritizing the governance via pricing, it is stressed that, in a global environment, volume authority can be more advantageous due to its contribution as a tool for dedication.

Limiting greenhouse gases through a ceiling in connection with electricity production facilities and manufacturing sites was introduced in 2013 (European Commission - Directorate-General for Climate Action, 2024d). According to the European carbon reduction objectives, the EU continuously every year lowers the value of this limit through a periodical mitigation coefficient which sets the tempo for abatement progress. Furthermore, the mitigation coefficient is employed in connection with the “reference cap value” representing the mean of the complete number of released permits as part of the EU ETS between 2008 to 2012. Up to the year 2020 the utilized mitigation coefficient amounted to 1,74 percent annually. Since the year 2021 this coefficient was adapted reaching 2,2 percent annually. As a result of the amendments to the *Directive 2003/87/EC* in *Directive (EU) 2023/959* in 2023, the related limit is targeted to reduce greenhouse

gases at a rate of 62 percent judged against the values from 2005 (European Union EUR-Lex, 2003; 2023c).

In order to accomplish the stated objective, the mitigation coefficient was raised amounting to 4,3 percent annually between 2024 and 2027 as well as equivalent to 4,4 percent starting in 2028 (European Commission - Directorate-General for Climate Action, 2024d). An additional couple of decreases referring to the refactoring of the mitigation coefficient are as well planned prior to the year 2030. As stated by the European Commission - Directorate-General for Climate Action (2024d), in this context permit amounts reach 90 Mio. during 2024 whereas the number will arrive at 27 Mio. during 2026. The European Environment Agency (2024) states that the updated objective of lowering greenhouse gases by 62 percent opposed to 2005 levels until 2030 may be fulfilled according to new forecasts if a set of persistent and determined measures are put in place.

Simultaneously, with the addition of greenhouse gases emitted by the marine transportation to the EU ETS starting in 2024, 78,4 Mio. additional emission permits were added raising the total ceiling level (European Commission - Directorate-General for Climate Action, 2024d). Taking in account the mean of emitted greenhouse gases declared by the marine transportation industry concerning the years 2018 as well as 2019 the raise was calculated. In 2024, the related limit of emission permits equals 1.386.051.745. Under the trading system, EU member countries mainly trade the permits themselves, with a number of them being assigned to manufacturing businesses at no cost to mitigate the threat of so-called carbon leakage. Introduced by 2021 and set to be running until 2030, an amount of cap shares was reserved with the aim of guaranteeing an adequate quantity of permits to be obtainable for distributing them exempt of any charges, also referred to as the “free allocation buffer” the European Commission - Directorate-General for Climate Action (2024d) states. Apart from that, the other related goal is to capitalize on those reserves in connection with different EU funding instruments like the Modernisation Fund, Innovation Fund, and the already mentioned Social Climate Fund. Moreover, a pool of permits out of the ceiling from the prior period between 2013 and 2020 is distributed to the latest additional participants accessing the trading scheme.

The EU marketplace for emissions decides on the price tag of permits (European Commission - Directorate-General for Climate Action, 2024c). The market itself is monitored based on an amount of strong supervision controls. Furthermore, through the continuous decrease of the limit, firms are made aware that the number of available permits will further reduce in the long run with authorities simultaneously guaranteeing that the commercial worth of permits remains. On the other hand, the cost of emissions presents organizations with a stimulus for efficiently lowering their expenses in relation to emitted greenhouse gases. The cost of emissions traded on the market in addition sets the level of earnings made through marketplace transaction of carbon permits. Through the EU ETS a total exceeding 175 billion EUR in earnings has been collected from 2013 on. According to Sandbag (2025), the current price for a carbon permit, published on 10.04.2025, for one ton of emissions emitted measured in CO_2eq and traded in futures on the carbon market amounts to 62,08 EUR. Figure 2 shows the development of carbon prices one tone of greenhouse gas emissions between 2008 and April 2025 which reached its peak in 2022 at a value close to 100 EUR per unit. Following the Corona pandemic and the introduction of the Green Deal together with its strategies and set of measures and instruments the price has increased back up again but remains fairly volatile.



Figure 2. Development of the EU ETS Permit Prices (2008-2025)

Source: Sandbag, 2025.

Goulder and Schein (2013) conclude that the cap-and-trade approach does not necessarily outrank the other mechanisms on carbon pricing such as emissions taxation as each has

the ability to lower emissions in an economical, fair and ecological manner. Together with similar setups, the implementation of the EU ETS has demonstrated the feasibility of freely exchanging greenhouse gas emissions while achieving the aimed emission abatements (Pecujlic & Germann, 2015). Its positive results serve as an encouragement to extend such scheme to different kinds of emissions.

The following subchapter provides an elaborate overview concerning the CBAM and its components as well as connects the policy measure to the 17 Sustainable Development Goals and environmental policy instruments such as Pigouvian taxation while simultaneously providing their contents.

2.3 The Carbon Border Adjustment Mechanism

A related tool from the European Green Deal is the CBAM, an essential component of the so-called "Fit-for-55" bundle (Dröge, 2021; European Union, 2024; European Parliament, 2022; European Union EUR-Lex, 2023a). In this context, the mechanism represents one of the central instruments by the EU to achieve net-zero-emissions until the year of 2050 aligned with the Paris Agreement (European Union EUR-Lex, 2023a). According to Hancock and Wollersheim, (2021), the problem of global warming has been continuously recognized by the EU both in the context of its associated states and in form of an international matter. The mechanism goes beyond representing a taxation instrument on exports to the EU but rather holds a purpose in the context of diplomacy. Eicke et al. (2021) notes that the CBAM is at the heart of the EU's approach to connect regulatory strategies in the areas of environmental protection and the exchange of goods as part of the EU Green Deal.

The mechanism connects the generated carbon footprint from manufacturing processes of EU import goods which are elevated emitters to a corresponding emissions cost by matching the cost of emissions among locally produced goods and imported ones (European Commission - Directorate-General for Taxation and Customs Union, 2024; European Union, 2024). Simultaneously, the CBAM is supposed to promote the transformation of the manufacturing sector to become greener in foreign countries. The Council of the European Union (2022) and the European Union (2024) state that the CBAM is complementary to the EU ETS as it enforces comparable guidelines regarding importing activities addressed by the ruleset. The CBAM is set to substitute for

components of the current scheme for mirroring the magnitude of EU ETS permits' distribution without charge.

The preliminary plan for the CBAM scheme was first presented by the European Commission during the month of July in 2021 (Council of the European Union, 2022; European Bank for Reconstruction and Development et al., 2023). The initiation of the instrument will be conducted bit by bit in a row with the dismissal of released quotas under the EU's ETS to additionally foster the low-carbon transformation of national manufacturing (European Bank for Reconstruction and Development et al., 2023; European Commission - Directorate-General for Taxation and Customs Union, 2024). As mentioned by the Council of the European Union (2022), the goals of the CBAM, to impede carbon leakage as well as importing of goods with high amounts of embedded emissions jeopardizing EU climate action regarding the lowering of harmful emissions, are to be achieved while being totally compliant within the framework of guidelines and principles of the multilateral trade systems. Through the step-by-step introduction of the mechanism analogous to the scale back of emission permits at no cost in connection to an amended EU ETS in the affected industries, the CBAM's compliance with the framework of guidelines and principles of the multilateral trade systems is expected to be secured.

Furthermore, free emission permits for the CBAM corresponding industries will be progressively eliminated in the context of the EU ETS between 2026 and 2034 (European Union EUR-Lex, 2003; European Bank for Reconstruction and Development et al., 2023, p. 7; European Commission - Directorate-General for Taxation and Customs Union, 2024; Simões, 2024; Simola, 2021). In line with the amended *Directive 2003/87/EC, Article 10a (1a)* (also see *Directive (EU) 2023/959*), the products set out in *Annex I* of *Regulation 2023/956* profit from small quantities of permits free of charge during the initial period (European Union EUR-Lex, 2003, (Article 10a(1a)); 2023a, (Annex I); 2023c; 2023d). Over the course of time, a coefficient, the so-called "CBAM factor" will be implemented diminishing the amounts of free permits concerning the manufacturing of the products relevant under the CBAM (European Union EUR-Lex, 2003, (Article 10a (1a)); 2023c; 2023d).

In further detail, this coefficient is set to be equivalent to 100 percent during the interval following the initial enforcement of the CBAM up to late-2025, according to the amended *Directive 2003/87/EC, Article 10a (1a)* laid out in *Directive (EU) 2023/959* (European Union EUR-Lex, 2003, (Article 10a (1a)); 2023c, 2023d). Over time the CBAM factor will then further decrease to 97,5 percent by 2026, 95 percent in 2027, 90 percent by 2028, 77,5 percent during 2029, 51,5 percent with the year 2030, 39 percent by 2031, 26,5 percent in 2032 as well as finally, 14 percent during 2033. Following the year 2034 the coefficient will be completely removed. Moreover, the targeted decline will be determined yearly on the basis of the average ratio regarding the request for free permits in connection with the manufacturing of CBAM relevant products against the estimated complete request for permits free of charge considering the entirety of facilities during the corresponding term specified in *Directive 2003/87/EC, Article 11(1)* (European Union EUR-Lex, 2003). The relevant coefficient will be used for calculating respectively.

The CBAM encompasses first off throughout the first transition period, the following high-emitting industries: aluminum, cement, electricity, fertilizers, hydrogen as well as iron and steel, also incorporating certain subsequent items such as various kinds of fasteners (Council of the European Union, 2022; European Bank for Reconstruction and Development et al., 2023; European Commission - Directorate-General for Taxation and Customs Union, 2024; European Union, 2024; DIHK, 2024; European Union EUR-Lex, 2023a, (Annex I & Annex II)). Table 1 displays in more detail the wide array of goods covered by the *Regulation 2023/956 Annex I and Annex II* on the basis of their corresponding Combined Nomenclature (CN) codes in the relevant sectors under the CBAM (European Union EUR-Lex, 2023a, (Annex I & Annex II)).

According to the European Commission – Directorate of Trade (n.d.), the CN scheme represents the code structure of the EU, encompassing the Hamonised System (HS) codings and addition individual EU segments. Moreover, the CN scheme supports the Common Customs Tariff of the EU while delivering trade data for activities inside the EU as well as among the EU and countries worldwide. Furthermore, the CN structure comprises of an eight figure long code, the so-called CN subheading, to categorize a good succeeded by a clarification as well as a customs rate. Contingent upon the circumstances it can also incorporate an additional component. The figures two through six represent

the so-called HS chapter (two figures), HS heading (four figures) and HS subheading (six figures), respectivley.

Table 1. CN Codes of the Goods Affected by the CBAM

Industries/products affected by the CBAM	**CN codes**	**Emissions are considered only; Direct or Indirect**
Aluminum	7601	Direct
	7603-7608	Direct
	76090000	Direct
	7610	Direct
	76110000	Direct
	7612	Direct
	76130000	Direct
	7614	Direct
	7616	Direct
Iron and steel	26011200	Indirect/Direct
	7201	Direct
	720211-19	Direct
	7202 60	Direct
	7203	Direct
	7205-7229	Direct
	7301	Direct
	7302,	Direct
	7303 00	Direct
	7304-7308	Direct
	7309 00	Direct
	7310	Direct
	7311 00	Direct
	7318	Direct
	7326	Direct
Fertilizers	28080000	Indirect/Direct
	2814	Indirect/Direct

	28342100 3102 3105	Indirect/Direct Indirect/Direct Indirect/Direct
Electricity	27160000	Indirect/Direct
Cement	25070080 25231000 25232100 25232900 25233000 25239000	Indirect/Direct Indirect/Direct Indirect/Direct Indirect/Direct Indirect/Direct Indirect/Direct
Chemicals (Hydrogen)	28041000	Direct

Source: DIHK, 2024; European Union EUR-Lex, 2023a, Annex I & Annex II.

The instrument considers the direct carbon dioxide footprint emerging in the manufacturing process and the so-called "indirect emissions", consisting of Scope 2 greenhouse gases, secondarily emitted gases from producing semi-finished goods as well as carbon output resulting from the electric power applied within production may likewise be part when estimating an importing good's embedded emissions in specific scenarios (European Bank for Reconstruction and Development et al., 2023, p. 7; DIHK, 2024). Although this aspect still requires definition as part of the corresponding legislation, according to European Bank for Reconstruction and Development et al. (2023). The cost of a CBAM certificate would be based on the pricing levels of the EU ETS.

The instrument is set to aim at importing goods in sectors accounting for high amounts of emissions (Council of the European Union, 2022). When determining the products covered by the CBAM the EU takes into consideration the carbon footprint as well as the danger of these emissions being shifted to another country enforcing more negligent regulation regarding the level of the carbon foodprint in connection with the concept of carbon leakage for the industries part of the EU ETS (European Union, 2024; European Union EUR-Lex, 2023a). Finally, it is the aim to ensure symmetry between a wide range of affected goods considering their carbon footprint and simultaneously control bureaucratic responsibilities as well as complicatedness.

The CBAM, on the other hand, does not cover imported goods holding small value as well as represent militaristic purpose (European Union, 2024; European Union EUR-Lex, 2023a, (Article 2)). Furthermore, the CBAM is not exercised regarding imported power coming from states outside of the EU with a local power marketplace which has been incorporated into the EU power market. Finally, imported commodities with an origin from states and regions covered by the EU ETS and those stemming from states with a mutual treaty with the EU connecting the local carbon exchange platform to the EU ETS such as Norway, Liechtenstein, Iceland, Switzerland as well as provinces like Heligoland and others are not included in the CBAM (European Union, 2024; European Union EUR-Lex, 2023a,(Article 2 & Annex III).

European Commission - Directorate-General for Communications and Von der Leyen (2019) emphasized that the sectoral extent of the CBAM will be enlarged step by step as part of her policy directions' plan for the European Commission 2019-2024. The continuous enlargement approach has also been reflected in the CBAM's regulatory framework (European Union EUR-Lex, 2023a). Beaufils et al. (2023) found that the present scope of the CBAM is fairly moderate in contrast to the overall emitted carbon levels of total EU importing trade. In consequence, the insufficient scope may hamper the CBAM's effectiveness.

The CBAM is set out to substitute for current initiatives to hinder the transfer of emissions in certain industries which are recognized as part of the EU ETS to other locations in third countries following strategies representing comparably reduced environmental action, referred to as carbon leakage (Council of the European Union, 2022; Eicke et al., 2021; European Bank for Reconstruction and Development et al., 2023, p. 7; European Union, 2024; European Union EUR-Lex, 2023a). The EU connects the risk of carbon leakage to their own eager environmental objectives (European Union EUR-Lex, 2023a). Furthermore, the EU believes that the regulatory framework of the CBAM fosters efforts by manufactures in non-EU-member states employing production techniques resulting in lower carbon emission and ultimately leading to a decreased carbon footprint. Hence, the EU anticipates a decrease of the carbon footprint in non-EU-member states with the help of the CBAM (European Union EUR-Lex, 2023a).

As of the year 2026 and the full commencement of the CBAM, approved CBAM petitioners alone will be able to engage in importing activities around commodities covered by the regulation (European Union, 2024; European Union EUR-Lex, 2023a, (Article 4)). In this context, importing parties and indirect customs agents are required to submit an application to the corresponding local body in their country or the so-called "CBAM registry" directly, to receive approval, by presenting underlying data regarding their business operations as well as tax and customs conformity in the prior five-year period, among others (European Union, 2024; European Union EUR-Lex, 2023a, (Article 5)). Moreover, in member countries of the EU local bodies maintain a record reflecting approved CBAM petitioners, according to European Union (2024). Furthermore, an overview and corresponding datasets on the approved CBAM petitioners and related CBAM certificates is set to be collected on a centralized platform, the "CBAM registry", managed by the European Commission which is meant to be accessible for authorized parties (European Union EUR-Lex, 2023a, (Article 5 and 14)).

Finally, from 2027 on, all CBAM petitioners will surrender a yearly statement, also referred to as "CBAM declaration", until May 31 per annum, showing the past year's operations (European Bank for Reconstruction and Development et al., 2023; European Union 2024; European Union EUR-Lex, 2023a, (Article 6)). The data presented in the context of operations must include the amount of any kind of imported good, the sum of commodities' incorporated emissions, the quantity of "CBAM certificates" which were submitted as well as reproductions of the different statements of confirmation (European Union 2024; European Union EUR-Lex, 2023a, (Article 6)).

Scholars emphasize that the mechanism is an instrument to ensure that greenhouse gases of imports with high contents of those to the EU are addressed similar to the intranational EU ETS system already in place (Hancock and Wollersheim, 2021; Shi et al., 2024). The incorporated emissions, also referred to as "embedded emissions", reflect direct emission generation unleashed throughout the manufacturing process as well as indirect emissions off the used power while producing (European Union, 2024). It is emphasized that CBAM petitioners must submit the compulsory amount of CBAM certificates, as otherwise they may be subject to receiving a fine. Moreover, petitioners must guarantee that the amount of CBAM certificates stored in the CBAM registry at the quarterly closing represents no less than 80 percent of emissions incorporated in the imported products following the

calendar year's beginning. The emissions costs already covered locally prior to exporting the goods to the EU as well as complimentary quotas under the EU ETS are deducted from the amount which must be submitted (European Bank for Reconstruction and Development et al., 2023; Lee, 2022; Simões, 2024).

Morchid et al. (2024) notes that the CBAM's design inclines the taxation of exporting trade, meant to target certain products produced in states where an emissions tax rate is not applied. With the aim to steer clear of the CBAM, countries must implement a domestic ETS which accomplishes pricing levels equal to the EU ETS from the perspective of the EU (Sangari, 2023). Furthermore, the CBAM, beyond performing the function of safeguarding the EU ETS, it encourages third nations in the introduction of a harmonized ETS at the same time. On that account, the CBAM could in fact be characterized as a "climate club", although the present plans as well as discussion around the mechanism fail to cover the ways of which such a setup could potentially get managed in the context of governance (Sangari, 2023, p. 613). Furthermore, Tarr et al. (2023) emphasize that in the context of nations aiming to enforce or augment emission charges across their market, an instrument such as the CBAM may provide support regarding the political consensus towards emission charges. Issayeva et al. (2023) stress the possible impact of the CBAM on the economic system in Kazakhstan, emphasizing the need for anticipatory policies to maneuver around prospective obstacles as well as to exploit windows of opportunity. Furthermore, emphasized by the analysis' conclusion, the implementation of a domestic tariff on emissions represents a tactical countermeasure towards the progressing scenery in the context of international efforts to protect the environment and lower carbon emissions.

Lee (2022) notes that individual states may have introduced separate legislations to lower greenhouse gases and hence, while manufacturing and exporting similar goods they face individual cost levels inclined by the CBAM. In the context of individual countries, the additional strain caused through the CBAM in one country may even be higher in another and therefore may become an advantage for the latter, e.g., for producers in Korea. On the other hand, Sangari (2023) mentions a couple of substantial difficulties in the context of governance. EU counterparts in trading would be pushed through the CBAM to implement a ETS structure as well as harmonize pricing levels of permits of the EU ETS.

Nonetheless, prospective attainability as well as hence cost levels of ETS permits is decided amongst the EU.

As part of the CBAM, starting by 2026, providing so-called CBAM certificates will be mandatory for importing parties in the EU market, serving as a fiscal correction (European Bank for Reconstruction and Development et al., 2023; European Union EUR-Lex, 2023a; Simões, 2024). Moreover, Lee (2022) states that although the importing party faces the cost of CBAM certificates for exports to the EU, in the end, the amount is shared by the manufacturing, importing and consuming parties. Through the lens of purchasers in the EU, rates for commodities affected by the CBAM may increase in price which would lead to diminishing earnings for consuming parties in the EU.

The CBAM certificates mirror the emissions cost in relation to the carbon footprint of the importing goods (European Bank for Reconstruction and Development et al., 2023; Simões, 2024). EU member countries are set to trade the CBAM certificates with approved petitioners under the CBAM locally in their state through a general centralized system implemented and supervised by the European Commission (European Union, 2024). The corresponding data from the system regarding CBAM certificate selling activities, buy-backs as well as revocations is conveyed to the related CBAM registry at the closing of the individual business days. In this context the European Commission needs to guarantee that all CBAM certificates are provided a singular registration code.

Furthermore, it is set to determine a rate per week for the certificates on the basis of the EU ETS' permits' mean rate at closing of their marketplace (European Union, 2024; European Union EUR-Lex, 2023a, (Article 21)). Moreover, the European Commission will repeal at no remuneration all surplus of CBAM certificates kept by the CBAM petitioners and obtained by them throughout the year ahead of the former calendar year, on July 1st every year (European Union, 2024; European Union EUR-Lex, 2023a, (Article 24)). On the other hand, petitioners are able to seek selling back not more than one third of CBAM certificates which were acquired during the year prior for their initial purchasing rate to the European Commission by means of the EU member countries until June 30 of every year (European Union, 2024; European Union EUR-Lex, 2023a, (Article 23)).

The CBAM with its corresponding requirements is set to be introduced step by step until 2026 in the wake of the gradual elimination of complimentary quotas under the EU ETS (Council of the European Union, 2022; European Commission - Directorate-General for Taxation and Customs Union, 2024; European Union, 2024; Simões, 2024). Moreover, the transition phase of the CBAM was commenced on October 1, 2023, with an initial declaration interval until January 31, 2024, for importing parties and is set to continue until December 31, 2025. The Council of the European Union (2022) states that during this first phase an eased version of the CBAM is basically implemented connected to merely declaration duties for the corresponding parties. Regarding the declaration during the transition period, importing parties as well as indirect customs agents are required to put forward a CBAM statement, starting on January 31, 2024, once every quarter, and share it with the European Commission (European Union, 2024). The submission or acquiring of the related CBAM certificates is not necessary throughout this time. During this phase a less comprehensive scheme is implemented which requires the disclosure of emission levels included in the corresponding imported goods (Simões, 2024). In the beginning the scheme is only enforced in the context of predetermined commodities with a significant risk regarding carbon leakage which encompass iron and steel, cement, fertilizer, aluminum as well as power production.

Moreover, the transition period is meant to collect knowledge and establish a learning curve for the related parties, such as manufacturers, importing bodies as well as the administration (Council of the European Union, 2022; European Union, 2024). Regarding the information on incorporated emissions, the EU Commission is set to examine the figures with aim of enhancing the approach and procedures intended for the stage of full application of the CBAM by 2026, according to the European Union (2024).

The approach for determining the amounts of incorporated emissions is laid out in *Article 7* and further elaborated on in *Annex IV* and *Annex V* of *Regulation 2023/956* (European Union EUR-Lex, 2023a, (Article 7, Annex IV & V)). The regulation distinguished between “simple goods” and “complex goods” (European Union EUR-Lex, 2023a, (Annex IV)). The so-called “simple goods” represent products manufactured through a method for manufacturing only necessitating components in form of precursors as well as fuels with no incorporated emissions. On the other hand, “complex goods” describe products apart from simple goods. A number of products. Itemized in *Annex II* solely

require the determination and consideration of direct emissions (European Union EUR-Lex, 2023a, (Article 7)). For approved CBAM petitioners it is mandatory to maintain the data used for the determination of the embedded emissions up to four years following the year of surrendering the CBAM statement. The collected data must also allow their examination by the administrative bodies regarding the CBAM statement as well as authorized auditors in connection with the determined embedded emissions. In this context, the determined incorporated emission levels shared as part of the CBAM statement must be confirmed by an authorized auditor prior to its filing (European Union EUR-Lex, 2023a, (Article 8)). The authorization process for auditors is laid out in *Regulation 2023/956, Article 18* (European Union EUR-Lex, 2023a, (Article 18)). The central monitoring function concerning the submitted CBAM statements lies with the European Commission (European Union EUR-Lex, 2023a, (Article 19)).

The EU has recently agreed on reducing the complexity and reinforcing the CBAM through adjustments that decrease the bureaucratic load for companies continuing to safeguard the CBAM initiative's features, as put forward by the EU Commission on February 26, 2025 (European Commission, 2025). A preliminary consensus regarding the EU Commission's initiative was concluded by the European Parliament and the Council on June 18, 2025. The recommendation's central element represents the introduction of an exclusion limit of 50 tones applied on products under the CBAM. Hence, firms staying below the fixed weight-based limit of 50 tones in imports for each importer annually, they are not considered as part of the CBAM requirements. These suggested actions may in majority concern private parties and SMEs that are involved in import trade encompassing limited or rather insignificant volumes of products under the scope of the CBAM.

The initiative aims to enhance the CBAM's adherence to cost efficiency while abiding by its environmental targets (European Commission, 2025). Still, approximately 99 percent of carbon emissions contained in the products relevant under the CBAM scope would remain subject to the regulation. The overarching goal is to decrease the bureaucratic and legislative load and adherence expenses for businesses in the EU and in particular for SMEs. Moreover, the initiative includes various streamlining measures addressing all actors involved in the import of CBAM products exceeding the limit. Specifically, the approval process, the information gathering procedures, the determination of the carbon

content, the auditing requirements for carbon emissions, the estimations of annual CBAM-related expenses of verified importers as well as the reimbursement requests of declaring parties under the CBAM for emission costs incurred in non-EU countries.

The initiative represents a mandatory starting point prior to the broader assessment of the CBAM framework that is set to be performed before the end of 2025 alongside a regulatory recommendation further broadening the scope of the CBAM towards processed goods as well as implementing further counter-evasion provisions (European Commission, 2025). Furthermore, the EU Commission assesses ways of avoiding the threat of emissions displacement in EU export sectors covered by the CBAM.

Shi et al. (2024) states that as a result of the possible repercussions in the context of the global exchange of goods as well as environmental action inclined by the CBAM, passionate discussions have been caused. Koç and Kaynak (2023) state that the CBAM will have a substantial impact on leading markets such as the US, China, India and Russia and on states with considerable commercial ties to the EU-27 like Türkiye. About 40 percent of Turkish export trade volume is linked to the EU and overall, the EU is the country's largest counterpart in trading (Alpay & Gökmen, 2023; Koç & Kaynak, 2023). Hence, tracking EU legislative plans is crucial, according to Koç and Kaynak (2023). Scholar Gros (2009) examines the effects of a border tax considering carbon emissions on degrees of global prosperity. Manders and Veendaal (2008) explore a carbon border taxes' impacts considering the European perspective in terms of likely contributions to competitiveness as well as carbon leaks. The scholars completed that the impacts are too minor to use it to justify its corresponding implementation.

Holzer (2010) draws attention to the aspect that models concerning emission allowances tied to discounts in the area of export and import trade activities contest the guidelines of World Trade Organization (WTO). The opposition of developing markets towards the CBAM in front of the WTO should be nearly inevitable (Casarano & Villalta Puig, 2024). Furthermore, wrongfully the CBAM puts both emerging and developing markets at a disadvantage while breaking the underlying standards of the WTO around free exchange of goods and services. The CBAM could potentially conflict the framework of the WTO in many ways (Yıldız & Öztürk, 2024). Hence, foreseeing such possible developments

throughout its enforcement and preparing the required actions will ease the CBAM's realization proceedings.

Furthermore, it is emphasized that the conflicting aspects of the CBAM in the context of the WTO rule work may not be solved by relying on the protection by the "exception clause" connected to the WTO's framework, GATT article XX and GATS article XIV (Yıldız & Öztürk, 2024, p. 603 & 611). Nonetheless, in the context of WTO rule wok, the EU's climate action may theoretically be lawful provided that steps are non- preferential as well as asymmetrical (Sarangi, 2023). Moreover, it is emphasized that the CBAM will have a major impact on the further development of global trading (Casarano & Villalta Puig, 2024; Yıldız & Öztürk, 2024). In the context of the WTO's rule work, the CBAM could, in particular, cause conflict with the fundamentals such as the "Most-Favored-Nation" requirement and "National Treatment" aspect, among others (Casarano & Villalta Puig, 2024, p. 55; Yıldız & Öztürk, 2024, p. 602). Davies (2022) notes that it would be the case anytime a claimant's imported goods are in total higher in emission values compared to the product produced within the EU, referring to the National Treatment fundament, or in the context of the same product manufactured in a different nation outside the EU, touching on the Most-Favored-Nation aspect. On the other hand, adopting a so-called "border adjustment" may give rise to immense problems as regulatory authorities cannot obtain adequate knowledge to precisely determine the required amount of taxation or allowances to successfully impede distortions of market conditions (Goulder & Schein, 2013, p. 8). In addition, border adjustments may without difficulty grow complicated from a bureaucratic perspective.

Furthermore, Eicke et al. (2021) states that except for the aspect of consistency in the context of the regulation set out by the WTO, political discussions have not focused enough on the CBAM's effects in third countries of the EU. Moreover, many scientific assessments around the topic of CBAM have been conducted but mainly focused on the national and regional consequences for the parties enforcing the mechanism as well as global actors like the US and China. The consequences of the CBAM for less developed nations are still to be determined. Nonetheless, according to Sarangi (2023), it goes without saying that the disparity concerning the economic output and prosperity levels will further grow amongst developing regions and industrialized nations. Overland and Sabyrbekov (2022) found that the CBAM could face opposition by a list of countries,

most probably Iran, Ukraine, US, the United Arab Emirates, Egypt, China, India, Kazakhstan, Russia, and Belarus. This is due to the fact that a large percentage of exporting goods for the EU market from these states which are affected by the CBAM are connected to major emission amounts as well as minor grades of advancing technology. Major countries such as the US, China, India and Russia may address their CBAM-related opposition through the WTO drawn on previous inception of resistance.

On the contrary the EU anticipates that through the CBAM it assists in fostering green transformation efforts in non-EU-member states (European Union EUR-Lex, 2023a). Zhong and Pei (2022) state that the CBAM could transfer the strain of legislative environmental action away from developed economies to their trading counterparts, mainly less developed markets. This potential consequence breaches the UNFCCC rule called "Common But Differentiated Responsibilities" (CBDR) and hence also challenges the fundamentals of the Paris Agreement (Sangari, 2023, p. 615; Zhong & Pei, 2022, p. 2). Although Sangari (2023) emphasizes that the issues about the CBDR may be comparatively small because of the addition of and relying on the NDCs in the context of the Paris Agreement as well as the composition of the CBDR as part of the Agreement.

Nonetheless, according to scientific findings the green transformation measures in nations of the "Global South" will possibly progress slower than needed endangering their ability to race the commercial competition on the international stage (Eicke et al., 2021, p. 1). Sarangi (2023, p. 611) noted that due to its intentional international effect, the degree of the CBAM's "spill-over effects" regarding a variety of nations is rarely considered and assessed. The scholar further recommends the quantitative evaluation of spill-over effects in particular impacting developing nations with increased exposure to the CBAM considering the magnitude and extent of the latter.

Scholars claim that there is a possibility that through the CBAM the current competitive order between nations and geographical areas may change, especially impacting industries with a large carbon footprint as well as those ones highly involved in the exchange of goods (Shi et al., 2024; Zhong & Pei, 2022; Zhong & Pei, 2023). Furthermore, the mechanism may affect the global exchange of goods significantly, in particular in industries with a high demand in power, which could have an effect on nations lacking a carbon pricing instrument as well as pressure the ones adopting late to

lowering their carbon footprint (Hancock & Wollersheim, 2021; Shi et al., 2024). Shi et al. (2024) state that additional scientific assessments which are currently lacking must be conducted considering the point-of-view of nations involved in the trade of goods with a large carbon footprint as these will incur extra duties.

Furthermore, the enforcement of the mechanism may result in intergovernmental strain as well as triggers doubts regarding its capability in the context of environmental measures (Eicke et al., 2021; Shi et al., 2024). Eicke et al. (2021) further emphasized that the effects of the CBAM nationally may vary. For nations whose trade volumes rely on large shares of selling goods abroad to the EU and hence their commercial activity, the CBAM may pose a danger of an economic slow-down for specific industries (Eicke et al., 2021). Considering both the national export dependency and unfitness to accommodate the implementation of required measures as a result of the CBAM define the magnitude of the inclined danger for a nation. The assessments show that the CBAM inclined commercial dangers spread around the world in an asymmetrical manner (Beaufils et al., 2023; Eicke et al., 2021; Sarangi, 2023; Zhong & Pei, 2022). Zhong and Pei (2022) conclude that based on the outcomes on an industry base, the CBAM may have a higher effect on developing markets like China, Türkiye, Russia, India and so forth. Beaufils et al. (2023) findings show that a number of poor- as well as medium-income states reliant on their export trading activities to the EU market may be unevenly impacted through the CBAM due to the fact that a great percentage of national carbon emissions may prospectively be addressed through the EU cost for carbon.

Tarr et al. (2023) claim that based on empiric findings and economic concepts the approach of a CBAM is not beneficial regarding international aims of lowering greenhouse gas emissions. On the other hand, such a mechanism is supposed to be effective in offsetting the favorable competitiveness in the context of export trade out of nations with a lacking regulatory framework concerning emission reduction. In consequence, the CBAM by the EU is set to enhance the EU's competitive capacity and that of its reliable partners in the context of sectors characterized by high power consumption as well as large trading volumes at the same time.

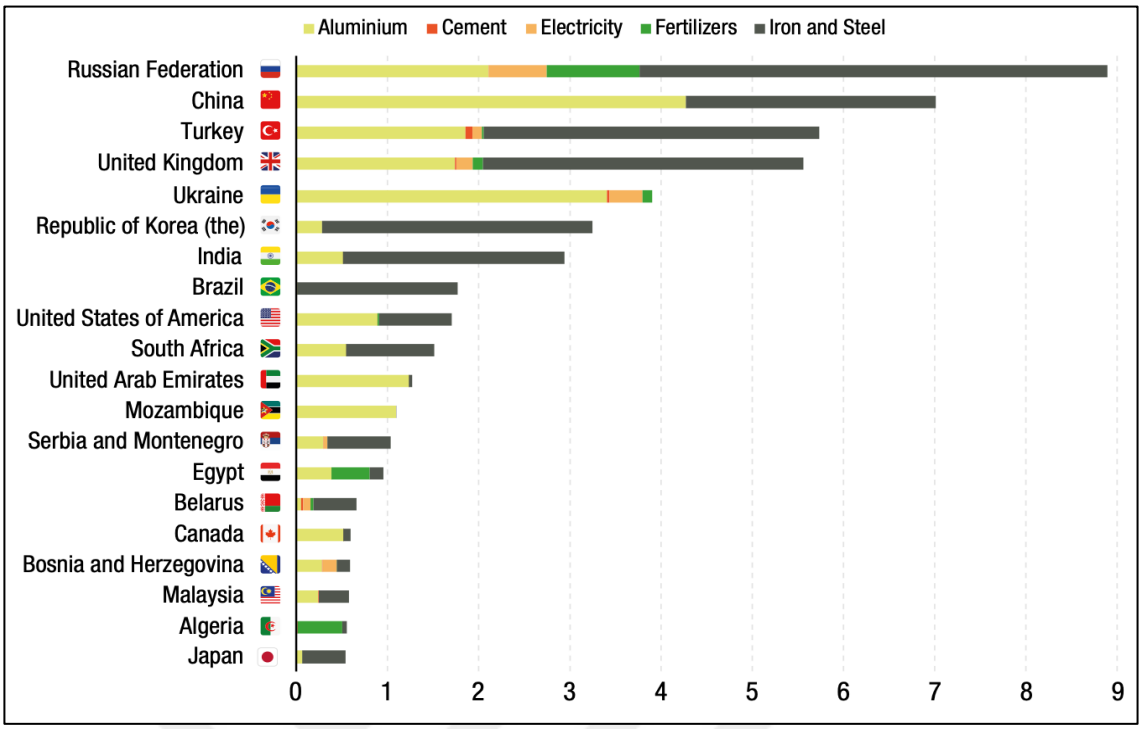


Figure 3. Country-Based Impact Concerning the CBAM-Relevant Sectors (Billion USD, 2019)

Source: United Nations Conference on Trade and Development, 2021.

Specific countries may be more affected by the CBAM than others are. Figure 3 above depicts an overview of the impact concerning the CBAM-relevant sectors in the context of export volumes to the EU by the 20 most vulnerable nations with regard to their total export sums in billion USD in 2019. This overview on the impact concerning the CBAM-relevant sectors in the context of export volumes to the EU provides a ranking of the 20 most vulnerable nations with regard to their total export sum in billion USD in 2019 (United Nations Conference on Trade and Development, 2021). According to the ranking, Russia, China as well as Türkiye represent the nations set to be most affected by the CBAM. Türkiye's high ranking is particularly driven by its high shares of exports in the iron and steel industry and followed by the aluminum sector. However, it is noted that the CBAM's practical effect in the context of export trade to the EU in the listed industries would rely upon the amounts of greenhouse gas emissions nested as part of the exported products as well as the emissions pricing, in case existing, previously covered in the exporting nations. Taking into account the degree of exporting trade going to the EU regarding the listed industries, in the context of most vulnerable nations from the developing world India, Brazil and South Africa may potentially be most affected. In

regard to “Least Developed Countries” (LDCs) Mozambique heads the ranking as most vulnerable nation (United Nations Conference on Trade and Development, 2021, p. 9).

Furthermore, a number of scholars examined the possible effects of the CBAM on national markets and industries as well as imported goods to the EU originating from trading nations like China, Russia, Türkiye, Morocco and Ukraine (see, e.g., Acar et al., 2022; Assous et al., 2021; Aşıcı, 2021; Beder, 2024; Bromels, 2024; Chepeliev, 2021; Gültekin, 2022; Huang et al., 2022; Koç & Kaynak; 2023; Simola, 2021; Urazgaliev, 2021; Yan & Yuan, 2023; Zhu et al., 2024).

Acar et al. (2022) found that the CBAM could negatively affect Türkiye’s economic development, projecting a possible Gross Domestic Product (GDP) decline of 2,7 percent to 3,6 percent by 2030. On the other hand, Urazgaliev’s (2021) research results demonstrate that the degree of harm on Russian exports differs depending on the range of greenhouse gas emissions considered, highlighting the reliance of exports on emissions among the commodity areas as well as the range of emissions assessed. Simola (2021) conducted an assessment of additional expenses likely for EU import products and considered as part of the CBAM states that these may vary starting at 200 Mio. EUR, considering the Indian case, to as far as 2,1 billion EUR on commodities from Russia, in a scenario where the cost for emission amounts to 60 EUR per ton. Percentwise, the likely on top expense could range from 0,1 percent for Chinese export products entering the EU and as far as four percent in relation to Ukrainian commodities. As a result, the CBAM introduced taxation mechanism related to greenhouse gas emission raises the expenses of exports for states with elevated carbon intensity levels. Morchid et al. (2024) assessed the possible effect of the CBAM of Moroccan export trade going to the EU by applying an input-output method. According to their assessment the CBAM would produce an additional emissions cost of between 20 to 34 Mio. USD for exporting parties in Morocco every year throughout the primary stage. In consequence, to reduce financial damages the country may implement a domestic ETS, amend taxation structures or accelerate green transformation efforts in their local market.

Zhu et al. (2024) assessed the effect of the CBAM on Chinese export trade to the EU, stating that exporting amounts to the EU diminish dissimilarly due to restraining and shifting impacts in the context of exports in the CBAM-relevant industries affected by

emission duties. Furthermore, the value of exporting activities is set to decrease for both Chinese and EU exports, while the trading conditions under the CBAM reach better levels for the EU and deteriorate from a Chines perspective. It is recommended based on the findings that specific activities are undertaken with the aim to reinforce global collaboration, to advance the building of an integrated domestic emission exchange as well as to further diversifying export trade and to set up a stable method of bookkeeping in the context of greenhouse gas emissions to reduce unfavorable outcomes.

According to Yan and Yuan (2023) the CBAM is set to cost Chinese aluminum and steel exports to the EU an extra 609,5-670,43 Mio. EUR and 540,2 Mio. EUR respectively in emission duties with prospective further increases depending on the development of emission cost levels in the context of the EU ETS. The scholars note that the EU has the authority to act and render concerning the CBAM, establishing further difficult surrounding conditions as well as obstacles regarding Chinese global trading. The scholars emphasize that China is required to be sufficiently prepared on the various political, economic, enterprise as well as sectoral stages furthering a wide array of measures such as fortifying the domestic ETS, boost green transformation activities in the industries as well as effective engagement in global debate on governmental emission strategies and spreading of Chinese legislation regarding emission bookkeeping and trade.

Applying a tripartite evolutionary game model, Tian et al. (2024) assessed the evolution of steel companies and administrative decision making in China under the effects of the CBAM. The results suggest, among others, that major companies are more substantially affected by the CBAM and display more vulnerability towards governmental strategies. In consequence, corresponding major manufacturers give precedence to decarbonization advancements in production and display smaller periods of consistency in decision-making. So-called “free-riding benefits” negatively impact the implementation of decarbonization advancements in manufacturing, calling for supervision and interference by authorities (Tian et al., 2024, p. 27). Furthermore, the quantity of exports in the steel sector is crucial for companies for determining to implement decarbonization measures. Rising quantities in export usually accelerate decision-making concerning the advancement towards environmentally friendly manufacturing. Moreover, raising the cost levels of emissions domestically over time is set to function as an efficient method

to confront the CBAM as it will contribute to ease the financial strain caused through the CBAM.

Chu et al. (2024) assessed the impact of the CBAM on the Vietnamese steel sector and corresponding exports to the EU, concluding that the instrument may substantially lower export trade with the EU in the steel industry and simultaneously not foster the decarbonization of steel manufacturing considerably. Nonetheless, the CBAM could encourage the implementation of emission charges, that determined by their cost value, may spur significant green transformation efforts to shift to manufacturing with reduced carbon intensity as well as speed up the shift to green power sources. According to Chu et al. (2024, p. 8), the "energy transition" is set to take a leading position concerning the reduction of greenhouse gas emissions in the Vietnamese steel industry. Bromels' (2024) assessment of the potential effect on import trade for the iron and steel in Sweden concludes a possibly marginal impact by the CBAM regarding prospective imports of the Swedish iron and steel industry. Nonetheless, the scholar emphasized that the findings may demonstrate change as they show reaction to shifts in context of the underlying hypothesis of the model, the cost levels of EU carbon permits as well as the calculation interval in connection with the CBAM. In this assessment the CBAM is regarded as a customs duty on imports, making the instruments impact on the latter customs charge calculable.

Beder (2024) found that the relative advantage of Türkiye in the basic metals sector, comprising the CBAM-relevant industries aluminum and iron and steel, in relation to the EU-27 mean from 2015 to 2020 diminishes with the introduction of the CBAM. Moreover, prior to the CBAM the country was not able to achieve a competitive advantage against eight EU countries which's gap even further grows following the introduction. Therefore, the CBAM is set to have an adverse effect on the ability to compete in the basic metals sector and that related intra-EU trade for this product category may rise. On the contrary, Koç and Kaynak (2023) note that in the context of Turkish economic ties with the EU-27 the CBAM needs to be deemed a chance.

Furthermore, Alpay and Gökmen (2023) emphasize that for Türkiye it may present a chance for furthering the green transformation, although simultaneously still posting a substantial economic risk for the country. Furthermore, it is noted that throughout the

assessment of greenhouse gas emissions of firms registered at the Borsa Istanbul, the Turkish stock exchange, with activity in the CBAM-relevant industries cement, aluminum, iron and steel as well as electricity, their corresponding emission amounts are not exhibited sufficiently. Moreover, only a small number of the corresponding firms as part of the assessment share records regarding levels of greenhouse gas emissions.

On the other hand, the assessment by Gültekin (2022) found that the CBAM may favorably impact eco-friendly investment activities, manufacturing as well as foreign commerce domestically. Simultaneously, the CBAM's introduction would establish an excellent chance for modernizing the Customs Union between the EU and Türkiye (Gültekin, 2022; Özekan, 2023). Although, the CBAM-related setup does not directly imply actual additional customs charges, its approach does hold a customs column putting forward that the economic strain is bound by the requirements in connection to customs charges. Moreover, Özekan (2023) emphasizes that the Türkiye-EU Customs Union has to be revised and enlarged by additional fields and the serviceability of the framework has to be augmented by further instruments. Otherwise, the EU's efforts in the context of climate action may challenge Türkiye substantially. The following subchapter describes the 17 Sustainable Development Goals and their contents while connecting it to the CBAM.

2.3.1 Sustainable Development Goals

The so-called 2030 Agenda for Sustainable Development together with the 17 SDGs was approved in 2015, a year characterized by a number of crucial multilateral decision such as the Paris Agreement, by the 193 member states of the United Nations (UN) (Aitsi-Selmi et al., 2016; Bowen et al., 2017; Reverte, 2022; Smith-Carrier & Van Tuyl, 2024; United Nations Department of Economic and Social Affairs, 2015; United Nations Department of Economic and Social Affairs, 2024b). The 2030 Agenda serves as a common framework for fostering peace and prosperity for both the public as well as earth at present and ahead (United Nations Department of Economic and Social Affairs, 2015; United Nations Department of Economic and Social Affairs, 2024b).

According to Stevens and Kanie (2016), the concept of the SDGs developed throughout the procedure resulting to the Rio+20 United Nations Conference concerning Sustainable Development in 2012. As part of the Rio+20 Conference, the paper recording the results

called "The future we want", outlined the concluded procedure for bargaining and building unanimity regarding the SDGs (Stevens & Kanie, 2016; United Nations General Assembly, 2012). These discussions around the conceptualization of the SDGs were mainly conducted by the so-called United Nations Open Working Group, alongside simultaneous, although sometimes nonparallel talks on financial matters and the broader development plan following 2015. The conceptualization process also involved discussions with a diverse range of stakeholders conducted within the UN on provincial and local stages as well using an online survey, among others (Gellers, 2016; Stevens & Kanie, 2016).

The SDGs form the primary focal point of the plan and simultaneously act as a request for measures addressing the entirety of nations as part of the worldwide collaboration network (Bowen et al., 2017; United Nations Department of Economic and Social Affairs, 2024b). Furthermore, while relying upon the Millennium Development Goals (MDGs) which were passed in 2000 with the goal to diminish severe poverty until 2015, the SDGs are also set to contribute to the MDGs' results further enhancement (Aitsi-Selmi et al., 2016; Bowen et al., 2017; United Nations Department of Economic and Social Affairs, 2015; United Nations Department of Economic and Social Affairs, 2024b). The total of 17 SDGs is coupled with a sum of 169 objectives together in combination emphasize the scope and aspiration of the set out global development framework with a focus on sustainability (United Nations Department of Economic and Social Affairs, 2015). On the basis of the above-mentioned comprehensive conceptualization efforts' outcomes the 17 SDGs with 169 aims were concluded (Stevens & Kanie, 2016). The SDGs aspire to harmonize a prosperous economy with a decline in disparities as well as to resolve problems in connection with global warming and ecosystem degradation, according to Reverte (2016). Opposed to the MDGs, the SDGs clearly emphasize ecological considerations, the interrelationship among various issues, and the connected properties of impoverishment and limitation (Stevens & Kanie, 2016).

Functioning as the primary stage for tracking and examining the SDGs, the yearly so-called High-level Political Forum for Sustainable Development is organized (United Nations Department of Economic and Social Affairs, 2024b). Assistance and empowerment in the context of the SDGs and associated subjects is delivered by the Division for Sustainable Development Goals as part of the United Nations' Department

of Economic and Social Affairs. The Department takes the lead regarding the assessment of the 2030 Agenda for Sustainable Development as well as for the promotion and for the corresponding undertakings connected to the SDGs.

Aitsi-Selmi (2016) note that the SDGs encompass a wide range of goals regarding development as well as underline the need for awareness to fragilities related to age, sex and handicaps, in the context of catastrophe damage. Moreover, the SDGs target the accomplishment of civil rights for everyone as well as to establish equal opportunities for both sexes and improve the status of female across all ages (United Nations Department of Economic and Social Affairs, 2015). Furthermore, the system of SDGs is described as unified, inseparable as well as to maintain the equilibrium among the three spheres of growth in the sustainability context which encompass the economy, the public and the environment. Bowen et al. (2017) stresses that the characteristics of the SDG system affect any nation and target to universally connect objectives of human development to a sustainable environment as part of a standalone worldwide plan. Moreover, all of the 17 SDGs are related to particular results which must accomplished whereas the sum of 169 objectives establish the foundation for supervision as well as disclosure.

Figure 4 depicts the wide array of SDGs touching upon various aspects of life. The first aim refers to the resolution of any type of poverty around the world (United Nations Department of Economic and Social Affairs, 2015). The second aim targets the solving of starvation globally while accomplishing reliable food supply, enhanced nourishment as well as encourage sustainability in the farming sector. Furthermore, this aim is followed by the objective of securing a healthy lifestyle as well as facilitating health for everyone among any age group. The consecutive goal is set to guaranteed inclusivity, quality as well as equitability in the educational sector and to encourage long-lasting access to studies for everyone. The fifth objective targets the accomplishment of the equal treatment of the sexes as well as strengthen the position of females along all age groups. Moreover, the sixth goal aims to guarantee the access and viable administration in connection with water supply as well as hygiene globally.

Assuring dependable, inexpensive, eco-friendly as well as contemporary entry to power around the world serves as the seventh goal (United Nations Department of Economic and Social Affairs, 2015). The consecutive objective is to facilitate the persistent,

universal development of the economy focused on aspects of sustainability. In addition, the aim is to encourage permanent, appropriate and effective jobs for everyone around the world. The ninth objective targets to establish a durable infrastructural base, to advance comprehensive industrial development while sticking to the aspects of sustainability as well as to support innovation. Moreover, diminishing disparity inside as well as between nations is the tenth objective. The consecutive goal aims to establish durable, sustainable, comprehensive as well as secure municipalities and places of living.



Figure 4. Sustainable Development Goals

Source: United Nations, 2024.

The twelfth goal is set to guarantee intake as well as manufacturing models considering sustainability aspects (United Nations Department of Economic and Social Affairs, 2015). Furthermore, undertaking pressing activities to tackle global warming and its effects is the objective of the 13th goal. The preservation and sustainable utilization of the planet's waters and maritime stocks to ensure stable growth serves as the consecutive goal. The 15th target aims to safeguard, revive and foster the utilization of the soil's ecosystem as well as to govern the woods always paying respect to the aspects of sustainability. In addition, the goal is to tackle deforestation, to terminate and overturn overcultivation as well as to cease the deprivation of eco-diversity. The 16th objective shall facilitate the establishment of universal and peaceful communities to ensure sustainable economic growth. Furthermore, the aim is to offer admission to a justice

system to everyone as well as to create useful, liable and comprehensive bodies across the board. Finally, the 17th goal sets out to reinforce the resources for enforcement as well as reinvigorate cooperation around the world in the context of sustainable economic growth.

A number of scholars assess and note the obstacles around governance around the world in the context of civilization and sustainability as well as the agenda of the SDGs (Bowen et al. 2016; Gellers, 2016; Joshi et al., 2015; Reverte, 2016; Stevens & Kanie, 2016). In regard to the realization of the SDGs specific obstacles concerning its administration are named (Bowen et al., 2016). The first one is the development of joint effort through establishing universal preferential forums for the parties concerned to cooperate throughout various industries as well as ranges. The second obstacle is having to reach compromise with the other parties concentrating on objectivity, impartiality and justice. Guaranteeing the establishment of instruments with the aim of holding stakeholders of society responsible in connection with their decision process, investing activities, operations as well as consequences serves as the final impediment to be considered.

Tremendous adverse expenses in connection with dysfunctional supervision with regard to the human cost, diminutive civil growth, the deterioration of the environment as well as the inadequate allocation of fiscal assets and institutional capabilities exist (Joshi et al., 2015). Reverte (2016) found that nations with increased governance degrees have the highest possibility of accomplishing the SDGs. This is the case when the performance of the government is improved and continuity in the political environment exists. On the other hand, higher degrees of free speech and associational freedom, firmer primacy of law as well as higher restrain on corruption should be established.

To monitor the advancements regarding the enforcement of the SDGs the UN Secretary General provides a comprehensive, yearly “SDG Progress report” (United Nations Department of Economic and Social Affairs, 2024b). The report’s findings are created in collaboration with the UN System and derived from the worldwide system of indicators, figures and facts from domestic analytics platforms as well as through data acquisition on a regional scale.

According to the results of the indicator monitoring for 2024, globally speaking the developments indicate a substantial drifting away from the accomplishment of the 2030

Agenda (United Nations Secretary General, 2024). Among the 135 goals on the basis of pattern information and further intelligence provided by other institutions, solely 17 percent of the set-out aims are on track for their completion until 2030. Moreover, almost half (48 percent) show mild to serious divergences compared to the required course. Furthermore, out of those, 30 percent make insignificant improvement and 18 percent display negligible advancement. Scarily, 18 percent imply stand still, and 17 percent have fallen under the baseline values from 2015.

Also, the EU Commission incorporates the SDGs in their policy frameworks and activities where they occupy a central place (European Commission - Directorate-General for Communication, 2020). The aim is to provide solid activities to establish substantial advancement across the various SDGs' sections. The plan on enforcing the SDGs is formed by the EU Commission president's policy guiding principles as well as the EU Commissions yearly activity plan. The EU Commission president's policy plan incorporates the SDGs as part of every proposition, plan as well as approach of the EU Commission.

Also, Türkiye has committed itself to the accomplishment of the 2030 Agenda for Sustainable Development and the connected 17 SDGs and additional aims (United Nations Türkiye, 2024). The country's second Voluntary National Review was conducted in 2019 (United Nations High-Level Political Forum on Sustainable Development, 2019b). The corresponding procedures were conducted in close cooperation with Turkish governmental bodies under the order of the Turkish President Erdogan (United Nations High-Level Political Forum on Sustainable Development, 2019a; United Nations High-Level Political Forum on Sustainable Development, 2019b). Türkiye actively incorporated the 2030 Agenda by connecting the set-out SDGs to their domestic so-called National Development Plans as well as other field-specific strategic plans. Throughout the assessment juridical as well as bureaucratic structures, plans and undertakings were examined from an SDG perspective. Primary areas of interest for the individual SDGs were detected and objectives were methodically assessed paying particular focus to groups at risk.

The overall assessment shows that the majority of goals were embodied in political plans and that regulation offers sufficient scheme for enforcement (United Nations High-Level

Political Forum on Sustainable Development, 2019a; United Nations High-Level Political Forum on Sustainable Development, 2019b). Hence, taking into account regulation, strategic and political plans the country has achieved an advanced degree whereas further advancement may be conducted in the areas of actual undertakings. Furthermore, substantial development was accomplished regarding SDG one "No Poverty", SDG three "Good Health and Well-Being", SDG six "Clean Water and Sanitation", "SDG seven "Affordable and Clean Energy", SDG nine "Industrie, Innovation and Infrastructure" and SDG eleven "Sustainable Cities and Communities" (United Nations, 2024; United Nations High-Level Political Forum on Sustainable Development, 2019a; United Nations High-Level Political Forum on Sustainable Development, 2019b).

According to the United Nations Country Team in Türkiye (2021), the nation has considerably advanced in the context of accomplishing the set out SDGs. Especially, with regard to the eradication of complete impoverishment as well as starvation connected to SDG one and two. Moreover, in respect of establishing accessibility of essential services such as well-being, education, hygiene and pure water as well as power, in the context of the SDGs three, four, five, six, seven and 15. As mentioned by the United Nations Türkiye (2024), in 2024, the majority of the UN's monetary resources at hand, in total 23,6 Mio. USD, was allocated to assist the SDG sixteen "Peace and Justice - Strong Institutions" (27,5 percent), SDG five "Gender Equality" (24,1 percent) and SDG 17 "Partnerships for the Goals (18,3 percent) in Türkiye.

United Nations Department of Economic and Social Affairs (2024a) states that also Germany is committed to the 2030 Agenda for Sustainable Development and conducts a number of undertakings in this regard which a few are as follows. In this context, Germany continues to evolve its so-called National Sustainable Development Strategy through a broad procedure assuring increased methodical conjunction of the related fields of policy as well as decision practices with the 2030 Agenda. In addition, this will also include the creation of a tangible program encompassing a series of steps to conduct the broad domestic transforming process. Furthermore, the aim is to reinforce the implementation of coherent policies among the various governmental bodies by fostering their collaboration as well as integrated attention to the SDGs throughout the fields of

transition. Moreover, the target is to integrate the SDGs into regulation and strategic action plans during the initial phase to increase their compulsoriness.

Germany has conducted its second and last Voluntary National Review in 2021 (United Nations High-Level Political Forum on Sustainable Development, 2021). An additional Voluntary National Review is planned for the year 2025 (United Nations High-Level Political Forum on Sustainable Development, 2024). As a result of the National Review in 2021, Germany determined that advancements in a total of six fields are crucial for the enforcement of the SDGs, both for third parties when cooperating with the country as well as for the country itself (United Nations High-Level Political Forum on Sustainable Development, 2021). The relevant fields encompass e.g. individual welfare and abilities as well as fairness in society touching on the SDGs three, four, five, eight, nine and ten. Furthermore, the SDGs seven and 13 are of relevance in connection with environmental protection and the transformation of energy supply. In addition, establishing a closed-loop economy is listed as relevant linked to the SDGs eight, nine and twelve. In the context of the SDGs seven, eight, nine, eleven, twelve and 13 sustainability regarding construction and transportation is named. Moreover, also sustainability in connection with agri-foods sector plays a vital role linked to the SDGs two, three, eight, twelve and 13. Finally, wiping out pollution in respect of the environment is stated associated with the SDGs six, eight, nine, 14 and 15.

According to the Indicator Report by the Federal Statistical Office (Destatis) (2021, pp. 138-149), Germany has achieved overall the most positive domestic results in the following SDG categories in 2019: SDG three “Good Health and Well-Being”, SDG eight “Decent work and economic growth”, SDG eleven “Sustainable Cities and Communities”, SDG 15 “Life on land”, SDG 16 “Peace, justice and strong institutions” and SDG 17 “Partnerships for the goals”.

Regarding the aim of welfare linked to sustainability a connection to all 17 SDGs can be determined (European Commission - Directorate-General for Communication, 2020; United Nations, 2024). The 17 SDGs have been allocated among the six main objectives set out by the EU Commission president’s policy guiding principles.

Despite it must be pointed out that not all SDGs apply to all of the different policies under the Green Deal in similar fashion (SDSN Europe, 2022). Nonetheless, the Green Deal

most substantially affects the following SDGs from most to less important: SDG 13 “Climate action”, SDG nine “Industry, innovation and infrastructure”, SDG seven “Affordable and clean energy”, SDG twelve “Responsible consumption and production”, and SDG eight “Decent work and economic growth” (SDSN Europe, 2022, pp. 26-29). As the CBAM is linked to the “Fit for 55” policy package the most relevant SDGs corresponding to that set of policy measures are considered in connection with the CBAM (SDSN Europe, 2022, p. 29). These encompass from most to less relevant SDG seven, SDG nine, SDG ten, SDG eleven, SDG twelve, SDG 13 as most important SDGs, SDG eight, SDG 15 and SDG 17 as well as SDG three, SDG four and SDG six as least relevant SDGs. Overall, the “Fit for 55” achieves the second highest score regarding its linkage to the SDGs only being surpassed by the strategy package “EU Strategy on Adaptation to Climate Change”. The SDGs not listed have no direct association to the “Fit for 55” policy package. In the following subchapter the theoretical framework Pigouvian taxation is introduced and described as well as put in the context of the CBAM and environmental policy measures.

2.3.2 Pigouvian Taxation and Environmental Policy

Pigou and Coase are the pioneers regarding the introduction of economic tools to decrease environmentally harmful greenhouse gases (Aristei, 2021). Both defined measures derived from the maxim that the polluting party has to cover the inclined costs. The two approaches by Pigou and Coase generate identical outcomes despite the fact that the tools necessitate separate activities. In the context of Pigouvian tax the governmental body takes advantage of the income due to the carbon levy. In the case of the Coaseian approach the limitations favor the manufactures due to the inclined raised pricing for products.

CO_2 taxation is substantially grounded on the conceptual framework established by Arthur Cecil Pigou (Kawecka-Wyrzykowska, 2024; Pigou, 1920). The scholar was the one initially introducing the notion which demonstrates that taxation, known as the Pigouvian tax, may be applied to lower exterior adverse consequences due to actions of bodies. Moreover, the economist proposes applying levy to discourage polluting activities equivalent to the inclined harm (Aristei, 2021; Pigou, 1920). Here, the government body establishes a rate of tax through transferring the expenditure to the firms which do not comply with the predefined prerequisites. Moreover, to become effective the levy needs

to match the minimal outer expenditures for rectifying the adverse outward effects. Companies must incorporate the expenditure of polluting activities as part of their manufacturing. Hence, the good produced includes the complete manufacturing expenditures when this kind of taxation is applied. Kawecka-Wyrzykowska (2024), Grądalski (2002) and Prandecki (2007) state that the scholar presented the conceptual framework with an obvious differentiation among personal and common expenditure of commercial operations. The CBAM introduces a duty on imports created with aim of counterbalancing the expenditure of buying carbon permits for manufacturers in the EU in the context of the EU ETS (European Union EUR-Lex, 2023a; Kawecka-Wyrzykowska, 2024).

Pigouvian taxation, an equalization, correction tax, refers to the maximization regarding resource utilization through establishing requirements connected to financial selection as well as offsetting the collapse of the marketplace (Nesheva-Kiosseva, 2023). The notion also referred to as “Pigou’s Tax” inherited its title from the originator of the theory to implement compensatory charges, British economic thinker Arthur Cecil Pigou (1877–1959) (Leeson 2014, p. xi; Nesheva-Kiosseva, 2023, p. 1). Furthermore, he was linked to neoclassicism in the context of economics, held the Royal Economic Society’s presidency, originator of the “market failure school” in microeconomics as well as associated with the Cambridge School of Economics (Leeson 2014, p. XI; Nesheva-Kiosseva, 2023, p. 1). The scholar initially introduces the concept of an equalization tax in his work “The Economics of Welfare” (Nesheva-Kiosseva, 2023, p. 1; Pigou, 1920). Furthermore, according to Nesheva-Kiosseva (2023, p. 2), the scholar led the way regarding the safeguarding of the environment’s commercial assessment featured in the “concept of sustainable development” at the present time. To ultimately decrease environmental harm through organizational operations Pigouvian taxation acts as an instrument. The adverse outward effects in the context of harms through polluting activities are considered an expense and encompass contamination of the atmosphere, the ground and bodies of water.

The Pigouvian approach shows that fixing marketplace collapse concerns changing the volume or price as well as that replacement and the earnings impact play a significant role (Helm, 2005). Moreover, Nesheva-Kiosseva (2023) states that based on the polluting activities of a company measured in particular quantities the Pigouvian taxation is

applied. Hereby, the differential harm inclined by the polluting activities linked to the manufacturing output is taken into consideration while the tax is imposed on the originator of adverse outer effects, also called "negative externalities" (Nesheva-Kiosseva, 2023, p. 1). Nesheva-Kiosseva (2023, p. 3) describes negative externalities "as the uncompensated impact of one's person or company action or company on the well-being". These outward impacts as well as public expenses represent issues emerging due to business operations of an organization such as manufacturing or a person's commercial participation in the form of intake resulting in consequences for a third bystander which may be either harmful or advantageous (Cheung, 1978; Nesheva-Kiosseva, 2023). The expenses caused by operations and the level of advantageous outcome in combination decide the operational activities of an organization (Nesheva-Kiosseva, 2023). These may vary from the public expenditure setting the society's sought-after level of operational activity.

The notion by Pigou proposes that the adverse outer effects brought about due to the shortcoming of marketplace mechanisms must be reflected in the manufacturing expenses of products through internalization (Long et al., 2012). In the context of internalizing expenses connected to the environment this refers to assuming the public expenditure caused by the organization's polluting activities and adding it to the manufacturing price which is ultimately part of the overall good's price. This way, the value of the environment may equalize in significance compared to manufacturing inputs such as e.g., monetary funds or employment (Long et al., 2012). Again, therefore, the aim is to add the outward expenses caused by the polluting organization to its own expenditures (Nesheva-Kiosseva, 2023). Thus, it is essential that the tax corresponds to the rate necessary to increase the expenses on the organizational (polluting) side to meet the differential expenditures of the public.

The fabricator of adverse outer impacts, also referred to as "negative externalities" is the actual target of Pigouvian taxation and was initially investigated by scholar Karl William Kapp (Kapp, 1950, p.14; Nesheva-Kiosseva, 2023, p. 2). Production expenses do not reflect these adverse outer effects leading to a conflict between the charges for commodities on offer and their overall value considered from a cost perspective (Nesheva-Kiosseva, 2023). Furthermore, this leads to implausible financial returns on the end of producers. As the expenses are not reflected in manufacturers' expenditures, they

are able to shift these towards the public. In this case society takes over the expenditures inclined by the manufacturing sector when at the same time producers obtain gains in an unjustified manner and untouched by the mechanisms of a marketplace environment. Ultimately, the collapse of the marketplace with its ruleset is being described where manufacturers of adverse outer effects transmit some of their expenses to the public while increasing cost competitiveness and obtaining gains.

An unbiased observer, referring to a public authority, is required to step in and rectify the breakdown when the marketplace collapses and the cost for products are not being considered reasonably as well as instinctively (Nesheva-Kiosseva, 2023). Hence, the term correcting levy is used in the context of Pigou's taxation notion as it refers to its remedial character regarding marketplace breakdowns as well as defects (Lee, 1975; Nesheva-Kiosseva, 2023). Offering repairs and offsetting expenses the public sustained in connection with the operations of private organizations refers to the rectification of a marketplace collapse (Nesheva-Kiosseva, 2023).

Organizations become debtors of the public due to the fact that they bearded the expenses and harms inclined by organizational operations while simultaneously, the organizations obtained gains in the absence of actually committing the inclined expenditures (Nesheva-Kiosseva, 2023). The scholar stresses that according to Pigou the taxation of polluting activities is meant to incentivize the corresponding organization to decrease polluting operations and the environmental harm caused. Moreover, organizational focus on reducing taxation spendings may ultimately drive organizations to instead of using (manufacturing) techniques linked to lots of pollution to switch to environmental-friendly alternatives.

A number of scholars have assessed and modified the approach of Pigouvian taxation during the past decades. To rectify the shortcomings regarding the distribution of resources scholars support the instrument of "indirect taxation" (Nerudová & Dobranschi, 2015, p. 148; Sandmo, 1975, p. 86). In this context, the assessment essentially helped the consideration of adverse outward effects in connection with pollution through assessing a "second-best" taxation framework at an optimum and resulting in the notion of "additive property" (Nerudová & Dobranschi, 2015, p. 148; Sandmo, 1975, p. 87). This notion refers to the fact that a products' minimal public harm is introduced into the fiscal

equation for the same good in a cumulative manner (Sandmo, 1975). It is not part of the fiscal equations of further goods irrespective of their structure in connection with mutuality or interchangeability. The scholar states that hence putting tax on further goods which could replace or complement a product causing adverse outer effects should not apply. Overall, the assessment confirms the Pigouvian taxation approach when included in an integrated indirect tax scheme. Furthermore, the Pigouvian model still keeps in a revised version at times where allocative notions perform the function of restoratives in connection with the rule of effectiveness in relation to tax.

Another approach is introduced by the scholar Coase grounded on introducing a restriction on manufacturing, providing restrained accessibility to insufficient resources (Aristei, 2021; Coase, 1960). Moreover, this sets the stage for the industrial stakeholders to anticipate which party is able to obtain the resources in conformity with marketplace powers. Thereafter, according to Coase' conceptual framework exchangeable credits were introduced as exhibited by scholars Dales and Montgomery (Aristei, 2021; Dales, 1968; Mongomery, 1972).

The scholar Coase (2013) criticizes the Pigouvian approach emphasizing that adverse outward negative effects may be settled through negotiations among the causing organization and the (affected) other side resulting in a reciprocally acceptable agreement. Furthermore, the scholar emphasizes that the determination of adverse outward negative effects is based on reciprocity. A decision must therefore be made as to which factor is more important. The challenge here is to know the correct value of a factor in each case. Moreover, Coase (2013) stresses that an environmental taxation addressing the polluter activities would only result in excessive expenses for pollution avoidance. Helm (2005) notes that Coase's approach demonstrates that internalizing rights of ownership, e.g., using a permit scheme, allows for an alternative method to accomplish comparable outcomes as through taxation. Moreover, this reasoning can also be applied to tackle public damage in the world by the creation of corresponding circles.

Libecap (2009) disagrees with Coase (2013) stating that negotiations among the parties according to the way suggested by the scholar is not possible. Insufficiently outlined and imposed rights of ownership are the root of resource issues related to ecology and the climate due to capitalization and civil product supply. Consequently, public welfare and

expenditure is not taken into consideration or attributed for by non-public stakeholder' manufacturing or capital activities. This disparity among final earnings of the public and the non-public stakeholders leads to adverse outward impacts for unbiased bystanders. The scholar states that potent legislation as well as taxation demands for legislators to have knowledge on public expenses, manufacturing volumes at optimum as well as dynamic non-public manufacturing and compliance expenditures which is not often the case. Libecap (2009) notes that instead legislators choose a homogeneous approach mitigating the need for knowledge and displaying legislation in an impartial manner.

Baumol (1972) supports the Pigouvian approach to address adverse outward effects but notes that once attempting to apply the tax notion in reality a lack of requirement becomes eminent. The scholar suggests a system where principles for admissibility in connection with environmentally harming activities are determined as well as levels of fees and taxation are established that complementarily support in reaching the mentioned principles. The scholar claims that through such a setup an effective distribution of necessary greenhouse gas mitigation in the midst of the polluting organizations may be accomplished as it is based on previously determined abatement levels while posing an only marginal expense for the public. Furthermore, this approach strengthens the argument that through funding and fiscal rates adverse outward effects may be governed although in fact a resource distribution at an optimum may not be achieved.

Scholars Bovenberg and Goulder (1996), also addressing the second-best circumstance, assess that with taxation of distortionary kind already existing the level of taxation at an optimum in connection with pollution usually falls lower than the Pigouvian approach proposes. This is still the case if ecological taxation earnings are employed with the aim of reducing taxation of distortionary kind according to Bovenberg and Goulder (1996). Oates (1995) stresses that environmental taxes may cause significant misrepresentation as their value may repeatedly surpass the earnings' decline from reusing the surplus in strain meaning the Pigouvian taxation's optimum may be smaller compared to the minimum public harm. Cremer et al. (1998) found that regarding the demonstration in favor of the taxation optimum concerning individual products pollution charges, both non-linear or linear, and Pigouvian taxation vary in the context of their equation. Furthermore, the Cremer et al. (1998) note that the identified additive property by Sandmo

(1975) does not uphold under any conditions e.g., failing once fiscal measures are composed of linear taxation of products and non-linear taxation of earnings.

Furthermore, Christiansen and Smith (2013) claim that the effectiveness of results may be increased by jointly applying taxation together with a requirement for utilizing mitigation tech solutions. Alternatively, simultaneous implementation of taxation and a financial support program for funding mitigation tech solutions may be enforced. Furthermore, the scholars demonstrated that the complementary implementation of legislation regarding tech solutions for mitigation purposes may lead to effective capital investing in relation to mitigation accompanied by smaller productivity compromise compared to solely applying taxation. Moreover, it was exhibited that already little financial support towards capital investing concerning technological solutions for mitigation leads to positive impact. In this context, this is due to the triggered encouragement of productivity levels instead of actual financial activity. Nonetheless, optimal results regarding capital investing may only be achieved by applying both taxation and funding at the same time.

Ghandi and Cuervo (1998) support the Pigouvian approach stating that the minimum public harm due to emitted greenhouse gases defines the rate of pollution taxation at an optimum. Nonetheless, for setting the amount of tax the minimum public harm must be specified which is an expensive, complex and vague undertaking. On the other hand, to specify the suitable taxation rate the scholars propose to establish a "level of environmental quality acceptable to the society" and in accordance fix a taxation amount supporting its accomplishment (Ghandi and Cuervo, 1998, p. 14). Nonetheless, also the second approach may not abolish the requirement of factually confirmed data regarding the connection among taxation with the reaction of polluters concerning carbon abatement. According to Ghandi and Cuervo (1998), scholar's views showcase ambiguity regarding the effectiveness in accomplishing the in advance specified objectives concerning condition markers of the environment by enforcing environmental taxation due to the challenges in setting of a suitable taxation rate.

Nesheva-Kiosseva (2023) points out that implementing the Pigouvian taxation model to decrease pollution represents an instrument used today to lower environmental damages as well as individual concerns regarding the decline of living standards for the public at

large. Furthermore, Pigouvian taxation together with additional approaches e.g., emissions trading as well as emission quotas, acts as a regulatory instrument to control ecological impact. The author emphasizes that the Pigouvian system must not be mistaken for the taxation of manufacturing as it only considers taxing environmentally damaging activities. Moreover, the scholar stresses that the Pigouvian approach follows the rationale that financial support shall be provided to economic actors which succeeded at decreasing their environmentally harmful activities.

Cadoret et al. (2020, p. 1-2) notes that academia is divided when it comes to the characterization of "environmental taxes", the reasons why they are implemented by administrations and whether they accomplish the intended objectives. Hence, to respond to the reasons for an administrative use of environmental taxation the Pigouvian and Levithan approach are proposed by the scholars. Pigou's theory serves the internalization as well as remedy of adverse outward effects to the environment irrespective in what manner corresponding earnings are applied (Baumol and Oates, 1988; Cadoret et al., 2020). Moreover, the objective of Leviathan administrations is to increase fiscal income streams from taxation while maintaining minimum governmental damage, to take advantage of this element as well as implement comparatively further ecological taxation, regardless their effectiveness in attaining green objectives (Cadoret et al., 2020; Kirchgässner and Schneider, 2003) Both assumptions, the Pigouvian and the Leviathan, represent contrary perspectives in regard to administrative concepts. The Pigouvian notion originating from welfare economics and the Leviathan assumption aiming for the maximization of benefits relates to public choice theory (Cadoret et al., 2020).

In an analysis conducted by Cadoret et al. (2020) the scholars assess in what manner ecological taxation is applied to consequently determine whether the Pigouvian or the Leviathan method is factually the more popular approach followed by governments. For their analysis the scholars consider the former 28 member states of the EU between the years 2005 to 2017 which have set objectives for decreasing greenhouse gas emissions. These emissions encompass "carbon dioxide (CO_2)", "methane (CH_4)", "nitrous oxide (N_2O)", "hydrofluorocarbons (HFCs)", "perfluorocarbons (PFCs)" and "sulphur hexafluoride (SF_6)" based on the classes shown in Annex I of Decision No. 406/2009/EC (European Union EUR-Lex, 2009 (Article 2)). Their volumes are stated in "tonnes of carbon dioxide equivalent" compiled in accordance with *Decision No. 280/2004/EC*,

although this decision in the meantime has been replaced by *Regulation (EU) 2018/1999*, and not counting greenhouse gas emissions included in *Directive 2003/87/EC*, according to Article 2 in *Decision No. 406/2009/EC (*European Union EUR-Lex, 2003; 2004; 2009; 2018b).

In conclusion, the assessment shows that the Pigouvian approach is predominant in connection with green fiscal policy while simultaneously being capable of rectifying ecological adverse outward effects (Cadoret et al., 2020). On the contrary, the results show that the Leviathan assumption is not being empirically endorsed. Moreover, elevated amounts of Pigouvian taxation lower the ecological adverse outward effects depicted by the level of the carbon footprint consequently diminishing ecological taxations' taxable amount. This is demonstrated by the significant relationship between the amounts of ecological taxation and the range away from the objective in addition to the adverse probability value. Furthermore, the degree of correlation between the amounts of ecological taxation as well as the decrease of the carbon footprint is comparable for nations which have reached their decarbonatization goals and states that need yet to achieve them. In conclusion, the results by Cadoret et al. (2020) indicate ecological regulatory measures' incorporation in taxation scheme still occurs following the achievement of specific political objectives.

Kirchgässner and Schneider (2003, p. 372) state that the implementation of ecological taxation has been growing ever since the finish line of the 1980s. More and more European states such as Germany, the Nordics or the Netherlands have implemented ecological taxation and in particular "energy taxes", Kirchgässner and Schneider (2003, p. 372) emphasize. Furthermore, modern-day type of policy tools named "economic instruments", or "voluntary agreements" were presented (Kirchgässner and Schneider, 2003, p. 372). Such tools have been rising in popularity although observed data barely compels regarding their effectiveness (Kirchgässner & Schneider, 2003; Rennings et al., 1997). Nonetheless, Kirchgässner and Schneider (2003) refer to the tools' essential role in the legislation of Switzerland with the aim of lowering greenhouse gases adopted in the year 1999. The scholars describe the gradual conquering of opposition towards market-driven ecological policy tools. The named reasons are the growth of emissions allowances for trading in the Unites States of America (US), the rising focus on ecological aspects in fiscal policy of European nations, the growing application of voluntary

agreements as well as the addition of a global emissions trading scheme to ultimately lower greenhouse gases to the Kyoto Protocol.

According to a survey with over 26.000 participating EU nationals conducted by the European Commission - Directorate-General for Environment (2024) interviewees firmly encourage the function of EU policy connected to environmental safeguarding. Although voting results demonstrated to be close together in the context of most competent measures to address pollution, the majority of Europeans support the encouragement of a closed-loop economical approach by lowering garbage volumes as well as reclaiming and "recycling" goods (17 percent) (European Commission - Directorate-General for Environment, 2024, p. 13). In second position environmental rehabilitation (15 percent) is listed succeeded by the effort to pay greater attention to the degree of non-polluting characteristics of goods traded in the EU (14 percent) as well as to guarantee that green legislation is being adhered to (14 percent). Only ten percent of participants vote for raising fiscal measures such as tax regarding operations harming the environment. Finally, just nine percent support the elimination of state subventions on not environmentally friendly operations.

Furthermore, 84 percent of participants support the need for EU green policy for ecological safeguarding in their respective member state (European Commission - Directorate-General for Environment, 2024). Moreover, 80 percent of interviewees back EU support for third countries outside the EU in enhancing local pollution criteria. In the 27 member states of the European Union (EU-27) six out of ten participants (60 percent) support the argument on the lack of taxpayers' money spent on measures to assist the shift towards a climate-friendly economic environment in their respective member state. In the context of covering the expenses for restoring environmental harm the majority of participants (92 percent) support the coverage of the inclined expenditures by firms whereas on the other hand 74 percent voted for government bodies to step in.

Nerudová and Dobranschi (2015, p. 154) note that a so-called "carbon tax" must be arranged in accordance with the taxing's ground principles. In this context, the initial concept is that taxation must represent a mappings' evident financial impact in the context of the economy. For example, the financial impact becomes evident through applying tax on the usage of power or gases for the generation of electrical power. Secondly, carbon

tax' nature must follow objectivity as its connected essential objective is the enhancement of the scheme to safeguard the environment fighting pollution rather than to accumulate earnings in form of state resources. The firearms emphasized by academia in the context of effective tax must be redirected to taxing at an optimum in favor of fighting pollution. Taxation of greenhouse gases provides the benefit that earnings may be reused as opposed to the array of instruments to address negative outward effects connected to pollution e.g., forms of emissions trading. Oates (1995) further emphasizes that special attention should be paid to the scheme of such instrument with the basis for reference to determine the level of taxation being the environmentally harming operation instead of an affiliate. Furthermore, the scholar emphasizes that environmental taxation may contribute substantially and productively to the fiscal regime. Environmental taxation assists in lowering the amount of environmentally harming operations as well as significantly encourages studying of modern and enhanced technological solutions for mitigation.

In addition, Oates (1995) claims presenting the mentioned actions in a manner of balanced earnings meaning that such earnings may be reused to mitigate a few even further harmful characteristics as part of the current fiscal setup may represent a compelling argument. Following the introduction of carbon taxation a scheme not exacerbating the misrepresentation evident in the current taxation framework must be constructed which follows a couple of objectives using taxation and remuneration. Nerudová and Dobranschi (2015) state that these objectives encompass safeguarding the climate as well as reducing the misrepresentation through other means of taxation in a direct manner such as in the context of funds and employment.

Metcalf and Weisbach (2009) assess the scheme for a carbon tax for an industrialized nation like the US. According to the findings of Metcalf and Weisbach (2009) for the case of the US, a successfully schemed greenhouse gas emissions tax may catch approximately 80 percent of nationally emitted carbon while charging less than 3.000 individuals and as far as nearly 90 percent where only small further expenses apply. It is recommended that in the context of hydrocarbons, emission taxation is applied as close to the start of manufacturing as possible to ultimately reduce expenses for surveillance and accumulation activities as well as to guarantee the utmost scope. The level of taxation should be determined by an additional organizational body which guarantees values consider the latest developments regarding the prices of greenhouse gases as well as for

their mitigation. Furthermore, the scholars suggest a scheme on the grounds of the origination point of a product in the context of the exchange of goods with nations not possessing an appropriate taxation system for greenhouse gases. Moreover, a scheme around taxation of imported goods at the frontier is recommended when a state does not apply taxes on greenhouse gases nationally. Metcalf and Weisbach (2009, p. 2) propose "a system of presumptive border tax adjustments" which grants single companies to present proof of smaller amounts of greenhouse gases. The linked taxation rate may be predicated using the mean of greenhouse gases emitted in the course of manufacturing a product provided by either the nation of import or export.

Christiansen and Smith (2013) emphasize that when carbon taxation is the single active measure, the regulatory side must compromise among encouraging investments in technological solutions to mitigate emissions and effectiveness in the context of determination of subsequent manufacturing. Since the taxation rate has been set at a consistent level and applied comprehensively, generally "ex post inefficiencies" occur as opposed to assumed enforcing of "state-adjusted" taxation (Christiansen and Smith, 2013, p. 26).

Ghandi and Cuervo (1998) emphasize that taxation of greenhouse gases may be among the most effective measure to accomplish carbon abatement goals. On the other hand, they also note that besides raising large amount of money, it may in addition slow down the expansion of the economy, impairing the allocation of earnings as well as weaken the competitive capacity of a nation`s trade with oversea. The impact of taxation of greenhouse gases concerning slowing down the expansion of the economy may vary based on the selected approach, the basic premises of even that approach as well as how the related fiscal earnings are employed. In connection with export trade the consequences due to taxation of greenhouse gases may be incremental although research states higher manufacturing expenses may be compensated for through lowering taxes on wages as well as earnings facilitated by the income of greenhouse gas taxes. The scholars propose the implementation of a global treaty laying the foundation for a harmonized approach to establish an emissions tax as uncertainties in relation to harming the competitive capacity in connection with export trade may be substantially lowered according to Ghandi and Cuervo (1998).

Figure 5 shows the model of Pigouvian Taxation (Nerudová & Dobranschi, 2015; Nesheva-Kiosseva, 2023). The differential expenses of organizations are referred to as "marginal private cost" (MPC) where, on the other hand, the differential expenditure for the public is denoted as "marginal social cost" (MSC) (Nerudová & Dobranschi, 2015, p. 151; Nesheva-Kiosseva, 2023, p. 3). Furthermore, with the aim of internalization of the outward expenses caused by an organization Pigou's notion suggests taxation at an even level as the harm imposed upon the public mirroring the value of the MSC as described in the formula below (Nerudová & Dobranschi, 2015).

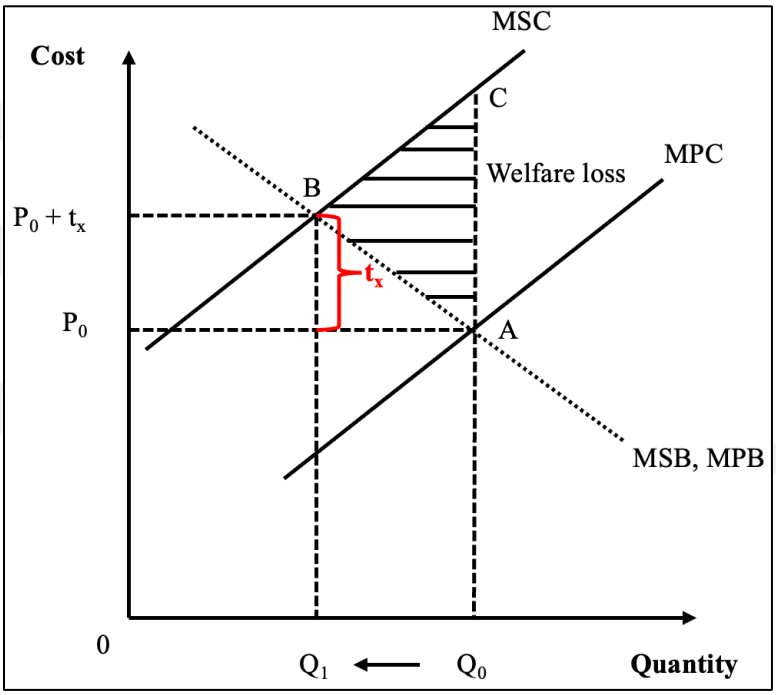


Figure 5. The Model of Pigouvian Taxation

Source: Modelled after Nerudová and Dobranschi 2015, p. 152 and Nesheva-Kiosseva, 2023, p. 3.

Based on Nerudová and Dobranschi (2015, p. 151) and Nesheva-Kiosseva (2023, p. 3) it is calculated through the following formula:

$$MSC = MPC + t_x$$

The variable t_x represents the level of adverse outer effects and at the same time matches the amount of (Pigouvian) taxation (Nerudová & Dobranschi, 2015; Nesheva-Kiosseva, 2023). The differential benefit for the public, also called "marginal social benefit" (MSB), reflects the request for a product (Nesheva-Kiosseva, 2023, p. 3). The hatched, triangular

area ABC indicates the “welfare loss” due to organizational operations (Nerudová & Dobranschi, 2015, p. 151). It is calculated through the gap between MSC and MPC prior to implementation of taxation. By taxing the adverse outer effects and hence raising the organizational expenses starting at P_0 to $P_0 + t_x$, organizational operations’ decline, and less volume is produced shown by the shift from Q_0 to Q_1 (Nerudová & Dobranschi, 2015). This change describes the “social optimum” as stated by Nerudová and Dobranschi (2015, p. 151).

Organizations originate adverse outer expenses shifting them to society and other unbiased observes while capitalizing on gains leading to the malfunction of marketplace instruments and contest (Nesheva-Kiosseva, 2023). Through the introduction of Pigouvian taxation organizations’ differential expenses increase so much so that the utmost degree of state grants is reached, being referred to as the outer effects’ absorption (Lee, 1975, p. 70; Nesheva-Kiosseva, 2023). Under the Pigouvian scheme, the decision among price and volume instruments as well as legislation is not decided, as the knowledge provided is complete (Helm, 2005). Furthermore, the functions' positioning regarding advantages and harms are certain. However, the scientific discipline and policymaking are shaped by vagueness.

As already mentioned above, the concept of Pigouvian taxation aims to achieve the internalization of adverse outward costs caused by polluting manufacturing activities of organizations and which are shifted to society (Nesheva-Kiosseva, 2023). This refers to reflecting those adverse outward costs which had previously not been reflected to the total expenses for the manufacturing of goods of an organization. Figure 6 depicts the model of internalization of adverse outward costs through Pigouvian taxation and its effects on manufacturing volumes. The abbreviation MNPP represents the “marginal net private profit” whereas MEC stands for the “marginal external cost” (Nesheva-Kiosseva, 2023, p. 4). Q_1 depicts the manufacturing volume in tons and Q_2 illustrates the pollution also in tons. Finally, Pigouvian taxation is reflected as t.

The following formula describes the internalization (Nesheva-Kiosseva, 2023, p. 4):

$$FC_A = F_P + \sum En$$

F_A represents the total manufacturing expenditure. E stands for the adverse outward costs occurred and $\sum n$ describes the Pigouvian taxation.

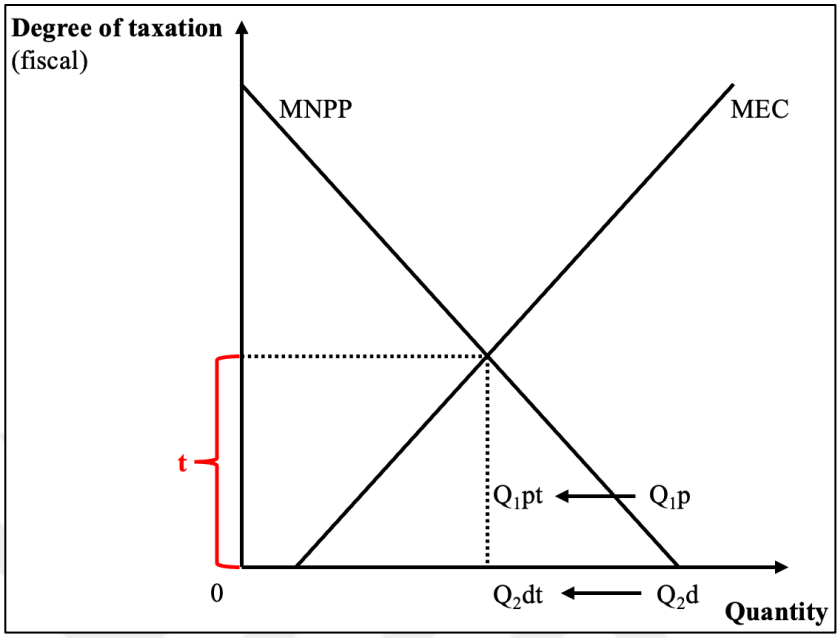


Figure 6. Internalization of Adverse Outward Costs Through Pigouvian Taxation

Source: Modelled after Nesheva-Kiosseva, 2023, p. 4.

In the following chapter the climate policies and decarbonization strategies in Germany and Türkiye are outlined and described in-depth.

3. CLIMATE POLICY AND DECARBONIZATION STRATEGIES IN GERMANY AND TÜRKİYE

The Turkish climate policy and decarbonization strategies are elaborated on in the following subchapter.

3.1 Climate Policy and Decarbonization Strategies in Türkiye

In 2004 and 2009 respectively, Türkiye joined the UNFCCC as well as the Kyoto Protocol, according to the Republic of Türkiye Ministry of Environment, Urbanization and Climate Change (2021). Türkiye provided its Intended Nationally Determined Contribution (INDC) to the bureau of the UNFCCC which comprised of a greenhouse gas mitigation goal of 21 percent until 2030 in agreement with the so-called "business as usual scenario" in 2015 (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2023a; Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2024). Later in April 2023, the country substantially raised is mitigation goal to 41 percent until 2030, presenting it primary revised NDC to the UNFCCC bureau. Committing parties to the Paris Agreement are required to develop NDCs which are then shared with bureau of the UNFCCC (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021, p. 18). The NDCs are valid for a period of five years and describe the country's measures in response to climate change as well as to lower their carbon footprint. Over time, the sequence of NDCs is intended to mirror a gradually rising grade of drive regarding climate action as opposed to the preceding round (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021).

Furthermore, on December 12, 2015, the country approved the Paris Agreement which was then sealed on April 22 of 2016 while giving importance to Türkiye's status as an emerging economy (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021; Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2023a). The Paris Agreement was later ratified and issued with the Official Gazette 31621 on October 7th, 2021.

Türkiye declared its objective for climate neutrality until 2053 in September 2021 commencing the local transformation process (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021). As a result of the declaration of

both the local carbon neutrality goal until 2053 as well as the ratification of the Paris Agreement require extensive modifications and transition across each industry. In this context, the Directorate of Climate Change (as part of the Republic of Türkiye Ministry of Environment, Urbanization and Climate Change) was given the responsibility to conduct the process of developing plans, measures and tactics in the local and global context, to lead corresponding talks as well as to guarantee an inclusive environment for other stakeholders, all in the context of climate action and accommodating the results of climate change. The introduction of the Directorate of Climate Change as part of the Republic of Türkiye Ministry of Environment, Urbanization and Climate Change in October 2021, was for the purpose of implementing the corresponding operations and procedures in cooperation with a number of Turkish organizations. The Directorate is responsible for local and universal political approaches, plans and measures in the context of the country reacting and adjusting to global warming, while leading discussions as well as guaranteeing organized stakeholder cooperation.

At the beginning of 2022, the nation's initial Climate Council was organized (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021). Through the organization 217 proposals were approved, with 76 of them being prioritized, and later disclosed. This supported in laying the path to the country's carbon neutrality goal until the year 2053. Furthermore, the proposals laid the foundation to formulate various policies and schemes such as the "Climate Law" or the "Climate Change Mitigation and Adaptation Action Plans" in Türkiye (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021, p. 23).

The Republic of Türkiye Ministry of Environment, Urbanization and Climate Change (2023a) states that the country's goal is to proceed along the course of sustainable economic growth by means of taking into account national strategic development pathways as well as progress abroad. At the same time, Türkiye thrives to tackle challenging matters in the context of the society, economy as well as environment adhering to a symmetrical approach. Furthermore, the country works persistently to follow its climate action objectives by means of various efforts such as danger and exposure analyses, data schemes as well as regulatory and legislative tools as displayed in Table 2. Some of these documents already exist and have been enforced whereas other

leading measures are in the preparatory phase and to set to be concluded as early as possible to strengthen the country's efforts against climate change.

Table 2. Existing and Pending Regulatory and Legislative Measures

Existing regulatory and legislative documentation:	Main regulatory and legislative documentation to be concluded:
- Climate Law - Environmental Law - Eleventh Development Plan (2019-2023) - Regulation on Strategic Environmental Assessment - National Climate Change Strategy (2010-2023) and Action Plan (2011-2023) - National Climate Change Adaptation Strategy and Action Plan (2011-2023) - Energy Efficiency Strategy and National Energy Efficiency Action Plan (2017-2023) - 2053 National Transport and Logistics Master Plan - Türkiye's Green Deal Action Plan - Final Recommendations of the Climate Council - Türkiye's National Energy Plan - Medium-Term Program (MTP) (2024-2026) - Twelfth Development Plan (2024-2028)	- Regulation on Local Climate Change Action Plan - Türkiye's Spatial Strategy Plan for 2053 - Water Law - Flood Law - Long-Term Climate Change Strategy for 2053 - Strategy and Action Plan on Circular Economy - Sustainable Consumption and Production Strategy - Sustainable Smart Transport Strategy and Action Plan - Green Growth Technology Roadmap - Climate Finance Strategy

Source: Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2023a, p. 40; 2025.

The Twelfth Development Plan 2024 to 2028 was accepted by The Grand National Assembly of Türkiye on October 31, 2023 (Presidency of the Republic of Türkiye, 2023c). The Plan acts as an orientation device to control the sustainable progression route of the country by a tactical method guaranteeing the effective application of assets present, their improvement over the mid and long run as well as aiming areas producing the utmost rate from a perspective of the economy and society. Taking into account the internationally topical tendencies and political strategies centered around the conversion to digital and a more sustainable system to establish increased competitivity as well as enhanced value-added as part of manufacturing methods are crucial. The country's adjustment to evolving surroundings in the context of competition demands improving skilled personnel, augmented manufacturing as well as capabilities in export trade concentrating on the conversion to digital and the transition to a more sustainable system setup. For creating endurable and powerful expansion activities compliant with digitalization and the green transition, endorsing financial investing into infrastructure and tech stays crucial as required in areas such as power, production, transportation as well as farming in accordance with the national climate neutrality objective until 2053. Furthermore, it is essential to guarantee the progression of capabilities in the context of digitalization and the green transition as well as to set up funding and promotional schemes.

In the context of political strategies as well as action steps a number of points have been identified by the Twelfth Development Plan (Presidency of the Republic of Türkiye, 2023c). Moreover, regarding establishing manufacturing with a competitive advantage alongside digitization and green transitioning activities the target for the production sector is securing the passage towards an augmented manufacturing organization through enhancing competitive advantage as well as output along the line of digitalization and the green transitioning activities across industries and in particular in those preferred, encompasses the central target for the production sector. The connected political strategies as well as action steps encompass the following aspects. For the production sector eco-friendly transitioning efforts are set to be endorsed whereas closed-loop and environment-friendly manufacturing customs are expected to be expanded. In particular research and development efforts alongside technological transfer shall be aided to help the acceptance, evolvement as well as spreading of environmentally friendly

manufacturing and tech in the area of the eco-friendly transition process. Undertakings regarding the green transition for broad application shall be planned in organized industrial zones as well as regular and little commercial zones while sustainable organized industrial zones and commercial zones are set to be enlarged. Furthermore, the generation and application of green power is defined to be endorsed. The utilization of garbage as well as activities around the closed-loop economic approach are intended to be amplified. Moreover, consciousness of little and mid-size companies regarding the green transitioning process will be augmented as well as industry-specific conversion portraits are set to be formed. In addition, the aim is to perform industry evaluations concerning the EU Green Deal as well as the green transition and policies for the conversion are intended to be put into practice. Furthermore, promotion of companies' power conservation efforts will be raised and financial investing in technologies exemplifying elevated power conservation capacity assisting in the maximization of proficiency and operation are set to be endorsed. Moreover, a standard for domestic activities in the context of analyses of the water as well as greenhouse gas footprint and their authentication are set to be prepared. Proficient transition advisors of ecofriendly industry companies are intended to get endorsed and receive certification. A foundation to surveil and assess transition progress in the manufacturing sector will be set up. In addition, production plants stating power and resource conservation in their manufacturing through decreased amounts of greenhouse gases contributing to the climate neutrality objective are set to receive certification to exhibit their ecofriendly manufacturing activities. In general, garbage produced through manufacturing is expected to be gathered individually from origin. Finally, in the context of the green transition process the evolvement and commercial application of parts, machinery and structures exhibiting local resources are set to be endorsed. In particular, concerning the manufacturing, storing, transporting as well as industry application proceedings along the hydrogen value stream.

The MTP from 2025 to 2027 is formulated in line with the targets of the Twelfth Development Plan for the period 2024 to 2028 and intends for sustained economic development through fortifying a stable macroeconomic and fiscal environment, sustaining budgetary control, accomplishing steadiness of prices through lowering inflation rates to one-figure numbers in the mid-run (Presidency of the Republic of Türkiye, 2024b). Furthermore, additional related measures are enhancing ability in the

context of research and development and inventions, guaranteeing technical change while concentrating on sustainability and digitalization aspects in the economic context, bolstering stock of competencies, additional stimulation of the employment market, enhancing the conditions for the private sector and investing as well as diminishing the informal activity in the economic context. The MTP for the timeframe 2025 to 2027 is the continuation of the MTP 2024 to 2026 and current release. The Program was formulated in a comprehensive manner and seeks to specify the essential macroeconomic scheme considering latest events and will determine the most important fundamental components to be employed throughout the prospective term of three years.

In the context of economic expansion regulatory schemes targeting confident behavior of investors as well as establishing a more business-friendly environment together with efforts for fundamental shift enforced throughout the Program term mainly in form of fiscal policy changes would result in a general enhancement of manufacturing conditions (Presidency of the Republic of Türkiye, 2024b). Furthermore, the research and development foundation is set to receive promotion in the economic environment causing a raise in investment participation by businesses helping economic expansion. To ensure the accomplishment of the aforementioned the target is to expedite regulatory schemes and promotion intended for reinforcing the innovative changemaker landscape as well as therefore growing production networks in particular for mid to big-size companies concentrating on conversion in the context of digitalization and eco-friendliness. Throughout the time ahead, the main fields of political action set out to endorse the macro-economic regulatory scheme encompass, among others, the accomplishment of technological change in the direction of an eco-friendly as well as digitized economic environment.

In regard to the fundamental transition of manufacturing the aim is to implement dynamic industry regulatory plans and measures on a sector-based ranking by priority (Presidency of the Republic of Türkiye, 2024b). The target is to ready vast investments turning the country into a manufacturing center for advanced technology in the area, instruments to privatize when deemed appropriate on a project level as well as appealing promotion bundles. In addition, enterprises may receive assistance by the HIT-30 scheme encompassing rising key technological fields like semi-conductors, e-mobility, clean

energy, sophisticated production, healthful lifestyle, space tech, as well as communication and advanced digitized tech.

Furthermore, the target is to implement regulatory plans and measure expediting the eco-friendly conversion of industries to achieve sustainable development, to be in line with global regulatory framework and to raise the utilization of green energy as well as of energy conservation (Presidency of the Republic of Türkiye, 2024b). The measures encompass completion of preparatory work on regulation to approach activities on global warming in a comprehensive way and enforce them. Furthermore, the groundwork for the second NDC encompassing the reduction of emission and adjustment objectives as well as obligations around global warming, and the national 2053 Long Term Climate Change Strategy are set to be finished. Moreover, the target is to set up an instrument to charge a cost for emissions with the ultimate goal to mitigate such emissions. This will sustain the market's ability to compete throughout the conversion proceeding towards increased eco-friendliness, lower the effects of the CBAM as well as assist in the shift towards becoming an economic system with minor levels of emission. In addition, the consequences of the European Green Deal and CBAM in regard to the wide array of industries is evaluated as well as sector-based strategic plans to mitigate emission are set to be concluded in the context of industries concerned with the regulatory packages by the EU.

The effects on society and the economy of emission charges mechanisms along with the corresponding taxing of emissions, concerning the growth as well as investing conditions are scheduled to be examined (Presidency of the Republic of Türkiye, 2024b). Furthermore, the so-called Green Finance Strategy and Action Plan aimed at playing a part in eco-friendly conversion activities will be implemented. Law-making efforts in the context of introducing green taxonomy domestically are to be finalized. The scheme will bear in mind both the country's preferences and will be in line with existing models from abroad, especially the taxonomy of the EU. Another policy measure, the Net Zero Emission Strategy and Action Plan for the transport industry is scheduled to be developed and enforced. Furthermore, the aim is to design a domestic scheme in the context of charging infrastructure with high voltage for the logistics industry. In addition, the goal is to boost electric cars, enhance the charging infrastructure system as well as foster the employment of local electric cars. To guarantee conditions in the context of the fiscal market offering proper data throughout the transition process in the direction of a green

economic environment, principles as well as a specialist network is set to be created to facilitate companies to ready enterprise reporting on sustainable aspects.

As part of the Green Deal Action Plan, the execution of undertakings in the field of transport to secure the mitigation of greenhouse gases and rising connectedness as well as sustainability is foreseen (Presidency of the Republic of Türkiye, 2024b). Advisory assistance and educational instructions in regard to the eco-friendly conversion of fields are endorsed. Legal measures concerning the provision of heating are to be developed to evaluate the country's heating capacity as well as utilize excess heat. Furthermore, the aim is to improve independence from energy import by raising power production from renewables. The corresponding Renewable Energy Resource Area (YEKA) undertakings are set to be formed including a requirement regarding application of national goods. Moreover, the country's capacity regarding wind energy offshore shall be assessed. Priority is given to industries with high power demand and related undertakings to grow power conservation are set to be endorsed considering the competitive capacity and national manufacturing of an industry. The plan is also to foster the National Green Certification System as well as sustainable compounds with elevated power conservation as well as the ones employing energy from renewable resources.

Efforts regarding research and development and inventions shall be endorsed to turn into a technology supplier as part of the supply chain regarding hydrogen (Presidency of the Republic of Türkiye, 2024b). A National Circular Economy Action Plan is to be put into practice, domestic recuperation rates are to be raised as well as industry synergy activities are to be promoted. After the regulation regarding eco-friendly design as well as green goods as part of the production sector, additional legislative framework are set to be prepared to estimate and supervise the greenhouse gas footprint as well as more sustainability metrics. In addition, the required digitized basis is set to be promoted. The Green Transformation Support Program shall promote investing activities that are in line with the closed-loop economic scheme and have the target of non-polluting manufacturing. Furthermore, activities around garbage reduction to a minimum are set to be endorsed. Finally, as part of eco-friendly forestry, additional sink zones are to be persistently developed by shielding and enlarging resources of the forests as well as woodland undertakings are set to be prolonged on grounds qualified.

In the context of labor, the effect of the shift regarding digitalization and decarbonization efforts upon employment markets is set to be assess and respective schemes concerning adjustment as well as the proceedings around a just transition shall be introduced (Presidency of the Republic of Türkiye, 2024b). Furthermore, to raise competitive capacities globally, regulatory strategies guaranteeing the conversion in the context of digitalization and decarbonization are to be enforced, conformity according to international legislation shall be fortified as well as the transition of exporters is set to be facilitated. Under these aspects, according to the EU's digitized economic legislation and the Green Deal concerning the points impacting export activities arrangements regarding the required legislative and assistance frameworks as well as global contracts to sustain and raise competitive capacity are set to be concluded. Furthermore, the domestic ETS' legislative apparatus shall be finalized, and its formation shall be in configured in line with the CBAM. In addition, the array of tools applied for funding export activities will be augmented to tackle the extra expenditure inflicted by the emission pricing instrument in given industries. Moreover, in the context of funding export activities to raise competitive capacities and endurance of exporting companies fostering admission to advantageous funding opportunities is set to be put first and export assistance facilities are set to be applied competently to improve exporting possibility in an eco-friendly as well as augmented value-added manner. In this respect in particular the topics digital and green transition receive attention.

The majority of emitted greenhouse gas emissions arose from the energy industry in 2021, accounting for 71,3 percent (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021). In second place was the category industry manufacturing and utilization of goods as well as the agricultural sector representing each 13 percent. The waste industry's emission contributions amounted to only three percent in 2021. Considering the composition of the energy's overall greenhouse gas emissions output, the majority of its large carbon footprint originates from electricity and heat (26 percent), followed by the transportation sector (16 percent), the production industry (twelve percent), compounds (eleven percent), as well as finally the category other accounting for only six percent.

Due to the close of the application phase for the CCMSAP between 2011 and 2023 which had been formulated by the Ministry of Environment, Urbanization and Climate Change,

the preparatory measures for a contemporary policy and program of measures were launched (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2024). This was conducted in accordance with the country's climate neutrality objective until 2053, the national twelfth Development Plan, the national MTP, the country's NDC as well as the Climate Council Decisions. For accomplishing the declared NDC objectives, two individual policy and measures programs for the timeframe 2024 to 2030 were formulated organized by the Directorate of Climate Change detailing the country's plans concerning the reduction of and adjustment to the shifting climate. The corresponding publications seek to determine joint targets in the context of addressing global warming as well as constructing an eco-friendly tomorrow collectively.

The CCMSAP for the timeframe 2024-2030 as well as the Climate Change Adaptation Strategy and Action Plan (CCASAP) for the same period were implemented at the same time (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2024). Throughout the groundwork period which continued for two years, a high number of discussions were organized and loads of actors attended involving delegates and specialists from governmental agencies, the business world as well as independent associations. Both, the CCMSAP and the CCASAP represent a landmark in the country's efforts battling global warming. Moreover, the programs necessitate robust cooperation among the governmental and business sides, public communities as well as man.

As part of the CCMSAP, a demands assessment was carried out regarding the country's tactics, approaches, schemes and related steps in the context of global warming to reduce climate pollution (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2024). On a sector basis reduction policies and measures were detected involving related parties. In the context of the CCMSAP a total of 49 policies and 260 measures were developed attending to multisectoral matters such as manufacturing, transport and compounds, among others. In the framework of the CCASAP Türkiye's particular forecast regarding global warming was applied and the outcomings were assessed to examine the dangers in the context of climate change anticipated in prospective due course.

Together with the country's NDCs the CCMSAP for the period 2024 to 2030 was developed by the Directorate of Climate Change also considering the results of the

Climate Council, the Twelfth Development Plan as well as the Medium-Term Program as well as adhering to transparency and collaborative ways throughout the proceedings (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021, p. 24). Under the CCMSAP seven areas were determined where the reduction of emissions is crucial according to the Republic of Türkiye Ministry of Environment, Urbanization and Climate Change (2021). These comprise of the compounds, energy and manufacturing industries, farming and cultivation, the transport and waste sectors as well as Land Use, Land Use Change and Forestry (LULUCF). The production of electricity is included in the energy sector and the use of this energy in the other fields on the other hand is considered in the context of the corresponding industry. While conducting the groundwork for the formulation of the Action Plan, issues such as incentives for the various industries, financial requirements and technological demands, skills development and educational actions were included under the policies and measures of the corresponding fields in order to ensure integrity. As a consequence of the discussions and assessments carried out throughout the groundwork process of the Action Plan, it was determined that it would be necessary to open individual chapters for the aspects “just transition” as well as “carbon pricing mechanisms” and to elaborate corresponding policies and measures for these issues. On the other hand, integrating social equality of opportunity in policies and measures for all corresponding sectors has been taken into consideration (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021, p. 25).

The CCMSAP contains all in all eight policies and 32 measures in the area of industry and in sum four policies as well as 20 measures under the carbon pricing mechanism (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021). Altogether, the plan encompasses nine chapters with an overall number of 49 policies and 260 measures. A number of control markers and institutions in charge and associations have also been identified for every respective measure within the extent of these policies. The policies set out the steps to be taken in various fields such as regulation, infrastructure of technical kind, technological development, financing, skills development, education and social consciousness at sectoral scale. Overall, 47 institutions and associations have an obligation in the context of the Action Plan. For the industrial sector the relevant policies include raising the share of green electricity utilized for production and

improving the levels of saving power during the production process, lowering greenhouse gas emissions and their severity levels in connection to the GDP as well as supporting declaration structures in regard to sustainable and environmental factors. Furthermore, developing further capabilities within the production community, encouraging the "circular economy" approach and the efficient use of sources as well as growing contemporary technological advancements using inventions and scientific work supported by local funds (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021, p. 26).

Finally, the aim is to establish viable tools for funding as well as to construct adequate investing funds (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021). In the context of the carbon pricing mechanism, the policies are set out to create a national greenhouse gas emissions trading scheme as well as to lead fundamental research regarding alternative tools for appraising greenhouse gases. Moreover, the aim is to construct the framework concerning a deliberate greenhouse gas emissions trading system as well as a scheme for counterbalancing carbon emissions and administering research with the goal to assess the contribution to the Paris Agreement's article six.

The Republic of Türkiye Ministry of Environment, Urbanization and Climate Change (2021, p. 28) stresses that "Monitoring and evaluation are critical for the long-term success of the Action Plan.". Furthermore, the supervision approach functions to watch how the measures are working as well as to understand if the intended turnout, also in connection with the measures, were accomplished funds. In this context, the Directorate of Climate Change will implement a virtual supervision setup as part of the "climate portal" (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2021, p. 28). This way the proceedings of the sum of liable corresponding organizations can be supervised and declared in a persistent as well as punctual manner.

The country's initial CCASAP for the period 2011 to 2023 was prepared with the aim to establish policies and measures in the context of adjustment efforts to global warming (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2023a). This scheme encompasses the governance of water supply, farming, food supply, duties in relation to the ecosystem, biodiversity and forest management, catastrophe risk mitigation as well as community health services. As part of a collectively funded effort

by the EU and Türkiye in the context of the groundwork for the CCASAP from 2024 to 2030, the “Enhancing Adaptation Action in Turkey Project” was conducted by the Republic of Türkiye Ministry of Environment, Urbanization and Climate Change in association with the United Nations Development Programme (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2023a, p. 41).

The CCASAP 2024 to 2030 covers more fields compared to its predecessor further comprising areas such as cities, power, leisure industry and assets of culture, manufacturing, transportation and communication as well as advancements in society (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2023a). Hence, the CCASAP 2024 to 2030 encompasses a total of twelve different fields which are cities, power, leisure industry and assets of culture, manufacturing, transportation and communication, advancements in society, governance of water supply, farming and food supply, duties in relation to the ecosystem and biodiversity, forest management, catastrophe risk mitigation community health services as well as multilayered problems. In regard to the major issues necessary to be tackle prior to composing the series of measure an evaluation of exposure and danger was conducted as it crucial to name the proper issues for establishing the suitable adjustment measures. As part of the groundwork for the CCASAP 2024 to 2030 overall 25 discussions with relevant participants were organized and more than 2.000 people from 180 individual governmental, business, scholarly as well as civil society bodies took part.

The CCASAP 2024 to 2030 sets out twelve fields, as aforementioned, linked to 40 tactical aims and connected to 129 adjustment measures which were detected together with accountable and related stakeholder groups (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2023a). A number of accountable bodies were appointed with the execution of measures described as part of the Action Plan and respective Sectoral Implementation Plans were designed to provide direction to the parties in charge of execution. In respect to the supervision and assessment of the CCASAP which is essential for improving the efficiency of measures and guaranteeing responsibility a corresponding web-based approach is set to be set up to follow the process. Every year the Directorate of Climate Change will put together a supervision and assessment reporting with the help of the corresponding main bodies accountable which is in part examined by the Climate Change and Adaptation Coordination Board (CCACB)

and the CCACB Working Groups. In the process of assessing the outcomes of the Action Plan individual aspects could be subject to amendment.

The Republic of Türkiye Ministry of Energy and Natural Resources (2024) published their strategic agenda for the time period 2024 to 2028 in the context of energy policy. The plan contains seven overarching objectives with individual underlying goals encompassing different focus areas. The objectives are listed as follows: guaranteeing of sustainable security in energy supply, decreasing the degree of external energy dependence, an energy transition with a focus on the net zero carbon target, sustainability, safety as well as value-added in connection with mining, raising the domestic and global competitiveness of Türkiye's marketplaces for energy and mining products, facilitation of local technological solutions in the area of energy and natural resources, and, finally, improving organizational capacities.

In total the Republic of Türkiye Ministry of Energy and Natural Resources (2024) determined the seven aims, as aforementioned, 30 corresponding goals as well as 131 parameters to supervise the performance in the context of the goals. Furthermore, the scheme is intended to perform control efforts in half-yearly intervals as well as assessments in yearly cycles. The parameters to supervise performance, in total 15, include e.g. the total of electrical power produced with national resources in billion kilowatt-hours (kWh) annually, among others. The aim is to increase the amount from originally 189 kWh per year at the start of the plan's interval to 270 billion kWh per year at the end of the plan's term. Moreover, the aim is to raise the portion in overall in electricity production of renewable energy from 43 percent to 50 percent until the end of the plan's interval. Furthermore, both the installed capacity of wind and solar power is set to increase to 19.300 Megawatt (MW) and 33.100 MW, respectively. In addition, the level of savings from energy efficiency efforts domestically is expected to increase from 0,9 Mio. Ton of Oil Equivalent (TOE) to 7,4 Mio. TOE until 2028.

According to SHURA Energy Transition Center (2024), the industry in Türkiye can be characterized as "low-tech, low value-added and carbon-intensive" (p. 55). Moreover, SHURA Energy Transition Center (2024) emphasizes that the shifting towards the use of more climate-friendly energy resources should be combined with the conversion of the industry while implementing comprehensive political strategies in areas such as the

exchange of goods or manufacturing. Ultimately, these strategies may elevate the technological degree in addition to lowering greenhouse gases, main industries' organizational change as well as enhanced synthesis with global production networks. Furthermore, this may provide even more favorable outcomes than originally foreseen. From this perspective assisting the shifting process through alterations in the goods' structuring towards enrichment, in particular in sectors using much power, may ease the unfavorable effects in connection with the process. Against this background, it is crucial to consider the potential impact of the CBAM as well as to produce political guidelines and approaches in the context of the international exchange of goods.

The introduction of the Climate Law to the Grand National Assembly of Türkiye and the corresponding vote was expected for the near future as announced by Turkish President Erdoğan and Minister of Environment, Urbanization and Climate Change Kurum in recent years (Presidency of the Republic of Türkiye, 2023b; Levi et al. 2024; Sonkaya & Açıkgöz, 2024). Furthermore, a first blueprint of the Climate Law was disclosed in August 2023 (Levi et al., 2024). Moreover, in November 2023 the blueprint for a legislation in the context of a local ETS was shared.

The blueprint of the Climate Law stresses the suggested domestic ETS, although scholars note the potential for more comprehensive rules regarding environmental legislation outside of a pricing mechanism for emissions (Levi et al., 2024). Furthermore, through the Climate Law Türkiye demonstrates its efforts to tackle the change of the climate, outlining particular approaches to reduce corresponding consequences. The plans encompass the reinforcement of regional authority positions, the integration of environmental concerns within infrastructural works as well as the advancement of energy from renewable resources and energy conservation.

On July 2, 2025, the Turkish Parliament passed the country's *Climate Law* encompassing 20 articles, two provisional ones as well as revisions to three distinct laws (*Resmî Gazete 32951*; Daily Sabah & Daştan, 2025; Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2025). The Law represents a comprehensive regulatory structure to respond to climate change, setting out framework and protocols for emission mitigation and climate resilience measures as well as related instruments. Furthermore, it encompasses the implementation of a local ETS, the strengthening of

responsibilities of the Climate Change Directorate to apply environmental policies while covering aspects such as just transition, a national CBAM and Green Taxonomy. The Law targets the creation of a stronger Turkish economy against the negative effects of climate change (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2025). Moreover, it is set to support more environmentally friendly and resource-efficient manufacturing to boost the global competitive capabilities of industries in Türkiye. The Law also aims to safeguard urban development, farming, livestock breeding, and natural spaces.

The Law was published on July 9, 2025, in the *Resmî Gazete 32951* stating in Article 1 that the framework aims to tackle global warming congruent with the country's low-carbon development plan and carbon neutrality goal (*Resmî Gazete 32951*).

Under its authority the Climate Change Directorate is responsible for inter-organizational alignment, initiatives and guidelines while tracking advancements in emission mitigation and climate resilience efforts (*Resmî Gazete 32951*; Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2025). Carbon pricing is set to be overseen by the Directorate through operations of market-oriented instruments. The Directorate will implement the local ETS, and related allowances will be issued under this framework. The Turkish Energy Market Regulatory Authority will be responsible for supervising ETS-linked operations in the energy sector (Daily Sabah & Daştan, 2025). The legislation includes an initial preliminary stage in the context of the ETS, set to be supervised by the Carbon Market Board prior to full implementation.

The Carbon Market Board is set to be headed by the Minister of Environment, Urbanization and Climate Change while including the individual deputy ministers from the following ministries as well: Ministry of Environment, Urbanization and Climate Change, the Ministry of Treasury and Finance, the Ministry of Trade, the Ministry of Energy and Natural Resources, the Ministry of Industry and Technology, the Ministry of Transport and Infrastructure, the Ministry of Agriculture and Forestry. Moreover, the Vice President of the Presidency of Strategy and Budget, the Chairman of the Turkish Capital Markets Board, the Chairman of the Energy Market Regulatory Authority and the President of the Directorate of Climate Change (*Resmî Gazete 32951*; Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2025). The Carbon

Market Board is set to authorize the local disbursement scheme, determine the issuance of complimentary allowances in the ETS context, establish the quantities of allowances to be sold as part of the primary market and set the proportions of offset operations permitted under the ETS framework, among other. Furthermore, the Board will formulate the guiding scheme regarding regulations and initiatives in the context of the ETS while defining the industries and areas bound by the global carbon market and specifying applicable restrictions as well as core legislative guidelines regarding import and export trade (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2025). The carbon market will be operated by the Energy Exchange Istanbul (EXIST) (Enerji Piyasaları İşletme A.Ş. (EPİAŞ)) (*Resmî Gazete 32951*).

The Law also prioritizes the capacity building, advancement and broad deployment of environmentally friendly technologies (*Resmî Gazete 32951*; Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2025). The Directorate of Climate Change is set to collaborate with concerned bodies to track the latest technological innovations to enhance climate mitigation efforts, e.g., tech solutions in the area of hydrogen and carbon capture and storage as well as the evolvement of initiatives in these domains. Furthermore, the Directorate can initiate and collaborate with bodies to conduct related R&D activities. Required R&D bodies can be created as under joint effort with associated organizations.

The aim is also to launch a Turkish Green Taxonomy system, and climate-related incentive-based instruments aimed at directing funding flows to be conducted by the Climate Change Directorate (*Resmî Gazete 32951*; Daily Sabah & Daştan, 2025; Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2025). The advancement and implementation of climate finance and incentive mechanisms for climate mitigation, building of corresponding insurance tools as well as boosting of climate-aligned financial market vehicles, credit facilities and more funding mechanisms are also prioritized by the Law (*Resmî Gazete 32951*; Daily Sabah & Daştan, 2025). Furthermore, a local CBAM will be implemented to tackle carbon emissions in the context of imports (*Resmî Gazete 32951*; Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2025). Here, the Turkish Ministry of Trade in collaboration with other responsible ministries will define the reporting obligations, extent, structure, operations as well as governing rules.

Locally, so-called Provincial Climate Change Coordination Boards are implemented in all provinces connected to the governor's office, including local delegates (*Resmî Gazete 32951*; Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2025). Furthermore, Climate Change Action Plans are set to be developed by December 31, 2027, with a possible deadline postponement by at most another year to be determined by the Ministry of Environment, Urbanization and Climate Change (*Resmî Gazete 32951*; Daily Sabah & Daştan, 2025; Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2025). Overall, the preparatory and adaptation conditions in the context of the regulations and organizational device set out by the Law must be met by the related bodies until December 31, 2027. The target date may be pushed by one year by the Presidency of the Republic of Türkiye. The German climate policy and decarbonization strategies are elaborated on in the following subchapter.

3.2 Climate Policy and Decarbonization Strategies in Germany

The Enquete Commission "precautionary measures to protect the earth's atmosphere" (*"Vorsorge zum Schutz der Erdatmosphäre"*) [Translation into English] of the German Bundestag was the first to propose official targets for the reduction of carbon dioxide emissions, which were published in a final third report on May 24, 1990 (Enquete-Kommission "Vorsorge zum Schutz der Erdatmosphäre," 1990, p. 1 ff.; Heinloth, 1990). The general base year applied is 1987. In this respect, the mitigation objective for the year 2005 is defined as 30 percent, representing the first stage. For the years 2020 and 2050, objectives providing direction are set out as an additional 20 percent and 30 percent respectively, depicting the second and third stage. Overall, a reduction of 80 percent of carbon emissions in connection with the base year 1987 are to be accomplished in the time period 1987 to 2050 in the three stages mentioned above.

According to Reimer (2023) on November 7, 1990, the German government at the time introduced the first CO_2 emission mitigation target of 25 percent for 2005 using the base year 1987. In consequence, Germany became the first country globally to define a domestic climate objective in 1990. In 1995, at the first COP held in Berlin then German Chancellor Helmut Kohl announced an adapted objective of 25 percent until 2005, but applying the base year 1990 as well as enlarging its scope of application to all of Germany, following the reunification of West and East Germany. Later, in 2005,

Germany failed to meet the formulated mitigation goal of 25 percent with West Germany only accounting for a decrease of ten percent. In 2007, the German government at the time introduced an updated CO_2 emission mitigation objective of 40 percent by 2020 compared to 1990-levels, although still not manifested as part of a legislation (Ell, 2024; Reimer, 2023). Following 2007, a number of programs, goals and schemes in the context of climate action were established by the different governments up to the introduction of the climate protection legislation referred to as Federal Climate Protection Act (*Bundes-Klimaschutzgesetz (KSG)* [German]) and its corresponding mitigation goals (Federal Ministry for Economic Affairs and Climate Action, 2021; Reimer, 2023). Furthermore, the CO_2 emission reduction objective for 2020 was met, also benefitting from the slowdown in activity due to the Corona pandemic, e.g. in the transportation sector (Ell, 2024; Reimer, 2023).

Germany ratified the Paris Agreement on September 22, 2016, following its signing on December 12, 2015, and hereby committing itself to the goal of ensuring that global warming remains less than two degrees Celsius (German Bundestag, 2016). Regarding the domestic NDCs Germany as an EU member state adheres to the points determined on an EU level which were last submitted on October 16, 2023, by Spain and the European Commission (European Commission, 2023b; United Nations Climate Change, 2025).

As mentioned by the Federal Ministry for Economic Affairs and Climate Action (2021) and the German Bundestag (2019), the climate protection legislation KSG was first approved by the German Federal Parliament on November 15, 2019, determining the first-ever domestic compulsory climate goals. Furthermore, from a regulatory perspective it outlined the mitigation route until 2030 concerning greenhouse gas emission across industries while introducing an instrument in connection with amendments to be implemented in case yearly mitigation goals are not met (Federal Ministry for Economic Affairs and Climate Action, 2021).

In spring 2021, the Federal Constitutional Court in Germany requested the more distinct determination of mitigation objectives in the context of the KSG regarding the time beyond 2030 providing lawmakers with a deadline to ergo revise the legislation before the end of 2022 (Federal Ministry for Economic Affairs and Climate Action, 2021). Moreover, the government at that time considered the Court’s ruling as well as the climate

protection goals' narrowing by the EU providing a chance for thoroughly adapting the KSG prior to the parliamentary election. Moreover, on May 12, 2021, an amended preliminary legislation was adopted by the cabinet and was enacted through the German Bundestag on June 23 of the same year, taking effect on August 31, 2021. The central parts of the adapted legislation encompass the expansion of the emission mitigation objective by 2030 to 65 percent instead of 55 percent in relation to 1990-levels. Furthermore, individual industry objectives for 2030 were narrowed further as well as the net-zero objective was reduced to 2045 as opposed to formerly 2050. Moreover, the manufacturing and power industries specifically are required to accomplish further reductions until 2030.

As already mentioned, the government at that time initially adapted the Germany's climate protection legislation which became active on August 31, 2021, increasing the caps for greenhouse gas emissions (Federal Ministry for Economic Affairs and Climate Action, 2021; Federal Government, 2022). According to the climate protection legislation KSG by the Federal German Government, Germany must achieve net zero by 2045 (Federal Government, 2022). Until 2030 the country must lower its carbon emissions by 65 percent compared to the values from the year 1990. Moreover, the target for 2040 even calls for a decrease of at least 88 percent of greenhouse gases. This target is supported by annual sub-goals for the reduction of emissions throughout the 2030s as reflected in the legislation. The goals for reducing greenhouse gas emissions directly impact the following areas such as energy, transportation, building, agriculture and the industrial field. The government has set up a tracking mechanism. A council with climate specialist (Expert Council for Climate Issues) is set to publish a review on the achievements in connection with goals, actions and tendencies in a biennial pattern.

The targeted net zero levels until 2045 refer to the symmetry of emitted carbon emissions as well as their compensation (Federal Government, 2022). Starting in 2050 the aim is to even reach greenhouse gas levels less than zero. Several landmarks have been set in the process to achieving net zero compensation. In 2024, the government was set to determine the yearly targets for reduction for the timeframe 2031 until 2040 on an individual industry basis. For the period 2023 until 2030 the sectoral targets had previously been raised in 2021, together with aligning on the annual overall targets of reduction for the period 2031 until 2040 compensation. At the latest in 2032 the government will then

determine overall yearly targets of reduction for the timeframe 2041-2045. Following in 2034 again sectoral targets will be determined for the previously mentioned period until 2045, the point in time when reaching net zero compensation.

In the context of the EU, it is pointed out that a synchronized selection of climate protection measures nationally and continentally should be the ambition (Federal Government, 2022). On a European level the corresponding governmental representatives, EU historically speaking, initiated among the most extensive policy bundles with the goal to protect the climate compensation. In this context, the tightening of preexisting measures in relation to climate protection was conducted. Here, the so-called “Fit-for-55” bundle by the European Commission lays the foundation, aiming for emission level to drop by 55 percent until 2030 in line with the Paris Climate Agreement’s requirements compensation.

An additional adaptation of the KSG followed in 2024 with the German Federal Parliament approving the changes on April 26, 2024, and the updated legislation becoming active on July 17, 2024 (German Bundestag, 2024; Federal Government, 2024b). The central amendments of the updated legislation touch upon the role of the Council of climate specialist for climate related issues as well as the orientation of the approach to greenhouse gas emissions and their calculation (Federal Government, 2024b). In the past the KSG concentrated on failed former objectives. Also, by suggestion of the Council of climate specialist for climate related issues, through a raised emphasis toward prospective greenhouse gas emissions the control mechanism in the context of achieving national reduction goals has been simplified and hence necessary actions may be taken.

Opposing the former setup, the adapted KSG is concerned with the total of emissions mitigated, neglecting the sector-specific consideration of the origin of greenhouse gases (Federal Government, 2024b; Ell, 2024). Ell (2024) states that environmentalist organizations denounced it to be a softening of the legislation whereas Hans-Martin Henning, Chairman of the Expert Council for Climate Issues and Director of the Fraunhofer Institute for Solar Energy Systems, emphasizes even prior to the amendment counterbalancing exceeding emissions in an individual industry was done through results in other areas falling short of the corresponding emission threshold. Given up were the

contingency schemes. Although Henning, stresses that industries accounting for going over emission ceiling as part of the forecast especially are required to suggest actions to be included in a comprehensive governmental agenda being assessed by the Council as well.

Protection goals in the climate context may be accomplished with increased economic effectiveness as well as societal fairness through mitigating greenhouse gas emissions especially in areas with the highest prospectives for saving (Federal Government, 2024b). In consequence, the general obligation laying with the German government intensifies as well as the adjustability among the different industries increases. Regardless of the general approach, the government proceeds to guarantee a totally transparent assessment in the context of the specific industries like transportation, power or buildings. The place of origin of greenhouse gas emissions and the target achievement of the single industries will still be stated by the government. Moreover, each of the German ministries in charge of the particular industries is required to assist in accomplishing the domestic objectives in the context of protecting the environment. In addition, the adapted KSG fortifies the position of the Council of climate specialist for climate related issues. From now on it is also responsible for the affirmation of emission predictions and may assess the overall yearly greenhouse gas emissions' amount to establish if they remain in line (Federal Government, 2024b; Ell, 2024). Furthermore, the Council may also put forward individual suggestions regarding the future enhancement of appropriate climate action.

According to Ell (2024), in 2024, the Council's assessment also considered the emission level forecast for the first time. Although the German Federal Government is convinced that national climate objectives are to be accomplished, the Council states that a fraction of presumptions regarding the prospective progress are overly positive. As stated in the Council's assessment the objective set out for 2030 will not be met by a slight margin as well as significant exceeding of the objectives in connection with the duration post-2030 is expected by the Council.

The so-called Climate Protection Program (*Klimaschutzprogramm*) [Translation into English] represents the general agenda for political climate action strategies by the German government (Federal Government, 2023a). Furthermore, the program packages the government's activities concerning climate objectives both on a domestic and EU

level (Federal Ministry for Economic Affairs and Climate Action, 2023b). The scheme summarizes the most crucial actions across the transportation, power, compounds, manufacturing and farming sectors and hence substantially supports accomplishing the set protective climate objectives (Federal Government, 2023a). A large number of actions from the topical scheme are being put into practice at present or have before been enforced, like the updated edition of the Building Energy Act (*Gebäudeenergiegesetz*) [Translation into English], the Germany Ticket (*Deutschlandticket*) [Translation into English], the toll imposed on trucks in relation to CO_2 emissions, expedited proceedings and zones in the context of the further development of energy from renewable resources as well as funding for building and restoration activities to establish energy efficiency (Federal Government, 2023a; Federal Ministry for Economic Affairs and Climate Action, 2023b). In addition, also measures around nature conservation are implemented, like the Natural Climate Protection Action Program (*Aktionsprogramm Natürlicher Klimaschutz*) [Translation into English] with the aim of fostering ecosystem preservation and natural carbon sinks.

The Federal Ministry for Economic Affairs and Climate Action (2023b) notes that the government determined a lack concerning climate action which may be cured by a considerable amount as long as the action outlined by the Program put into practice steadily. Simultaneously, it goes without saying the intended actions up to now have been deemed inadequate so far throughout industries in accomplishing the climate objectives by 2030. Between 2022 and 2030 an opening of about 200 Mio. tons of CO_2eq has been identified. Although the actions of the Program tackle a total of 80 percent out of the opening which represents a substantial improvement compared to the previous legislative period. In the power sector, the Climate Protection Program includes comprehensive actions to expedite the growth of renewable sources of energy.

For example, the amendment of the legislation *WindSeeG* leading to an augmentation of growth objectives measured in installed capacity, among others, in the area of wind energy offshore (Federal Government, 2023b; Federal Ministry for Economic Affairs and Climate Action, 2023b). The updated objectives set out no less than 30 GW until 2030, at least 40 GW until 2035 and finally, no less than 70 GW for 2045. Overall, the design and permitting processes were expedited as well as tendering was enlarged to zones which had not been considered initially. Moreover, for the first time ever, through the Energy

Efficiency Act [Translation into English] the government determined a legitimate and valid scheme in regard to the needed power savings (Federal Ministry for Economic Affairs and Climate Action, 2023b). Furthermore, a number of additional actions were introduced to foster the enlargement renewable energy projects in the wind and solar, such as simplifying the installation of systems and plants for the use in private housing.

In the building sector, the Climate Protection Program introduced a federal funding instrument for compounds for fostering efficiency actions, among others, the so-called *Bundesförderung für effiziente Gebäude* (Federal Ministry for Economic Affairs and Climate Action, 2023b). Furthermore, to successfully decarbonize the production industry an essential transitioning of manufacturing methods is required. The inclined change needs to be derived from methods that decarbonize, electrify, connect different industries with one another as well as are in with the closed-loop economic approach. The essential basis for the transitioning of manufacturing methods represent green hydrogen applications as well as electrifying operations specifically. To increase CO_2 savings in this sector a number of actions was determined such as the Contracts for Difference (*Klimaschutzverträge*) [Translation into English], the Strategy on Carbon Management (*Carbon Management-Strategie*) [Translation into English] or the Decarbonization Funding Program in the Industry (*Förderprogramm Dekarbonisierung in der Industrie*) [Translation into English]. In general, the effects of the Program's actions are consistently overseen and assessed through a controlling setup as reflected in the amended KGS, incorporating review and prospective forecast.

The Federal Ministry for Economic Affairs and Climate Action has developed different policies to facilitate the decarbonization of the industry in Germany. The German industry, consisting of manufacturing and construction sectors, contributes substantially to wealth levels in Germany employing 10 Mio. people and accounting for 755 billion EUR GDP at factor cost only in 2021 (Federal Ministry for Economic Affairs and Climate Action, n.d.). Simultaneously, the same sectors produced 24 percent of overall carbon emissions nationally in the same year, with the iron and steel, cement and chemical sectors reaching the highest levels of pollution. The above-mentioned climate protection legislation has determined high-reaching goals to be achieved by the industry in Germany. Here, the lowering of its carbon footprint towards 118 Mio. tons until 2030 is one of the targets, in relation to a ⅓ decline as opposed to 2021 levels of 181 Mio. tons.

During the years until 2021, representing the period where the economy was flourishing and the GDP was expanding, emissions were incrementally lowered especially by improving efforts for energy efficiency (Federal Ministry for Economic Affairs and Climate Action, n.d.). The industry sector emitted one Mio. ton less than emission levels set out by the climate protection law in 2021. Nonetheless, to comply with the goals defined by the climate protection law regarding carbon footprint levels, the adequacy of current efforts and incentive structures is not given.

Transforming ways of manufacturing is necessary to achieve the desired emission levels (Federal Ministry for Economic Affairs and Climate Action, n.d.). In this context, the circular economic approach, electrifying and decarbonizing must act as the foundation. To facilitate the transition the German federal authorities, count on market economy mechanisms such as the carbon cost mechanism through the EU ETS, the German trade legislation regarding fuel emission outputs (*Brennstoffemissionshandelsgesetz* (BEHG)) as well as additional financial backing of sustainable technological approaches. Germany's government has identified an array of actions to reach predetermined levels for the carbon footprint of the industry through enaction the so-called Climate Protection Program 2030 (*Klimaschutzprogramm 2030*) [Translation into English] as well as the so-called Bundle for the Future (*Zukunftspaket*) [Translation into English] (Federal Ministry for Economic Affairs and Climate Action, n.d.).

The Federal Ministry of Economic Affairs and Climate Protection aims to facilitate creating an environment driving innovation for the protection of the climate in industrial sectors (Federal Ministry for Economic Affairs and Climate Action, n.d.). In this context, the ministerial side claims that it is substantial to set up structures for the industrial sector to benefit from as part of approaching periods of reinvestment during this ten-year period to apply for the green transformation of their manufacturing processes. In their opinion as part of the green transition and the development of net-zero marketplaces industrial companies as well as startups may produce timely value proposition approaches and raised competitiveness by at the same time contribute to the expansion of the economy and employment over the medium to long haul. For this purpose, the creation of dependable structures facilitating investing, providing expense predictability as well as setting norms and marks for green goods is necessary. For the successful advancement and application of modern technological approaches in a preliminary phase as well as

across the board tailored financing mechanisms are necessary as supporting measures. In this regard, such subsidy schemes shall be created in a manner putting aside preferences and prejudice towards technological approaches to allow seeking the most elaborate methods.

The Ministry for Economic Affairs and Climate Action provides supporting schemes e.g. around the application of the energy-carrier hydrogen, efforts on lowering carbon emissions as well as subsidies to increase efficiency levels in the industrial sector (Federal Ministry for Economic Affairs and Climate Action, n.d.). The German Federal Government also works on a subsidy scheme referred to as Carbon Contracts for Difference which supports the industrial sector regarding operating expenses and aims to establish improved predictability (Federal Ministry for Economic Affairs and Climate Action, n.d.). This allows as well as facilitates the transitioning to energy-carriers with minimal carbon levels which are generally still connected to higher expenses. Moreover, the goal is to encourage the development of low-carbon marketplaces to foster purchasing interest in such goods in the preliminary phase. Here, the government established both judicial and fiscal terms in the context of the Contracts for Difference to act as the main measure for the transitioning process (Federal Ministry for Economic Affairs and Climate Action, 2023b). Through the Contracts actors may counterbalance the inclined increased operational expenses due to a low-carbon manufacturing setup against conventional manufacturing methods. Consequently, cost-effectiveness may be accomplished sooner as well as expenses turn increasingly foreseeable.

The Ministry also stresses the Federal German government's simultaneous dedication to the creation of systematic comprehensive structures to establish a green industrial sector with a competitive advantage as part of the EU Green Deal of regional degree with the EU (Federal Ministry for Economic Affairs and Climate Action, n.d.). The structures shall facilitate the establishing of low-carbon manufacturing lines and optimal realization of value. Furthermore, they shall adequately safeguard against migration of greenhouse gas emissions to third countries outside the EU as well as form an individual marketplace for green goods within the EU. Furthermore, it is emphasized that the Federal German Government carries out in-depth exchanges with stakeholders in the global context. Carried out for the assurance that efforts to protect the climate in the industrial sector are

integrated in free and competitive marketplaces in accordance with jointly synchronized, foreseeable and transparent regulations.

At the end of 2023 the Federal Ministry for Economic Affairs and Climate Action introduced their industry strategy. The strategic paper emphasizes that the value of the manufacturing sector for the country is incremental, e.g., from the prosperity or social cohesion perspectives, and its preservation is crucial (Federal Ministry for Economic Affairs and Climate Action, 2023a). The strategy also highlights the importance of value chain diversification as well as restoring and preserving production in Germany and the EU. This would allow for more independence from third (autocratic) countries given that the world is becoming a place of less safety.

The Federal Ministry for Economic Affairs and Climate Action (2023a) identified three strategical challenges that the German industrial base is facing: at crossroads in geopolitics, regional factors which have been overlooked and finally, the change process to reach zero emissions targets. Concerning the crossroads in a geopolitical context the strategy refers to the Russian-Ukrainian war but also points out the shifts within global politics and the economy. Recently, intergovernmental disputes and clashes in the context of geoeconomics affect economic policymaking again. Here, the relevant policy devices refer to the exchange of goods, technology and the country's manufacturing base.

Regarding the given local circumstances, the Federal Ministry for Economic Affairs and Climate Action (2023a) refers to a decay due to the fact that crucial changes were not implemented as well as a lack in investing for years. Here, examples may be that the development of renewable sources of energy was overlooked, or the infrastructural base was not restored as well as the deficit of a qualified workforce in the country.

Finally, the Federal Ministry for Economic Affairs and Climate Action (2023a) states that the green transformation process to achieve a zero emissions footprint represents a strategical challenge for the country and emphasizes that due to global warming climate action is required. Moreover, the Ministry points out that the change process to reach carbon neutral as well as the corresponding reviving effects on prosperity may provide medium- and long-term opportunities. On the other hand, from an industrial perspective as well as the related workforce the process may require many attempts and high expenditure.

To ensure the preservation of Germany's industrial base during this turning point the new strategy is formulated taking into consideration a European perspective, the enhancing of location factors as well as dynamic policy to promote and support (Federal Ministry for Economic Affairs and Climate Action, 2023a). Moreover, the derived priority areas for the industry strategy compromise of enhancing of location factors, achieving of a secure economy as well as transforming the industrial base towards a net zero, a renewing process, according to the Federal Ministry for Economic Affairs and Climate Action (2023a).

The following chapter assesses the potential effects of the CBAM on trade between Germany and Türkiye by examining global, bilateral and national trade flows. Furthermore, the trade relationship among the two countries is reviewed as well as their trade ties in the context of the CBAM related sectors iron and steel, aluminum, fertilizer and cement. Finally, the potential effects of the CBAM on Turkish exports to Germany in the iron and steel as well as aluminum sector are assessed.

4. THE POTENTIAL EFFECTS OF THE CARBON BORDER ADJUSTMENT MECHANISM ON TRADE BETWEEN GERMANY AND TÜRKİYE

The aim of this thesis is the assessment of potential economic effects in the context of trade between Germany and Türkiye. As part of this thesis an examination of the potential cost effects by the CBAM regulation on Turkish export trade to Germany is conducted. The focus here lies on the analyses of cost effects in the iron and steel as well as aluminum sectors. The research question is as follows: What are the potential economic effects for exported goods from Türkiye to Germany on a sectoral basis?

As part of the assessment the total additional cost on a four-digit CN code basis is calculated for the iron and steel as well as aluminum sectors annually for the period 2019 to 2024. Furthermore, the relative shares of the additional cost in relation to the overall Turkish export trade volume to Germany is assessed. Moreover, policy recommendations are provided based on the analysis of bilateral trade relationship and the CBAM framework. The research results shall enable the private and public sector to identify individual risks and develop as well as carry out corresponding precautions and risk management measures.

Both Germany and Türkiye are deeply engaged in international trade relations. According to the World Bank's (2025a) statistics on export of services and products Germany ranks third among the strongest export nations, following the United Stated in second place and China in first place in 2024. On the contrary, Türkiye is listed as 24th in the same year. Table 3 below shows the distribution of export volumes of services and goods in billion USD of the TOP 10 exporters as well as the results for Türkiye and the world in form of a ranking for the year 2024. The global result for the export trade of goods and services reaches a value of 31,7 trillion USD in 2022, slightly decreases to 31,1 trillion USD in 2023 and rising again to its all-time high at 32,4 trillion USD in 2024.

Table 3. Export Ranking of Goods and Services: TOP-10 Exporters, Türkiye and the World (Billion USD, 2024)

Ranking	Country Name	2024 (Billion USD)
	World	32.379,4
	European Union	9.783,1
1	China	3.793
2	United States	3.190,6
3	Germany	1.949,1
4	United Kingdom	1.116,6
5	France	1.071,1
6	Netherlands	1.032,5
7	Singapore	978,6
8	Japan	922,4
9	Korea	835,1
10	India	822
24	Türkiye	372,8

Source: World Bank, 2025a.

According to the ranking of the TOP-10 exporters and Türkiye by their shares in the total global export volume in goods and services, Germany's export trade represents six percent of the total exports exchanged globally (World Bank, 2025a). In 2023, the result accomplished a share of 6,3 percent, implying a slight decrease. The EU represents a trading powerhouse standing for 31 percent in 2023 and 30,2 percent of international export trade in 2024. On the other hand, Türkiye's exports account only for 1,1 percent of total export trade internationally in 2023. This value remains almost the same amounting to 1,2 percent in 2024. Figure 7 showcases the distribution of shares among the TOP-10 exporting nations, Türkiye as well as the EU in connection with the total global export volume of services and goods in 2024.

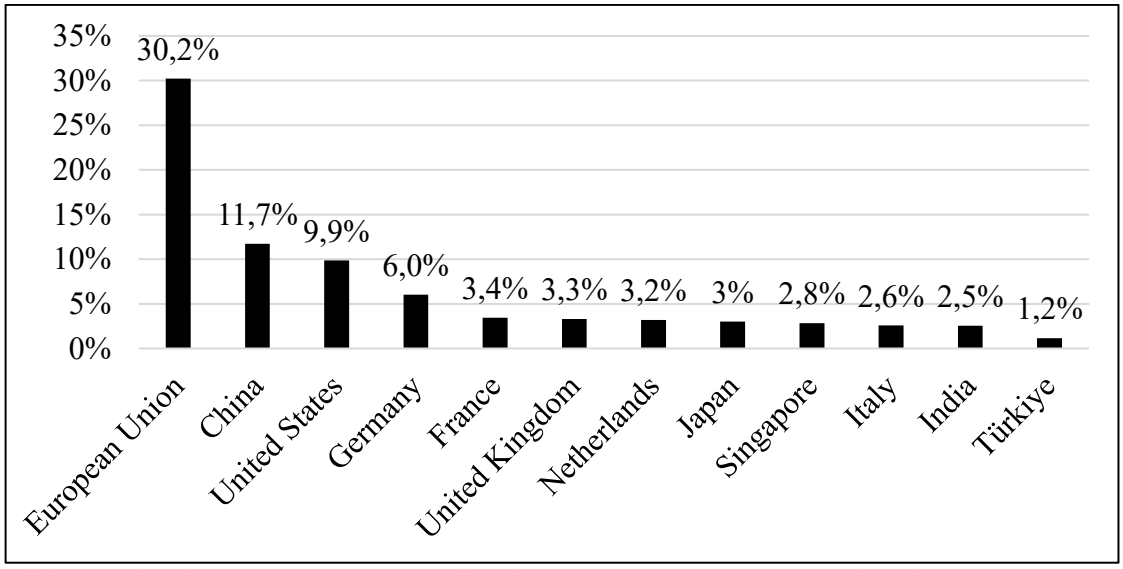


Figure 7. Ranking of the TOP-10 Exporters, Türkiye and the EU in Total Global Export Volume of Services and Goods (in Percent, 2024)

Source: World Bank, 2025a.

In the following subchapter Germany's trade relationship with the world is assessed regarding total trade, imports and exports while also distinguishing between trade in goods and in services as well as showing its impact on the national GDP.

4.1 Germany's Trade Development with the World

As already described above, considering global export trade Germany continuous to be one of the leading export trading nations internationally. According to the World Bank (2025a), the country achieved a result of 1,9 trillion in 2022, of about two trillion USD in 2023, and, again, of 1,9 trillion USD in 2024, indicating a slight stagnation tendency in export trade over the past few years.

The majority of German foreign trade activity accounting for approximately two-thirds of the total volume is occurring inside of Europe, as noted by the Federal Agency for Civic Education (bpb) (2024). Overall, the main trading partners of Germany consist of the following countries: China, the US, the Netherlands, France, Poland and Italy.

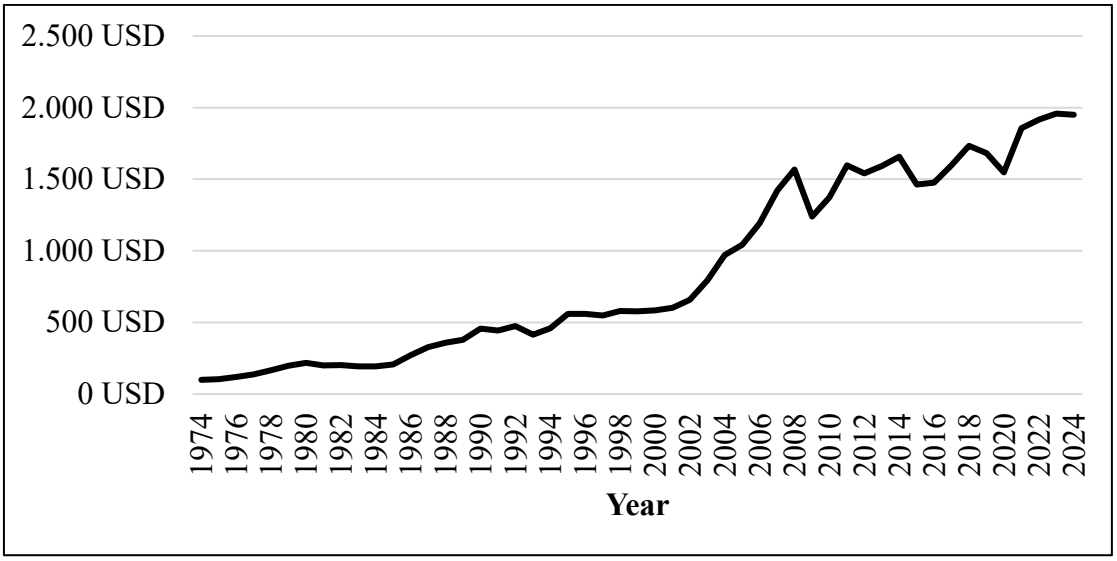


Figure 8. German Export Trade (Services and Goods) Development with the World (Billion USD, 1974-2024)

Source: World Bank, 2025a.

Figure 8 displays the development of German export trade with the world between the years 1974 and 2024. The Corona crisis in 2020 as well as the global financial crisis between 2007 and 2008 account for the largest and most significant decreases in Germany's export growth over the past 20 years. In particular during the period 2000 up to the global financial crisis in German export trade with the world substantially increased.

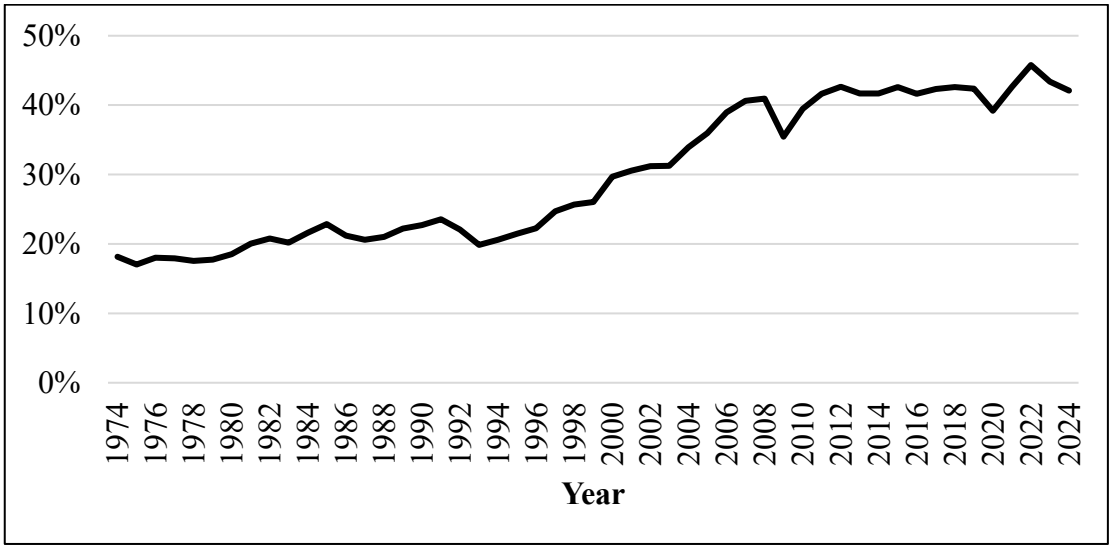


Figure 9. Development of the GDP Share of German Export Trade (Services and Goods) with the World (in Percent, 1974-2024)

Source: World Bank, 2025b.

The export business plays an important role for the German economy, local value creation and the society's welfare. Close to half of Germany's GDP is generated from export trade as demonstrated by the data from World Bank (2025b) as seen in Figure 9 above, displaying the development of GDP shares of German export trade in services and goods with the world between 1974 and 2024. Although the share of GDP fell to 42,1 percent in 2024 and 43,4 percent in the year 2023 from previously 45,8 percent in 2022.

In 2023, the proportionate distribution of economic sectors in gross value added was 70,6 percent from service sectors, 23,1 percent from manufacturing excluding construction, 5,4 percent from construction and agriculture, forestry and fishing contributed 0,9 percent, according to Statista (2025b). In 2023 and 2024, the GDP growth in real terms was negative amounting to 0,3 percent and 0,2 percent, respectively, compared to 1,4 percent in 2022 (Statista, 2025a). The prognosis by the German Institute for Economic Research for 2025 indicates no GDP growth in real terms, followed by an increase of 1,1 percent in 2026. The data by World Bank (2025b) also shows that the world's average GDP share of export trade amounts to 29 percent in 2024, so a much lower result in comparison to the total result of Germany at 42 percent.

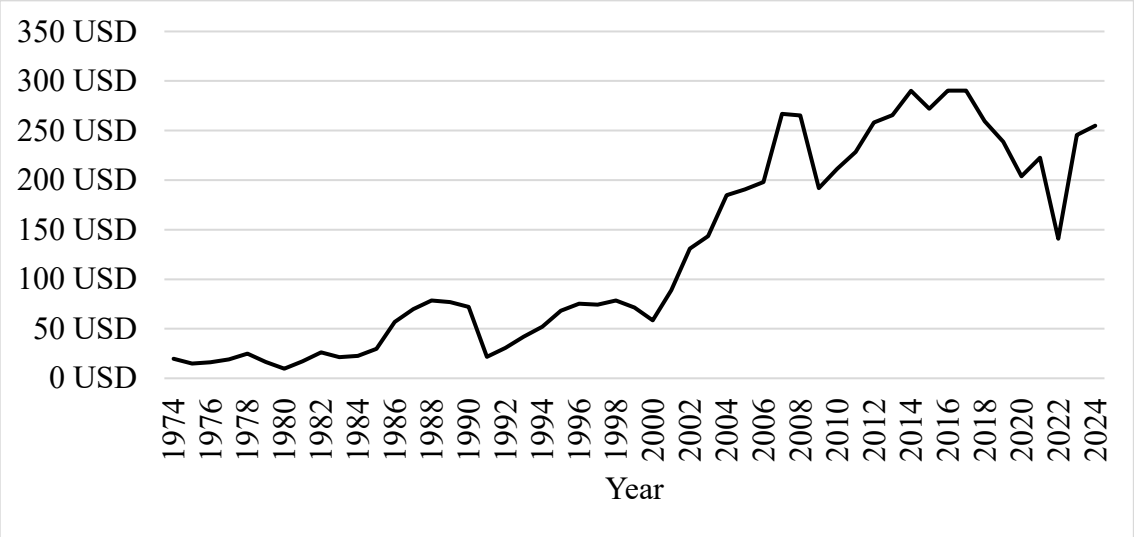


Figure 10. Development of German Net Trade in Goods with the World (Billion USD, 1974-2024)

Source: World Bank, 2025c.

As demonstrated by the empirics of World Bank (2025c) and as depicted in Figure 10, the German results for net trade in goods have remained overall positive over the course

of time in between 1974 and 2024. Especially in the early and mid 2000s until the global financial crisis hit the world economy, the German trade surplus grew significantly, from 89 billion USD in 2001 to 266,9 billion USD by 2007. In general, global economic hits and slow down directly affect the development of the German trade balance leading to notable losses, e.g., the so-called dot-com bubble in 2000, the impact of the global financial crisis from 2007 to 2008 or the Corona pandemic in 2020.

This demonstrates how closely intertwined the German economy and consequently its trade are with world trade as well as global economic development and hence, demand and supply. Germany is therefore an important trading partner for many countries around the world but is also dependent on global political and economic developments and must follow them closely.

In 2022, Germany experienced a historical decline in trade surplus the lowest level ever since the year 2000 (Federal Statistical Office (Destatis), 2023). This development was impacted by sharply increased costs for energy imports following the Russian war in Ukraine. Moreover, the German exports to China decreased substantially and the country's ranking as an export destination shifted from second place to fourth. Since the start of the recorded data in 1950 covering German-Chinese foreign trade, Germany experienced its highest trade deficit.

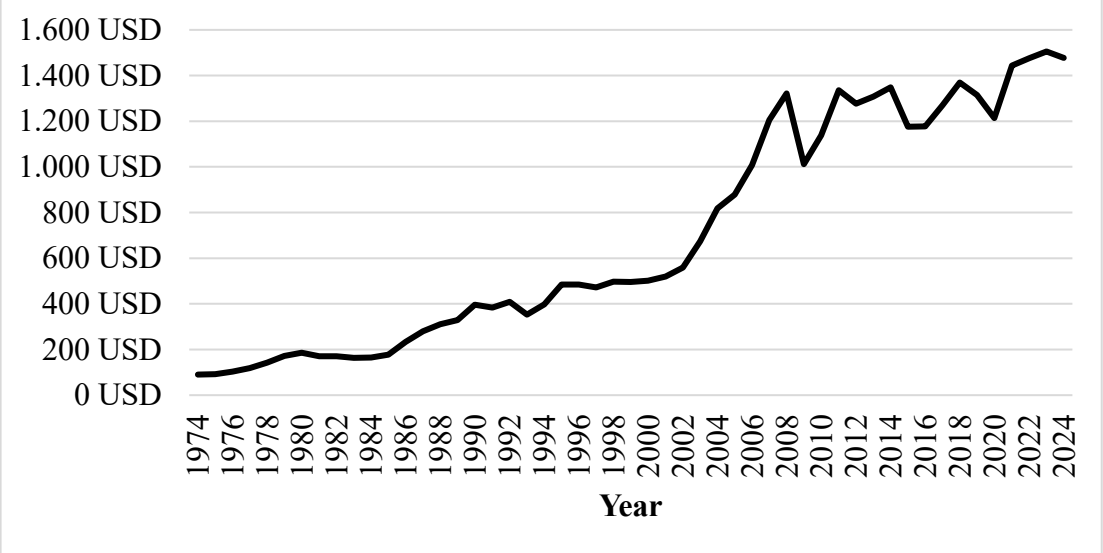


Figure 11. German Export Trade (Only Goods) Development with the World (Billion USD, 1974-2024)

Source: World Bank, 2025d.

As already mentioned above, Germany is an important trading partner for many countries around the world and is dependent on international demand for its export goods. Figure 11 showcases the progress of German export trade in goods with the world between the years 1974 and 2024 (World Bank, 2025d). Following a fairly steady upward development between the 1970s and 1990s, the German export volume began to significantly raises in the early 2000s until the year 2008 where due to the global financial crisis demand momentarily decreases. Post the year 2008 German export volumes recover and in total continue to increase until 2023, although growth rates fluctuate due to an ever-changing economic and political environment. Between 2000 (501,9 billion USD) and 2008 (1.332,2 billion USD) German exports grow by 165,4 percent whereas from 2008 (1.332,2 billion USD) to 2024 (1.447,5 billion USD) German export trade only raises by about eleven percent (World Bank, 2025d). Out of the total exports in both goods and services as displayed in Figure 8, the sole export of goods accounts for a share of 75,8 percent in 2024 (World Bank, 2025a; World Bank, 2025d).

In 2024, motor vehicles and motor vehicle parts remain Germany's top export products, totaling 262,8 billion EUR and accounting for 17 percent of the country's overall exports (Destatis, 2025b). Furthermore, machinery ranks second among Germany's export trade with the world, representing 14 percent of the total and accounting for 217,6 billion EUR. Chemical goods secure third place with a nine percent stake valuing at 138,9 billion EUR. In 2022, 38,7 percent of total products exported from Germany comprised of capital goods whereas the stake of intermediate goods amounted to 32,5 percent (Federal Agency for Civic Education (bpb), 2024).

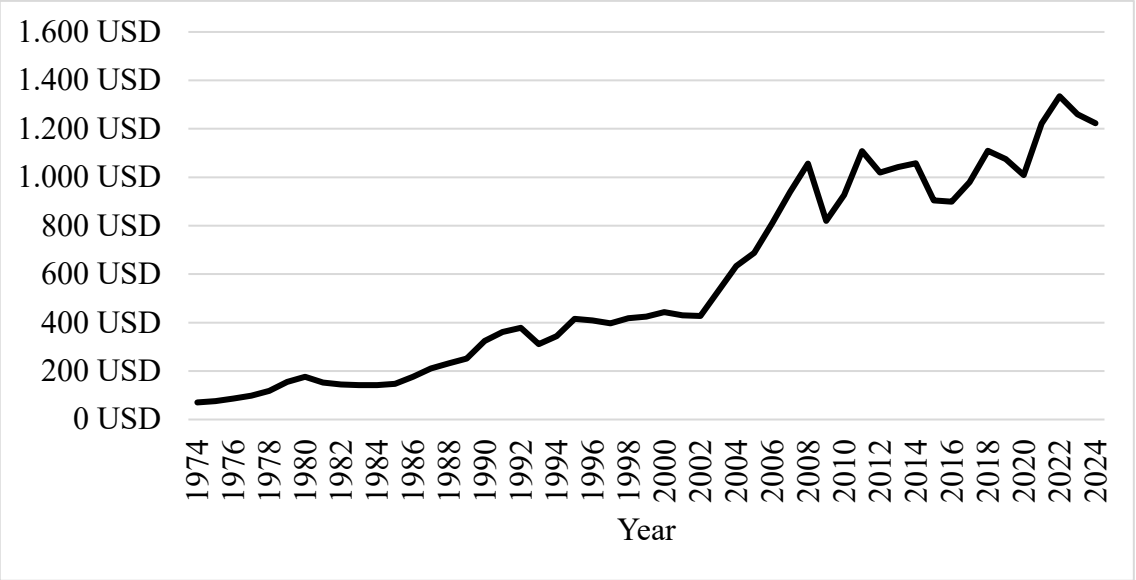


Figure 12. German Import Trade (Only Goods) Development with the World (Billion USD, 1974-2024)

Source: World Bank, 2025e.

Figure 12 depicts the development of German import trade in goods with the world between the years 1974 and 2024 (World Bank, 2025e). Similar to the development of export volumes, a fairly steady upward trend can be witnessed starting in the 1970s and continuing up to the 2000s. In the early 2000s the import of goods grew quickly until 2008 when due to the global financial crisis demand immediately slowed down. Following the crisis year 2008 German imports volumes improve and overall keep rising until 2022 while decreasing in 2023 and 2024. The recent historical peak of 1.334,5 billion USD can be explained by the sudden rise in energy prices due to the Russian war in Ukraine. The Federal Environment Agency (2024) notes that approximately 70 percent of energy consumption in Germany is met through a wide array of energy product imports. Nonetheless, growth rates strongly fluctuate in this time period due to an ever-changing economic and political environment. A similar development can be witnessed in the period between 2014 to 2016, where global energy prices, e.g., for oil and gas declined substantially (European Commission, 2020). From the year 2000 (443,3 billion USD) to 2008 (1.056,8 billion USD) German export trade increases by 138,4 percent whereas between 2008 (1.056,8 billion USD) and 2024 (1.222,5 billion USD) German import grows by 15,7 percent (World Bank, 2025e).

Motor vehicles and motor vehicle parts represent Germany's most imported goods out of total imports with the world, amounting to 148,5 billion EUR and accounting for a share of 11 percent in 2023 (Federal Agency for Civic Education (bpb), 2024). Data processing equipment, electronic and optical products rank second, accounting for 142,5 billion EUR and constituting 10,5 percent of total imports. Finally, electrical equipment comes in third place representing a value of 109,8 billion EUR and an 8,1 percent share. In 2022, Germany imported most intermediate goods accounting for a stake of 32 percent. Capital goods secured second place with a part of 24,7 percent, substantially smaller compared to their export shares.

In the following subchapter Türkiye's trade relationship with the world is outlined both in terms of total trade, imports and exports while also distinguishing between trade in goods and in services as well as showing its impact on the national GDP.

4.2 Türkiye's Trade Development with the World

According to World Bank (2025a), Türkiye is part of the TOP 24 exporting nations in the world as already emphasized above in 2024. In 2022, Türkiye's export trade encompassing services and goods amounted to 346,6 billion USD. The following year the result further increases to 357,6 billion USD. In 2024, Turkish exports in goods and services result in 372,8 billion USD, reaching a historical all-time-high for Türkiye. The results represent the continuous increase in exports since the Corona pandemic in 2020. Figure 13 depicts the development of Turkish export trade in services and goods with the world during the period of 1974 to 2024. During the 1970s up to the 1980s export trade developed steadily with low growth rates. This slowly began changing during the late 1980s up to the late 1990s leading up to the 2001 economic crisis in Türkiye. Ever since the 1990s Türkiye's export trade with the world has been developing in a positive manner, but political and economic shocks both international and domestic have caused the growth to periodically decrease and even negative levels. Examples for significant shocks as seen in Figure 13 are the global financial crisis in 2008, the domestic failed coup attempt in 2016 or the Corona pandemic and related measures leading to an economic slowdown in 2020.

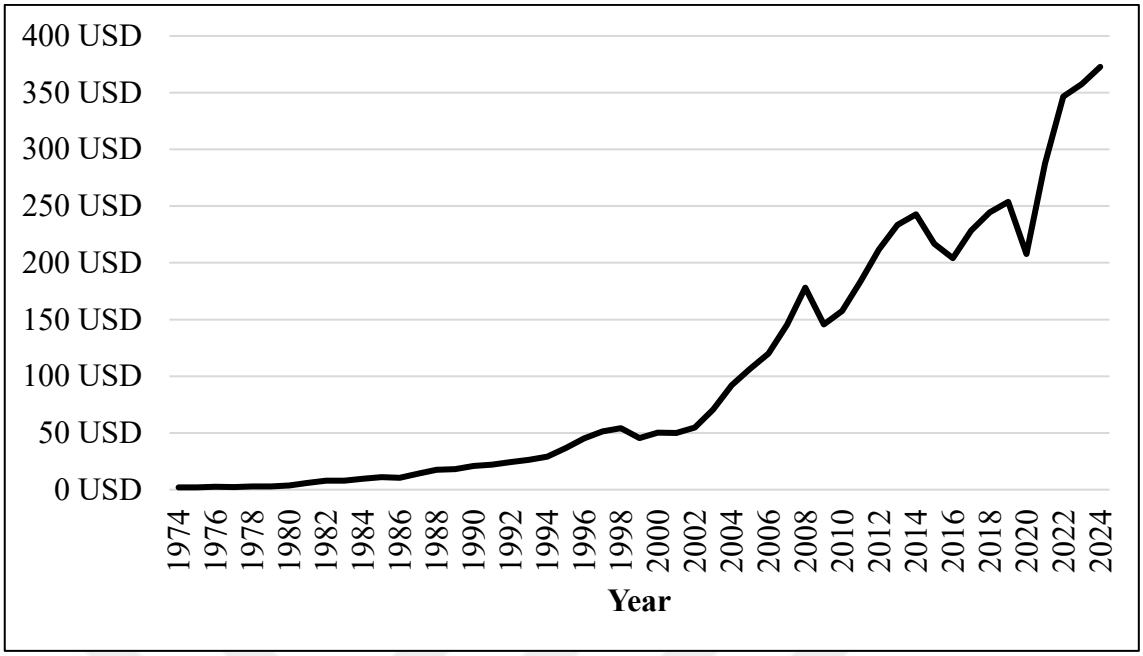


Figure 13. Turkish Export Trade (Services and Goods) Development with the World (Billion USD, 1974-2024)

Source: World Bank, 2025a.

From 1974 until 2024 the share in the GDP has overall increased (World Bank, 2025b). Figure 14 shows the development of the GDP shares of Turkish export trade in services and goods with the world between 1974 and 2024. When its progression is compared with the graph shown in Figure 13, it is noticeable that the share of GDP only develops in parallel with the export volume at times. In 2022, the GDP share reached its so far highest value of 38,6 percent which dropped to 31,9 percent in 2023 and further to 28 percent in 2024. The empirics by World Bank (2025b) indicate that the global average GDP share of export trade amounts to 29 percent in 2024. In comparison, Türkiye's result of 28 percent is slightly below the global result in 2024.

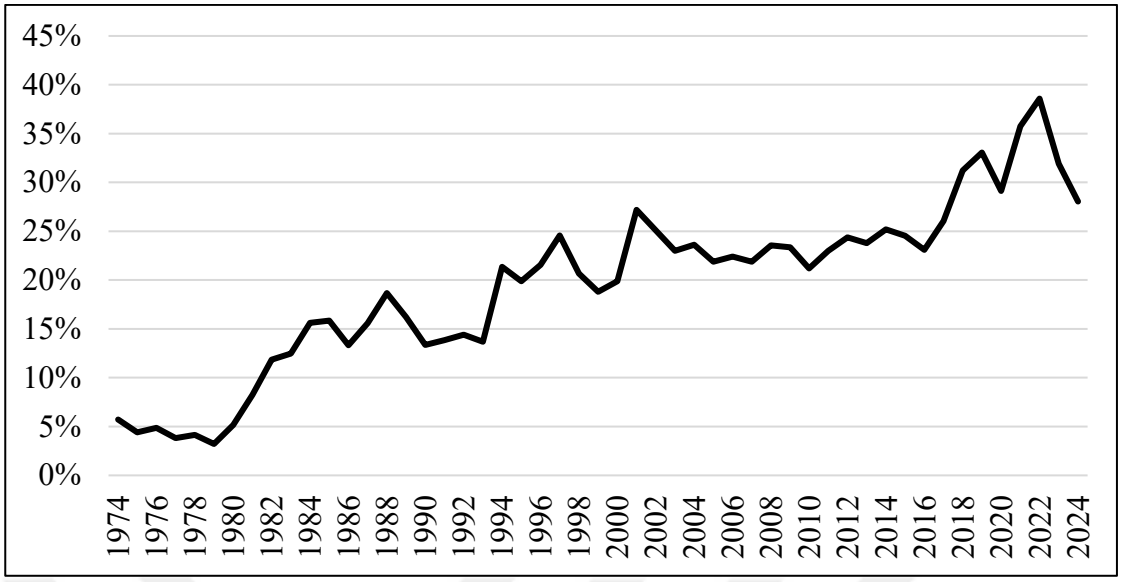


Figure 14. Development of the GDP Share of Turkish Export Trade (Services and Goods) with the World (in Percent, 1974-2024)

Source: World Bank, 2025b.

Measured on the basis of economic activity in connection with Turkish export trading in 2023, 94,2 percent of value added originated from the production industry, making it the most important economic export category (TURKSTAT, 2024a). Agriculture, forestry and fishing ranked second with a share of 3,8 percent whereas mining and quarrying came in third place accounting for 1,5 percent. The category others only made up for a stake of 0,5 percent.

In 2024, the results painted a similar picture amounting to 94,1 percent in connection with good from the production sector, 3,6 percent for products from agriculture, forestry and fishing activities as well as 1,7 percent from mining and quarrying. The others-category resulted in 0,5 percent (TURKSTAT, 2025a).

According to TURKSTAT (2024a), based on the Broad Economic Categories Classification (BEC), intermediate goods accounted for 72,2 percent of total import trading, followed by capital goods at 14,6 percent and consumption goods at 13,2 percent in 2023. In comparison, in the same year intermediate goods represented the majority of total export trade with a share of 50,5 percent. Moreover, consumption goods account for 35,5 percent ranking second, followed by capital goods holding a stake of 13,2 percent and the category others amounting to 0,9 percent (TURKSTAT, 2024c).

For the year 2024 intermediate products represent 69,3 percent of all imports (TURKSTAT, 2025a). A small decrease compared to the previous year. Furthermore, capital goods account for 14,7 percent remaining almost stable in comparison to the previous year. On the other hand, the import of consumption goods grows to 15,8 percent compared to 2023 results whereas the category other decreases to 0,2 percent. The structuring of imported and exported goods based on the above results supports the assumption that a large number of semi-finished products are imported to the Turkish market for further processing or are also exported (back) to customers abroad for further processing as the shares of capital goods are fairly small compared to those of intermediate goods. This may also indicate the existence of a large supplier base in Türkiye with trade relations to customers abroad.

Türkiye has been experiencing a continuous trade deficit for the past decades as depicted in Figure 15 below showing the development of Turkish net trade in goods with the world between 1974 and 2024 (World Bank, 2025c). The country's export trade coverage has been developing in a positive manner reaching 69,9 percent in 2022, 70,6 percent in 2023 and 76,1 percent 2024 (TURKSTAT, 2024a; TURKSTAT, 2025a). Based on Figure 15, the development of the trade deficit is relatively stable from the mid-1970s to the end of the 1980s (World Bank, 2025c). Nonetheless, from the 1990s onwards the fluctuation of the graph continues to increase. The deficit declines or rises frequently in the process. In 1993, the trade deficit reaches a double-digit billion figure for the first time. From the mid-2000s, the negative result of the trade balance increases significantly, and also the fluctuations regarding the progression rise sharply. Türkiye's trade deficit historically peaks in 2022 with a value of -89.6 billion EUR. The progression of the graph as shown in Figure 15 indicates that Türkiye is becoming increasingly integrated into world trade over time and as globalization progresses. In addition to positive effects, this also has the disadvantage that external shocks and global political and economic crises may affect Turkish trade activities.

Throughout the time period of the 1960s and 1970s, Türkiye, like many other developing countries, pursued a strategy to foster the development of its economy focused on import-substitution plans (Central Bank of the Republic of Türkiye, 2002). This era was marked by large-scale governmental investment schemes intended for boosting domestic manufacturing capacities concerning large-scale production as well as capital goods.

International trade activities were well secured through quantitative quotas. At the same time a rule regarding a fixed exchange rate was introduced which was typically inflated relative to purchasing power parity. The liberalization process of foreign trade commenced together with a number of measures at the start of the 1980s.

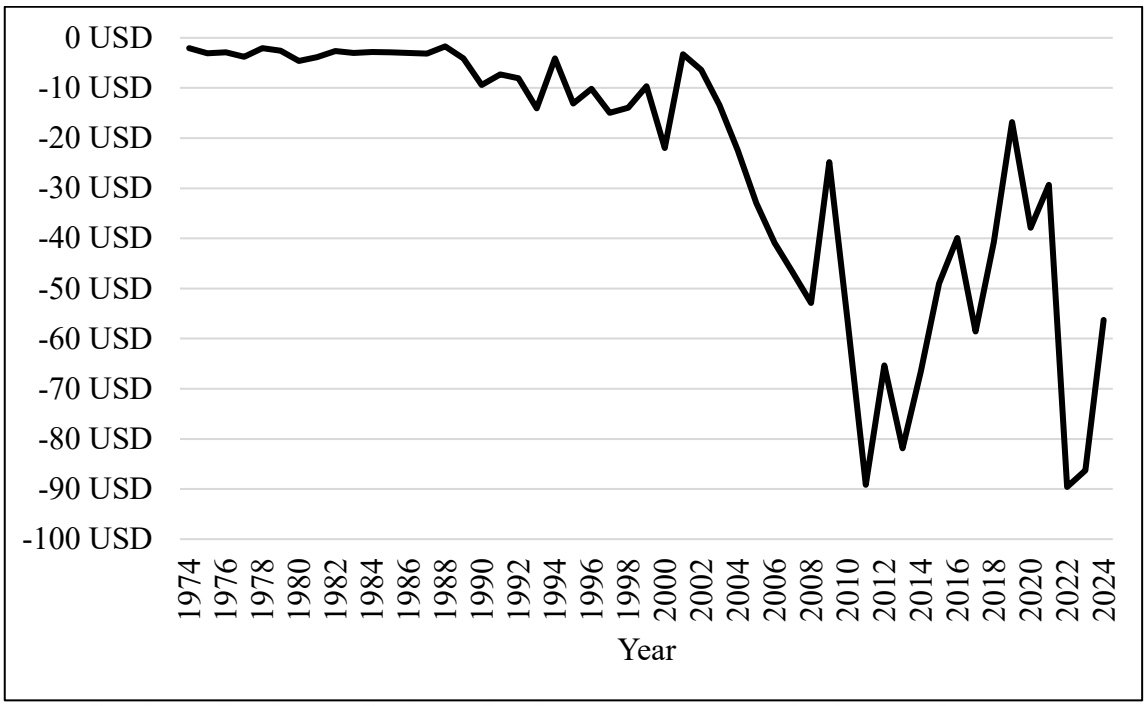


Figure 15. Development of Turkish Net Trade in Goods with the World (Billion USD, 1974-2024)

Source: World Bank, 2025c.

Figure 16 depicts the development of Turkish export trade in goods with the world between the years 1974 and 2024 (World Bank, 2025e). Similar to the progression as seen in Figure 13, during the 1970s up to the 1980s export trade evolved steadily with rather low growth rates. In the 1990s the rate of development increases which led to an almost tripling of the export trading volume between 1990 and 1998. In 1999 the export of goods dropped significantly to 11,8 billion USD, the lowest since 1989. With the turn of the millennium export trading results began to substantially pick up on pace again. Between 2000 (30,9 billion USD) and 2008 (140,9 billion USD) Turkish product exports increased by 356 percent whereas from 2008 (140,9 billion USD) to 2024 (257,5 billion USD) Turkish export trading only rose by 82,8 percent (World Bank, 2025d).

Ever since the mid 1990s Türkiye's export trade in goods with the world has been developing in an overall positive manner. Nonetheless, political and economic crises both global and domestic have led to a decrease in growth over certain periods and negative results. Examples for such shocks are the global financial crisis in 2008, the domestic failed coup attempt in 2016 or the Corona pandemic and related measures leading to an economic slowdown in 2020. In recent years following the Corona crisis, the export volume in goods has once again risen sharply amounting to 224,7 billion USD in 2021 and hence passing this mark for the first time in Turkish history.

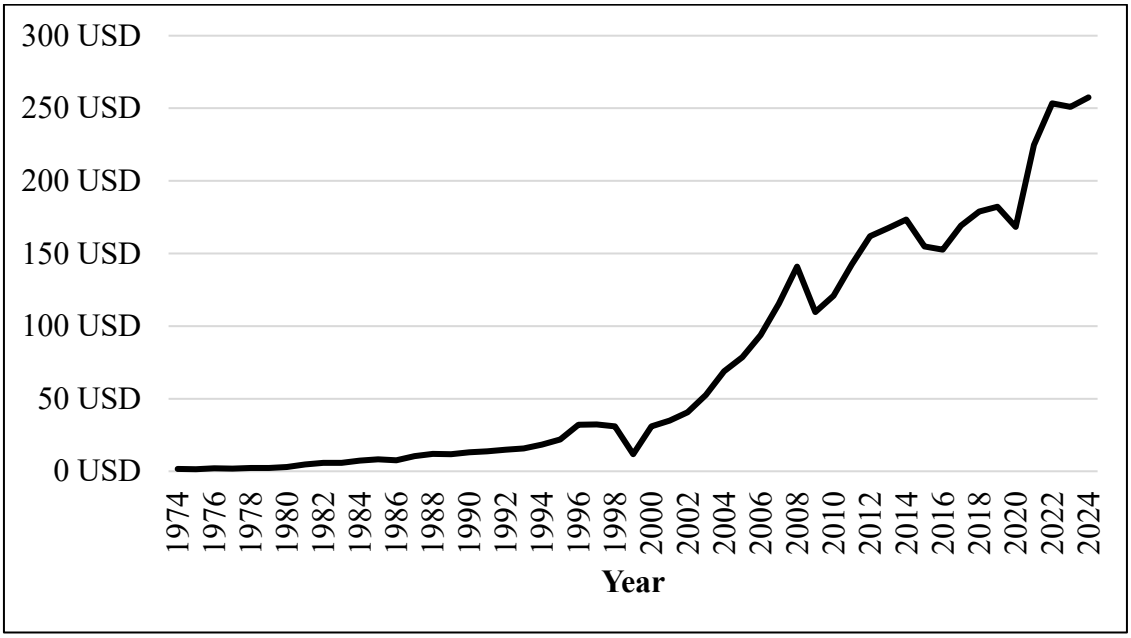


Figure 16. Turkish Export Trade (Only Goods) Development with the World (Billion USD, 1974-2024)

Source: World Bank, 2025d.

Although the graphs in Figure 13 and Figure 16 take a similar course, certain crises have a lesser or greater effect on their progression. For example, the sum of events of the Russian and Asian financial crises in 1997 and 1998, respectively, as well as the earthquake occurring in Kocaeli, Türkiye, a region with the country's strongest industry base, in 1999 all facilitated a sudden decrease in exports in goods by 61,8 percent in 1999 (Atabek Demirhan & Ercan, 2018).

According to TURKSTAT (2025e), in 2023 vehicles other than railway or tramway rolling-stock, parts thereof represent Türkiye's top export category, amounting to 29,5 billion EUR. Boilers, machineries and mechanical appliances, parts thereof secure second

place among Türkiye's export trade with the world, accounting for 22,4 billion EUR. The category precious stones, precious metals, pearls and articles thereof accomplish third place with a value of 13,6 billion EUR. In 2024, the ranking of export product categories for Türkiye remains almost the same. The category vehicles other than railway or tramway rolling-stock, parts thereof amounts to 31,1 billion EUR, an increase compared to the previous year. Furthermore, remaining in second place together with a slight decline in exports, the product category boilers, machineries and mechanical appliances, parts thereof achieving an outcome of 22,3 billion EUR. Finally, the product category electrical machinery and equipment, parts thereof accounts for a result of 14,2 billion EUR, also registering an increase.

Figure 17 showcases the development of Turkish import trade in goods with the world in the period 1974 to 2024 (World Bank, 2025e). Like the development of export volumes as seen in Figure 16, overall, an overtime increasing upward trend for import trading can be observed from the mid 1970s on, continuing up to today.

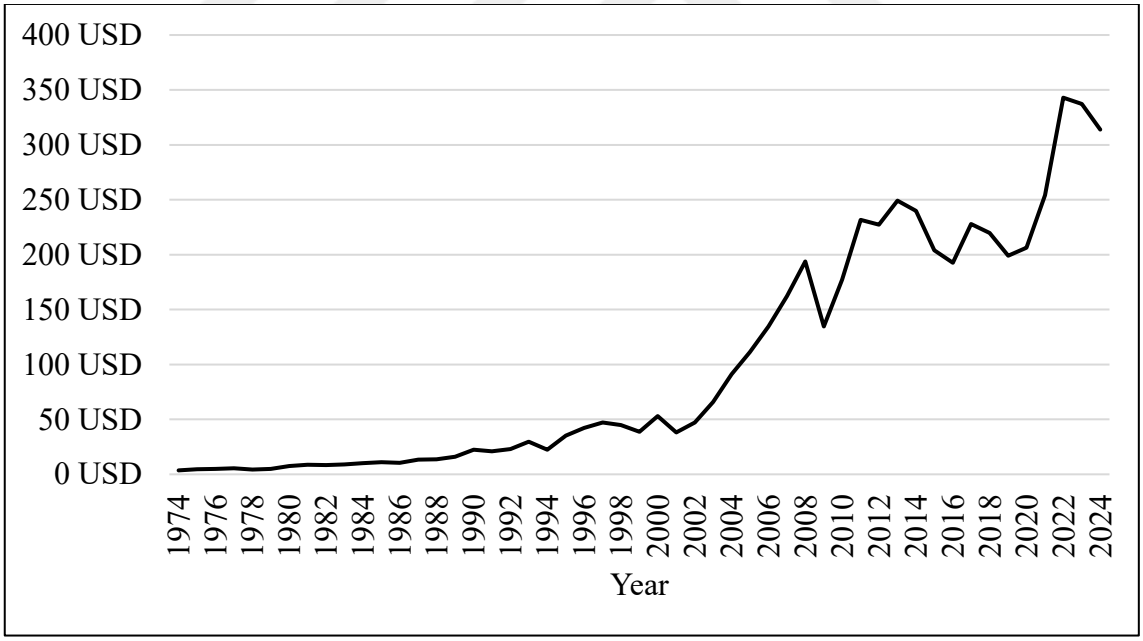


Figure 17. Turkish Import Trade (Only Goods) Development with the World (Billion USD, 1974-2024)

Source: World Bank, 2025e.

From the mid-1970s on until the late 1980s the growth of imports was steadily rising at a moderate pace (World Bank, 2025e). Starting in the early 1990s values of export trading

start to substantially pick up, peaking in 2000 before decreasing the following year right around the domestic economic crisis. Following the year 2002 with economic growth recovering and increasing imports rise significantly, reaching three-digit values in billion USD for the first time in 2005.

As already mentioned, Türkiye's economy became more and more integrated in international value chains. During the global financial crisis imports to Türkiye considerably drop, also due to the caused shifts in demand. Following this shock Turkish imports recovered quickly. In 2015, imports again dropped significantly due to the globally falling prices for energy products (Bonfield, 2016). Türkiye is to 74 percent reliant on foreign imports to fulfill the local energy demand, according to the Republic of Türkiye Ministry of Foreign Affairs (n.d.). During the time period of 2014 to 2016 global energy prices, e.g., for oil and gas decreased at large (European Commission, 2020).

After the year 2016 where the failed coup attempt riddled domestic stability, imports start to increase again as showcased by the data in Figure 17 (World Bank, 2025e). This trend did not last long, as the domestic currency crisis from 2018 on and the Corona pandemic in 2020 once again put a strain on economic development and foreign trade. In 2021 and 2022 imports then sharply increased reaching a historical peak of 342,9 billion USD in 2022. This development is mainly due to the increase in the price of energy products as a result of the Russian war in Ukraine, the volatile development of the national currency and rising prices for goods on the global market, among others. In 2023 import levels remain high but are slowly leveling off. In 2024, results further decrease reaching 313,8 billion USD. The energy trade deficit soared to a historical record-high of 81,1 billion USD in 2022, compared to the total of 42,4 billion USD in the previous year (Central Bank of the Republic of Türkiye, 2023).

During the period 2000 (52,9 billion USD) to 2008 (193,8 billion USD) Turkish import trading grows by 266,4 percent whereas between 2008 (193,8 billion USD) and 2024 (313,8 billion USD) imports to Türkiye increase by 61,9 percent (World Bank, 2025e). In 2023, the most imported products from abroad stemmed from the category mineral fuels, minerals oils and product of their distillation accounting for a total of 63,4 billion USD (TURKSTAT, 2025e). Furthermore, import trading around boilers, machineries and mechanical appliances, parts thereof ranked second, with a total of approximately 38,2

billion EUR. Finally, precious stones, precious metals, pearls and articles thereof secure third place with an import volume of 33,2 billion EUR. In 2024, the ranking remains the same. Mineral fuels, minerals oils and product of their distillation account for 59,5 billion USD, boilers, machineries and mechanical appliances, parts thereof equal 36,8 billion USD and precious stones, precious metals, pearls and articles thereof amount to 30,8 billion USD.

Assessed based on economic activity in connection with Turkish import trade in the year 2023, 80,7 percent of value added originated from the production industry, making it the most crucial economic import category (TURKSTAT, 2024b). Mining and quarrying ranked in second accounting for 12,8 percent whereas agriculture, forestry and fishing activities secured third place with a share of 3,8 percent. These two categories changed places compared to the results concerning economic activity in connection with Turkish export trading. Finally, the category others only made up for a stake of 2,7 percent.

In 2024, evaluated based on economic activity in regard to Turkish import trade 81,4 percent of value added originated from the production sector, making it the most important economic import category (TURKSTAT, 2025h). Mining and quarrying came in second place representing 12,4 percent. The category agriculture, forestry and fishing, on the other hand, ranked third place with a share of 3,2 percent. Again, these two categories changed places compared to the results concerning economic activity in connection with Turkish export trading. At last, the others-category stood for a stake of three percent.

This following subchapter provides an overview of the Turkish-German trade relationship concerning total trade, exports and imports, economic ties and foreign direct investment activities.

4.3 Trade Relationship between Germany and Türkiye

Over the past 30 years Turkish-German trade relations have been expanding, considering both imports and exports as seen in Figure 18, depicting the development of imports, export and the trade volume as well as in Figure 19, showing the trade balance in addition to imports and exports. Germany and Türkiye have established a Joint Economic and Trade Commission in 2018 as well as the German-Turkish Energy Forum, as an exchange

forum for governmental representatives and the private sector from both sides (Federal Foreign Office, 2024b).

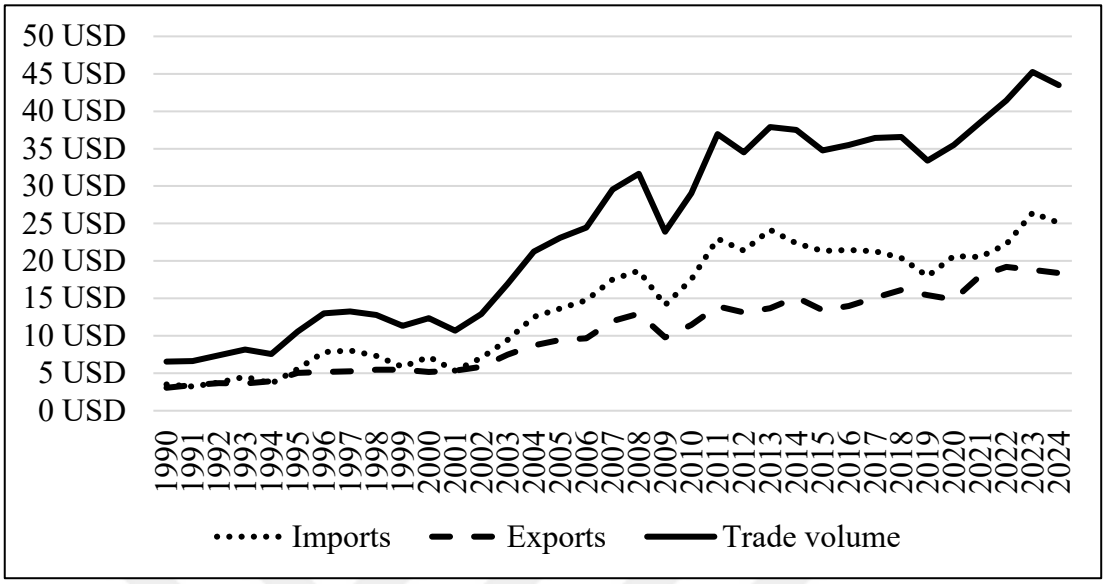


Figure 18. Development of Turkish Imports and Exports with Germany (Billion USD, 1990-2024)

Source: TURKSTAT, 2025c.

According to the results of the Foreign Trade Statistics (Special Trade System) by TURKSTAT, over the past two decades bilateral trade between Türkiye and Germany has been developing for the majority of time in a positive manner (TURKSTAT, 2025c). Between 2004 and 2024 the total turnover in trade grew by 104,6 percent (also see Figure 18).



Figure 19. Development of Turkish Trade and Trade Balance with Germany (Billion USD, 1990-2024)

Source: TURKSTAT, 2025c.

With the emergence of the global financial crisis emerging between 2007 and 2008, bilateral trade dropped by 24,5 percent according to the overall turnover in 2009 versus 2008 (TURKSTAT, 2025c). During this period especially imports from Germany to Türkiye dropped. Following the global crisis years bilateral trade quickly recovered, exceeding pre-crisis results as early as 2011 mainly driven by the increase of German exports to Türkiye. The period between 2011 and 2019 represents continuous fluctuation but with an overall stagnation of bilateral trade between the two countries. Moreover, Corona pandemic in 2020 affects the trade turnover negatively but not as much as in 2009. Furthermore, with trade recovering following the pandemic year of 2020, Turkish-German bilateral trade reached an all-time high of about 45,3 billion USD, consisting of 26,4 billion USD in Turkish imports and 18,8 billion USD in Turkish exports in 2023. The bilateral trade result slightly decreases in 2024, reaching 18,4 billion USD in Turkish exports and 25,1 billion USD in Turkish imports which amounts to a total of about 43,5 billion USD.

The results make Germany the most important trade partner for Türkiye out of the EU-27, followed by Italy, France and Spain in 2023 and 2024 (TURKSTAT, 2025c). The EU-27 accounted for a total trade volume of 193,1 billion USD in 2023, with 94,8 billion USD in Turkish export and 98,3 billion USD in imports to Türkiye (TURKSTAT, 2025d). In 2024, EU-27 export trade from Türkiye reaches 99,6 billion USD and approximately 103 billion USD in EU-27 imports to Türkiye accounting for a total of 202,5 billion USD.

In 2023, Türkiye reached a result of 232,2 billion USD in exports and 339,1 billion USD in imports in 2023, amounting to a total of 571,2 billion USD in total (TURKSTAT, 2025g). Hence, the EU-27 represent about 33,8 percent of Türkiye's total trade volume with the world with shares of 40,8 percent of Turkish exports and 29 percent of Turkish imports (TURKSTAT, 2025d; 2025g)

In 2024, Turkish export trade with the world further increased accounting for 237,5 billion USD and, on the contrary, Turkish imports decreased 321,4 billion USD, amounting for an overall diminished result of 558,9 billion USD (TURKSTAT, 2025g). In this respect, trade activity with the EU-27 equaled a share of about 32 percent of Turkish imports, 41,9 percent of Turkish exports and 36,2 percent of Türkiye's overall trade volume with the

world (TURKSTAT, 2025d; 2025g). The total number of exporting companies amounted to 139.830 in 2023 (Republic of Türkiye Ministry of Trade, 2024a).

When considering the trade balance's development over the past two decades imports from Germany have been mostly exceeding exports from Türkiye, causing a trade deficit from a Turkish perspective (TURKSTAT, 2025c). On average between 1990 and 2024, the Turkish trade deficit with Germany amounted to about -3,9 billion USD, reaching its all-time high in 2013 at about -10,5 billion USD and an amount of about -7,6 billion USD in 2023 and -6,7 billion USD in 2024. In 1994, the period's highest ever Turkish trade surplus was reached at 288,7 Mio. USD.

According to the Turkish export trade volume Germany was the country's largest export destination in 2023 (TURKSTAT, 2025c). In 2023, German exports made up for the third largest share in Türkiye's total import volume. Overall, Germany is Türkiye's third most important trade partner country in 2023, after Russia and China. Also in 2024, considering the Turkish export trade volume Germany was the country's leading export destination. Again, in 2024, Germany's export trade with Türkiye made up for the third largest share in Türkiye's total import volume. In 2024, Germany remains Türkiye's third most important trade partner country, after Russia and China in first and second place, respectively.

In 2024, considering German trade statistics, overall Turkish exports rank 14th in the international comparison and Türkiye's import volumes to Germany value the country as 16th largest the same year (Destatis, 2025a). Measured by turnover referring to Turkish-German total exports plus imports, Türkiye is Germany's 14th largest partner in trade in global comparison. Moreover, measured by the individual foreign bilateral trade balance which means calculating exports minus imports, Türkiye reaches 21st places with a positive result amongst the international ranking in 2024.

In Figure 20 the TOP-3 export trade categories are depicted using the year 2024 as a base (TURKSTAT, 2025f). The categories are shown in accordance with the Harmonized System (HS) codes, a scheme working with numbers to ensure the classification of exchanged commodities when being exported (International Trade Administration, n.d.; TURKSTAT, 2025f). Under the Harmonized System the level "H2 (chapter)" filter was selected in the Foreign Trade Statistics (Special Trade System) by TURKSTAT. The

categories with the overall highest volume are *Vehicles other than railway or tramway rolling-stock, parts thereof*, *Boilers, machineries and mechanical appliances, parts thereof* and *Knitted and crocheted goods and articles thereof* (TURKSTAT, 2025f). Expanding the scope to capture the TOP-10 export trade categories to Germany, the results show that over all especially (industrial) products such as machinery, equipment, materials for further processing and consumption goods, e.g., articles of steel and iron, textile products, plastics as well as rubbers and aluminum make up most of Türkiye's exported goods to Germany. The total export volume from Türkiye to Germany between 2002 and 2023 across the TOP-10 sectors amounts to 212,1 billion USD and 225,5 billion USD between 2002 and 2024. In 2002 the export volume over the TOP-10 export trade categories reached 4,4 billion USD, whereas in 2023 the numbers equaled to 13,9 billion USD and to 13,4 billion USD in 2024. In comparison, this result increased by 204,6 percent comparing 2024 and 2002. In 2024, the TOP-10 export categories account for 13,4 billion USD, covering 72,8 percent of the total Turkish export volume to Germany for that year (TURKSTAT, 2025c; 2025f).

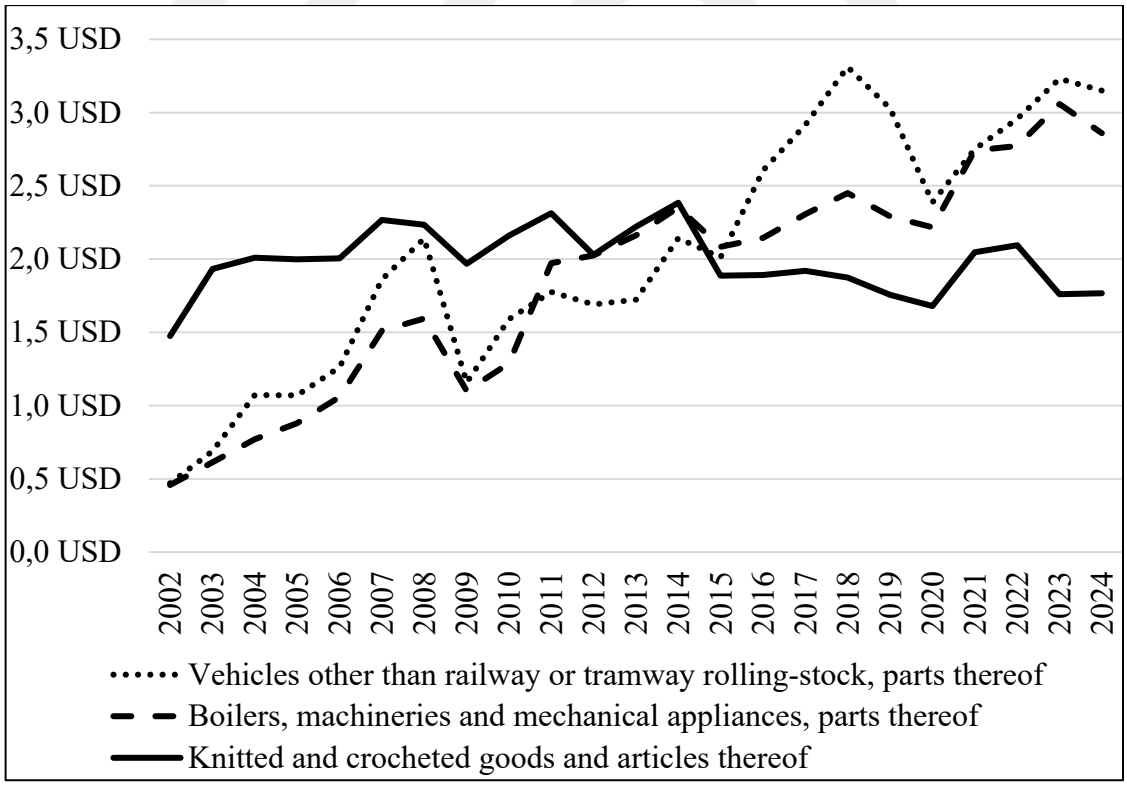


Figure 20. Current TOP-3 Export Categories in Turkish-German Bilateral Trade (Billion USD, 2002-2024)

Source: TURKSTAT, 2025f.

According to the European Commission - Directorate-General for Trade (2024), in 2023, the trade volumes between Türkiye and the EU as part of the Customs Union substantially grew, amounting to a historic level of approximately 206 billion EUR. As a result, in the same year, Türkiye's overall share stood at 4,1 percent out of the overall global exchange of goods by the EU, securing the country the 5th rank among the major trading counterparts.

As of February 2024 in Türkiye, 8.463 firms having capital shares from Germany have been detected locally, making it the second largest country-of-origin (Republic of Türkiye Ministry of Industry and Technology, 2025). Large companies such as Bosch, MAN, Mercedes-Benz and Siemens have been active in the country for numerous decades (Witzens, 2005). Furthermore, in the energy sector, large German companies such as Nordex, Enercon, e.on, EnBW, Siemens and RWE have operations in Türkiye (Presidency of the Republic of Türkiye Investment Office, 2024).

From 2002 to February 2024 German Foreign Direct Investment (FDI) reached a total of about 13,1 billion USD, representing a share of 6,7 percent out of the total FDI (Republic of Türkiye Ministry of Industry and Technology, 2025). Considering the inflow of German FDI over time, volumes at times strongly change as seen in Figure 21. Inflow peaks were reached first in 2008 and later in 2013 with an all-time high of 1.970 Mio. USD.

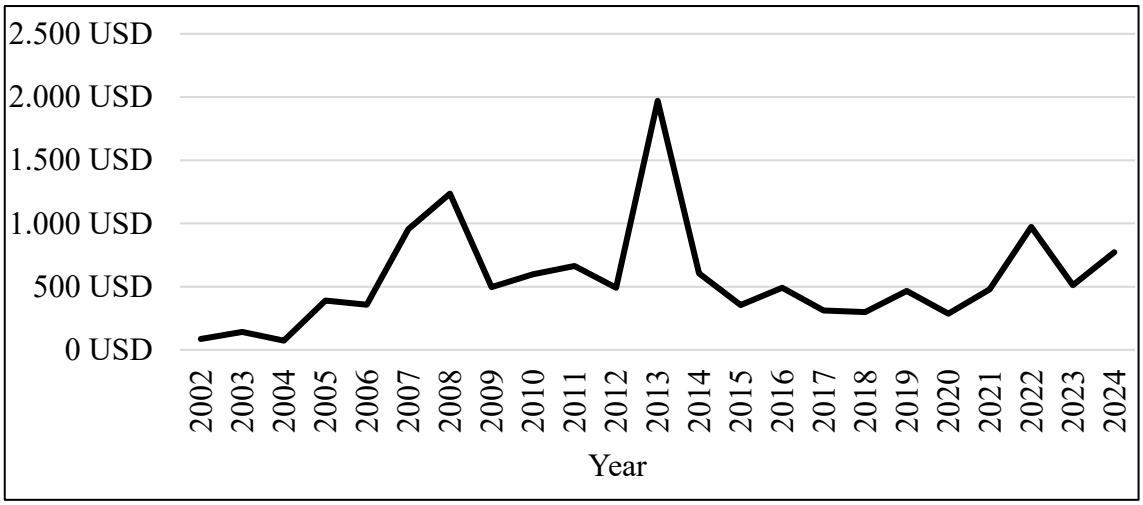


Figure 21. German FDI in Türkiye (Mio. USD, 2002-2023)

Source: Republic of Türkiye Ministry of Industry and Technology, 2025.

Following 2013 investments dropped by about 70 percent in 2014 compared to the previous year (Republic of Türkiye Ministry of Industry and Technology, 2025). In 2022, for the first time since 2013 levels exceeded the 900 Mio. USD mark. Values dropped again under the 600 Mio. USD level in 2023 but recovered in 2024 reaching 772 Mio. USD. The following subchapter assesses German-Turkish trade ties, in particular Turkish export activities, in the context of the CBAM and the sectors related to it with a focus on the aluminum, iron and steel, cement and fertilizer industries.

4.4 Trade Relationship in the Context of the Carbon Border Adjustment Mechanism Related Sectors

The framework of the EU's CBAM covers aluminum, cement, electricity, fertilizers, hydrogen as well as iron and steel also incorporating certain subsequent items such as kinds of fasteners (Council of the European Union, 2022; European Bank for Reconstruction and Development et al., 2023; European Commission - Directorate-General for Taxation and Customs Union, 2024; European Union, 2024; DIHK, 2024; European Union EUR-Lex, 2023a, (Annex I & Annex II)). These industry products provide strong opportunities in the context of the migration of greenhouse gas emissions to third countries by moving their manufacturing facilities accordingly (European Commission - Directorate-General for Taxation and Customs Union, 2024; DIHK, 2024). The instrument considers the direct carbon dioxide footprint emerging in the manufacturing process as well as the secondarily emitted gases from producing semi-finished goods or the electrical energy used in manufacturing (European Bank for Reconstruction and Development et al., 2023; DIHK, 2024). In the context of EU's emissions trading system, the mentioned products encompass about 50 percent of the industries it encompasses (DIHK, 2024). DIHK (2024), European Commission - Directorate-General for Communications and Von der Leyen (2019) and European Union EUR-Lex (2023) (*Regulation 2023/956*) note that the goods covered by the CBAM will most likely increase.

The trading categories *Articles of iron and steel* and *Aluminum and articles thereof* are ranked fifth and eight consecutively as part of the most exported goods by Türkiye to Germany in 2024 (TURKSTAT, 2025f). Between 2002 and 2024, the volume of trade in the category articles of iron and steel rose by 948,4 percent. Likewise, during the same

period of time the increase in the category aluminum and articles thereof amounted to 1.020 percent.

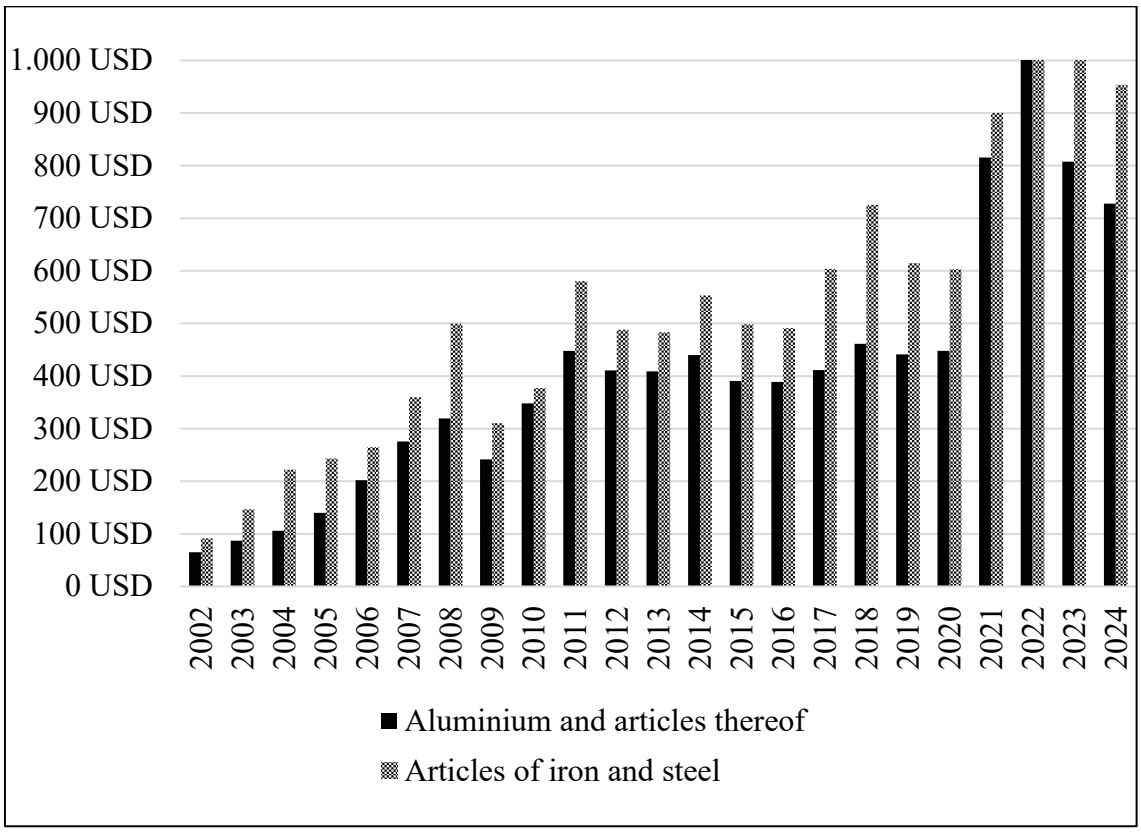


Figure 22. Turkish Total Export in *Aluminum and Articles Thereof* and *Articles of Iron and Steel* to Germany (Mio. USD, 2002-2024)

Source: TURKSTAT, 2025f.

Hence, the export trade of aluminum as well as iron and steel goods have substantial risen over time, as seen in Figure 22. Figure 22 showcases the Turkish export volume to Germany over time in the product categories aluminum and articles thereof as well as articles of iron and steel in Mio. USD between 2002-2024. In both categories, especially in the recent years 2021, 2022 and 2023 the export gains in value significantly before declining back to 2021-values in 2024 (TURKSTAT, 2025f). The initial significant increase was in 2021 when exports in the category aluminum and articles thereof amounted to 815,7 Mio. USD, an increase of 82,2 percent compared to the previous year. In the same year, for the first time the volume of exports in the category articles of iron and steel reached 899,9 Mio. USD and therefore a gain of 49,2 percent. In 2023, the export volume of aluminum and articles thereof dropped to 807,4 Mio. USD but remains still on high levels. On the other hand, articles of iron and steel slightly continue to increase to

1.111,4 Mio. USD, reaching their all-time high within the past two decades in 2023. In comparison, in the following year 2024 corresponding exports levels decline accounting for a volume of 727,6 Mio. USD (-9,9 percent compared to 2023) in the category aluminum and articles thereof and achieved a result of 953,6 Mio. USD (-14,2 percent compared to 2023) in articles of iron and steel. Overall, the two categories each account for about 5,9 percent (*Articles of iron and steel)* and 4,3 percent (*Aluminum and articles thereof)* of the total export volume from Türkiye to Germany in 2023 (TURKSTAT, 2025c; 2025f). In 2024, the two categories each represent a share of 5,2 percent (*Articles of iron and steel)* and about four percent (*Aluminum and articles thereof)* out of the total export volume from Türkiye to Germany in 2024.

Şahin et al. (2021) notes that the ties between Türkiye, European countries and the EU may be endangered in the context of this instrument and underlines the necessity of its assessment. The European Bank for Reconstruction and Development (EBRD), the Republic of Türkiye Ministry of Environment, Urbanization and Climate Change together with Climate Focus published a quantifying study on the "Potential Impact of the Carbon Border Adjustment Mechanism on the Turkish Economy" in 2023. Türkiye ranks in position six of the EU's list of countries with the biggest trade volumes (European Bank for Reconstruction and Development et al., 2023). Hence, an increase of trade expenses for the country following the CBAM's application is being anticipated. This may directly affect the country's competitive advantage and may lead to transitional effects on expansion of the GDP as well as job creation. In conclusion the mechanism puts Türkiye in tangible danger of economic effects.

In an assessment by Eicke et al. (2021), the scholars measure the possible magnitude of consequences inclined by the CBAM for nations based on their level of export trade dependance on the EU market and unfitness to accommodate the implementation of required measures as a result of the CBAM. The study uses two different cases where in the first case the CBAM considers solely "emission-intensive and trade-exposed (EITE)" products, such as aluminum and steel (Eicke et al., 2021, p. 2). Whereas in the second case the mechanism takes into account every product exported to the EU market. According to the findings by Eicke et al. (2021), regarding each case Türkiye is exposed to a comparatively elevated danger in connection with commercial consequences inclined by the CBAM.

The outcomes underline that the mechanism may impact the iron and steel industry the strongest, followed by the cement industry (Republic of Türkiye Ministry of Environment, Urbanization and Climate Change, 2023b). Furthermore, the study concludes that establishing a local price mechanism for emissions may decrease the expenses of the CBAM, which are calculated as part of the study. The scenario considering both Scope 1 and Scope 2 carbon emissions of exporting goods for the EU market and a CBAM pricing of EUR 75/tCO_2e project a yearly additional burden of 138 Mio. EUR in the year of 2027 due to the mechanism (European Bank for Reconstruction and Development et al., 2023). Furthermore, in a scenario where the CBAM prices reach EUR 150/tCO_2e the expenses arising from that may reach 2,5 billion EUR yearly by the year of 2032. However, the application of a national cost for emissions, e.g. EUR 20/tCO_2e, could lower the CBAM expenses reaching 56 Mio. EUR annually by 2027. If the cost for emissions locally would increase to EUR 50/tCO_2e, inclined additional expenses in connection with the CBAM could decrease amounting to 1,08 billion EUR yearly up to 2032. In this case CBAM expenses would be lowered by 1,5 billion EUR.

In the underlying scenario of a CBAM cost of EUR 150/tCO_2e Türkiye's export trade with the EU could decrease economic development at 0,04 percent in the year 2032 (European Bank for Reconstruction and Development et al., 2023). On the other hand, the realization of a carbon cost mechanism with an expense of EUR 50/tCO_2e could lead to the country's economy to grow by one percent by 2032. the favorable expansion effect on the Turkish economy in combination with an increased carbon cost locally is due to the growing share of green energy resources and the industry's further development with a focus on exporting and sustainability aspects together with a systematic transition towards this aim.

The CBAM's impact from an expense perspective may lead to implication regarding the total export trading activity from Türkiye to the European market (European Bank for Reconstruction and Development et al., 2023). The CBAM is set to commence in 2026, where direct effects on corresponding trading activity are expected to be small. Nonetheless, with an underlying CBAM cost of EUR 75/tCO_2e or EUR 150/tCO_2e by 2032, Turkish exports to the European market may decline up to two or even three percent in that order, as opposed to a situation without any CBAM as well as without a local carbon cost mechanism in place. On the contrary, corresponding trading activity may

increase to an equal degree in case of the realization of a local carbon cost mechanism due to the fact that the export trading activity of commodities with a decreased carbon footprint, e.g., green goods in the vehicle and iron and steel sector could grow.

Türkiye may adapt strategies from an array of possibilities to guard local firms against fiscal repercussions due to the CBAM (European Bank for Reconstruction and Development et al., 2023). In this context, a local carbon price mechanism as well as a policy overhaul may support in reducing any fiscal weight the CBAM puts at risk of causing. Furthermore, such strategies may foster and speed up the efforts of carbon reduction in local industries. The implementation of a local carbon price mechanism connected to the EU Emissions Trading System or the integration into even that system may represent the sole possibilities leading to a total immunity against the CBAM.

The Republic of Türkiye Ministry of Environment, Urbanization and Climate Change (2023b) notes that the report further elaborates that through the application of a domestic carbon pricing mechanism the country may have the ability to absorb the earnings of that mechanism rather that implicitly shouldering the financial burden of the expenses of CBAM. Moreover, it may offer the possibility of leading with a competitive advantage to Turkish exporting companies as part of the trading activities with the European market by means of decarbonized manufacturing methods. At the moment, the CBAM legislation foresees that locally paid carbon costs in connection with exporting goods decrease the amount of CBAM related certificates required (European Bank for Reconstruction and Development et al., 2023). Hence, the setup of a Turkish emissions trading system may lower the expenses in relation to the CBAM which would have to be covered by the importing party in the EU. At the same time, it fosters efforts to decrease the carbon footprint of the Turkish. Furthermore, the activities around the carbon reduction in local industries may be further facilitated with the help of supporting strategies which may be taken into account from an authority standpoint.

In accordance with the EU's *Regulation 2023/956*, a number of goods from various sectors have been determined to be covered by the CBAM on a CN code basis (European Union EUR-Lex, 2023a). The relevant CBAM CN codes on an industry basis are listed in Table 1 above. The iron and steel, aluminum, fertilizer and cement industries may be most affected by the CBAM according to the amount of selected CN codes active and the

annual Turkish export volumes in the context of German-Turkish bilateral trade (DIHK, 2024; European Union EUR-Lex, 2023a, (Annex I & Annex II); TURKSTAT, 2025f). Overall, based on the trade volumes in Mio. USD the iron and steel industry is most impacted, followed by the aluminum sector (TURKSTAT, 2025f). The fertilizer and cement industries follow subsequently but only account for overall small export volumes in comparison to the iron and steel as well as aluminum sector as displayed in Figure 23. Figure 23 describes the development of exports to Germany in the scope of the CN codes for the iron and steel, aluminum, fertilizer and cement as defined under the CBAM between 2014 and 2024 in Mio. USD.

Considering Turkish-German bilateral trade levels amounting to about 45,3 billion USD, consisting of 26,4 billion USD in Turkish imports and 18,8 billion USD in Turkish exports in 2023, the total Turkish export volume stemming from the sectors as shown in Figure 23 and 24 based on the CN codes covered as part of the CBAM, account for a volume of about 1,8 billion USD and a share of approximately four percent of total Turkish-German bilateral trade volume in 2023 (TURKSTAT, 2025c; 2025f). Furthermore, the Turkish industries' export results for the total CBAM-relevant iron and steel, aluminum, fertilizer and cement exports to Germany as seen in Figure 23 and 24, again, account for 1,8 billion USD, representing approximately 9,6 percent of overall Turkish export trade in bilateral exchange activities between the two countries in 2023. In 2024, overall Turkish export trade amounted to 18,4 billion USD and imports from Germany reached 25,1 billion USD, accounting for a trade total of 43,5 billion USD (TURKSTAT, 2025c). Considering the export categories and results shown in Figure 23 and 24 exports from Türkiye to Germany amount to a total of 1,6 billion USD. Furthermore, in relation to the total trade activities between the two countries its proportion accounts for 3,7 percent. Moreover, regarding the sole overall export trade volume to Germany its share results in 8,7 percent. The outcomes imply a decline in weight of trade in the CBAM-relevant product categories in relation to Turkish export trade and the overall bilateral exchange among the two countries in 2024 compared to the year 2023.

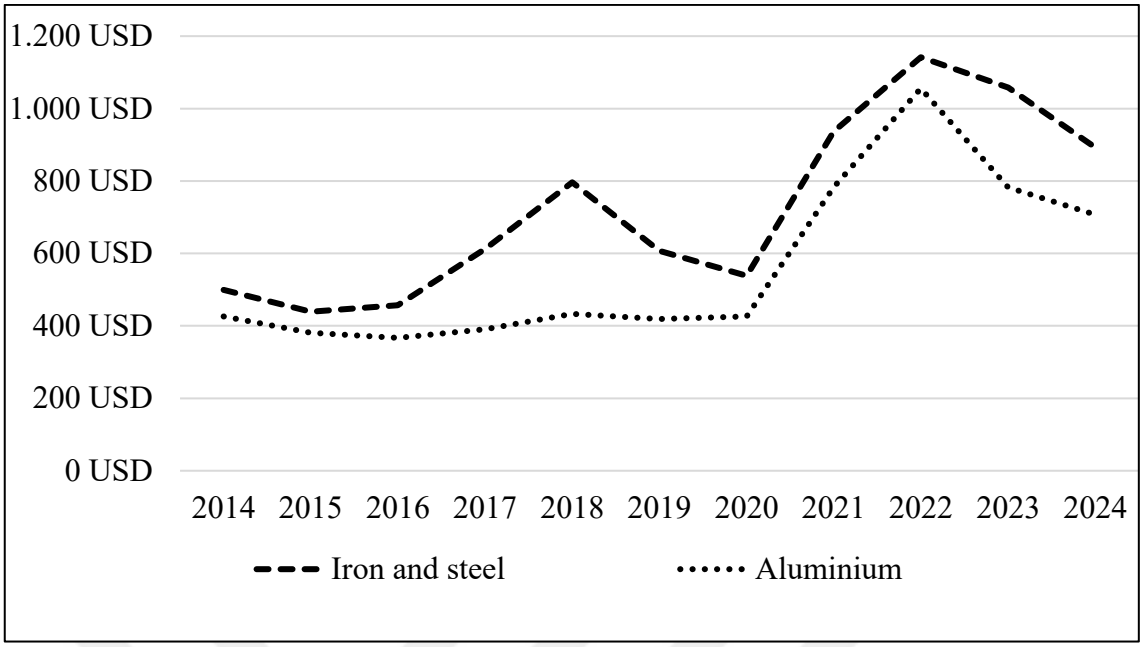


Figure 23. Türkiye's Iron and Steel and Aluminum Exports' Value to Germany (Mio. USD, 2014-2024)

Source: TURKSTAT, 2025f.

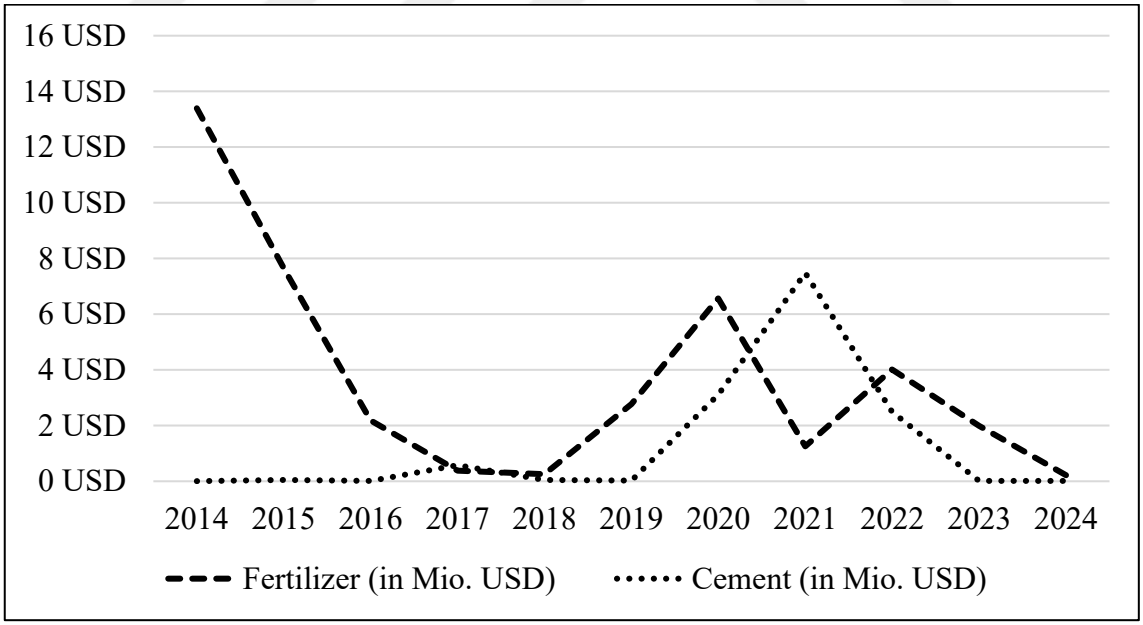


Figure 24. Türkiye's Fertilizer and Cement Exports' Value to Germany (Mio. USD, 2014-2024)

Source: TURKSTAT, 2025f.

In general, it must be noted that not all CN codes listed determined by the CBAM are relevant in the context of Turkish exports to Germany between 2014 and 2024 and may

therefore not be listed in particular as part of the sector-based analysis in the upcoming subchapters. Hence, the CBAM-relevant sectors hydrogen and electricity are not displayed, as no significant trade flows can be determined throughout the aforementioned timeframe. The following subchapter further assesses the potential effect of the CBAM regulation on Turkish exports to Germany for the iron and steel industry by examining overall trade flows and in the context of the affected CN codes.

4.4.1 Iron and Steel Sector

In accordance with the EU's *Regulation 2023/956*, the following goods have been determined to be affected by the CBAM as part of the iron and steel sector (European Union EUR-Lex, 2023a). The relevant CN codes are, again, summarized in Table 4 below. The iron and steel industry is most affected by the CBAM on the basis of the amount of selected CN codes.

Table 4. CN Codes of the Iron and Steel Goods Affected by the CBAM

Industries/products affected by the CBAM	**CN codes**	**Direct emissions are considered only**
Iron and steel	26011200	Indirect/Direct
	7201	Direct
	720211-19	Direct
	7202 60	Direct
	7203	Direct
	7205-7229	Direct
	7301	Direct
	7302	Direct
	7303 00	Direct
	7304-7308	Direct
	7309 00	Direct
	7310	Direct
	7311 00	Direct
	7318	Direct
	7326	Direct

Source: DIHK, 2024; European Union EUR-Lex, 2023a, Annex I & Annex II.

Considering the development of Turkish Exports to Germany in the scope of the CN codes between 2014 and 2024 we can see a fluctuating picture with an overall clear linear upward trend as displayed in Figure 25 below. Figure 25 describes the development of exports to Germany in the scope of the CN codes for the iron and steel sector as defined under the CBAM between 2014 and 2024 in Mio. USD.

During the period 2014 to 2016 export levels remain fairly unchanged, followed by an increase in 2017 and a peak in 2018 at 796,1 Mio. (TURKSTAT, 2025f). USD. Between 2019 and 2020 trade levels fell again below the results of 2017. In the timeframe 2021 to 2022 exports rise substantially, reaching the highest levels at 1,1 billion USD in 2022. In 2023, the results again slightly drop, although they remain slightly above the one billion USD mark. The decline continues throughout 2024 reaching 892,78 Mio. USD. Nonetheless, overall, Figure 25 displays an upward trend between 2014 and 2024.

As already mentioned, Turkish-German bilateral trade achieved an all-time high of about 45,3 billion USD, consisting of 26,4 billion USD in Turkish imports and 18,8 billion USD in Turkish exports in 2023 (TURKSTAT, 2025c). In comparison to these results, the total exports of the iron and steel industry from Türkiye on the basis of the CN codes relevant under the CBAM accounted for approximately 2,3 percent of Turkish-German bilateral trade in 2023 (TURKSTAT, 2025c; 2025f). Furthermore, the Turkish iron and steel industry's results equaled to approximately 5,6 percent of overall export trade in bilateral exchange activities between the two countries in 2023.

On the other hand, trade levels declined in 2024 amounting to 18,4 billion USD in Turkish exports to Germany, 25,1 billion USD in imports to Türkiye and a total of 43,5 billion USD in overall Turkish-German bilateral trade (TURKSTAT, 2025c). Comparing these results, the total export trade of the iron and steel industry from Türkiye to Germany on the basis of the CN codes relevant under the CBAM accounted for approximately 2,1 percent of Turkish-German bilateral trade in 2024 (TURKSTAT, 2025c; 2025f). Furthermore, the Turkish iron and steel industry's results amounted to approximately 4,6 percent of Turkish export trade in bilateral exchange activities between the two countries in 2024.

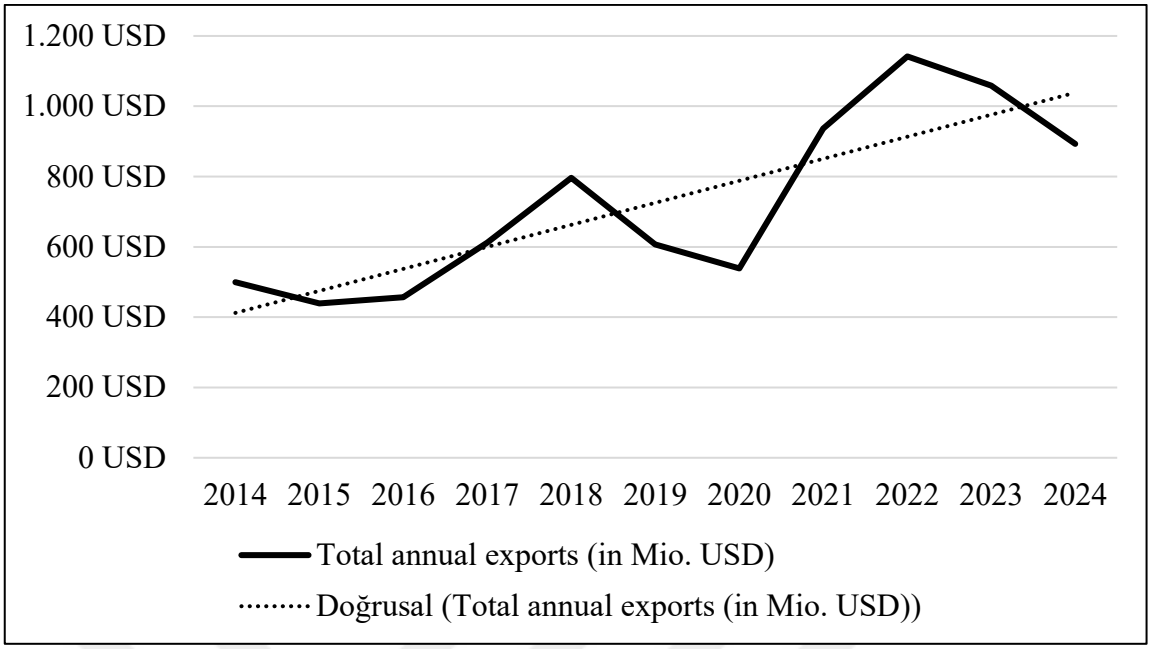


Figure 25. Total Iron and Steel Export to Germany (Mio. USD, 2014-2024)

Source: TURKSTAT, 2025f.

Figure 25 displays the total iron and steel export volumes in the CBAM relevant product categories to Germany between 2014 and 2024. Among the product categories considered under the CBAM in the iron and steel industry, derived from the most recent Turkish export trade volumes, the TOP-3 export product categories can be determined, as displayed in Figure 26. Figure 26 shows the TOP-3 exports categories for the iron and steel sector between 2014 and 2024 relevant under the CBAM. On the basis of the CN codes for the iron and steel sector and the export trade levels between 2014 and 2024, the goods' classification groups *7326*, *7318* and *7308* represent the most significant product categories according to export volumes measured in USD (TURKSTAT, 2025f). Moreover, the product categories *7326* and *7318* overall clearly dominate export trade among the listed CN codes throughout the mentioned time period.

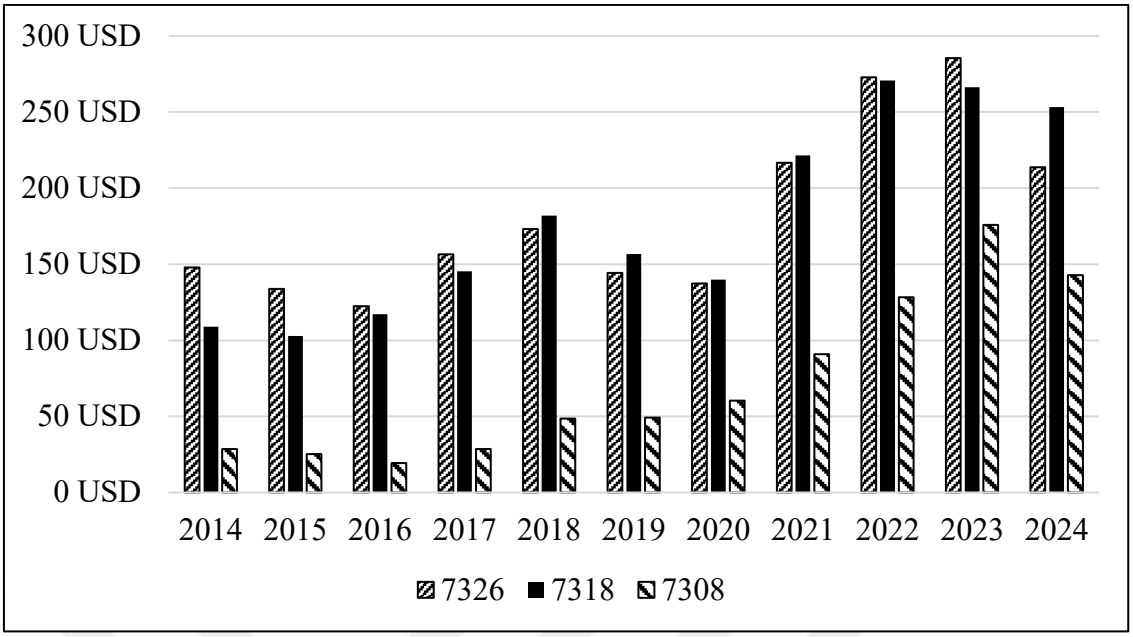


Figure 26. CBAM-Relevant TOP-3 Export Categories for the Iron and Steel Sector (Mio. USD, 2014-2024)

Source: TURKSTAT, 2025f.

The CN code *7326* represents "*articles of iron or steel, n.e.s. (excl. cast articles)*", which between 2014 and 2024 amounted to a total export volume of two billion USD, making it the most significant product group (TURKSTAT, 2025f). Furthermore, the product category "*screws, bolts, nuts, coach screws, screw hooks, rivets, cotters, cotter pins, washers, incl. spring washers, and similar*", symbolized by the code *7318*, ranks in second place with a result of slightly below two billion USD throughout the years 2014 to 2024. Ranking third, the CN code *7308* represents "*structures and parts of structures e.g., bridges and bridge-sections, lock-gates, towers, lattice masts, roofs, roofing*" and accounts for an export trade volume of 797,6 Mio. USD during the same time period.

The course of the graph as seen in Figure 25 is mainly determined by the CN codes *7326*, *7318* and *7308* as seen in Figure 26 (TURKSTAT, 2025f). The good *7308* "*Structures and parts of structures "e.g., bridges and bridge-sections, lock-gates, towers, lattice masts, roofs, roofing*" started substantially increasing following 2020 while during previous times its levels were fairly small, achieving its peak at 175,8 Mio. USD in 2023 and its lowest at 19,4 Mio. USD in 2016. The average value for this product category between 2014 and 2024 amounts to only 72,5 Mio. USD. On the other hand, the product categories *7326* "*Articles of iron or steel, n.e.s. (excl. cast articles)*" and *7318* "*Screws,*

bolts, nuts, coach screws, screw hooks, rivets, cotters, cotter pins, washers, incl. spring washers, and similar" achieve their highest results between 2021 and 2024. The two product categories regularly alternate in the ranking for first and second place, increasing at similar rates over time. Considering the decrease of overall levels in 2024, in particular the category 7326 declined from 285,5 Mio. USD in 2023 to 213,7 Mio. USD in 2024.

Overall, a total Turkish export trade volume to Germany of about eight billion USD was achieved in the related CBAM product categories on a CN code basis for the iron and steel industry between 2014 and 2024 (TURKSTAT, 2025f). Moreover, the Turkish export trade in the goods' classification groups *7326*, *7318* and *7308* to Germany between 2014 and 2023 amounted to about 4,2 billion USD, accounting for a share of 58,7 percent in relation to the total. Adjusting the time period, Turkish export trade in the goods' classification groups *7326*, *7318* and *7308* to Germany between 2014 and 2024 the results showcased about 4,8 billion USD, resulting in a share of approximately 59,7 percent in relation to the total.

In 2023, the export results in the same product categories *7326*, *7318* and *7308* amounted to 727,7 Mio. USD, representing a share of 68,8 percent in relation to the result of approximately one billion USD representing all export trade across the relevant CN codes of the iron and steel sector under the CBAM (TURKSTAT, 2025f). In 2024, considering the same product categories these amounted to 609,8 Mio. USD accounting for 68,3 percent of the total amount of 892,8 Mio. USD representing all export trade across the relevant CN codes of the iron and steel sector under the CBAM.

Considering only the total 2023 Turkish export trade results in Turkish-German bilateral exchange of 18,8 billion USD the aforementioned Turkish export levels in the TOP-3 product categories out of the relevant CN codes in the iron and steel industry of 727,7 Mio. USD, they represent a share of about 3,9 percent (TURKSTAT, 2025c; 2025f). For the year 2024 the TOP-3 product categories *7326*, *7318* and *7308* amounting to 609,8 Mio. USD account for a proportion of 3,3 percent in relation to the 18,4 billion USD Turkish export trade with Germany. The following subchapter further assesses the potential effect of the CBAM regulation on Turkish exports to Germany for the aluminum sector by examining overall trade flows and in the context of the affected CN codes.

4.4.2 Aluminum Sector

In accordance with the EU's *Regulation 2023/956*, the following products have been determined to be affected by the CBAM as part of the aluminum sector (European Union EUR-Lex, 2023a). The relevant CN codes are, again, summarized in Table 5 below.

Table 5. CN codes for aluminum products under the CBAM

CN codes	Direct emissions are considered only
7601	Direct
7603-7608	Direct
76090000	Direct
7610	Direct
76110000	Direct
7612	Direct
76130000	Direct
7614	Direct
7616	Direct

Source: DIHK, 2024; European Union EUR-Lex, 2023a, Annex I & Annex II.

Considering the development of Turkish Exports to Germany in the scope of the CN codes trade flows a constant picture is painted achieving values around the 400 Mio. USD mark between 2014 and 2020. Following the year 2020, export levels fundamentally increase, reaching 783,4 Mio. USD in 2021 and succeeded by a peak at approximately 1,1 billion USD in 2022 (TURKSTAT, 2025f). In 2023 and 2024, export values decrease back to 2021 results, amounting to 782,2 Mio. USD and 707,2 Mio. USD. Overall, the trade flows represent an upward trend mainly driven by the above-average developments between 2021 and 2022.

In the context of Turkish-German bilateral trade results in 2023, the Turkish aluminum sector's export levels on the basis of the CN codes which are significant in the context of the CBAM represented approximately 1,7 percent of Turkish-German bilateral trade in 2023 (TURKSTAT, 2025c; 2025f). In 2024, this share amounted to about 1,6 percent. Moreover, the aluminum sector's results from Türkiye accounted for about 4,1 percent of overall export trade in bilateral trade between the two countries in 2023 and for 3,8 percent in 2024. Figure 27 shows the total aluminum export from Türkiye to Germany encompassing the CBAM relevant product categories between 2014 and 2024.

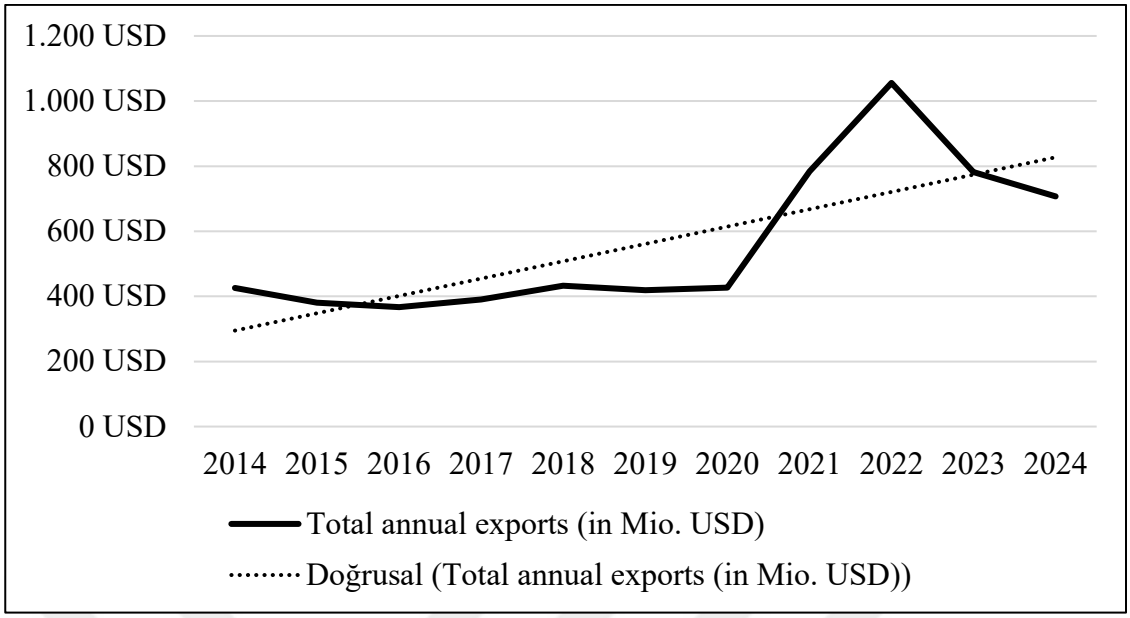


Figure 27. Total Aluminum Export to Germany (Mio. USD, 2014-2024)

Source: TURKSTAT, 2025f.

As part of the product categories considered under the CBAM in the aluminum sector, emerged from the most recent Turkish export trade volumes, the TOP-3 categories can be defined, as shown in Figure 28. Figure 28 showcases the TOP-3 export categories relevant in the context of the CBAM for the aluminum sector for the time period 2014 to 2024. Based on the CN codes for the aluminum industry and the export trade results between 2014 and 2024, the products' classification groups *7604*, *7606* and *7616* represent the most significant categories of goods according to export trade volumes presented in USD (TURKSTAT, 2025f). Moreover, in total, the product category with the CN code *7604* distinctly leads the ranking on overall amounts of export trade among the listed CN codes from the sector throughout the above-mentioned time period.

The CN code *7604* represents "*bars, rods and profiles, of aluminum, n.e.s.*", which between 2014 and 2024 accounted for an overall export volume of approximately 3,1 billion USD, making it the most important product group (TURKSTAT, 2025f). Moreover, the CN code *7606* depicting "*plates, sheets and strip, of aluminum, of a thickness of > 0,2 mm (excl. expanded plates, sheets and strip)*", comes in second place with a total result of about 1,3 billion USD in between 2014 and 2024. Ranking third, the CN code *7616* represents "*articles of aluminum, n.e.s.*", amounting to an export trade volume of 790,6 Mio. USD during the aforementioned timeframe.

The development of the graph as displayed in Figure 27 is primarily determined by the CN codes *7604* and *7606* as seen in Figure 28 (TURKSTAT, 2025f). While up to the year 2020 only showcasing low growth rates on average, the product category *7604* "*bars, rods and profiles, of aluminum, n.e.s.*" experiences substantially increasing result in 2021 and 2022, peaking the same year at 617,5 Mio. USD (2022) compared to the mean value of 279,7 Mio. USD between 2014 and 2024. In 2023, levels than, again, drop amounting to 457,6 Mio. USD and 377,1 Mio in 2024. USD. In relation to the latter, the product category *7606* "*plates, sheets and strip, of aluminum, of a thickness of > 0,2 mm (excl. expanded plates, sheets and strip)*" exhibits on average fairly low result. Although, in 2021 and 2022 also this category showcased substantial growth rates reaching its height at about 206 Mio. USD in 2022, followed by a decline to 128,5 in 2023 and, again, a slight increase in 2024 to 144,5 Mio. USD. The average value for this good between 2014 and 2024 amounts to only 120,3 Mio. USD.

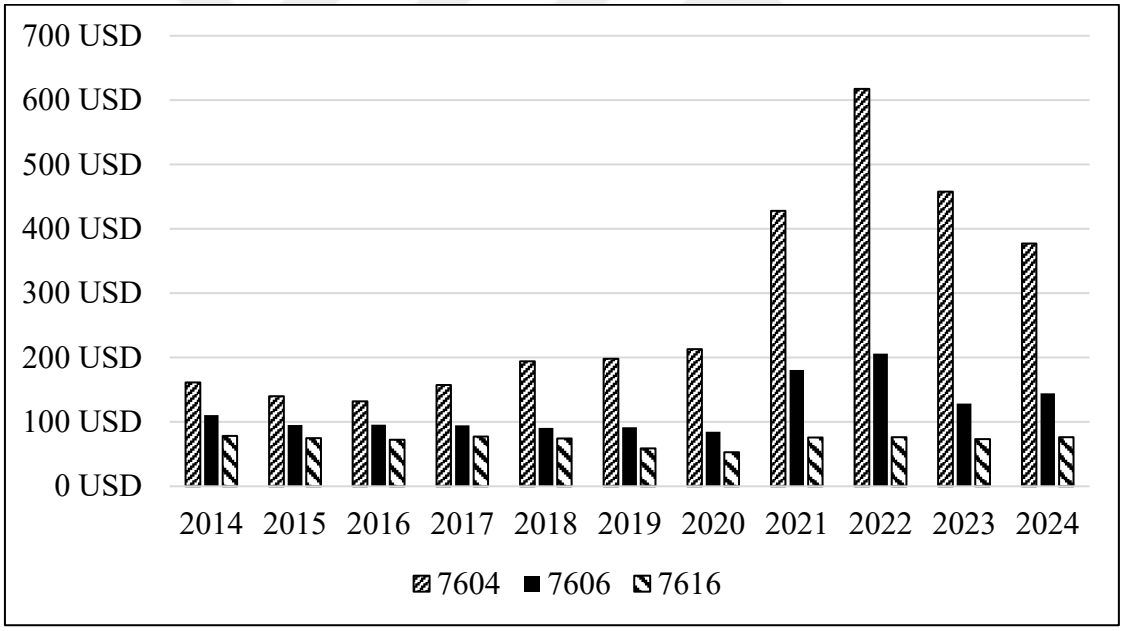


Figure 28. CBAM-Relevant TOP-3 Export Categories for the Aluminum Sector (Mio. USD, 2014-2024)

Source: TURKSTAT, 2025f.

Overall, a total export trade volume of approximately 6,2 billion USD was achieved in the related product categories on the basis of the relevant CBAM CN codes of the aluminum sector from Türkiye to Germany between 2014 and 2024 (TURKSTAT, 2025f). Furthermore, the Turkish export trade in the product classification groups *7604*,

7606 and *7616* to Germany from 2014 to 2024 resulted in about 5,2 billion USD, accounting for a share of 84,3 percent compared to the total.

In 2023, the export levels for the same product categories *7604*, *7606* and *7616* accounted for a value of 659,4 Mio. USD, representing a share of 84,3 percent in relation to the total of 782,2 Mio. USD originating from all export trade among the corresponding CN codes of the aluminum sector under the CBAM (TURKSTAT, 2025f). Taking into account the overall 2023 Turkish export trade levels in Turkish-German bilateral exchange of 18,8 billion USD and the aforementioned Turkish export levels in the TOP-3 product categories out of the relevant CN codes in the aluminum sector of 659,4 Mio. USD, they represent a share of approximately 3,5 percent (TURKSTAT, 2025c; 2025f).

In 2024, the export levels for the product categories *7604*, *7606* and *7616* represented an amount of 597,7 Mio. USD, representing a proportion of 84,5 percent of the total amount of 707,2 Mio. USD originating from the compiled export trade across the corresponding CN codes of the aluminum sector under the CBAM (TURKSTAT, 2025f). Considering the overall Turkish export trade results in Turkish-German bilateral exchange of 18,4 billion USD in 2024 and the aforementioned Turkish export levels in the TOP-3 product categories product categories *7604*, *7606* and *7616* in the aluminum sector of 597,7 Mio. USD, they exemplify a proportion of approximately 3,3 percent (TURKSTAT, 2025c; 2025f). The following subchapter further assesses the potential effect of the CBAM regulation on Turkish exports to Germany for the fertilizer industry by examining overall trade flows and in the context of the affected CN codes.

4.4.3 Fertilizer Sector

In accordance with the EU's *Regulation 2023/956*, the following goods have been determined to be affected by the CBAM as part of the fertilizer industry. The relevant CN codes are, again, summarized in Table 6 below.

Table 6. CN Codes of the Fertilizer Goods Affected by the CBAM

Industries/products affected by the CBAM	**CN codes**	**Direct emissions are considered only**
Fertilizers	28080000 2814	Indirect/Direct Indirect/Direct

	28342100 3102 3105	Indirect/Direct Indirect/Direct Indirect/Direct

Source: DIHK, 2024; European Union EUR-Lex, 2023a, Annex I & Annex II.

Considering the development of Turkish Exports to Germany in the scope of the CN codes between 2014 and 2024, again, a fluctuating development is recorded with an overall downward trend as displayed in Figure 29 below. Figure 29 shows the total fertilizer exports from Türkiyd to Germany between 2014 and 2024.

During the period 2014 to 2018 export levels drop substantially, from 13,4 Mio. USD in 2014 prior to hitting a low at 253 thousand USD in 2018 (TURKSTAT, 2025f). Between 2019 and 2020 trade levels developed positively reaching 6,6 Mio. USD in 2020 but still falling short of the export results in 2014. In 2021 exports again decrease to below 1,3 Mio. USD, followed by a slight recovery to about four Mio. USD in 2022. In the following year, levels moderately diminish to approximately two Mio. USD, although remaining above 2021 results. Export amounts further substantially decline in 2024, reaching 218,1 thousand USD and hence portraying the lowest results during the period 2014-2024. Overall, between 2014 and 2023, the linear trend of the export level's development is overall negative primarily due to the decline between 2014 and 2018 and the then fluctuating results leading up to another significant decrease in 2024.

As part of Turkish-German bilateral trade flow results, from Türkiye the fertilizer industry's export levels based on the CN codes relevant in the context of the CBAM accounted for a minor proportion of almost zero percent compared to overall Turkish-German bilateral trade in 2023 and 2024 (TURKSTAT, 2025c; 2025f). Moreover, the fertilizer industry's export activities from Türkiye amounted to close to zero percent of overall Turkish export trade in bilateral exchange activities between the two countries in 2023 and 2024. Whereas for the year 2024, this result further decreases to a share of close to zero percent.

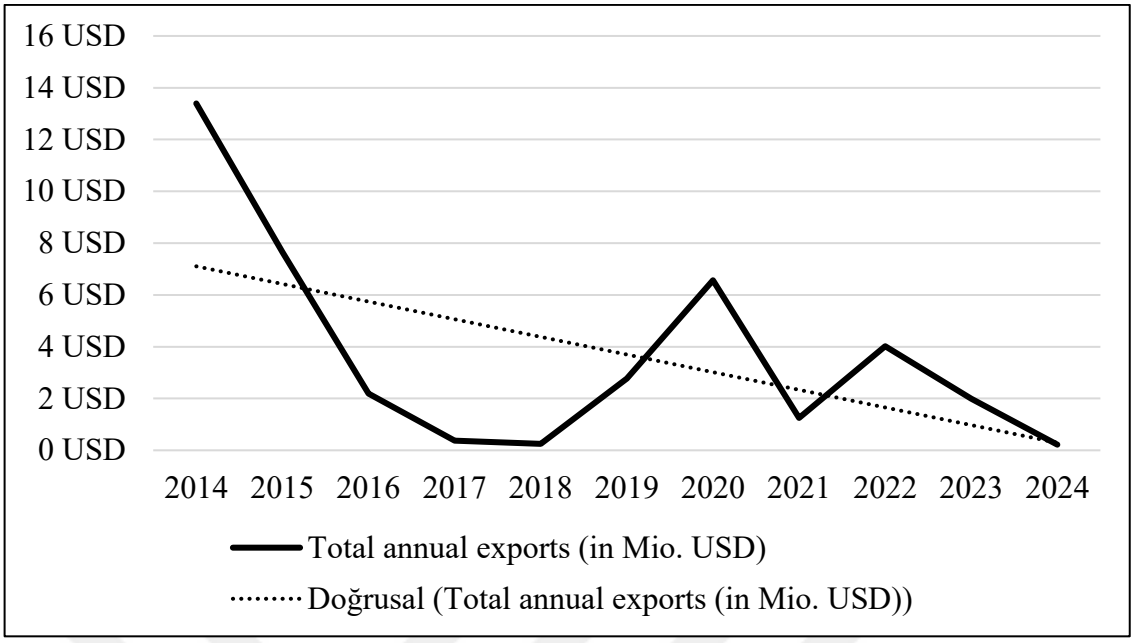


Figure 29. Total Fertilizer Export to Germany (Mio. USD, 2014-2024)

Source: TURKSTAT, 2025f.

Taking into account the product categories considered as part of the CBAM for the fertilizer industry, derived from the most recent Turkish export trade volumes, the TOP-3 can be determined, as shown in Figure 30. Figure 30 depicts the TOP-3 export categories for the fertilizer sector between 2014 and 2024. Based on the CN codes for the fertilizer industry and the export trade results, the products' classification groups *3102*, *2814* and *3105* represent the most significant product categories according to export trade volumes presented in USD between 2014 and 2024 (TURKSTAT, 2025f). Although, starting by 2017, export trade activities for the CN code *2814* have come to a stillstand in contrast to the high but diminishing volumes between 2014 and 2016. Furthermore, overall, the product category with the CN code *3102* on average leads the ranking of export trade results among the listed CN codes from the fertilizer sector throughout the mentioned time period.

The CN code *3102* stands for the category "*mineral or chemical nitrogenous fertilisers (excl. those in tablets or similar forms, or in packages with a gross weight*", which between 2014 and 2024 accounted for an overall Turkish export trade volume to Germany of more than 19,5 Mio. USD, making it the most significant product group (TURKSTAT, 2025f). Furthermore, the CN code *2814* representing "*ammonia, anhydrous or in aqueous solution*" ranks in second place with an overall outcome of about 18,1 Mio. USD from

2014 to 2024. Moreover, the CN code *3105* referring to "*mineral or chemical fertilizers containing two or three of the fertilizing elements nitrogen, phosphorus and potassium*" accounts for a volume in export trade of approximately 3,1 Mio. USD throughout the timeframe 2014 through 2024, with recurring yearly returns during the same period unlike the aforementioned two CN codes *3102* and *2814*.

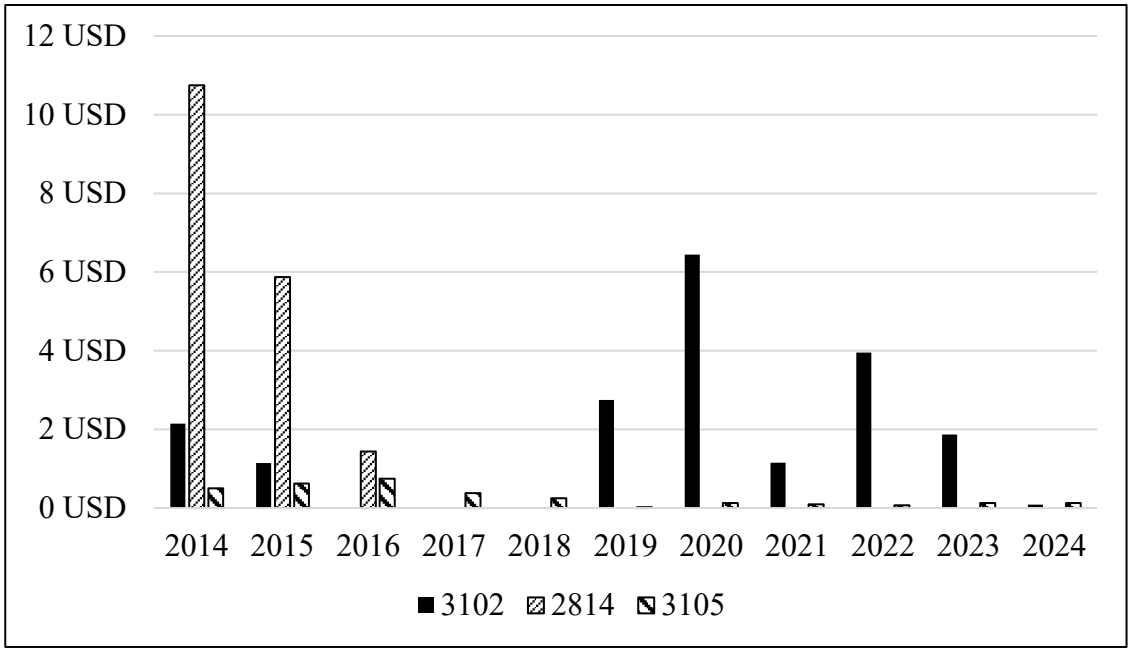


Figure 30. CBAM-Relevant TOP-3 Export Categories for the Fertilizer Sector (Mio. USD, 2014-2024)

Source: TURKSTAT, 2025f.

The course of the graph as seen in Figure 29 is particularly driven by the CN codes *3102* in 2014 and 2015 as well as from 2019 to 2023, *2814* between 2014 and 2016 and *3105* at comparably low levels throughout the whole period of time (TURKSTAT, 2025f). In 2020, the product category *3102* "*mineral or chemical nitrogenous fertilisers (excl. those in tablets or similar forms, or in packages with a gross weight*" reaches a peak at 6,4 Mio. USD in 2020 and achieves a mean value of approximately 2,2 Mio. USD between 2014 and 2024. From 2014 to 2016 the good *2814* "*ammonia, anhydrous or in aqueous solution*" substantially increased reaching its height at 10,8 Mio. USD in 2014. The average value for this good between 2014 and 2024 amounts to only six Mio. USD between 2014 and 2016. Although following the year 2016 up until 2024 no further export trade activity to Germany has been registered. Moreover, the CN code *3105* referring to "*mineral or chemical fertilizers containing two or three of the fertilizing elements*

nitrogen, phosphorus and potassium" achieved their best result at 749 thousand USD in 2016. The average export amount for the period 2014 to 2024 amounts to fairly low levels of about 280,2 thousand USD in comparison to the other two CN codes *3102* and *2814*.

All in all, a total Turkish export trade volume of approximately 40,7 Mio. USD was accomplished in the corresponding product categories on a CBAM CN code basis of the fertilizer industry to Germany between 2014 and 2024 (TURKSTAT, 2025f). Moreover, Turkish export trade levels to Germany in the product classification groups *3102*, *2814* and *3105* throughout 2014 and 2024 amounted to approximately 40,7 Mio. USD, accounting for a share of approximately 100 percent in relation to the total.

In 2023, the export levels for the same product categories *3102*, *2814* and *3105* resulted in a value of approximately two Mio. USD, with the product group *2814* accounting for zero returns (TURKSTAT, 2025f). This represents again a share of about 100 percent in relation to the total of approximately two Mio. USD originating from all export trade among the corresponding CN codes of the aluminum sector under the CBAM during that period. Taking into account the overall 2023 Turkish export trade levels in Turkish-German bilateral exchange of 18,8 billion USD and the aforementioned Turkish export levels in the TOP-3 product categories out of the relevant CN codes in the fertilizer sector of two Mio. USD, they represent an insignificant share of close to zero percent (TURKSTAT, 2025c; 2025f).

In 2024, the export levels for the CN Codes *3102*, *2814* and *3105* accounted for an amount of approximately 218,1 thousand USD, with the product group *2814* accounting for zero returns, again (TURKSTAT, 2025f). This stands for a proportion of 100 percent with reference to the total of 218,1 USD originating from the overall export trade among the corresponding CN codes of the aluminum sector under the CBAM. Considering the total Turkish export trade levels for the year 2024 in Turkish-German bilateral exchange amounting to 18,4 billion USD and the aforementioned Turkish export levels in the TOP-3 product categories out of the relevant CN codes for the fertilizer sector of 218,1 thousand USD, the results exemplify only a negligible proportion of close to zero percent, again (TURKSTAT, 2025c; 2025f). The following subchapter further assesses the potential effect of the CBAM regulation on Turkish exports to Germany for the cement industry by examining overall trade flows and in the context of the affected CN codes.

4.4.4 Cement Sector

In accordance with the EU's *Regulation 2023/956*, the following products have been determined to be affected by the CBAM as part of the cement industry. The relevant CN codes are, again, summarized in Table 7 below.

Table 7. CN Codes of the Cement Goods Affected by the CBAM

Industries/products affected by the CBAM	CN codes	Direct emissions are considered only
Cement	25070080	Indirect/Direct
	25231000	Indirect/Direct
	25232100	Indirect/Direct
	25232900	Indirect/Direct
	25233000	Indirect/Direct
	25239000	Indirect/Direct

Source: DIHK, 2024; European Union EUR-Lex, 2023a, Annex I & Annex II.

In context of the course of Turkish exports to Germany under the scope of the relevant CBAM CN codes between 2014 and 2024 the development is heterogenous as displayed in Figure 31, below. Between 2014 and 2019 overall exports remain fairly stable and at very low levels with a mean value of approximately 119 thousand USD, except for the year 2017 where results reached about 580 thousand USD (TURKSTAT, 2025f). Starting in 2020 export levels began to rise fundamentally amounting to 3,1 Mio. USD and achieving a peak at about 7,5 Mio. USD in 2021. In the following years, 2022 and 2023, levels again dropped significantly amounting to approximately 2,5 Mio. USD in 2022 and only 14,2 thousand USD in 2023. Throughout 2024, export amounts increased slightly reaching continued low results of 16,5 thousand USD. The linear trend of the export level development is overall positive between 2014 and 2024 primarily driven by the small peak in 2017 and the favorable results from 2020 to 2022 compared to prior levels.

In the context of Turkish-German bilateral trade flows in 2023, the Turkish cement industry's export results, taking into consideration only the CN codes relevant under the CBAM, accounted for a negligible share of overall Turkish-German bilateral trade in 2023 (TURKSTAT, 2025c; 2025f). Moreover, the cement industry's sole export activities to Germany resulted in a share of solely close to zero percent in relation to overall Turkish export trade in bilateral trade between the two countries in 2023, again. This trend continues throughout 2024.

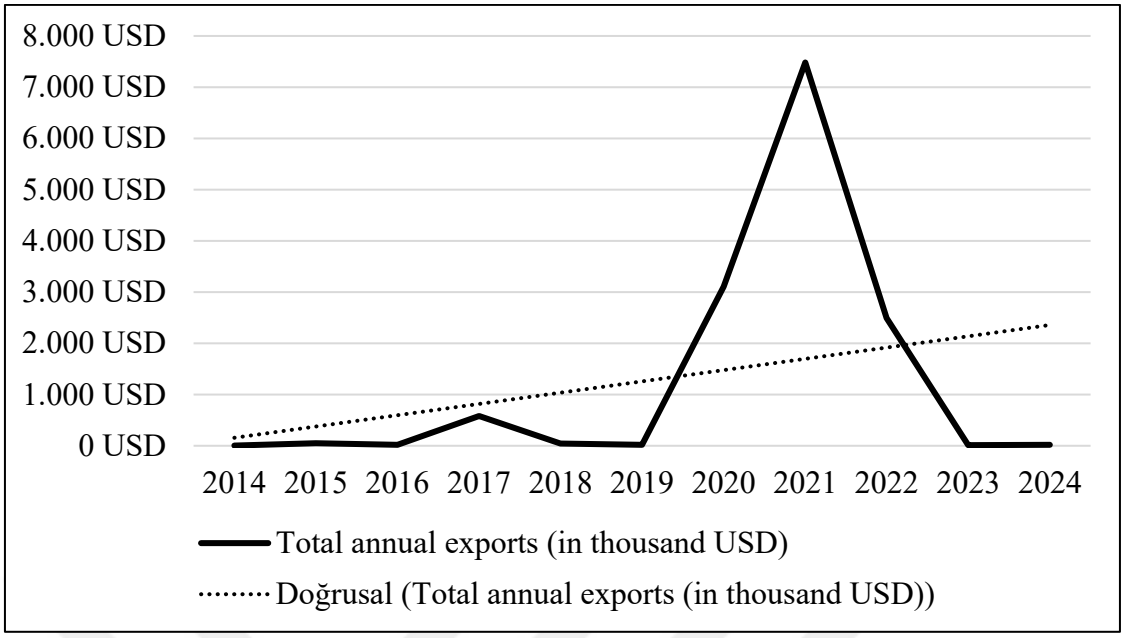


Figure 31. Total Cement Export to Germany (Thousand USD, 2014-2024)

Source: TURKSTAT, 2025f.

Considering the product categories regarded in the context of the CBAM for the cement industry, derived from the most recent Turkish export trade volumes, the TOP-3 can be concluded, as displayed in Figure 32. On the basis of the CN codes for the cement industry and the corresponding export trade results, the products' classification groups *25231000*, *25232100* and *25233000* in form of CN codes represent the most significant product categories according to export trade volumes presented in USD between 2014 and 2024 (TURKSTAT, 2025f). Although, overall, the product category with the CN code *25231000* by a large margin leads the ranking of total export trade levels among the listed CN codes from the cement sector throughout the above-determined time period.

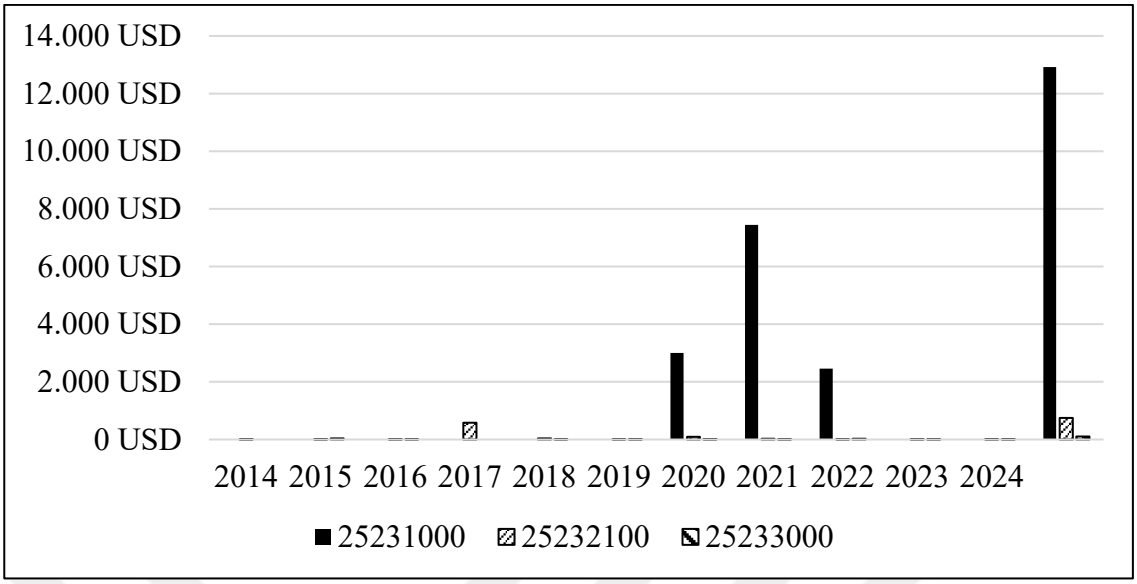


Figure 32. CBAM-Relevant TOP-3 Export Categories for the Cement Sector (Thousand USD, 2014-2024)

Source: TURKSTAT, 2025f.

The CN code *25231000* depicts the category "*cement clinkers*", which between 2014 and 2024 accounted for an overall export trade volume of approximately 12,9 Mio. USD, making it the most crucial product group in this sector (TURKSTAT, 2025f). Furthermore, the CN code *25232100* comprising the good "*white portland cement, whether or not artificially coloured*" is listed in second place with an overall export trade result of about 750,9 thousand USD throughout the timeframe 2014 to 2023. Furthermore, the CN code *25233000* representing the product category "*aluminous cement*", accounting for a small volume in export trade of approximately 99,4 thousand USD during the period 2014 to 2024.

The course of the graph as seen in Figure 31 is mainly determined by the CN codes *25232100* in 2017 and *25231000* between 2019 and 2022 (TURKSTAT, 2025f). In 2017, the good category *25232100* "*white portland cement, whether or not artificially coloured*" experiences a peak at 579,5 thousand USD with a mean value of 68,3 thousand USD between 2014 and 2024. On the other hand, from 2020 to 2022 the product category *25231000* "*cement clinkers*" substantially increased reaching its height at 7,4 Mio. USD in 2021. The average value for this good during the time period 2014 to 2024 amounts to only 1,4 Mio. USD. Furthermore, the CN code *25233000* "*aluminous cement*" remains at low export levels with a peak of 43,2 thousand USD in 2015 with an overall mean value

of about nine thousand USD. Between 2023 and 2024 export levels generally decreased substantially to overall approximately 21 thousand USD across the TOP-3 CN codes during the two-year period. The CN code *25231000* accounted for the majority of the export trade results (93,8 percent) in relation to the total of the TOP-3 CN codes during 2014 to 2024. Overall smaller contributions were made by the product category *25233000* (5,5 percent) and negligible export amounts (0,7 percent) occurred in connection with the CN Code *25232100* during the same period in relation to the total.

Overall, the total Turkish export trade volume to Germany amounted to approximately 13,8 Mio. USD for the related CBAM CN codes in the cement industry throughout the time period 2014 to 2024 (TURKSTAT, 2025f). At the same time, Turkish export trade levels in context of bilateral trade with Germany in the product classification groups *25231000*, *25232100* and *25233000* during the timeframe 2014 and 2024, also reached approximately 13,8 Mio. USD, therefore, almost covering 100 percent of the total.

In 2023, the export levels for the same CN Codes *25231000*, *25232100* and *25233000* resulted in a value of approximately 8,9 thousand USD (TURKSTAT, 2025f). This represents again a share of about 62,2 percent in relation to the total of approximately 14,2 thousand USD originating from all export trade across the corresponding CN codes of the cement sector relevant under the CBAM. Taking into account the overall 2023 Turkish export trade levels in Turkish-German bilateral exchange of 18,8 billion USD and the aforementioned Turkish export levels in the TOP-3 product categories of the corresponding CN codes in the cement sector of 8,9 thousand USD, they represent an insignificant share of close to zero percent (TURKSTAT, 2025c; 2025f).

On the other hand, in 2024, values increased with export levels for the CN codes *25231000*, *25232100* and *25233000* amounting to approximately 12,2 thousand USD (TURKSTAT, 2025f). Moreover, this equals a proportion of about 74 percent in relation to the total of approximately 16,5 thousand USD deriving from the overall export trade across the corresponding CN codes of the aluminum sector under the CBAM. Considering the total Turkish export trade results in 2024 in the context of Turkish-German bilateral exchange of 18,4 billion USD and the aforementioned Turkish export levels in the TOP-3 product categories of the corresponding CN codes in the cement sector of 12,2 thousand USD, they stand for a negligible proportion of close to zero

percent (TURKSTAT, 2025c; 2025f). The following subchapter focuses on the potential effects of the CBAM on Turkish exports to Germany in the iron and steel and aluminum sectors. Furthermore, the prospective additional costs on a CN code and sectoral basis are calculated and assessed.

4.5 Potential Effects of the Carbon Border Adjustment Mechanism on Turkish Exports

As of the following assessment only the iron and steel as well as aluminum sectors are considered. According to the overview of the impact concerning the CBAM-relevant sectors in the context of export volumes to the EU by the 20 most vulnerable nations with regard to their total export sums in billion USD in 2019 have been identified as shown in Figure 3 (United Nations Conference on Trade and Development, 2021). The graph in Figure 3 emphasizes that in the context with Türkiye the iron and steel and aluminum sectors will be most affected by the application of the CBAM. Furthermore, considering the export trade results in the CBAM-relevant sectors between 2014 and 2024 as assessed in the subchapter 5.4 the outcome shows that the iron and steel and aluminum sectors account for substantial trade volumes in Turkish export trade (also see Figure 23). The cement and fertilizer sectors on the other hand represent significantly lower shares in connection to trade outcomes. Hence, the potential economic impact on an overall bilateral trade basis remains comparably small. In conclusion, as part of the detailed assessment regarding the potential effects of the CBAM on Turkish exports to Germany the focus lies on the iron and steel as well as aluminum sectors.

As part of this thesis the aim is to assess the potential effect of the CBAM on German-Turkish trade activities, in particular Turkish exports. The corresponding target of the research is to study the prospective cost effects of Turkish export trade with Germany in in selected industries relevant under the framework of the CBAM in accordance with the predetermined CN codes (also see Table 1). Hereby, the aim is to calculate the potential additional cost added to a product's price exported from Türkiye to Germany through the required consideration of the added cost of carbon permits for importers in the EU. As the iron and steel as well as aluminum sectors stand for the majority of Turkish export trade activity with Germany among the industries relevant under the CBAM, the assessment will focus on the aforementioned sectors only.

For the calculation of additional yearly costs on a product basis the amount of the good(s) in tons, the carbon intensity as well as the price for CBAM certificates.

Scholars Assous et al. (2021) and Simola (2021) have proposed the following formula:

$$exp_{Türkiye} * CI_{good} * P_{CBAMC}$$

As part of the formula $exp_{Türkiye}$ stands for the Turkish export trade with Germany measured in tons on product basis considering the corresponding CN codes. The Turkish export trade results in 2024 for the CBAM-related CN codes in the iron and steel as well as aluminum sectors form the basis for the assessment. *CI* represents the carbon intensity of a good given in ton CO_2e/ton goods (tCO_2e/t). Furthermore, P_{CBAMC} stands for the pricing of CBAM permits/EU ETS carbon permits in USD per ton.

The European Commission has published predefined values in tCO_2e/t to be used during the transition phase of the CBAM leading up to December 31, 2025 (European Commission - Directorate-General for Taxation and Customs Union, 2023). The given predefined values are valid with no relation to the place of origin of any product. Starting by 2026, a different collection of default rates is set to be enforced and established by a corresponding implementing act up for approval in 2025. These rates are intended to reflect the mean carbon intensity levels of individual export nations and further raised through proportionally drafted surcharge. In addition, through an assessment by the Joint Research Centre of the European Commission in form of a technical report emission' intensity levels for the iron and steel, fertilizer, aluminum and cement sectors in the context of the EU's primary counterparts in the exchange of goods have been determined on a country-basis (Vidovic et al., 2023). The emission' intensity levels provided are given on the basis of the CN Codes relevant under the CBAM and for the countries affected in tCO_2e/t. The rates are presented in form of indirect and direct emissions as well as in sum. Both the determined country-based values and the default values are considered as part of this research.

Locally, the cost of carbon already settled before exporting a product to the EU market and complimentary quotas under the scope of the EU ETS are subtracted from the amount required to be submitted to the EU (European Bank for Reconstruction and Development et al., 2023; Lee, 2022; Simões, 2024). Although, as the distribution of free permits is set

to be gradually discontinued under the scope of the EU ETS between 2026 to 2034, amounts of potential free emission permits are not considered in this assessment (European Union EUR-Lex, 2003; European Bank for Reconstruction and Development et al., 2023, p. 7; European Commission - Directorate-General for Taxation and Customs Union, 2024; Simões, 2024; Simola, 2021). The price for CBAM certificates will be connected to the price of permits under the EU ETS (European Bank for Reconstruction and Development et al.; 2023). In regard of the CBAM, over time, the introduction of the CBAM factor, a coefficient, is expected to be conducted, continuously lowering the levels of free permits available in connection to the manufacturing of product's associated with the CBAM (European Union EUR-Lex, 2003, (Article 10a(1a)); 2023c; 2023d).

For the assessment under this thesis cost scenarios of 80 USD and 100 USD are applied for the corresponding CBAM certificates determining the additional cost to be covered by the EU importing party. For the calculations conducted as part of this research on a sector-based level the monthly export volumes from Türkiye to Germany on a four-digit CN code base were considered. The following subchapter focuses on the cost assessment in connection with the CBAM regulation for the iron and steel sector using the corresponding export trade date from 2019 to 2024 as well as the above-mentioned 80 USD or 100 USD emission cost scenarios in combination with the CBAM default values or regional rates in place of the emission coefficient.

4.5.1 Iron and Steel Sector

In the following the iron and steel sector is further assessed concerning the potentially inclined additional CBAM costs. Table 8 shows the total of potential additional cost through the CBAM regulation applying the 80 USD and 100 USD emission cost scenarios on a four-digit CN code basis using the data of German-Turkish bilateral trade in 2024. In the context of the iron and steel sector the assessment shows a significant cost increase for the corresponding exports from Türkiye. Applying the 100 USD price scenario the highest result is achieved in the context of the regional emission intensity levels amounting to 81,5 Mio. USD in 2024 (TURKSTAT, 2025b). This result represents a share of 8,6 percent in relation to the total trade volume of 941,7 Mio. USD across the relevant CN codes in the iron and steel sector for the same year. In the context of the 80

USD price scenario, again, the primary outcome is achieved for the provided regional rates equaling to 65,2 Mio. USD in 2024.

This result portrays a proportion of 6,9 percent in respect to the total trade volume of 941,7 Mio. USD across the relevant CN codes in the iron and steel sector for the same year (TURKSTAT, 2025b). Overall, the results show no substantial difference between the outcomes in the context of the provided default rates and regional values. Across the relevant CN codes in the iron and steel sector on a four-digit CN code basis the average percentage share of the additional cost in relation to the total trade volume in the individual product category is twelve percent for the 100 USD scenario and nine percent for the 80 USD scenario using the regional emission intensities. In respect to the default rates the average percentage share of the additional cost in relation to the total trade volume in the individual product category represents twelve percent under the 100 USD case and ten percent for the 80 USD scenario.

Table 8. Sum of Additional CBAM Cost (in USD, 2024)

Regional rates/100 USD	**Default rates/100 USD**	**Regional rates/80 USD**	**Default rates/80 USD**
81.449.990,67	81.098.906,29	65.159.992,53	64.879.125,03

Source: TURKSTAT, 2025b.

Considering the percentage share in relation to the total trade volume on an individual product (CN code) basis the rates range between approximately a minimum of zero and a maximum of 27,4 percent in both scenarios, when using the default or country-based rates (TURKSTAT, 2025b). The individual shares are calculated dividing the costs by the total export volume achieved for that CN code the same year.

In the context of the default rates in the 80 USD scenario the highest share can be found at 21,9 percent for the CN code *7206* "*Iron and non-alloy steel in ingots or other primary forms (excl. remelting scrap ingots, products obtained by continuous casting and iron of heading 7*", followed by the CN code *7214* "*Bars and rods, of iron or non-alloy steel, not further worked than forged, hot-rolled, hot-drawn or hot-extruded, but incl. those twisted after rolling*" with a percentage share of 20,6 percent (TURKSTAT, 2025b). The CN code *7209* "*Flat-rolled products of iron or non-alloy steel, of a width of >= 600 mm, cold-rolled "cold-reduced", not clad, plated or coated*" accounts to 18,1 percent, the

product group *7207* "*Semi-finished products of iron or non-alloy steel*" at 17,9 percent and the CN code *7205* "*Granules and powders of pig iron, spiegeleisen, iron or steel*" amounts to 17,9 percent. The CN codes are listed in third and fourth places at around 18 percent. In fifth place is the CN code *7306 "Tubes, pipes and hollow profiles "e.g., open seam or welded, riveted or similarly closed", of iron or steel (excl. of cast iron, seamless tubes and pi"* at 17,2 percent. The Top-5 CN codes in this scenario account for an export volume of 81,3 Mio. USD and an additional CBAM cost of 14,3 Mio. USD. In the 100-USD-scenario the relative price effect is further reinforced with the CN code *7206* reaching a result of 27,4 percent, the CN code *7214* equaling 25,8 percent and the CN code *7209* standing for 22,6 percent. Furthermore, sharing the fourth rank *7205* and *7207* both at 22,3 percent, followed by *7211 "Flat-rolled products of iron or non-alloy steel, of a width of < 600 mm, hot-rolled or cold-rolled "cold-reduced", not clad, plated or coated"* at 21 percent. The Top-5 CN codes in this scenario account for an export volume of about 17 Mio. USD and an additional CBAM cost of about four Mio. USD.

In 2024, in the context of the country-based rates in the 80 USD scenario the highest share can be found at 21 percent for the CN code *7214* "*Bars and rods, of iron or non-alloy steel, not further worked than forged, hot-rolled, hot-drawn or hot-extruded, but incl. those twisted after rolling*", followed by the CN code *7207* "*Semi-finished products of iron or non-alloy steel*" with a percentage share of 18,7 percent (TURKSTAT, 2025b). The CN code *7206* "*Iron and non-alloy steel in ingots or other primary forms (excl. remelting scrap ingots, products obtained by continuous casting and iron of heading 7*" is ranked in third place at 17,8 percent, followed by *7209* ranking fourth at 17,3 percent and CN code *7306* at 16,7 percent in fifth place. The Top-5 CN codes in this scenario account for an export volume of 88,1 Mio. USD and an additional CBAM cost of 12,9 Mio. USD.

In the country-based 100 USD scenario the price effect is further heightened with the CN code *7214* reaching a result of 26,3 percent, the CN code *7207* equaling 23,4 percent and the CN codes *7206* accounting for 22,2 percent. Followed by *7209* "*Flat-rolled products of iron or non-alloy steel, of a width of >= 600 mm, cold-rolled "cold-reduced*" standing for 21,6 percent in fourth and *7306* at 20,8 percent in fifth place. The Top-5 CN codes in this scenario account for an export volume of 79,1 Mio. USD and an additional CBAM cost of 16,1 Mio. USD.

The CN codes *7318* "*Screws, bolts, nuts, coach screws, screw hooks, rivets, cotters, cotter pins, washers, incl. spring washers, and similar articles, of iron or steel*", *7326* "*Articles of iron or steel, n.e.s. (excl. cast articles)*" and *7308* "*Structures and parts of structures "e.g., bridges and bridge-sections, lock-gates, towers, lattice masts, roofs, roofing frameworks, doors and windows*" make up the TOP-3 in regard to the corresponding trade volumes in USD in 2024 (TURKSTAT, 2025b). In the category *7318* the applied default rates in the 80 USD and 100 USD scenarios result in a 2,2 percent and 1,8 percent shares in relation to the total trade volumes in 2024. In the context of the country-based emission levels for the two scenarios outcomes depict similar percentage shares at 2,1 percent and 2,6 percent, respectively. Hence, the effect is minor in comparison to the total trade volumes achieved.

For the CN code *7326* the default rates applied in the context of the 80 USD and 100 USD scenarios achieve a proportional outcome of 4,5 and 5,6 percent, respectively (TURKSTAT, 2025b). When using the country-based emission levels for the calculations the outcome for the 80 USD and 100 USD cases amount to 4,8 percent and six percent, accordingly. The price effect of the additional emissions costs is higher compared to the aforementioned CN code but still at a moderate level. In the category *7308* the used default rates in the 80 USD and 100 USD scenarios result in 8,8 percent and eleven percent share in relation to the total trade volumes in 2024. In the context of the country-based emission levels for the two scenarios outcomes depict similar percentage shares at 8,8 percent and 11,1 percent, respectively. Here, the emission cost has a more noticeable price effect on the export volumes from Türkiye to Germany.

Based on the two scenarios provided for the emission values, the default values and the regional rates, and the CBAM cost scenarios a total expense for the period 2019 to 2024 can be estimated as displayed in Figure 33. The results consider the trade volumes of the CN codes affected under the CBAM between the years 2019 to 2024. Applying the underlying formula described above for calculating the inclined CBAM costs the regional and default emission values are used alongside with the 80 USD and 100 USD cost scenario concerning the CBAM certificates. The CBAM costs naturally rise with the increase in Turkish exports to Germany explaining the increase in value in 2021 and 2022 in comparison to the previous and following annual results. The scenario applying the regional emission rates in connection with the 100 USD cost scenario showcases the

highest outcomes on average with a peak in 2022 at 107,3 Mio. USD, followed by the results using the same cost scenario in combination with the default emission values reaching its maximum at 106,3 Mio. USD the same year (TURKSTAT, 2025b). The order remains the same also when applying the 80 USD cost scenario in connection with the regional emission rates and default emission values, reaching its peak at 85,8 Mio. USD and 85 Mio. USD respectively in 2022.

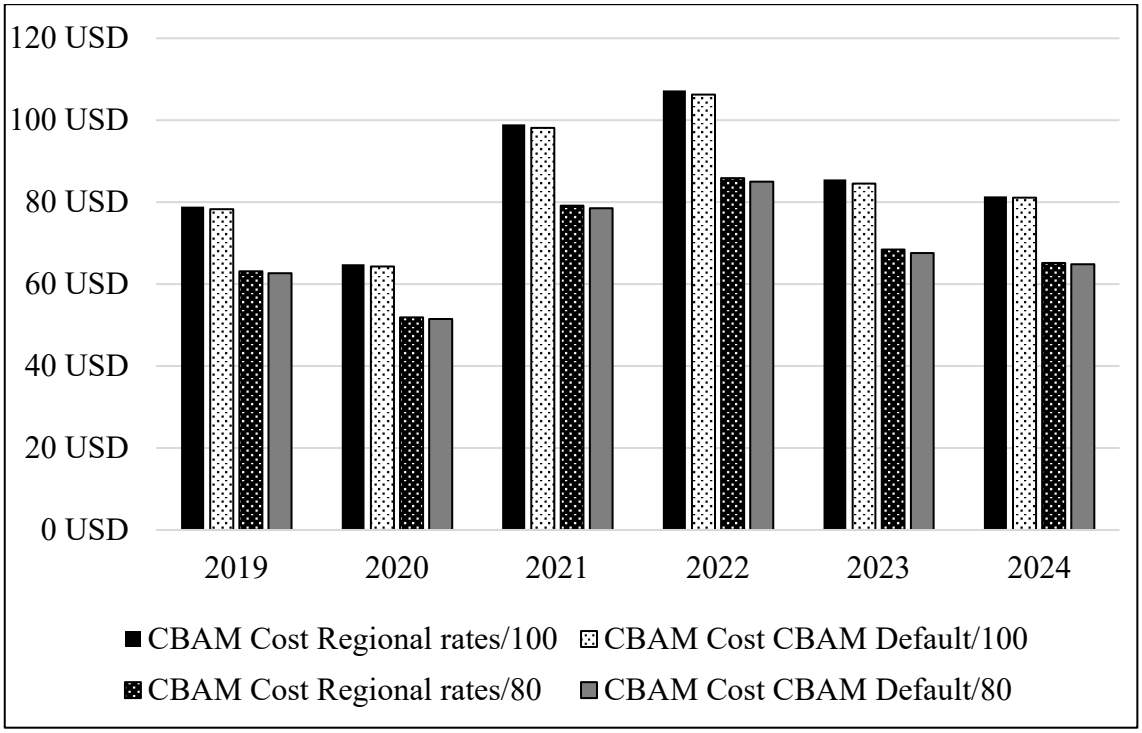


Figure 33. Sum of Annual CBAM Cost on a Scenario Basis (Mio. USD, 2019-2024)

Source: TURKSTAT, 2025b.

To assess the inclined CBAM cost its results may be compared with the overall annual export trade volumes, calculating the share of the scenario-based CBAM costs in relation to total exports annually. Considered here are the results to the CBAM-relevant CN codes of that sector. The corresponding results are displayed in Figure 34 below. The highest results are again achieved for the regional rates applied as underlying emission levels in combination with the 100 USD scenario in connection with the CBAM certificates, followed by the outcomes in the context of the default values in combination with the same cost scenario for CBAM certificates (TURKSTAT, 2025b). The same order applies when using the 80 USD scenario. In 2019, the peak is achieved for the regional rates in relation to the 100 USD scenario amounting to 12,5 percent and in connection with the

default values reaching 12,4 percent. In the 80 USD scenario the proportions account for ten percent and 9,9 percent in the context of the regional rate and default values respectively the same year.

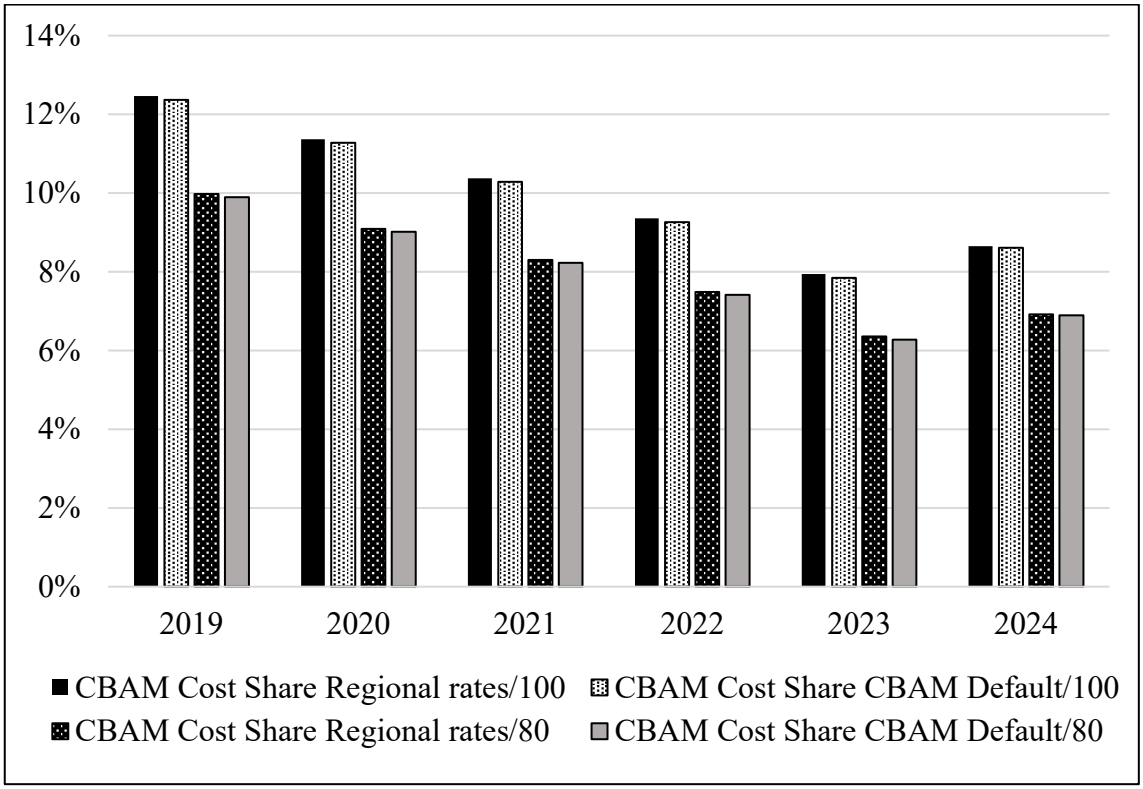


Figure 34. Annual CBAM Cost Share Relative to Overall Annual Trade Volumes on a Scenario Basis (in Percent, 2019-2024)

Source: TURKSTAT, 2025b.

Across all relevant four-digit CN codes the average rates for the additional CN code related CBAM cost in relation to the total yearly trade volume on a CN code basis between 2019 and 2024 are as depicted according to their share in percentage in Table 9 below. The individual shares per CN code are calculated dividing the costs by the total export volume achieved for that CN code the same year. Again, the highest shares among all the different scenarios are achieved in 2019, followed by the year 2020. In 2021 the outcomes continue to decrease and do so until 2023 (TURKSTAT, 2025b). The lowest results occur during 2022. Following 2023, 2024 levels grow again slightly. Overall, it must be noted that the percentage range on an annual product basis shows clear outliers. Although their individual contribution to the overall export volume to Germany is relatively less significant than that of the TOP-3 export categories some CN codes

demonstrate cost shares exceeding 20 percent in the relation to the total annual export trade. In general, when considering the relative shares, the change in price per ton for a product and its potentially decreasing impact on the relative percentage proportions of additional CBAM costs compared to the total export volume should be considered.

Table 9. Annual Average Rates of CBAM Costs Across CBAM-Relevant CN Codes (in Percent, 2019-2024)

Year	Regional rates/100 USD	Default rates/100 USD	Regional rates/80 USD	Default rates/80 USD
2019	16,8%	17,3%	13,4%	13%
2020	16%	16,4%	12,8%	12,7%
2021	12,2%	12,4%	9,8%	9,7%
2022	10,6%	11%	8,8%	8,6%
2023	10,9%	12,7%	8,8%	10%
2024	11,8%	12,3%	9,5%	9,7%

Source: TURKSTAT, 2025b.

The default values regarding the emission coefficients are obtained using the global average on a CN code basis. The greater the added costs in the context of default values are, compared to regional rates the higher the additional costs are globally compared to local values.

In this context, considering the scenario of regional rates results in connection with a CBAM certificate pricing of 100 USD, the added cost result in about 517 Mio. USD between 2019 and 2024 (TURKSTAT, 2025b). In terms of default values in combination with a CBAM certificate pricing of 100 USD the outcome accounts for 512,6 Mio. USD during the same time period. For the Turkish iron and steel sector this implies a disadvantage in global comparison. Regarding the percentage share of added costs on a scenario-basis divided by the overall annual export volume, in the context of regional rates and 100 USD pricing for CBAM certificates, the corresponding shares result in on average ten percent between 2019 and 2024. On the other hand, applying the default values and the 100 USD pricing scenario the average accounts for 9,9 percent. The results indicate a cost disadvantage.

The most-selling product categories in Turkish exports to Germany include CN codes *7318*, *7326* and *7308* in the steel and iron sector. In the context of the iron and steel industry the outcome for the CN code *7318* in connection with regional rates and the 100

USD CBAM certificate pricing scenario results in 63,7 Mio. USD (TURKSTAT, 2025b). Moreover, applying default values jointly with the same pricing scenario the result is 65,4 Mio. USD. In the context of CN code *7326* the regional rates in connection with the 100 USD pricing scenario account for 95 Mio. USD. Furthermore, the default values generate a result of 89,1 Mio. USD. The CN code *7308* linked to the regional rates, and the 100 USD pricing scenario equals to 69,9 Mio. USD and in the context of the default values to 69,3 Mio. USD.

Considering the cost impact for the TOP-3 Turkish export goods in the iron and steel sector CBAM costs differ across the CN codes *7318* "*Screws, bolts, nuts, coach screws, screw hooks, rivets, cotters, cotter pins, washers, incl. spring washers, and similar articles, of iron or steel*", *7326* "*Articles of iron or steel, n.e.s. (excl. cast articles)*" and *7308* "*Structures and parts of structures "e.g., bridges and bridge-sections, lock-gates, towers, lattice masts, roofs, roofing frameworks, doors and windows*". Overall, the highest CBAM costs in relation to the total annual trade volume are recorded for the CN code *7308* with an average share of 9,9 percent across all scenarios in 2024 (TURKSTAT, 2025b). Listed in second place is the CN code *7326* with a substantially lower average value of 5,2 percent across all scenarios the same year. Finally, the CN code *7318* accounts for the lowest average result with a proportion outcome of 3,7 percent in 2024. Compared to the average shares of CBAM costs in relation to the overall export volumes across the different scenarios between 2019 to 2024 the TOP-3 Turkish export categories remain below the total average outcomes.

Overall, the inclined CBAM costs for the CN code *7326* are the highest amounting to a total of 330,6 Mio. USD between 2019 and 2024 (TURKSTAT, 2025b). Figure 35 and Table 10 state the development of CBAM costs between 2019 and 2024. Furthermore, Table 10 provides a detailed overview of the individual CBAM cost outcomes across the various scenarios applying different cost and emission coefficient values.

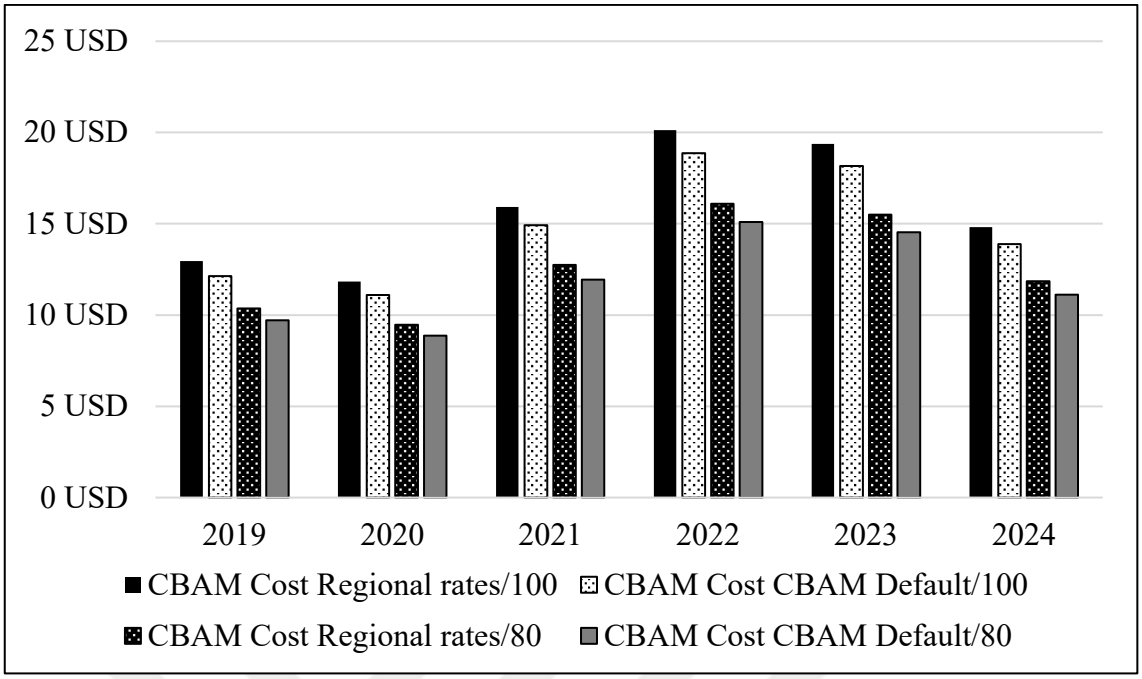


Figure 35. Annual CBAM Cost on a Scenario Basis for CN Code *7326* Between 2019 and 2024 (Mio. USD, 2019-2024)

Source: TURKSTAT, 2025b.

The costs are overall highest for the emission cost scenario of 100 USD in connection with the regional emission coefficient rates peaking at 20,1 Mio. USD in 2022 (TURKSTAT, 2025b). On average for this scenario the average value amounts to 15,8 Mio. USD during the time period 2019 to 2024. For the scenario of regional rates applied in connection with the cost scenario of 80 USD the highest result occurs at 16,1 Mio. USD in 2022. The corresponding average value amounts to 12,7 Mio. USD during the period 2019 to 2024. Applying the default values in connection with the 100 USD CBAM certificate pricing the costs peak at 18,9 Mio. USD in 2022. In this context, the corresponding average results in 14,8 Mio. USD for the period 2019 to 2024. Finally, using the default values in combination with the 80 USD pricing assumption the cost heightens at 15,1 Mio. USD in 2022. The average value equals to 11,9 Mio. USD for the period 2019 to 2024.

During the period 2019 to 2020 the results are lowest due to comparably low export volumes (TURKSTAT, 2025b). The increase in exports to Germany following 2020 leads to an increase in CBAM costs. In 2024, in line with declining export trade to Germany in this product category CBAM costs overall decrease. Between 2019 and 2014 the average

value of CBAM cost amounts to 13,8 Mio. USD across all scenarios, making it the category with the highest overall CBAM costs among the TOP-3 export product categories. Furthermore, for the 100 USD scenarios the combined average value equals to 15,3 Mio. USD and for a pricing of 80 USD amounts to 12,3 Mio. USD between 2019 and 2024.

Table 10. Annual CBAM Cost on a Scenario Basis for CN Code *7326* (Mio. USD, 2019-2024)

Year	CBAM Cost Regional rates/100	CBAM Cost CBAM Default/100	CBAM Cost Regional rates/80	CBAM Cost CBAM Default/80
2019	12.949.488,00 USD	12.140.145,00 USD	10.359.590,40 USD	9.712.116,00 USD
2020	11.838.390,48 USD	11.098.491,08 USD	9.470.712,38 USD	8.878.792,86 USD
2021	15.923.962,08 USD	14.928.714,45 USD	12.739.169,66 USD	11.942.971,56 USD
2022	20.123.858,88 USD	18.866.117,70 USD	16.099.087,10 USD	15.092.894,16 USD
2023	19.383.916,56 USD	18.172.421,78 USD	15.507.133,25 USD	14.537.937,42 USD
2024	14.816.439,12 USD	13.890.411,68 USD	11.853.151,30 USD	11.112.329,34 USD

Source: TURKSTAT, 2025b.

Table 11 shows the annual CBAM cost in relation to total export trade from Türkiye to Germany for the CN code *7326* during the period 2019 to 2024. Overall, the cost scenario in the context of regional rates is higher compared to the CBAM default values (TURKSTAT, 2025b). Lower export volumes are generally connected to a higher percentage share of CBAM costs in relation to the total trade. The effect of the cost for a CBAM certificate directly affects the share in comparison to the total annual export value. For the CN code *7326* the respective costs represent single digit shares below ten percent. The individual shares are calculated dividing the costs by the total export volume achieved for that CN code the same year. For the outcomes assuming a CBAM certificate pricing of 100 USD the percentage rates are slightly higher (average: 6,9 percent) relative to the ones connected to the lower CBAM certificate cost of 80 USD (average: 5,5 percent). Considering the regional rates as the underlying scenario for the 100 USD case the average percentage amounts to 7,1 percent for the period 2019 to 2024 whereas for the 80 USD pricing scenario the average amounts to 5,7 percent. Furthermore, assessing the CBAM default scenarios of 100 USD and of 80 USD the averages account for 6,7 percent and 5,3 percent, respectively. In comparison to the other CN codes out of the TOP-3 export product categories the CN code *7326* represents the second lowest values

with an overall average of 6,2 percent. This results also positions the product category below the sectoral proportional average of nine percent.

Table 11. Annual CBAM Cost in Relation to Total Yearly Export Trade for CN Code *7326* (in Percent, 2019-2024)

Year	CBAM Cost Regional rates/100	CBAM Cost CBAM Default/100	CBAM Cost Regional rates/80	CBAM Cost CBAM Default/80
2019	8,4%	7,9%	6,8%	6,3%
2020	8%	7,5%	6,4%	6%
2021	7%	6,6%	5,6%	5,3%
2022	7%	6,5%	5,6%	5,2%
2023	6,3%	5,9%	5%	4,7%
2024	6%	5,6%	4,8%	4,5%

Source: TURKSTAT, 2025b.

The total CBAM costs for the CN code *7308* account for 250,5 Mio. USD, ranking it in second place among the TOP-3 export categories between 2019 and 2024 (TURKSTAT, 2025b). Figure 36 and Table 12 state the development of CBAM costs between 2019 and 2024. Furthermore, Table 12 provides a detailed overview of the individual CBAM cost outcomes across the various scenarios applying different cost and emission coefficient values.

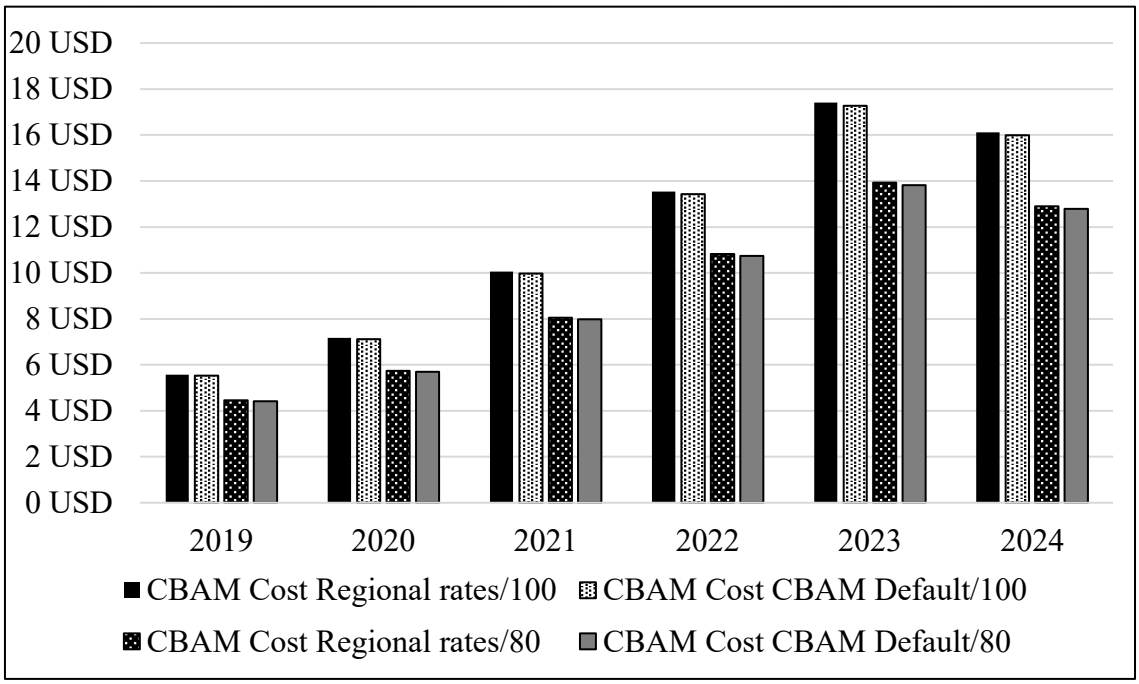


Figure 36. Annual CBAM Cost on a Scenario Basis for CN Code 7308 (Mio. USD, 2019-2024)

Source: TURKSTAT, 2025b.

The costs are overall highest for the emission cost scenario of 100 USD connected to the regional emission coefficient rates peaking at 17,4 Mio. USD in 2023 (TURKSTAT, 2025b). This result is connected to the comparably increased export trade results in this category that year. For this scenario during the time period 2019 to 2024 the average value amounts to 11,6 Mio. USD. For the scenario of regional rates applied in connection with a cost of 80 USD the highest result also occurs in 2023 at 13,9 Mio. USD. The corresponding average is 9,3 Mio. USD during the period 2019 to 2024. Using the default values in connection with the 100 USD CBAM certificate pricing the costs also peak in 2023 at 17,3 Mio. USD. Here, the connected average for the time period 2019 to 2024 is 11,6 Mio. USD. Finally, using the default values in combination with the 80 USD pricing assumption the cost again peaks in 2023 at 13,8 Mio. USD. The average value amounts to 9,2 Mio. USD during 2019 to 2024.

Overall, it must be noted that the difference between CBAM costs using the default values or regional values as the corresponding emission coefficient only slightly vary (TURKSTAT, 2025b). During the period 2019 to 2022 the overall CBAM costs are lowest due to diminished but with time increasing export trade with Germany for the CN code *7308*. Following the peak in 2023, export volumes decrease while also CBAM costs diminish in 2024. Between 2019 and 2024 the total cost across all scenarios amounts to 10,4 Mio. USD, placing it in second place among the TOP-3 export categories. For the 100 USD scenarios the combined average value amounts to 11,6 Mio. USD and for the 80 USD pricing case to 9,3 Mio. USD between 2019 and 2024.

Table 12. Annual CBAM Cost on a Scenario Basis for CN Code *7308* (Mio. USD, 2019-2024)

Year	CBAM Cost Regional rates/100	CBAM Cost CBAM Default/100	CBAM Cost Regional rates/80	CBAM Cost CBAM Default/80
2019	5.568.814,70 USD	5.523.904,91 USD	4.455.051,76 USD	4.419.123,93 USD
2020	7.176.994,51 USD	7.119.115,52 USD	5.741.595,61 USD	5.695.292,42 USD
2021	10.056.164,90 USD	9.975.066,79 USD	8.044.931,92 USD	7.980.053,43 USD
2022	13.536.482,32 USD	13.427.317,14 USD	10.829.185,86 USD	10.741.853,71 USD
2023	17.414.768,32 USD	17.274.326,64 USD	13.931.814,66 USD	13.819.461,31 USD
2024	16.117.076,82 USD	15.987.100,40 USD	12.893.661,46 USD	12.789.680,32 USD

Source: TURKSTAT, 2025b.

Table 13 depicts the yearly CBAM cost in relation to the total yearly export trade volume from Türkiye to Germany for the CN code *7308* between 2019 and 2024. The shares are

calculated dividing the costs by the total export volume achieved for that CN code the same year. Here, CBAM default values and regional rates lead to similar outcomes although the latter represents higher results (TURKSTAT, 2025b). Depending on the scenario shares are clustered around the ten percent mark with an average of 10,4 percent for a CBAM certificate pricing of 100 USD to be paid by the importer. In the context of the 80 USD CBAM certificate pricing case percentage shares remain below the ten percent mark with an average value of 8,3 percent. Regarding the regional rates as the underlying scenario for the 100 USD case the average percentage amounts to 10,4 percent for the period 2019 to 2024 whereas for the 80 USD pricing scenario the corresponding average accounts for 8,3 percent. Furthermore, concerning the CBAM default cases of 100 USD and of 80 USD the connected averages amount to 10,3 percent and 8,2 percent, respectively. The percentage shares in this product category are the highest among the TOP-3 export categories and account for an overall mean value of 9,3 percent. This indicates a relatively increased proportion of carbon emissions being released during the production process for this CN code positioning it above the sectoral average of nine during the period 2019 to 2024.

Table 13. Annual CBAM Cost in Relation to Total Annual Export Trade for CN Code *7308* (in Percent, 2019-2024)

Year	CBAM Cost Regional rates/100	CBAM Cost CBAM Default/100	CBAM Cost Regional rates/80	CBAM Cost CBAM Default/80
2019	11,2%	11,1%	8,9%	8,9%
2020	9,2%	9,1%	7,3%	7,3%
2021	10,8%	10,7%	8,6%	8,6%
2022	10,3%	10,3%	8,3%	8,2%
2023	9,7%	9,7%	7,8%	7,7%
2024	11,1%	11%	8,8%	8,8%

Source: TURKSTAT, 2025b.

In third place with a recorded total CBAM cost of 232,5 Mio. USD for the period 2019 to 2024 is the CN code *7318* out of the TOP-3 export trade categories (TURKSTAT, 2025b). Figure 37 and Table 14 below state the development of CBAM costs between 2019 and 2024. Table 14 provides a detailed overview over the individual CBAM costs across the various scenarios applying different cost and emission coefficient values.

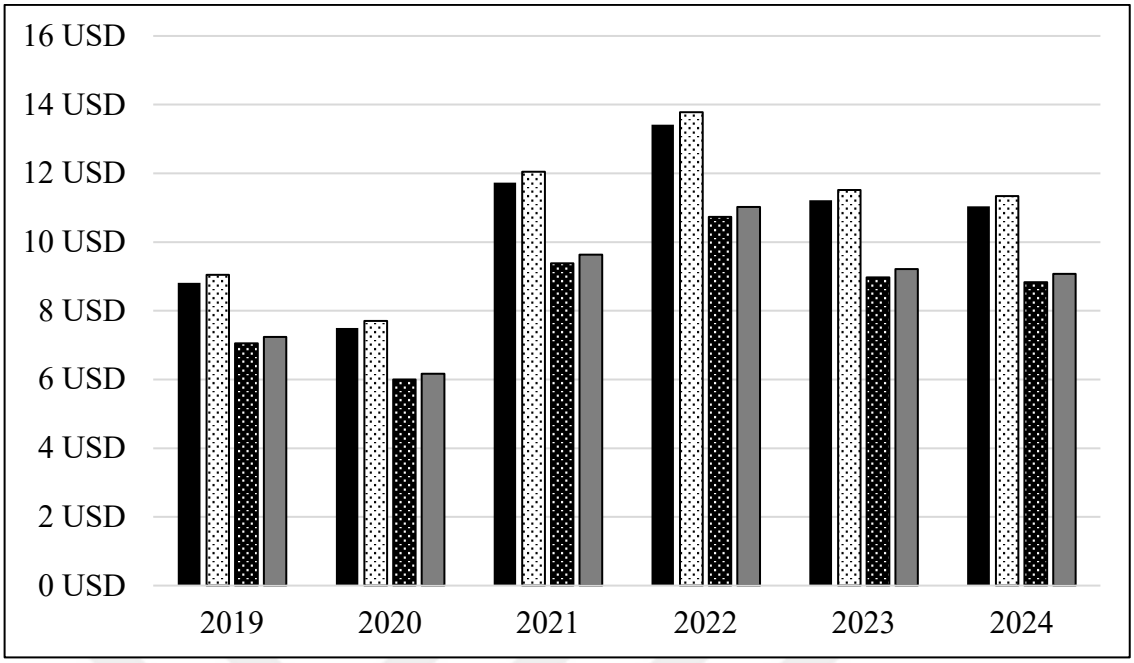


Figure 37. Annual CBAM Cost on a Scenario Basis for CN Code 7318 (Mio. USD, 2019-2024)

Source: TURKSTAT, 2025b.

The costs are overall highest for the emission cost scenario of 100 USD connected to the default values given for the emission coefficients peaking at 13,8 Mio. USD in 2022 (TURKSTAT, 2025b). Again, this result is connected to the comparably heightened export trade results in this category the same year. On average for this scenario the value amounts to 10,9 Mio. USD during the time period 2019 to 2024. For the scenario of default values applied in connection with the cost scenario of 80 USD the highest result occurs at eleven Mio. USD in 2022. The corresponding average value amounts to 8,7 Mio. USD during the period 2019 to 2024. Applying the regional rates in connection with the 100 USD CBAM certificate pricing the inclined costs peak at 13,4 Mio. USD in 2022. In this context, the corresponding average results in 10,6 Mio. USD for the period 2019 to 2024. Furthermore, using the default values in combination with the 80 USD pricing assumption the cost heightens at 10,7 Mio. USD in 2022. The average value equals to 8,5 Mio. USD during the period 2019 to 2024.

Simultaneously, it must be noted that the difference between CBAM costs using the default values or regional values as the corresponding emission coefficients leads to fairly small variations in CBAM costs across the different scenarios (TURKSTAT, 2025b). In

the years 2019 and 2020 the overall CBAM costs are lowest in connection with diminishing export trade to Germany hitting its lowest point in 2020. In 2021 simultaneous to increasing exports for the CN code *7318* also CBAM costs start increasing again. In 2023 and 2024 CBAM costs again decrease even below 2021 values implying decreasing export trade activity with Germany in this product category. The average value of CBAM cost amounts to 9,7 Mio. USD across all scenarios, making it the category with the lowest overall CBAM costs among the TOP-3 export product categories during the period 2019 to 2024. Furthermore, for the 100 USD scenarios the combined average value results in 10,8 Mio. USD between 2019 and 2024. For a pricing of CBAM certificates of 80 USD the average amounts to 8,6 Mio. USD during the same period.

Table 14. Annual CBAM Cost on a Scenario Basis for CN Code *7318* (Mio. USD, 2019-2024)

Year	CBAM Cost Regional rates/100	CBAM Cost CBAM Default/100	CBAM Cost Regional rates/80	CBAM Cost CBAM Default/80
2019	8.814.212,28 USD	9.049.886,40 USD	7.051.369,82 USD	7.239.909,12 USD
2020	7.503.499,73 USD	7.704.128,06 USD	6.002.799,78 USD	6.163.302,45 USD
2021	11.729.594,64 USD	12.043.220,16 USD	9.383.675,71 USD	9.634.576,13 USD
2022	13.419.713,91 USD	13.778.529,79 USD	10.735.771,13 USD	11.022.823,83 USD
2023	11.215.870,29 USD	11.515.759,87 USD	8.972.696,23 USD	9.212.607,90 USD
2024	11.042.151,78 USD	11.337.396,48 USD	8.833.721,42 USD	9.069.917,18 USD

Source: TURKSTAT, 2025b.

Table 15 displays the yearly CBAM expenditure in relation to the total annual export trade from Türkiye to Germany during the period 2019 to 2024 for the CN code *7318*. The individual shares are calculated dividing the CBAM costs by the total export volume achieved for that CN code the same year. Depending on the underlying scenario between regional rates and CBAM default values the results differ but remain in very close proximity showing that the assumed emission coefficients are similar (TURKSTAT, 2025b). The CBAM default values on average result in the highest percentage proportions in relation to the results of the regional rates. For the CBAM pricing scenario 100 USD the average proportion equals 4,8 percent and for the 80 USD case accounts for only on average 3,8 percent in relation to total export trade. In the context of the CBAM default values for the 100 USD scenario the average percentage amounts to 4,8 percent whereas for the 80 USD pricing case the average equals to 3,9 percent for the period 2019 to 2024. Moreover, regarding the application of the regional rates connected to the pricing of either

100 USD or 80 USD the corresponding averages amount to 4,7 percent and 3,8 percent, respectively. Overall, the percentage share remains in the single-digit area and outcomes are scattered around the four percent mark with a mean value of 4,3 percent. This represents the lowest proportional results among the TOP-3 export product categories. Furthermore, the product category remains far below the sectoral average share of nine percent. The following subchapter focuses on the cost assessment in connection with the CBAM regulation for the aluminum sector using the corresponding export trade date from 2019 to 2024 as well as the above-mentioned 80 USD or 100 USD emission cost scenarios in combination with the CBAM default values or regional rates in place of the emission coefficient.

Table 15. Annual CBAM Cost in Relation to Total Annual Export Trade for CN Code *7318* (in Percent, 2019-2024)

Year	CBAM Cost Regional rates/100	CBAM Cost CBAM Default/100	CBAM Cost Regional rates/80	CBAM Cost CBAM Default/80
2019	5,3%	5,4%	4,2%	4,3%
2020	5,1%	5,2%	4,1%	4,2%
2021	5,1%	5,2%	4,1%	4,2%
2022	4,7%	4,9%	3,8%	3,9%
2023	4%	4,1%	3,2%	3,3%
2024	4,1%	4,2%	3,3%	3,4%

Source: TURKSTAT, 2025b.

4.5.2 Aluminum Sector

In the following the aluminum sector is further assessed regarding the inclined CBAM costs. Table 16 displays the sum of potential cost added due to the CBAM regulation when applying the 80 USD and 100 USD emission cost scenarios in the context of the four-digit CN code using the data of German-Turkish bilateral trade in 2024. When using the 100 USD price scenario the highest outcome is demonstrated in the context of the default emission intensity levels amounting to about 43 Mio. USD across the relevant CN codes in the aluminum sector in 2024 (TURKSTAT, 2025b). This result represents a share of 5,8 percent in relation to the total trade volume of 738,8 Mio. USD across the relevant CN codes in the aluminum sector during the same year. Regarding the 80 USD price scenario the top result is depicted in the default rates amounting to 34,4 Mio. USD in 2024. This result portrays a proportion of 4,7 percent in respect to the total trade volume of 738,8 Mio USD.

In general, the results show no crucial disparity between the outcomes in the context of the provided default rates and country-based values (TURKSTAT, 2025b). Across the relevant CN codes in the aluminum industry on a four-digit CN code basis the average percentage share of the additional yearly cost on a scenario basis in relation to the total annual trade volume in the single product categories is 5,2 percent for the 100 USD scenario and 4,2 percent for the 80 USD scenario applying the country-based emission intensities. In respect to the default rates the average percentage share of the additional cost in relation to the total trade volume in the individual product categories represents 6,2 percent under the 100 USD case and five percent for the 80 USD scenario.

Table 16. Sum of Additional CBAM Cost (Mio. USD, 2024)

Regional rates/100 USD	**Default rates/100 USD**	**Regional rates/80 USD**	**Default rates/80 USD**
36.337.568,77	43.029.136,34	29.070.055,01	34.423.309,07

Source: TURKSTAT, 2025b.

Considering the percentage share in relation to the total trade volume on a CN code basis the rates range between approximately a minimum of 1,6 percent and a maximum of 12,6 percent in both scenarios, when applying the default or country-based rates in combination with the two pricing cases (TURKSTAT, 2025b). The individual shares are calculated dividing the costs by the total export volume achieved for that CN code the same year.

In the context of the default rates in the 80 USD scenario the highest shares can be found at seven percent for the CN code *7601* "*Unwrought aluminium*" and *7606* "*Plates, sheets and strip, of aluminium, of a thickness of > 0,2 mm (excl. expanded plates, sheets and strip)*" at 6,8 percent, followed by the CN codes *7607* "*Aluminium foil, "whether or not printed or backed with paper, paperboard, plastics or similar backing materials", of a thickness "excl. any backing*" at 5,9 percent and *7614* "*Stranded wire, cables, plaited bands and the like, of aluminium (excl. such products electrically insulated)*" with a percentage proportion of 5,7 percent (TURKSTAT, 2025b). The CN code *7603* "*Powder and flakes, of aluminium (excl. pellets of aluminium, and spangles)*" follows with a result of 5,3 percent. The listed Top-5 CN codes in this scenario represent an export volume of 199,4 Mio. USD and an additional CBAM cost of 13,1 Mio. USD. In the 100-USD-scenario the price effect is further reinforced through the CN code *7601* reaching an

outcome of 8,7 percent, the CN code *7606* equaling 8,5 percent and the CN codes *7607* at 7,4 percent, *7614* at 7,2 percent and *7603* at 6,7 percent. The CN codes in this scenario account for an export volume of 199,4 Mio. USD and an additional CBAM cost of 16,4 Mio. USD.

In the context of the country-based rates in the 80 USD scenario the highest shares can be found at 5,7 percent for the CN codes *7601* "*Unwrought aluminium*" and *7606* "*Plates, sheets and strip, of aluminium, of a thickness of > 0,2 mm (excl. expanded plates, sheets and strip)*", followed by the CN codes *7614* "*Stranded wire, cables, plaited bands and the like, of aluminium (excl. such products electrically insulated)*" at 5,4 percent and *7607* "*Aluminium foil, "whether or not printed or backed with paper, paperboard, plastics or similar backing materials", of a thickness "excl. any backing"* with a percentage share of five percent (TURKSTAT, 2025b). The CN code *7603* "*Powder and flakes, of aluminium (excl. pellets of aluminium, and spangles"* is listed in fifth place with an outcome of 4,4 percent. The CN codes in this scenario account for an export volume of 199,4 Mio. USD and an additional CBAM cost of about eleven Mio. USD.

In the 100 USD scenario the price effect is further heightened with the CN code *7601* at 7,2 percent, *7606* at 7,1 percent and *7614* reaching a result of 6,8 percent. Furthermore, the TOP-5 CN code ranking is complemented by *7607* amounting to 6,2 percent and *7603* and equaling 5,5 percent (TURKSTAT, 2025b). The TOP-5 CN codes in this scenario account for an export volume of 199,4 Mio. USD and an additional CBAM cost of 13,8 Mio. USD.

The CN codes *7604* "*Bars, rods and profiles, of aluminium, n.e.s.*", *7606* "*Plates, sheets and strip, of aluminium, of a thickness of > 0,2 mm (excl. expanded plates, sheets and strip)*", *7616* "*Articles of aluminium, n.e.s.*" form the TOP-3 concerning the corresponding trade volumes in USD in 2024 (TURKSTAT, 2025b). For the CN code *7604* the used default rates in the 80 USD and 100 USD scenarios lead to shares of 4,5 percent and 5,6 percent, respectively, in relation to the overall trade volumes in 2024. Regarding the country-based emission levels in connection with the two scenarios the outcomes result in 3,8 percent and 4,8 percent. In comparison to the overall trade volumes the effect is fairly small. Concerning the CN code *7606* the default rates applied in the context of the 80-USD- and 100-USD-scenarios achieve a proportional outcome 7,1

percent and 8,5 percent, respectively. When applying the country-based emission levels in the context of the 80 USD and 100 USD scenarios the results amount to 5,7 percent and 6,8 percent, accordingly in 2024.

Although the proportional effect regarding the additional cost due to the emissions is higher compared to the aforementioned CN code, it still remains at a moderate degree (TURKSTAT, 2025b). In the category *7616* the used default rates in the 80 USD and 100 USD scenarios result in a 2,2 percent and 2,7 percent share in relation to the total trade volumes on a CN code basis in 2024. In the context of the country-based emission levels for the two scenarios outcomes remain on similar levels with both amounting to 1,8 percent (80 USD) and 2,3 percent (100 USD). In this case emission costs are neglectable.

Across all relevant four-digit CN codes the average rates for the additional CN code related CBAM costs relative to the total export trade volume on a CN code-basis that year from Türkiye to Germany between 2019 and 2024 are as depicted based on their share in percentage in Table 17 below. The individual shares on a CN code basis are calculated dividing the costs by the total export volume achieved for that CN code the same year. The highest results across the various scenarios are achieved in 2020, followed by the year 2019 (TURKSTAT, 2025b). In 2021, shares increase reaching the lowest results during 2022. In 2023 and 2024 levels increase again but do not catch up to the values prior to 2022. The overall highest results are achieved using the 100 USD cost scenario in connection with the default rate in 2020 at 7,8 percent, followed by the year 2019 using the same assumptions equaling to an outcome of 7,2 percent. Overall, the percentage range on an annual and product basis is relatively close together with only a few outliers.

Table 17. Annual Average Rates of CBAM Costs Across CBAM-Relevant CN Codes (in Percent, 2019-2024)

Year	Regional rates/100 USD	Default rates/100 USD	Regional rates/80 USD	Default rates/80 USD
2019	6,2%	7,2%	4,9%	5,8%
2020	6,7%	7,8%	5,4%	6,2%
2021	5,3%	6,2 %	4,2%	5%
2022	4,4 %	5,1 %	3,5 %	4,1 %
2023	4,8%	5,6 %	3,8 %	4,5 %
2024	5%	5,8%	4%	4,7%

Source: TURKSTAT, 2025b.

On the basis of the different emission values and the CBAM cost scenarios expense levels can be calculated as seen in Figure 38. The results take into account the trade volumes of the CN codes affected by the CBAM between the years 2019 to 2024. Applying the above-described formula for calculating the inclined CBAM costs both the regional and default emission values are applied alongside with the 80 USD and 100 USD cost scenario concerning CBAM certificates. The CBAM costs grow with the increase in Turkish exports to Germany explaining the increase in value in 2022 (TURKSTAT, 2025b). At the same time, the relative share of products with higher emission levels as part of the total export volume must be considered, explaining the lower CBAM cost in connection with a higher export volume e.g., when comparing the year 2021 to the year 2023. Furthermore, the change in price per ton for a product and its potentially diminishing effect on the relative share of added costs compared to the total export volume must be considered. The scenario using the default emission values in connection with the 100 USD cost scenario displays on average the highest results with a peak in 2022 at 54,2 Mio. USD, followed by the outcome for the same cost scenario in combination with the regional emission rates with a peak at 45,8 Mio. USD the same year. The ranking remains the same also when applying the 80 USD cost scenario in connection with the default emission values and regional emission rates, reaching its height at 43,3 Mio. USD and 36,6 Mio. USD respectively in 2022.

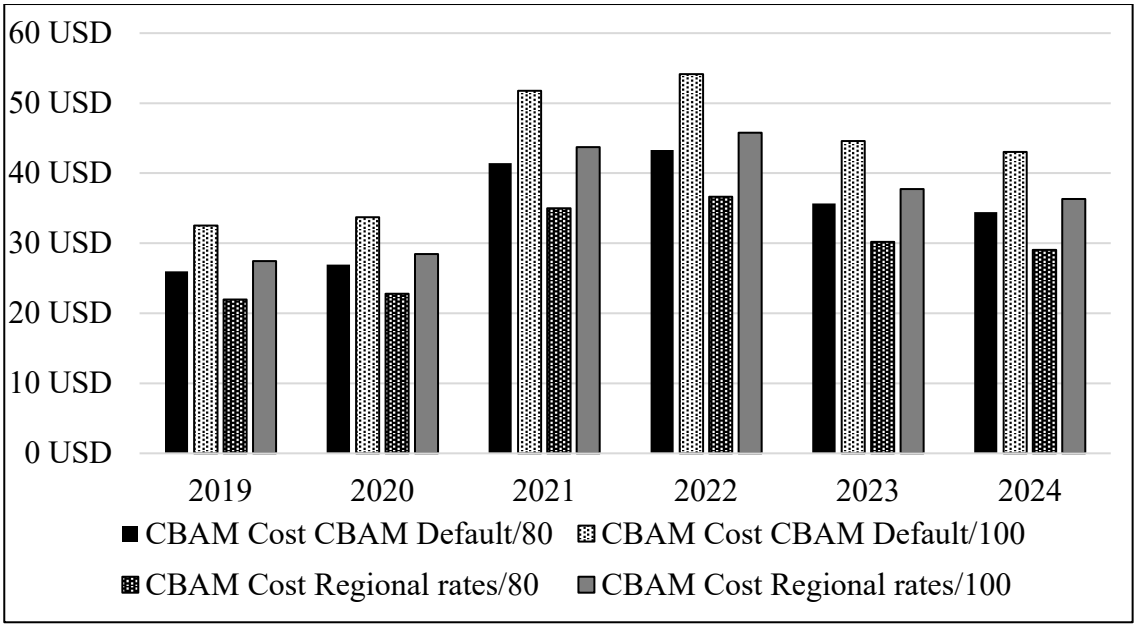


Figure 38. Sum of Annual CBAM Cost on a Scenario Basis (Mio. USD, 2019-2024)

Source: TURKSTAT, 2025b.

In the context of the total perspective in terms of exports from Türkiye to Germany and the added costs due to the CBAM for aluminum sector between 2019 and 2024, the difference in cost levels between the different scenarios provides an indication regarding the competitiveness of the sector on a global scale. Regarding the scenario of regional rates in combination with a CBAM certificate pricing of 100 USD, the added costs represent 219,4 Mio. USD during the period 2019 to 2024 (TURKSTAT, 2025b). For the scenario default values together with a CBAM certificate pricing of 100 USD the result accounts for 259,7 Mio. USD for the aluminum sector during the same period. The added costs imply an on average lower cost level than the results using the default values which represent the global average regarding emission levels on a product basis. As a result, a corresponding cost advantage can be determined.

Considering the percentage shares of the added costs in relation to the overall export volume, in the context of regional rates in connection with a 100 USD CBAM certificate pricing, the proportions amount to 5,2 percent on average during the period 2019 to 2024 (TURKSTAT, 2025b). When applying default values in combination with the 100 USD pricing scenario the average result amount to 6,2 percent. From the perspective of the aluminum sector the results show a cost advantage in a global comparison due to the higher results in connection with the default values.

The results underline the effect of emission values on the total cost of the CBAM as well as the impact of the difference in values as part of the two emission level assumption models for production provided, the default emission values and the regional emission rates. Moreover, it emphasizes that the costs to be paid for the CBAM certificate can significantly lower or raise the overall additional costs from the importer perspective. In this context, the potential deduction of an already paid local price for emissions by the exporter may decrease the importer's burden and enhance the exporting parties' cost-competitiveness in comparison to sellers from other countries.

As previously mentioned, to assess the inclined CBAM cost its results may be put in relation with the total annual export trade volumes on a scenario basis, calculating the proportion of the CBAM costs relative to total exports in percent. The corresponding results are showcased in Figure 39 below. The highest results are achieved in the context of the applied default values followed by the regional rates in connection with the 100

USD cost scenario (TURKSTAT, 2025b). The outcomes related to the 80 USD scenario showcase the same ranking among default values and regional rates during the period 2019 to 2024. In 2020, the overall peak regarding the share is accomplished in connection with the default values for emission levels accounting for 7,5 percent and the regional rates amounting to 6,3 percent applying the 100 USD case. For the default values and regional rates in the 80 USD cost scenario the proportions account for six percent and 5,1 percent respectively in the same year.

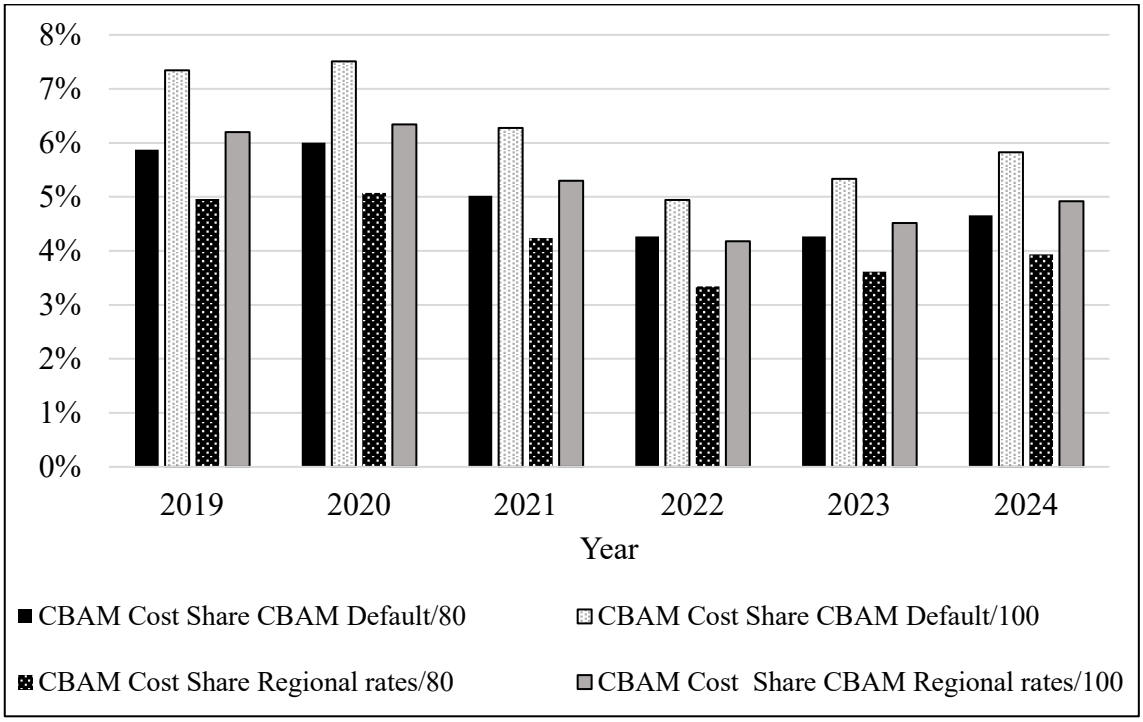


Figure 39. Annual CBAM Cost Share Relative to Overall Trade Volumes (in Percent, 2019-2024)

Source: TURKSTAT, 2025b.

The discrepancy levels between default values and regional rates are also reflected in the percent proportions, emphasizing the importance of the correct assessment of these estimates. Furthermore, overall, the shares in the context of the default values and the regional rates are significantly lower in comparison to the iron and steel sector (TURKSTAT, 2025b).

Considering the cost impact for the TOP-3 Turkish export goods in the aluminum sector CBAM costs vary among the CN codes *7604* "*Bars, rods and profiles, of aluminium, n.e.s.*", *7606* "*Plates, sheets and strip, of aluminium, of a thickness of > 0,2 mm (excl.*

expanded plates, sheets and strip)" and *7616* "*Articles of aluminum, n.e.s.*" (TURKSTAT, 2025b). The individual shares are calculated dividing the costs by the total export volume achieved for that CN code the same year. In total, the highest CBAM costs in relation to the overall bilateral trade volume are recorded for the CN code *7606* with an average share of seven percent across all scenarios in 2024. The same year, listed in second place is the CN code *7604* with a lower average result of 4,7 percent across all scenarios. Finally, the CN code *7616* accounts for the lowest average outcome amounting to an average share of only 2,3 percent in 2024. In comparison to the average shares of CBAM costs in relation to the overall export volumes across the different scenarios between 2019 to 2024 the CN codes *7604* and *7616* remain below the total average outcomes. On the other hand, the CN code *7606* reaches shares above the averages recorded between 2019 and 2024.

In total, the CBAM costs for the CN code *7604* are the highest, accounting for an overall volume of 446,9 Mio. USD between 2019 and 2024 (TURKSTAT, 2025b). Figure 40 and Table 18 show the development of CBAM costs between 2019 and 2024. Moreover, Table 18 reflects a detailed overview of the individual results regarding the CBAM cost across the various scenarios using the different cost and emission coefficient values.

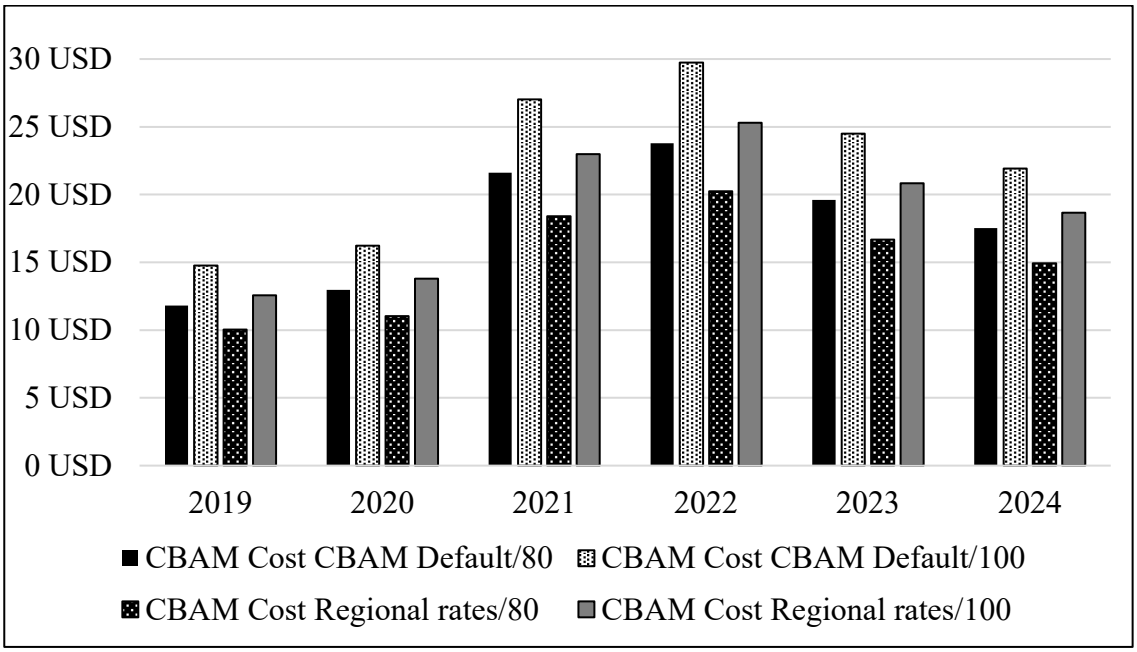


Figure 40. Annual CBAM Cost on a Scenario Basis for CN Code *7604* (Mio. USD, 2019-2024)

Source: TURKSTAT, 2025b.

The costs are overall highest for the emission cost scenario of 100 USD in connection with the CBAM default values for the applied emission coefficient rates peaking at 29,7 Mio. USD in 2022 (TURKSTAT, 2025b). On average for this scenario the value amounts to 22,4 Mio. USD during the time period 2019 to 2024. For the scenario of default values applied in connection with the cost scenario of 80 USD the highest result occurs at 23,8 Mio. USD in 2022. The corresponding average value amounts to 17,9 Mio. USD during the period 2019 to 2024. Applying the regional rates in connection with the 100 USD CBAM certificate pricing the inclined costs peak at 25,3 Mio. USD in 2022. In this context, the corresponding average results in 19 Mio. USD for the period 2019 to 2024. Furthermore, using the default values in combination with the 80 USD pricing assumption the cost peaks at 20,2 Mio. USD in 2022. The average value equals to 15,2 Mio. USD during the period 2019 to 2024.

During the period 2019 to 2020 the overall costs are at its lowest due to comparably low export volumes (TURKSTAT, 2025b). The increase in exports to Germany from 2021 on also leads to an increase in CBAM costs. Following 2022, export volumes and hence CBAM costs drop below 2021 levels. In 2024, in line with declining export trade to Germany in this product category CBAM costs even further decrease. The average value of CBAM cost amounts to 18,6 Mio. USD across all scenarios, making it the category with the highest overall CBAM costs among the TOP-3 export product categories between 2019 and 2024. Moreover, for the 100 USD scenarios the joint average value amounts to 20,7 Mio. USD between 2019 and 2024. For a pricing of 80 USD the average results in 16,6 Mio. USD during the same period.

The different level of costs as seen in Table 18 in connection with the default and regional rates implies that the assumptions regarding the level of emissions locally and internationally differ significantly. The lower cost level in conjunction with the regional values implies that the product corresponding to CN code *7604* is produced with lower emissions in Türkiye in an international comparison (TURKSTAT, 2025b).

Table 18. Annual CBAM Cost on a Scenario Basis for CN Code *7604* (Mio. USD, 2019-2024)

Year	CBAM Cost Regional rates/100	CBAM Cost CBAM Default/100	CBAM Cost Regional rates/80	CBAM Cost CBAM Default/80
2019	12.555.661,60 USD	14.755.782,12 USD	10.044.529,28 USD	11.804.625,70 USD

2020	13.802.409,71 USD	16.220.997,10 USD	11.041.927,77 USD	12.976.797,68 USD
2021	22.992.631,78 USD	27.021.615,89 USD	18.394.105,43 USD	21.617.292,71 USD
2022	25.299.756,30 USD	29.733.016,35 USD	20.239.805,04 USD	23.786.413,08 USD
2023	20.841.829,18 USD	24.493.929,52 USD	16.673.463,34 USD	19.595.143,62 USD
2024	18.654.244,30 USD	21.923.015,55 USD	14.923.395,44 USD	17.538.412,44 USD

Source: TURKSTAT, 2025b.

Table 19 shows the yearly CBAM costs in relation to the total export trade from Türkiye to Germany during the period 2019 to 2024 in the context of the CN code *7604*. As already mentioned, the results emphasize that the assumptions regarding the emission levels as part of the production process displayed by the CBAM default values and regional rates substantially differ (TURKSTAT, 2025b). The individual shares are calculated dividing the CN code related CBAM costs by the total export volume achieved for that CN code the same year. The regional rate for this CN code is much lower and should rather be considered than the more general CBAM default values implying much higher emission levels. For the 100 USD CBAM certificate pricing scenarios the overall average value is 5,5 percent while numbers remain in the single-digit area. In this scenario for the CBAM default value case the mean value accounts for about six percent and for the regional rates for five percent. In the context of the CBAM certificate pricing scenario of 80 USD the general average amounts to 4,4 percent. Regarding the CBAM default values in this case the average results in 4,8 percent and concerning the regional rates to 4,1 percent. Across all underlying scenarios the highest proportional results are achieved during the period 2019 to 2020. Furthermore, across all scenarios for the period 2019 to 2024 the general average amounts to five percent positioning it right below the sector average of 5,2 percent for even that timeframe. Among the TOP-3 export product categories the product category comes in second place concerning the proportional levels of the inclined CBAM costs connected to the total export trade from Türkiye to Germany.

Table 19. Annual CBAM Cost in Relation to Total Export Trade for CN Code *7604* (in Percent, 2019-2024)

Year	**CBAM Cost Regional rates/100**	**CBAM Cost CBAM Default/100**	**CBAM Cost Regional rates/80**	**CBAM Cost CBAM Default/80**
2019	6%	7,1%	4,8%	5,7%
2020	6,2%	7,3%	5%	5,8%
2021	5,2%	6,1%	4,1%	4,9%
2022	4%	4,6%	3,2%	3,7%

2023	4,2%	5%	3,4%	4%
2024	4,8%	5,6%	3,8%	4,5%

Source: TURKSTAT, 2025b.

Ranking in second place is CN code *7606* amounting to an overall volume of CBAM costs of 233,1 Mio. USD between 2019 and 2024 (TURKSTAT, 2025b). Figure 41 and Table 20 state the development of CBAM costs between 2019 and 2024. Furthermore, Table 20 depicts a thorough summary of the unique outcomes concerning the CBAM cost across the various scenarios under application of the varying cost and emission coefficient estimates.

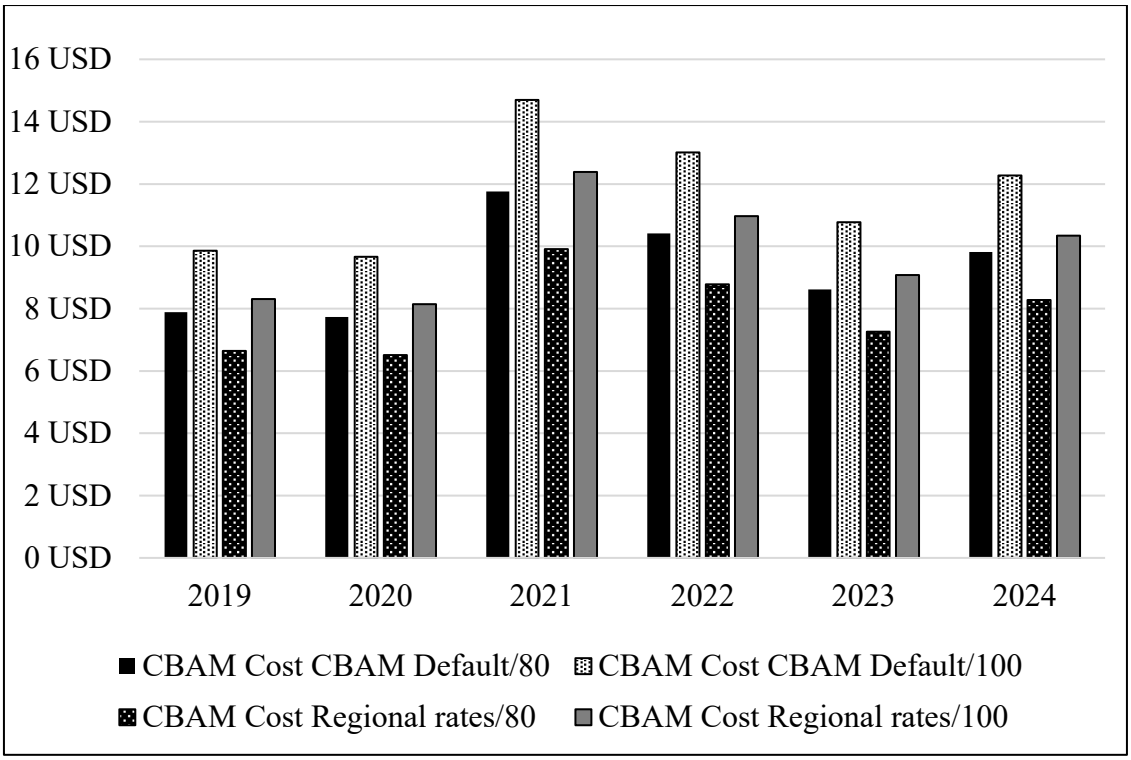


Figure 41. Annual CBAM Cost on a Scenario Basis for CN Code *7606* (Mio. USD, 2019-2024)

Source: TURKSTAT, 2025b.

Also in this case, CBAM costs are generally highest for the emission cost scenario of 100 USD in connection with the CBAM default values used as the emission coefficient rates reaching its height at 14,7 Mio. USD in 2021 (TURKSTAT, 2025b). On average for this scenario the value amounts to 11,7 Mio. USD during the time period 2019 to 2024. For the scenario of default values applied in connection with the cost scenario of 80 USD the highest result occurs at 11,8 Mio. USD in 2021. The corresponding average value

amounts to 9,4 Mio. USD between 2019 and 2024. Applying the regional rates in connection with the 100 USD CBAM certificate pricing the inclined costs peak at 12,4 Mio. USD in 2021. In this context, the corresponding average results in 9,9 Mio. USD for the period 2019 to 2024. Moreover, using the default values in combination with the 80 USD pricing assumption the cost peaks at 9,9 Mio. USD in 2021. The average value equals to 7,9 Mio. USD during the period 2019 to 2024.

In the years 2019 and 2020 the overall costs are at its lowest due to comparably low export volumes (TURKSTAT, 2025b). The increase in exports to Germany from 2021 on simultaneously causes an increase in CBAM costs as reflected in the numbers. In 2022, export volumes and hence CBAM costs decrease. This decline continues throughout 2023 in line with declining export trade to Germany in this product category CBAM costs even further decrease. In 2024, results again increase but do not surpass 2022 levels. The average value of CBAM cost amounts to 9,7 Mio. USD across all scenarios, making it the category with the second highest overall CBAM costs among the TOP-3 export product categories between 2019 and 2024. Moreover, for the 100 USD scenarios the joint average value amounts to 10,8 Mio. USD between 2019 and 2024. With a pricing of 80 USD the average amount to 8,6 Mio. USD during the same period.

The best-selling product categories in Turkish exports to Germany encompass the CN codes *7604*, *7606* and *7616* in the aluminum sector (TURKSTAT, 2025b). In terms of the CN code *7604*, utilizing the regional rates in connection with the 100 USD pricing scenario for CBAM certificates, the outcome amounts to 114,1 Mio. USD. Moreover, in the context of the default values together with the same CBAM certificate pricing the results account for 134,1 Mio. USD. Regarding the CN code 7606 the result using the 100 USD pricing in combination with the default values amounts to 70,3 Mio. USD whereas together with the regional rates to 59,2 Mio. USD. Moreover, against the backdrop of CN code *7616* using the same pricing scenario together with the default values the value accounts for 17,3 Mio. USD and in connection to the regional rates amounts to 14,5 Mio. USD.

Table 20. Annual CBAM Cost on a Scenario Basis for CN Code *7606* (Mio. USD, 2019-2024)

Year	CBAM Cost Regional rates/100	CBAM Cost CBAM Default/100	CBAM Cost Regional rates/80	CBAM Cost CBAM Default/80
2019	8.308.350,64 USD	9.859.702,42 USD	6.646.680,52 USD	7.887.761,94 USD
2020	8.138.921,38 USD	9.658.636,99 USD	6.511.137,10 USD	7.726.909,59 USD
2021	12.385.344,27 USD	14.697.960,42 USD	9.908.275,42 USD	11.758.368,34 USD
2022	10.969.058,12 USD	13.017.222,50 USD	8.775.246,50 USD	10.413.778,00 USD
2023	9.079.143,35 USD	10.774.419,08 USD	7.263.314,68 USD	8.619.535,27 USD
2024	10.340.041,62 USD	12.270.754,78 USD	8.272.033,29 USD	9.816.603,83 USD

Source: TURKSTAT, 2025b.

Table 21 depicts the annual CBAM cost shares in relation to total export trade for the CN code *7606* from Türkiye to Germany during the period 2019 to 2024. Generally, due to the higher emission coefficient used in the context of the CBAM default values proportions across the different scenarios are greater compared to the results in connection with the regional rates (TURKSTAT, 2025b). The individual shares are calculated dividing the CN code related CBAM costs by the total export volume achieved for that CN code the same year. The average value of shares across all scenarios amounts to 7,4 percent for the period 2019 to 2024. This indicates that compared to the sectoral average of 5,2 percent for the same period the share in emission costs relative to the export trade from Türkiye to Germany is higher. In the context of the CBAM default values for the 100 USD CBAM certificate pricing scenario the shares account for an average of 8,2 percent and for the 80 USD case amount to an average of 6,6 percent. The greatest results in shares are achieved in 2019 and 2020 for these scenarios. Moreover, regarding the regional rates concerning the 100 USD pricing case the average results in 7,5 percent whereas for the 80 USD scenario equals to six percent. Here, the highest outcomes are also accounted for during the period 2019 to 2020 as well. Among the TOP-3 export categories this CN code represents the greatest results regarding the relative percentage shares achieved during the 2019 to 2024 period.

Table 21. Annual CBAM Cost in Relation to Total Export Trade for CN Code *7606* (in Percent, 2019-2024)

Year	CBAM Cost Regional rates/100	CBAM Cost CBAM Default/100	CBAM Cost Regional rates/80	CBAM Cost CBAM Default/80
2019	9,1%	10,8%	7,2%	8,6%

2020	9,6%	11,4%	7,7%	9,1%
2021	6,8%	8,1%	5,5%	6,5%
2022	5,3%	6,3%	4,2%	5%
2023	7%	8,3%	5,6%	6,7%
2024	7,1%	8,5%	5,7%	6,8%

Source: TURKSTAT, 2025b.

Out of the TOP-3 export categories for the aluminum sector the CN code *7616* ranks in third place accounting for a total volume of CBAM costs of 57,2 Mio. USD between 2019 and 2024 (TURKSTAT, 2025b). Figure 42 and Table 22 depict the development course of CBAM costs for the period 2019 to 2024. Moreover, Table 22 shows a detailed summary of the individual results in regard to the CBAM cost among the different scenarios using the heterogenous cost and emission coefficient values.

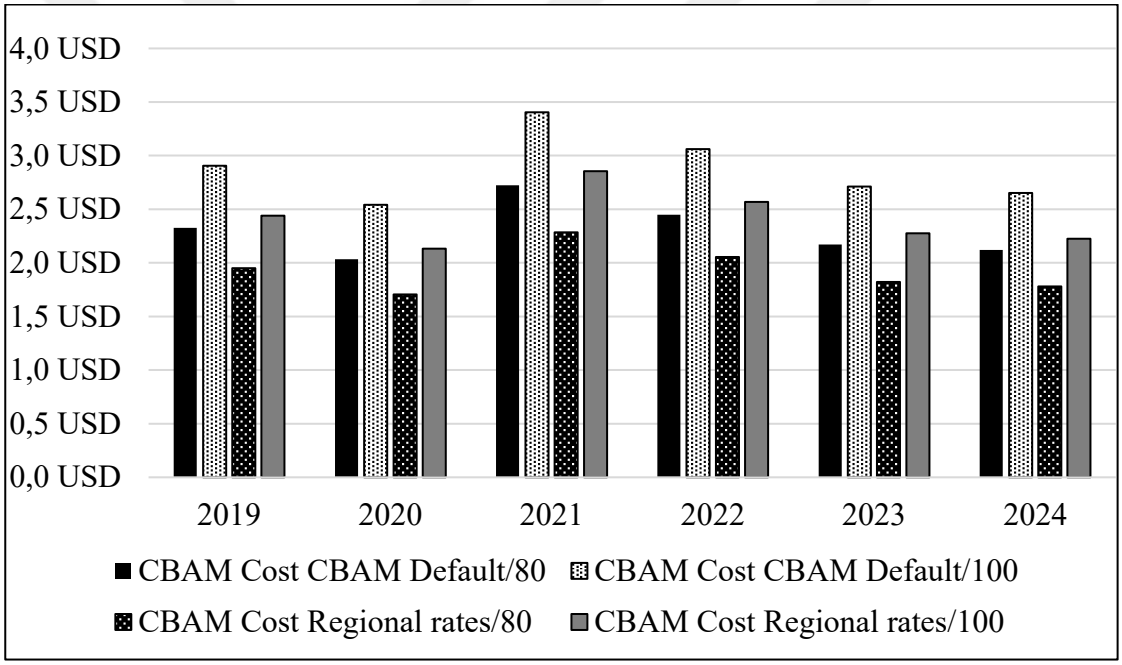


Figure 42. Annual CBAM Cost on a Scenario Basis for CN Code *7616* (Mio. USD, 2019-2024)

Source: TURKSTAT, 2025b.

As previously stated in the context of the aforementioned CN codes out of the TOP-3 export categories the CBAM costs are overall highest in the context of the emission cost scenario of 100 USD connected to the CBAM default values applied in form of emission coefficient rates reaching its peak at 3,4 Mio. USD in 2021 (TURKSTAT, 2025b). On average for this scenario the value amounts to 2,9 Mio. USD during the time period 2019 to 2024. For the scenario of default values applied in connection with the cost scenario of

80 USD the highest result stands at 2,7 Mio. USD in 2021. The corresponding average value amounts to 2,3 Mio. USD between 2019 and 2024. Applying the regional rates in connection with the 100 USD CBAM certificate pricing the inclined costs peak at 2,9 Mio. USD in 2021. In this context, the corresponding average results in 2,4 Mio. USD for the period 2019 to 2024. Moreover, using the default values in combination with the 80 USD pricing assumption the cost reaches its maximum at 2,3 Mio. USD in 2021. The average value equals to 1,9 Mio. USD during the time period 2019 to 2024.

In 2022, overall CBAM costs decline but remain high in comparison to the other years during the same period (TURKSTAT, 2025b). These results are succeeded by the cost levels in 2019. During the following year the total CBAM costs are at its lowest due to comparably low export volumes. The comparably low levels continue during the period 2023 to 2024. Overall, CBAM cost levels remain fairly low across the different cost scenarios and emission coefficients in comparison to the other two CN codes relevant as part of the TOP-3 product categories in connection with the aluminum sector. Here, the average value of CBAM cost amounts 2,4 Mio. USD across all scenarios, making it the category with the highest overall CBAM costs among the TOP-3 export product categories between 2019 and 2024. Moreover, for the 100 USD scenarios the joint average value amounts to 2,6 Mio. USD between 2019 and 2024. With a pricing of 80 USD the average amount to 2,1 Mio. USD during the same period.

Table 22. Annual CBAM Cost on a Scenario Basis for CN Code *7616* (Mio. USD, 2019-2024)

Year	CBAM Cost Regional rates/100	CBAM Cost CBAM Default/100	CBAM Cost Regional rates/80	CBAM Cost CBAM Default/80
2019	2.438.926,22 USD	2.906.737,49 USD	1.951.140,97 USD	2.325.390,00 USD
2020	2.133.486,38 USD	2.542.711,14 USD	1.706.789,11 USD	2.034.168,91 USD
2021	2.855.439,99 USD	3.403.142,92 USD	2.284.351,99 USD	2.722.514,34 USD
2022	2.567.746,30 USD	3.060.266,61 USD	2.054.197,04 USD	2.448.213,29 USD
2023	2.276.011,87 USD	2.712.574,49 USD	1.820.809,50 USD	2.170.059,60 USD
2024	2.224.607,86 USD	2.651.310,67 USD	1.779.686,29 USD	2.121.048,53 USD

Source: TURKSTAT, 2025b.

Table 23 shows the yearly CBAM cost shares relative to the total export trade for the CN code *7616* from Türkiye to Germany for the timeframe 2019 to 2024. Overall, the results for the scenarios connected to the CBAM default values are higher for this CN code, although compared to the aforementioned product categories the difference remains

comparatively low (TURKSTAT, 2025b). The individual shares are calculated dividing the CN code related CBAM costs by the total export volume achieved for that CN code the same year. The average value of shares throughout all scenarios amounts to only 2,7 percent for the period 2019 to 2024. Hence, this means that compared to the sectoral average of 5,2 percent during the same period the percentage in emission costs relative to the export trade from Türkiye to Germany is substantially lower. In case of the CBAM default values in the context of the 100 USD CBAM certificate pricing scenario the proportions equal to an average of 3,3 percent and for the 80 USD case amount to an average of 2,6 percent. Furthermore, the highest outcomes regarding the percentage proportions are accounted for during 2019 and 2020 for these scenarios. On the other hand, concerning the regional rates in the context of the 100 USD pricing scenario the average amounts to 2,8 percent whereas for the 80 USD case represents about 2,2 percent. Also here, the greatest results occur during the period 2019 to 2020. Among the TOP-3 export categories the CN code *7616* achieves the lowest relative percentage proportions during the period 2019 to 2024. In the following subchapter the findings and results of the assessment are discussed.

Table 23. Annual CBAM Cost on a Scenario Basis for CN Code *7616* (Mio. USD, 2019-2024)

Year	CBAM Cost Regional rates/100	CBAM Cost CBAM Default/100	CBAM Cost Regional rates/80	CBAM Cost CBAM Default/80
2019	3,2%	3,8%	2,5%	3%
2020	3,1%	3,7%	2,5%	3%
2021	2,9%	3,4%	2,3%	2,7%
2022	2,7%	3,2%	2,2%	2,6%
2023	2,4%	2,9%	1,9%	2,3%
2024	2,3%	2,7%	1,8%	2,2%

Source: TURKSTAT, 2025b.

4.6 Findings Regarding Potential Effects

As demonstrated by the recent trade data Turkish-German trade relations play an economically important role from the perspective of both countries. Hence, the implementation of the CBAM will affect the course of bilateral trade ties and requires that measures are taken to prevent negative implementations. In the context of Turkish exports to Germany the product categories articles of iron and steel and aluminum and articles thereof are ranked high, fifth and eight consecutively, in the context of the most

exported products from Türkiye to Germany in 2024 (TURKSTAT, 2025f). Overall, in 2024 corresponding Turkish exports levels to Germany decline accounting for a volume of 727,6 Mio. USD (-14,2 percent compared to 2023) in the category aluminum and articles thereof. Moreover, in the category articles of iron and steel the total amounts to 953,7 Mio. USD (-9,9 percent compared to 2023). The two product categories each account for about 5,9 percent (*Articles of iron and steel)* and 4,3 percent (*Aluminum and articles thereof)* out of the overall Turkish export volume to Germany in 2023 (TURKSTAT, 2025c; 2025f). Furthermore, the two categories each represent a share of 5,2 percent (*Articles of iron and steel)* and about four percent (*Aluminum and articles thereof)* out of the total export volume from Türkiye to Germany in 2024.

Due to the comparably negligible export trade amounts from Türkiye to Germany in the cement and fertilizer sectors between 2014 and 2024 the assessment focuses only on the potential cost effects in the aluminum and iron and steel sectors (TURKSTAT, 2025b). In the context of the iron and steel sector the assessment shows a significant cost increase for the corresponding exports from Türkiye to Germany between 2019 and 2024. In comparison to the aluminum sector, the iron and steel industry is relatively more affected by the additional costs inclined by the CBAM regulation. The different scenarios used in terms of the pricing for CBAM certificates of 80 USD and 100 USD as well as the individual emissions coefficients, regional rates and default values, let to various outcomes regarding the costs.

In the context of the iron and steel sector, considering only the year 2024, using the 100 USD price scenario for CBAM certificates to be purchased by the importer the highest result is achieved in the context of the regional emission intensity levels amounting to an additional cost of 81,5 Mio. USD (TURKSTAT, 2025b). This result represents a share of 8,6 percent in relation to the total trade volume of 941,7 Mio. USD across the relevant CN codes in the iron and steel sector in 2024. In the context of the 80 USD price scenario for CBAM certificates the primary outcome is achieved for the provided regional rates equaling to 65,2 Mio. USD in 2024. This result portrays a proportion of 6,9 percent in respect to the total trade volume of 941,7 Mio. USD. Overall, the results show no substantial difference between the outcomes in the context of the provided default rates and regional values, indicating that the values are in close proximity to one another.

In the context of the aluminum the assessment shows a smaller cost raise for the corresponding exports from Türkiye to Germany in relation to the overall trade volumes than in comparison to the iron and steel sector (TURKSTAT, 2025b). When using the 100 USD price scenario the highest outcome is demonstrated in the context of the default emission intensity levels amounting to 43 Mio. USD across the relevant CN codes in the aluminum sector in 2024. This result represents a percentage share of 5,8 percent relative to the total trade volume of 738,8 Mio. USD across the relevant CN codes for the same year. Regarding the 80 USD price scenario the top result is depicted in the default rates amounting to 34,4 Mio. USD in 2024. This result portrays a proportion of 4,7 percent in respect to the total trade volume of 738,8 Mio.

On a sectoral basis for the iron and steel sector, considering the average rates for the additional CBAM cost in relation to the total trade volume between 2019 and 2024, the highest shares among all the different scenarios are achieved in 2019, followed by the year 2020 (TURKSTAT, 2025b). Applying the regional emission rates in connection with the 100 USD cost scenario showcases the highest outcomes on average with a peak in 2022 at 107,3 Mio. USD. Overall, the CBAM costs rise with the increase in Turkish exports to Germany explaining the growth in value in 2021 and 2022 among the other years.

In the context of the aluminum sector, the scenario using the default emission values in connection with the 100 USD cost scenario results in on average the highest results with a peak at 54,2 Mio. USD in 2022 (TURKSTAT, 2025b). This outcome is followed by the result applying the same cost scenario in combination with the regional emission rates amounting to a peak at 45,8 Mio. USD in 2022 as well. The ranking remains the same also when applying the 80 USD cost scenario in connection with the default emission values and regional emission rates, reaching its height at 43,3 Mio. USD and 36,6 Mio. USD respectively in 2022. The results for the regional rates are mentioned here as they are closer to the local conditions in connection with emission levels in production facilities.

When evaluating the iron and steel sector’s shares of CBAM costs in relation to total exports that year the highest results are achieved in connection with the regional rates applied as the underlying emission coefficient using the 100 USD scenario (TURKSTAT,

2025b). In 2019, the peak is achieved for the regional rates in relation to the 100 USD scenario amounting to 12,5 percent. Throughout the years with growing CBAM costs the export trade with a comparatively increased share of carbon-intensive goods rose. Hence, higher emission levels caused, when multiplied with the different expense scenarios for CBAM certificates, overall growing costs.

In the context of the aluminum sector the average rates for the additional CBAM cost in relation to the total annual export trade volume from Türkiye to Germany between 2019 and 2024 are evaluated as well and the greatest outcomes occur in connection with the default rates in combination with the 100 USD cost scenario (TURKSTAT, 2025b). The results peak in 2020 in connection with the default rates and the 100 USD cost scenario accounting for a result of 7,5 percent whereas the same pricing scenario combined with the regional rates only amounts to 6,3 percent.

Overall, from a sectoral perspective the iron and steel industry and the corresponding CN codes are on average more affected by the additional costs inclined through the CBAM in context of Turkish exports to Germany (TURKSTAT, 2025b). As the default values are derived from the global average on a product basis, corresponding higher results in connection with the default values in comparison to the regional rates imply that in a global comparison the added costs would be greater internationally than locally.

Considering only the scenario of regional rates results in connection with a CBAM certificate pricing of 100 USD, the additional cost amount to 517 Mio. USD between 2019 and 2024 (TURKSTAT, 2025b). Compared to that the added costs for the aluminum sector regarding the identical scenario represent 219,4 Mio. USD. In the context of the scenario applying default values in connection with a CBAM certificate pricing of 100 USD the corresponding outcome amounts to 512,6 Mio. USD for the iron and steel sector and to 259,7 Mio. USD in the context of the aluminum sector during the timeframe 2019 to 2024. The results provide an indication regarding the positioning of the aluminum and iron and steel sectors from an added cost perspective on a global scale as results can be compared. In respect to the iron and steel sector, Türkiye is at a disadvantage as the result in connection with the default values is lower than the outcome derived from the regional rates. On the other hand, the added costs concerning the Turkish aluminum sector remain

on average lower than the international results and hence imply a corresponding cost advantage.

For both sectors annual CBAM cost results vary due to the facts that relative proportions of the individual product categories as part of export trade to Germany change (TURKSTAT, 2025b). Therefore, when the relative share of products with a comparably higher emission coefficient grows, the overall added costs also increase. In the context of the percentage proportions of the additional costs relative to the overall annual export volume, regarding the scenario regional rates in combination with a 100 USD pricing for CBAM certificates, the shares account for on average ten percent for the timeframe 2019 to 2024. For the aluminum sector the corresponding outcome only amounts to on average 5,2 percent between 2019 and 2024.

The scenario using default values in connection with the 100 USD pricing scenario generates an average result of 9,9 percent for the iron and steel sector and of 6,2 percent in terms of the aluminum sector (TURKSTAT, 2025b). These outcomes emphasize the Turkish iron and steel sector's cost disadvantage. Furthermore, from the perspective of the aluminum sector they show a cost advantage in a global comparison. In general, the percentage shares underline the comparably greater effect in the context of the Turkish iron and steel sector. Moreover, the additional costs may potentially harm the price competitiveness of the iron and steel sector as importers would have to pay on average a relatively higher price when procuring products from Türkiye. From an international benchmark perspective Turkish iron and steel exports to Germany are positioned above the global average due to more emission intensive manufacturing and the absence of a national carbon pricing mechanism.

Furthermore, it must be noted that the percentage range on an annual product basis shows clear outliers in the context of the iron and steel sector (TURKSTAT, 2025b). Although their individual contribution to the overall export volume to Germany is comparably less significant than that of the sector's TOP-3 export categories some CN codes demonstrate cost shares exceeding 20 percent in the relation to the overall yearly export trade. On the other hand, the results of the aluminum sector portray a more consistent image with only a few small outliers.

The TOP-3 export categories are assessed on a sectoral basis as well. The best-selling product categories in Turkish exports to Germany include CN codes *7318*, *7326* and *7308* in the steel and iron sector and CN codes *7604*, *7606* and *7616* in the aluminum sector (TURKSTAT, 2025b). For the iron and steel industry the CN code *7318*, in the context of regional rates and the 100 USD CBAM certificate pricing scenario, accounts for 63,7 Mio. USD. On the contrary, applying the default values together with the same pricing scenario the result is 65,4 Mio. USD. Regarding the CN code *7326* the regional rates in combination with the 100 USD pricing scenario cause an outcome of 95 Mio. USD whereas the default values account for a result of 89,1 Mio. USD. The CN code *7308* in combination with the regional rates and the 100 USD pricing scenario amounts to 69,9 Mio. USD and connected to the default values to 69,3 Mio. USD. Besides the outcomes for CN code *7318*, the other results confirm the overall findings in the context of the iron and steel sector that on average production in Türkiye is more emission intensive compared to the global average. The fact that the results connected to the default values fall below those linked to the regional rates verifies that emission coefficients in Türkiye for the corresponding CN codes are on average higher.

In the context of the CN code *7604*, applying the regional rates in combination with the 100 USD CBAM certificate pricing scenario, the result accounts for 114,1 Mio. USD (TURKSTAT, 2025b). On the other hand, against the backdrop of the default values in connection with the same CBAM certificate pricing the value amounts to 134,1 Mio. USD. For the CN code *7606* the outcome applying the 100 USD pricing scenario in connection with the default values results in 70,3 Mio. USD and with the regional rates in 59,2 Mio. USD. Furthermore, in the context of the CN code *7616* when applying the same pricing scenario in combination with the default values the outcome amounts to 17,3 Mio. USD and linked to the regional rates' results in 14,5 Mio. USD. The results for the aluminum sector confirm that in global comparison emission levels in Türkiye are lower than those on an international average. The same result was found when considering the sectors total added cost outcomes as well. Here, Turkish producer's may benefit from improved price competitiveness compared to their average competitor on an international stage.

As part of the assessment the TOP-3 export product categories from Türkiye to Germany among the CBAM related CN codes for the iron and steel sector the CBAM costs are

calculated accordingly. From a total cost perspective, the average value of CBAM cost amounts to 13,8 Mio. USD for the CN code *7326*, making it the category with the highest overall CBAM costs among the TOP-3 export product categories (TURKSTAT, 2025b). Regarding the CN code *7308*, the overall cost across all scenarios amounts to 10,4 Mio. USD, placing it in second place among the TOP-3 export categories between 2019 and 2024. In the context of the CN code *7318* the average value of CBAM cost accounts for 9,7 Mio. USD across all scenarios, making it the category with the lowest overall CBAM costs among the TOP-3 export product categories during the period 2019 to 2024.

Considering the TOP-3 export product categories from Türkiye to Germany among the CBAM related CN codes for the aluminum sector, depending on export and emission levels also here the inclined costs differ (TURKSTAT, 2025b). For the CN code *7604* the average value of CBAM cost amounts to 18,6 Mio. USD across all scenarios, making it the category with the highest overall CBAM costs among the TOP-3 export product categories between 2019 and 2024. In the context of the CN code *7606* the average value of CBAM cost accounts for 9,7 Mio. USD across all scenarios, ranking it in second place. In the context of CN code 7616 the average value of CBAM cost amounts 2,4 Mio. USD across all scenarios, making it the category with the lowest overall CBAM costs.

Considering the percentage shares in the context of annual CBAM cost in relation to total annual export trade on a CN code basis *7308* represents the highest among the TOP-3 export categories and accounts for an overall mean value of 9,3 percent (TURKSTAT, 2025b). In comparison the CN code *7326* represents the second lowest values with an overall average of 6,2 percent. Regarding the CN code *7318* outcomes account for an average value of 4,3 percent representing the lowest proportional results among the TOP-3 export product categories. Furthermore, except for the product category *7308* the CN codes remain far below the sectoral average of nine percent, calculated through dividing the annual CBAM costs per scenario by the total yearly exports share. For the CN code *7308* this indicates a relatively increased proportion of carbon emissions being released during the production process for this CN code positioning it above the sectoral average of nine percent during the period 2019 to 2024.

In the context of the aluminum sector percentage shares in the context of annual CBAM cost in relation to total annual export trade on a CN code basis across the different product

categories vary as well (TURKSTAT, 2025b). The average value of shares for the CN code *7606* across all scenarios accounts for 7,4 percent during the timeframe 2019 to 2024. In the context of the TOP-3 export categories this CN code stands for the highest results concerning the percentage shares achieved during the 2019 to 2024 period. Regarding the CN code *7604* the average across all scenarios amounts to about five percent. This product category ranks in second place among the other two TOP-3 CN codes. For the CN code *7616* average value of shares throughout all scenarios amounts to only 2,7 percent for the period 2019 to 2024. Among the TOP-3 export product categories this represents the lowest relative percentage share for the timeframe 2019 to 2024. The sectoral average when dividing the annual CBAM costs per scenario by the total yearly exports equals 5,2 percent for the period 2019 to 2024. Both the CN codes *7604* and *7616* are positioned below the sectoral average whereas the CN code *7604* accounts for a higher average percentage share.

The different expenditure outcomes in the context of the regional rates and default values providing the emission coefficient emphasize the impact of emission levels on the total sum of costs inclined by the CBAM. This disparity underlines the variation in the applied emission coefficients emphasizing that the actual emission load must be lower locally compared to the global average. Consequently, providing a competitive advantage to the local industry in Türkiye in an international comparison. Moreover, it underlines that the expenses to be covered for the purchasing of CBAM certificates can substantially decrease or increase the total additional costs from the importing parties' perspective. Furthermore, the varying levels of cost in connection with the default and regional rates also imply that the assumptions regarding the level of emissions locally and internationally differ significantly. The lower cost level in conjunction with the regional values implies that products e.g., corresponding to CN code *7604* and *7606* are produced with lower emissions in Türkiye than in an international comparison. The effect of the pricing of CBAM certificates on the overall incurring additional CBAM costs also emphasizes the importance of a local carbon pricing mechanism as it directly impacts the competitiveness of product pricing levels from the perspective of the EU importer.

The results in both the aluminum and iron and steel sector show that the cost effects on a product basis may strongly differ, making it challenging to draw a general conclusion on a sectoral basis as not every item and every producer is affected equally.

As already mentioned, generally the assumption that CBAM costs grow with the increase in Turkish exports to Germany holds true. Although, at the same time, the relative share of products with higher emission levels as part of the total export volume must always be considered as they act as the cost driver. In some cases, e.g., in the aluminum sector when comparing the CBAM costs of the year 2021 to the year 2023 (TURKSTAT, 2025b). In 2023, CBAM costs are relatively lower although the export volume is higher in comparison to 2021. This example emphasizes the importance of considering the relative share of CBAM costs to the overall annual export volume. Here, the calculated average, dividing the annual CBAM cost per scenario by the total annual export volume, using the default values in combination with the 100 USD scenario amounts to 5,3 percent in 2023 versus 6,3 percent in 2021. Nonetheless, in addition, the change in price per ton of a good needs to be considered as well. The higher the price per ton of product the lower the relative share of carbon tax despite the fact that emission levels are comparably higher and hence their overall incurred cost.

For the assessment in accordance with the regulation only Scope 1 emissions are considered. Furthermore, for a number of CN codes both in the context of the regional rates and default values a category average is applied. This means that on a four-digit CN code level an emission coefficient is not provided and hence, the calculated averages out of the given values in connection with the longer CN codes out of this product category are used. As mentioned above, due to the substantial role the emission coefficients play in calculating the CBAM costs, their correct determination is crucial. Regarding the calculated costs as part of this thesis more importance should be given to the outcomes in connection with the regional rates as the corresponding emission coefficient. As they are based on a national assessment, they may be truer to the actual production conditions found locally. In the context of the CBAM, manufactures must assess the emission levels that occur during the production process on the basis of the three emission scopes given. Furthermore, this also implies that the emission coefficients applied during the assessment only allow for a general picture in terms of the results regarding the potential costs as emission levels on a production facility basis may differ locally.

Regarding the applied pricing for the CBAM certificates, as carbon costs are set to rise in the EU an assumption in form of two scenarios, 80 USD and 100 USD, was implemented, considering the current costs for EU ETS allowances and the potential deductible due to

a local ETS to be introduced in Türkiye. Due to the fact that the values for the emission coefficient and the cost of CBAM certificates are assumed in the context of the calculations, the actual occurring expenses for CBAM certificates to be purchased by an EU importer in connection with exports from Türkiye in the corresponding sectors may differ in the future. Nonetheless, the results offer a reliable indication in terms of what potential cost in connection with the CBAM regulation from the perspective of the Turkish iron and steel as well as aluminum sector could amount to. In particular for the iron and steel sector where additional costs reach double-digit percentage shares in relation to the overall trade volume in USD, the findings provide a cost estimation.

Referring to findings from recent scientific work, the results underline the likely negative impact of the CBAM on trade relations and economic development, also for the case of the Turkish-German trade axis. Although it must be noted that a comparable study focusing on Turkish exports to Germany, in particular in the aluminum and steel and iron sectors has not previously been conducted. As recommended by Chu et al. (2024), Morchid et al. (2024), Yan and Yuan (2023) and Zhu et al. (2024) the implementation of a local ETS is important to diminish the economic impact and may be accelerated due to the CBAM, as it may also be the case for Türkiye. In this context the pricing for emissions on an EU and local level play a key role, as raised by Bromels (2024), Tian et al. (2024) and Yan and Yuan (2023). On the other hand, the CBAM can also function as an accelerator for green transformation activities and may be regarded as a chance for Türkiye, as stated by Alpay and Gökmen (2023), Gültekin (2022), Koç and Kaynak (2023), Tian et al. (2024) as well as Yan and Yuan (2023). As determined by Beder (2024), Chu et al. (2024), Yan and Yuan (2023) and Zhu et al. (2024) export trade may decrease in the aluminum and steel sectors and prices for corresponding export goods may rise as already displayed in the context of other countries.

In terms of the implementation of a local ETS, national carbon price levels will have a substantial effect on prices for goods exported from Türkiye to Germany. Although, the underlying assumption is that a carbon market will facilitate as well as incentivize the green transformation of industry and climate action, these national processes require time, know-how and investments. From the perspective of the exporter, the local additional costs to be covered due to a carbon price may be passed on to the importer on the customer side. This may also hold true in terms of the cost of decarbonization investments to be

passed on to the customer by the producer. On the other hand, the lower the carbon price to be paid locally is in comparison to the cost of CBAM certificates, the more the German importer will have to pay as only little can be deducted. Furthermore, the level of Turkish carbon pricing also affects the national industries overall, including companies that sell to the national market rather than export. This may also lead to price effects on Turkish products in the national market.

In this context, the policy framework and pricing of carbon emissions must consider both the perspective of non-exporting and exporting industry to prevent micro- and macro-economic implications. On the other hand, in the context of exports to Germany it must be emphasized that cost competitiveness from a global perspective must be considered. This includes both the scenario that exporters pass on the carbon price to German customers abroad via higher product prices and that the German importer has to pay higher costs for CBAM certificates if the local carbon price in Türkiye is low. This risk must be considered by both the private sector and the public sector in the course of bilateral trade relations. On the Turkish side, the main concern here is to maintain its own competitiveness both in the course of climate action and in terms of the price competitiveness of products. From a German perspective, this is about the security, diversification and resilience of supply chains as well as avoiding price increases that would have an impact on the domestic market and the exporter's own further business activities. A potential risk may be that supplying industries in countries abroad can no longer compete due to slow progress regarding decarbonization of production processes or asymmetry in carbon pricing locally.

In terms of recommendations for further research to be conducted similar assessments could be conducted in the context with the EU in general as well as other individual countries. Furthermore, these assessments could cover the other sectors relevant under the CBAM which were not considered as part of this analysis in detail such as the fertilizer or cement industries. Once confirmed emission level data sets are available on production facility basis further research regarding the actual cost on a sector basis could be executed across the CBAM-affected industries in Türkiye. In addition, with the full introduction of the CBAM following the end of the transitional phase in 2026, the cost assumptions can be tested and verified against actual trade data available in this regard. Furthermore, studies regarding local carbon pricing levels in the context of price competitiveness and

micro- and macro-economic impact may provide orientation and a perspective on potential risks and opportunities. From a European and German perspective an assessment of potential risks regarding supply chain resilience, diversification and security as well as price effects should be conducted.

CONCLUSION

Turkish-German relations are linked by approximately a thousand years of common history, dating back to the 11th century. Bilateral relations extend beyond the economic and political dimensions including also close social ties, e.g., due to a large Turkish diaspora living in Germany. In recent decades bilateral trade relations have reached significant levels, contributing to the economic development of both countries while furthering economic integration. Bilateral German-Turkish trade also benefitted from the introduction of the EU-Türkiye Customs Union in 1996 substantially removing barriers to trade. Its introduction can be regarded as another catalyzer for growing bilateral trade relations.

Furthermore, in particular from a Turkish perspective, with Germany being the primary export destination for Türkiye and the third most important trade partner in 2024, the trade relations with the country are of special significance. From a German perspective almost 8.500 companies with German capital shares have invested in Türkiye, representing the second largest country-of-origin, benefitting from both advantageous location factors and the national sales market. The level of economic integration between the countries makes bilateral trade relations flourish and substantial but at the same time more vulnerable to potential economic effects such as economic shocks and changes in framework conditions. In consequence, such shifts may lead to an impact on the countries' national economic development beyond the direct effect on bilateral trade ties. Hence, risk management, continuous dialogue, precautious measures and collaboration on both the end of the private and public sector are crucial in times of such shifts.

Climate change shapes policy agendas globally, as the world is exposed to its implications which are expected to get worse over time. With the goal of implementing appropriate measures to prevent lasting harm and diminish the effects of climate change a vast number of governments have taken corresponding actions by introducing regulatory packages. These climate action and protection measures include, e.g., green transformation efforts in the context of the manufacturing industries, financing, financial aid and incentives for green projects, activities around the general prevention of pollution as well as the implementation of economic instruments such as an ETS or the CBAM against the backdrop of environmental policy.

In the case of Türkiye and Germany, both countries have committed themselves to the Paris Agreement in 2021 and 2016, respectively. Türkiye and Germany also introduced individual net zero targets. The Turkish goal is set for 2053 whereas the German government targets the year 2045. In addition, Germany determined further sub targets such as lowering its carbon emissions by 65 percent until 2030 and by 88 percent until 2040 compared to 1990 values.

Simultaneously, a number of national climate action measures have been introduced. Türkiye has recently passed its initial national Climate Law which will also include a framework for the implementation of a local ETS. On the other hand, Germany introduced its national climate legislation in 2019 and has been participating in the EU ETS since its implementation in 2005. In addition, it has also enforced a local ETS in place since 2021 for the heating and transport sectors. In the context of the EU ETS, it is emphasized that it has benefitted the reduction of carbon emissions since its implementation. As part of the EU, Germany must comply with and carry out EU legislation and climate action activities such as the European Green Deal and its corresponding measures. Simultaneously, as the EU and Germany represent a part of Türkiye's most important trade partners also Türkiye in ways is required to adapt accordingly to facilitate the smooth course of relations.

Moreover, the EU ratified the Paris Agreement and is committed to the corresponding climate neutrality goal until 2050. The EU's Green Deal represents the related policy package to facilitate the path to climate neutrality, to foster climate protection and green transformation measures while decoupling economic expansion from the use of resources and promote conditions around fairness and competitiveness in conjunction with its climate neutrality target.

Internationally, the European Green Deal targets to facilitate the lowering of carbon emissions while preventing the phenomenon of carbon leakage, where production facilities are shifted to third country locations with less ambitious climate protection measures in place. In this context the policy package intends to make use of the CBAM which links the during the production process generated carbon emissions to a corresponding carbon price on goods imported to the EU. At the same time, the instrument aims to foster the green transformation processes of industries in third

countries. During the initial stage the CBAM will cover the aluminum, cement, electricity, fertilizers, hydrogen as well as iron and steel sectors. Scholars have underlined that the CBAM may put strain on relations between Türkiye and the EU as well as its member states. Moreover, the potential cost impact of the instrument on Turkish exports to the European market is mentioned. This concern holds true considering the results of the assessment conducted as part of this thesis.

In the context of sustainability and climate protection the SDGs are of considerable significance. As part of this thesis a link to the policy framework of the European Green Deal was reviewed. In conclusion, in the framework of the European Green Deal a link to all of the SDGs can be determined. Nevertheless, it is noteworthy that out of the number of SDGs not all of them relate to the individual policies in like manner.

Against the backdrop of environmental policy economic instruments may be introduced to further the reduction of carbon emissions such as Pigouvian taxation which forms the conceptual foundation for putting a levy on greenhouse gas emissions. Here, the public body benefits from the income through carbon taxation which can be used locally to finance and incentivize transition efforts. The conceptual framework of Pigouvian taxation can be directly linked to the CBAM and provides its theoretical foundation. In the context of global trade, such a taxation mechanism may act as an instrument to encourage third countries to further decarbonization efforts and climate action.

On the other hand, it exerts pressure on foreign markets and causes asymmetry among them. From the perspective of third-country exporters the carbon levy introduces a price risk and a potential loss of competitive advantage against others, although the costs for CBAM certificates are covered by the European importer. At the same time, it puts pressure on existing trade relations, which cannot keep up with the international competition at product level due to more emission-intensive production processes. As a result, the carbon tax triggers both the need for an accelerated decarbonization of the industry as well as the need for the introduction of a local ETS to lower price risks and finance sectoral green transformation efforts.

In this context, countries that are able to reflect greenhouse gas emissions under a national ETS are at an advantage as locally paid carbon costs are deducted from the price for CBAM certificates. In addition, the governments may use the income from the ETS as

funds to reinvest in capacity and capability building and activities as well as project initiatives regarding decarbonization efforts and the green transformation of industries. Besides funding and financing, it must be noted that such transitional processes require time, the availability and feasibility of market-ready technologies and the availability of a skilled workforce, among others.

In general, countries with a good set of know-how, market-ready technology and continuous technological advancements as well as financial capabilities in these areas as well as project development and execution activities ongoing hold an advantage. Simultaneously, this puts individual countries without this set of instruments and capabilities available at a disadvantage compared to others, creating a sheer insurmountable asymmetry. From a German or European perspective, this harbors the risk of weakening the security and resilience of supply chains and makes it more difficult for the procurement to diversify supply through various suppliers due to price pressure and limited choices. At the same time, the price risk can also lead to national price increases as well as competitiveness loss in the global context on the European side, as importers pass the additional carbon cost on to the product price to be paid by their customer locally or abroad. Therefore, it must be in the interest of the EU and EU member states to assist the transition process in third countries, e.g., through comprehensive support programs, local capacity and capability building, financing and funding schemes, in-depth education and collaboration formats as well as knowledge and know-how transfer.

The analyses as part of this thesis aims to assess the potential economic impact of the CBAM on Turkish-German trade relations on a sectoral basis. The assessment centered on the potential cost effects inclined by the CBAM while focusing on Turkish export trade activities in the iron and steel as well as aluminum sectors to Germany. For the research the overall potential additional cost is determined on a four-digit CN code basis in the context of the iron and steel as well as aluminum sectors during the time period 2019 to 2024, annually. Moreover, the additional costs in relation to the overall Turkish export trade volume to Germany are estimated on a percentage basis.

Based on the TOP-3 export categories a comprehensive analysis on a product basis was drawn. For the assessment only the export activities concerning the CBAM-relevant CN

codes in the corresponding were considered. Two different scenarios in the place of the corresponding emission coefficients are used for the calculation of additional costs. The CBAM default rates reflect rather a global average on a CN code basis whereas the regional rates depict values derived from country-based expert assessments. The different outcomes in the context of the regional rates and the default values providing the emission coefficient emphasize the impact of emission levels on the total sum of costs inclined by the CBAM.

From a sectoral perspective the iron and steel industry and the corresponding CN codes are most affected by additional cost inclined through the CBAM in terms of Turkish exports to Germany. Considering only the scenario in the context of regional rates results in connection with a CBAM certificate pricing of 100 USD, the additional cost would amount to 517 Mio. USD between 2019 and 2024. In comparison, the added costs for the aluminum sector under the identical scenario would only account for 219,4 Mio. USD. In the context of the scenario default values in combination with a CBAM certificate pricing of 100 USD the result amounts to 512,6 Mio. USD for the iron and steel sector and to 259,7 Mio. USD for the aluminum sector between 2019 and 2024.

Overall, as the default values applied as emission coefficients are obtained using the global average on a CN code basis, greater costs outcomes in the context of default values compared to regional rates suggest from an international benchmark perspective the added costs would be higher globally than nationally. In the case of Türkiye this would mean a competitive price advantage. In case of the iron and steel sector Türkiye is at a disadvantage in global comparison whereas from the perspective of the aluminum sector the results imply a relative cost advantage compared to the international average.

In both sectors CBAM costs on an annual basis differ as the share of the individual product categories in export volumes changes. As a consequence, when the proportion of products with a relatively higher emission coefficient rises, the overall added costs increase. Considering the percentage share of the added expenses in relation to the overall annual export volume, for the above-mentioned scenario (regional rates and 100 USD pricing for CBAM certificates), the proportions amount to ten percent in the iron and steel sector, on average, between 2019 and 2024. In the context of the aluminum sector this result only represents 5,2 percent on average during the same time period. The

combination out of default values and the 100 USD pricing scenario leads to average results of 9,9 percent for the iron and steel sector and 6,2 percent for the aluminum sector.

The results again underline the slight cost disadvantage of the Turkish iron and steel sector and, on the other hand, the cost advantage for the aluminum sector in global comparison. Overall, the proportional shares emphasize the relatively larger impact on the iron and steel sector. Here, the added cost could lead to a loss of price competitiveness as importers would have to cover it when procuring products from Türkiye. Turkish iron and steel exports lie above the global cost average due to more emission intensive production processes and a lack of a local ETS to provide the opportunity of deducting already paid carbon costs.

Furthermore, is important to note that the percentage range on an annual product basis displays clear outliers in the context of the iron and steel sector. Despite the fact that their individual contribution to the overall exports to Germany is comparably less significant than that of the sector's TOP-3 export categories some CN codes demonstrate relative cost proportions exceeding 20 percent in connection with the overall annual Turkish export trade to Germany. On the contrary, aluminum sector's outcomes portray a more consistent picture including only a few small outliers.

The best-selling product categories in Turkish exports to Germany include CN codes *7318*, *7326* and *7308* in the steel and iron sector and CN codes *7604*, *7606* and *7616* in the aluminum sector. Besides the outcomes for CN code *7318*, the other results confirm the overall findings in the context of the iron and steel sector that on average production in Türkiye is more emission intensive compared to the global average. The fact that the results connected to the default values fall below those linked to the regional rates verifies that emission coefficients in Türkiye for the corresponding CN codes are on average higher. On the other hand, the results for the aluminum sector confirm that in global comparison emission levels in Türkiye are lower in this sector than those on an international average. The same result was found when considering the sectors total added cost outcomes as well. Here, Turkish producer's may benefit from improved price competitiveness compared to their average competitor on an international stage.

Moreover, it underlines that emission levels have a direct impact on the expenses to be covered for the purchasing of CBAM certificates. This can substantially decrease or

increase the total additional costs from the importing parties' perspective. Against this backdrop, the possible subtraction of an already covered national emissions' price by the exporter may lower the importer's financial burden while requiring the installation of a local ETS at the same time. In this context, the local pricing of emissions would play a key role as well as the number of industries covered under the ETS. The closer the local carbon pricing is to the price levels of the EU ETS or the CBAM certificates the smaller are the amounts to be paid by the importing party. On the other hand, the higher the costs for carbon allowances are the greater is the pressure on local manufactures to cover these additional expenses. In particular from the perspective of non-exporting industrial players this may lead to conflict. Furthermore, as already mentioned exporting producers could apportion the additional costs to the price of their products.

Nonetheless, establishing a local ETS may enhance the exporting parties' level of cost-competitiveness versus that of sellers from other countries. Furthermore, it may facilitate efforts of local industry to invest in the decarbonization of production facilities. Moreover, the income from the sale of carbon allowances can be used for public incentive and support programs to promote and finance green transformation efforts locally. This is also true in the context of operating "green" production facilities to lower the emission footprint of manufactured products at the source. Hence, facilitating green transformation efforts among industrial players and promoting the green transition in the energy sector to increase shares of clean energy in the grid are crucial.

In the context of further research similar assessments may be conducted in the context with the EU in general as well as other individual countries to compare their results with the outcomes of this assessment. The other sectors relevant for the CBAM which were covered as part of this work may be considered. With the increasing availability of proven and production-facility-based emission data further assessments may potentially lead to more accurate and specific results on a sector-basis. The cost assumptions and potential risk may be verified once the CBAM has been fully implemented. In addition, research regarding levels of carbon pricing considering price competitiveness and micro- as well as macro-economic effects could support the setting of a local carbon cost and linked risks as well as opportunities. From the viewpoint of the EU and Germany a risk analysis in terms of supply chain resilience, diversification and security as well as potential price effects should be performed.

The findings clearly show that Turkish-German trade relations are expected to be affected by the CBAM regulation. In particular, the iron and steel sector will relatively be most impacted in comparison to the aluminum sector. This can ultimately cause a negative course of economic development on a macro and micro level from a Turkish perspective if corresponding measures are not taken. Moreover, for Germany this may result in a price increase on imports which would potentially be passed on to the customer or consumer. In consequence, on a micro level German products may increase in price and on a macro level inflation may rise. Furthermore, there is a risk of losing suppliers for German importers and simultaneously a danger of losing an important sales market from the perspective of Turkish exporters. Due to increasing price pressure German companies could start to buy goods from other countries-of-origin with a competitive price advantage compared to Turkish products. These developments would simultaneously exert pressure on the historically grown bilateral trade relations and may cause them to decrease.

Overall, the results emphasize the risk of a loss in competitive advantage due to increasing price levels for Turkish exports in the aluminum and in the iron and steel sector. For this reason, it is crucial to carry out corresponding measures to ready the local manufacturing industry such as facilitating green transformation efforts, implementing a national ETS, developing as comprehensive regulatory framework in the context of climate action and establishing sufficient incentive and funding structures to support transitional processes. These comprehensive measures may also offer further collaboration opportunities between Germany and Türkiye. As economic ties between the two countries are historically tight it is also in the interest of Germany to support the transitional process of its trading partner. Due to the large number of economic stakeholders benefitting from the bilateral trade relations and the connected welfare the securing of existing supply chains and related economic activities is in the interest of both partners. Besides the green component, supply chain resilience and security are crucial in times of global unrest. Furthermore, the transition activities and connected collaboration windows provide an opportunity to even further grow trade ties between the two countries if Turkish export goods in the CBAM-affected sectors can maintain their competitive advantage.

Policy Recommendations

In this chapter based on the findings and results from the assessment the following policy recommendations for Türkiye and Germany can be determined to manage the potential risks and the impact of the CBAM regulation on bilateral trade relations. From the perspective of both countries the CBAM exerts additional cost pressures that affect the exporting and importing party as well as possibly the countries' economic development on a micro and macro level. In addition, the CBAM poses a risk from a supply chain security, resilience and diversification standpoint for both Germany and Türkiye. From a Turkish risk perspective, the buyer's side is more relevant here, whereas from a German point of view, the supplier side harbors a risk. On the other hand, the CBAM is a tool to ultimately facilitate the reduction of greenhouse gas emissions and foster the green transformation of industry as well as decarbonization of sectors in third countries.

Overall, to lower potential risks and economic effects cooperation between the two trade partners across the different policy areas is required. In particular due to the high importance of Germany as an export market from the Turkish perspective measures must be taken to prevent negative effects. Simultaneously, exports targeting other EU markets and beyond will also benefit from corresponding policy measures. Furthermore, Türkiye may regard this adaptation as an opportunity to position itself as a green sourcing country on a global scale. At the same time, it also provides the opportunity for German-Turkish economic ties to further evolve and grow as a result of the adaption process towards a greener supply country.

Due to the intended facilitator role of the CBAM in terms of the reduction of greenhouse gas emissions, green transformation of industry and decarbonization efforts comprehensive actions in these and connected areas, in particular regarding the CBAM-affected sectors, form the foundation for corresponding policy recommendations. Hence, from the Turkish perspective it is crucial to provide a comprehensive legislative framework, in form of a master plan such as the Climate Law which was passed in Türkiye on July 2, 2025, in the context of climate protection and corresponding measures, climate action, green transformation as well as clear targets covering the micro- and macro-economic level.

This regulatory scheme should be in line with international norms and standards and must reflect and consider internationally concluded frameworks and agreements such as the Paris Agreement. Moreover, on a micro-economic level it may also include specific measures and actions for exporters in the context of the CBAM and the corresponding affected sectors. Furthermore, the responsibility of formulation, coordination, tracking and following-up on a macro level of the different aspects of the framework, such as target attainment should be done through a central governmental body. The formulation, implementation of measures and action plans, tracking, follow-ups and coordination on a micro level, on the other hand, should be conducted by the for the specific area responsible public authority such as the corresponding ministries. If required beyond the framework of the Climate Law but complementary to it ministries may formulate additional legislation on a micro level.

Furthermore, this legislative framework should provide clear emission and pollution reduction targets linked to specific action plans on an overall economic and sectoral basis. The overall targets should concern the macro-economy and country as a whole whereas the sectoral targets should reflect the goals on a micro level for specific sectors. These targets should follow the logic of SMART goals, meaning they must be measurable, concrete, achievable and linked to a certain point in time. Simultaneously, orientation for the affected stakeholders such as companies and society should be provided through comprehensive action plans and roadmaps. In addition, awareness-building in the context of these targets should be widely conducted. Furthermore, public authorities may render corresponding guidance and contact points. In particular, small- and medium-sized enterprises as well as civil society must be supported throughout the transitional process.

As part of the execution of action plans and targets concerning climate protection and the green transformation process measures and sectors should be prioritized under a climate law. As the transition process is time- and cost-intensive, prioritizing specific measures and especially emission-intensive sectors provides for a more coordinated and more sustainable path towards goal achievement.

The transition process and decarbonization efforts require financial resources. This affects all groups of society including the public and private sectors as well as civil society. Therefore, public authorities must develop a comprehensive plan encompassing

various financial support mechanisms and tools as well as incentives to ease the transitioning process. In this context as well through the prioritization of specific targets to be achieved and sectors financial resources can be distributed accordingly. The funding programs and related mechanisms and tools should be easily accessible and must consider the aspect of a just transition to prevent preferential treatment of certain stakeholder groups while taking into account levels of vulnerability as well as their importance from a micro and macro perspective. In particular more vulnerable stakeholder groups such as small and medium enterprises or women should be considered against the backdrop of a just transition. In terms of the CBAM exporters should receive additional financial support to facilitate the transformation of production processes and create sufficient internal capabilities to adapt and manage the requirements.

Nonetheless, designing funding and incentive programs, the approach of a liberal market policy and market development should be taken into account. For example, funding and incentive programs should not lead to preferential treatment of individual technologies, products or stakeholder groups and thus distort the resulting market picture. In the course of the green transformation, technological openness should be practiced and all technologies that contribute to decarbonization and can prevail on the market against competition should be considered. Subsidies can lead to unintended influence on pricing, distort markets and prevent a fair market and competitive environment, particularly in newly emerging markets. Depending on the context, funding instruments and subsidies should be used to promote the natural emergence of green lead markets rather than financing their existence such as the tool contracts for difference. This is crucial to sustainably create new and competitive markets and make the transitional process feasible.

Generally, funding in form of subsidies or incentives can be used to reduce the entry barrier and financial burden, e.g. when using alternative, green energy sources or new technologies. This applies across all groups in society and may be crucial to initiate market development and the transition process. Moreover, in particular in the context of global markets in certain cases funding may be crucial to protect or increase levels of competitiveness during the transitional process although the aspects of market distortion and fairness must always be considered. A distinction is made here between support for investment and operating costs. Based on certain standardized criteria to be developed

such as the stakeholder group, type of technology to be used, cost and project scope, importance of the projects for society or the economy, corresponding appropriate funding concepts should be developed and the funding of investment and/or operating costs determined.

Beyond establishing a regulatory framework and sufficient financial resources the development of local capabilities and expert know-how in the area of climate protection and green transformation is crucial. Moreover, this also applies in the context of the CBAM, the connected areas and the skills and know-how required. The availability of local capabilities is crucial in terms of preparing, carrying out and coordinating the transition as well as in the context of prevention. Also, in the context of the CBAM and its requirements for exporters this holds true. Educational programs across the various educational levels should be introduced to facilitate awareness building for the topic of climate change and protection and to develop a skilled workforce accordingly. In addition, by the CBAM affected groups, in particular those most vulnerable due to limited resources such as small- and medium-sized, should be supported in this regard. Furthermore, public authorities should develop corresponding programs and offer funding for corresponding efforts to be conducted by third parties.

The awareness building is particularly important in the context of prevention work, to create interest in climate action and green transformation measures as well as motivate stakeholders to participate in these processes. Awareness building activities should start at a young age and the lowest educational level. The development of a skilled workforce is key to plan, prepare and conduct the transition and corresponding actions as well as achieve the set targets in the various different areas. This skilled workforce encompasses both white- and blue-collar workers as well as scientists and educators, among others. Furthermore, due to the transition certain jobs will automatically be eliminated whereas others will be added. Retraining opportunities are therefore also important. In addition, an increased demand for experts and Research and Development (R&D) activities will occur due to the innovative nature of certain areas of climate action and the green transformation process. This also applies in the context of the CBAM for exporting companies where new services may be required, and internal capabilities may have to be extended through hiring additional expert stuff. Public authorities should develop

corresponding programs and offer funding for corresponding efforts to be conducted by third parties.

Public authorities should also actively support the development, facilitation and funding of national R&D capacities, e.g., for the development of required decarbonization technologies and their application in close cooperation with the private sector or the in-depth analyses of sectoral demands and risks. Forming own capabilities in these areas can support local value creation, contribute to the development of new sales markets, lower the dependency in terms of know-how and availability of technology to third parties and accelerate the transition process.

Furthermore, public authorities should continuously evaluate and track the possible price effects and outlooks as well as potential effects on the supply chain with a particular focus on the most important sales markets for Turkish exporters in the EU due to the CBAM. Moreover, scenarios must be identified to lower corresponding risks on a sectoral basis in case demand from the European market declines in the context of the CBAM. Scenario analyses should also include continuous impact assessments of national economic development. Overall, based on the corresponding results of the above-mentioned suggested research measures on a micro and macro level should be formulated and implemented.

For the purpose of incentivizing emission reduction efforts and funding the green transition a national ETS with a comprehensive sectoral coverage must be implemented. Against the backdrop of the CBAM such an ETS would lower the risk of diminishing price competitiveness for Turkish exporters as the locally paid carbon price can be deducted from the cost of CBAM certificates to be purchased by the German importers. When establishing the price for carbon emissions in the Turkish market a benchmark considering potential CBAM certificate prices, carbon costs in third countries and limiting price factors locally, e.g., possibly exerted high-cost pressure on non-exporting firms, must be assessed. In addition, international and EU standards as well as regulations must be taken into account to ensure compatibility of the systems.

From a German standpoint the CBAM's central benefit is that it protects the local manufacturing industry from a loss of competitiveness due to carbon leakage. Nonetheless, possibly rising prices for imported goods due to an added emission costs as

well as an increased risk regarding supply chain diversification, security and resilience call for precautious measures to be taken from a policy perspective.

As already mentioned, as an EU member state Germany must support third countries and trade partners locally as part of their adaption process to the CBAM regulation. Furthermore, the lack of readiness in the context of the CBAM regulation of exporting third countries to Germany poses a supply chain risk to German importers as the competitiveness of preexisting trade ties may be jeopardized. Here, a collaborative dialogue, technology and know-how transfer, close cooperation as well as provision of financial resources through specific funding programs may form the foundation of corresponding support measures. Specific action plans, programs and cooperation formats must be formulated and implemented in a continuously collaborative manner and on a demand-basis together with the partner and relevant stakeholders. Beyond the cooperation between governmental bodies both countries must make sure to foster and include partnerships between the affected stakeholder groups such as from the private sector or civil society. Overall, this area also provides the opportunity to further grow and multiply relations in the Turkish-German context. Generally, in particular due to the strong nature of economic ties with Türkiye such measures should be adhered.

Based on assessments and analyses German public authorities should consistently estimate and follow up on the price risks and forecasts as well as potential impacts on the supply chain on a supplier country basis. Furthermore, possible alternative sourcing scenarios must be developed to minimize corresponding risks on a sectoral basis. Moreover, the impact of price increases on imported products from a sectoral perspective and its effects on national economic development and local inflation must be assessed as German importers may pass the price rise on to their customer or the local consumer. These measures apply both in the context of Turkish-German ties but also hold true in relation to other countries. Based on the corresponding outcomes of the above-mentioned suggested research corresponding policy measures on a micro and macro level should be formulated and implemented.

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