ASSESSING THE POTENTIAL IMPACT OF THE EU GREEN DEAL ON TURKISH REFINERIES: ANALYZING NET-ZERO EMISSION STRATEGIES THROUGH EXPERT INSIGHTS

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ETHICAL DECLARATION

I hereby declare that I am the sole author of this thesis and that I have conducted my work in accordance with academic rules and ethical behaviour at every stage from the planning of the thesis to its defence. I confirm that I have cited all ideas, information and findings that are not specific to my study, as required by the code of ethical behaviour, and that all statements not cited are my own.

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ABSTRACT

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The European Union's Green Deal is a comprehensive policy framework that addresses economic, social, and environmental aspects. The EU has committed to achieving a carbon-neutral continent with the Green Deal by 2050 with various policies and aspects in various areas. EU members have started to implement its requirements. However, the Green Deal also affects non-EU countries, especially their trade partners. This study presents the potential effects of the Green Deal on Turkish refineries. This study especially evaluates the implications of these potential effects for the Turkish refinery industries, focusing on Net-zero emission and decarbonization targets. First, the Green Deal targets related to refineries were analyzed, and then global refinery industry examples were reviewed. Interviews were conducted with experts using qualitative analysis to evaluate the potential effect of the Green Deal on Turkish refineries. The findings demonstrate that the Green Deal will affect the Turkish refineries in a manner that strategies could be developed to align with market variables

and recent updates of the Green Deal and Turkish regulations.

Keywords: The EU Green Deal, Oil Refinery, Decarbonization, GHG emissions, Net Zero targets.

ÖZET

AB YEŞİL MUTABAKAT'ININ TÜRK RAFİNERİLERİ ÜZERİNDEKİ POTANSİYEL ETKİSİNİN DEĞERLENDİRİLMESİ: NET-SIFIR EMİSYON STRATEJİLERİNİN UZMAN GÖRÜŞLERİYLE ANALİZİ

Akdağ Kerimov, Arzu

Sürdürülebilir Enerji Yüksek Lisans Programı

Tez Danışmanı: Prof. Dr. Mehmet Efe BİRESSELİOĞLU

Mayıs, 2024

Avrupa Birliği'nin Yeşil Mutabakatı ekonomik, sosyal ve çevresel yönleri ele alan kapsamlı bir politika çerçevesidir. AB, Yeşil Mutabakat ile 2050 yılına kadar karbon-nötr bir kıtaya ulaşmayı çeşitli alanlarda çeşitli politikalar ve unsurlarla taahhüt etmiştir. AB üyeleri Yeşil Mutabakat'ın gerekliliklerini uygulamaya başlamıştır. Yeşil Mutabakat, başta ticaret ortakları olmak üzere AB üyesi olmayan ülkeleri de etkilemektedir. Bu çalışma, Yeşil Mutabakat'ın Türk rafinerileri üzerindeki potensiyel. etkilerini ortaya koymaktadır. Çalışmada, özellikle Net-sıfır emisyon ve karbonsuzlaştırma hedeflerine odaklanarak, Yeşil Mutabakat'ın Türk rafineri endüstrileri üzerindeki potensiyel etkisi değerlendirilmektedir. Öncelikle rafinerilerle ilgili Yeşil Mutabakat hedefleri analiz edilmiş, ardından dünyadaki rafineri sektörü örnekleri incelenmiştir. Yeşil Mutabakat'ın Türk rafinerileri üzerindeki potansiyel etkisini değerlendirmek için nitel analiz methodu kullanılarak deneyimli uzmanlarla görüşmeler yapılmıştır. Bulgular, Yeşil Mutabakat'ın, Türk rafinerilerini, piyasa

değişkenlerine ve Yeşil Mutabakat ile Türk mevzuatındaki son güncellemelere uyum sağlayacak stratejiler geliştirilebilecek şekilde etkileyeceğini göstermektedir.

Anahtar Kelimeler: Avrupa Yeşil Mutabakatı, Petrol Rafinerisi, Seragazı Emisyonları, net sıfır hedefleri.

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CBAM: Carbon Border Adjustment Mechanism

CBD: Convention on Biological Diversity

CCS: Carbon Capture and Storage

CCUS: Carbon Capture, Utilization and Storage

COP: Conference of the Parties

ETS: Emission Trading System

EU: European Union

GHG: Greenhouse Gas Emission

IEA: International Energy Agency

MEUCC: Ministry of Environmental, Urbanization, and Climate Change

MRV: Monitoring, Reporting and Verification

NDC: Nationally Determined Contribution

R&D: Research and Development

SAF: Sustainable Aviation Fuel

TÜİK: Turkish Statistical Institute

UNFCCC: United Nations Framework Convention on Climate Change

UN: United Nations

ZRF: Zero Routine Flaring

CHAPTER 1: INTRODUCTION

Global warming is a significant topic and a current issue in all countries. Climate change mitigation action plans were initiated in 1992, which means that efforts to reduce the impact of climate change have been ongoing for almost three decades. Three main interlinked issues impact humanity and the environment: climate change, desertification, and biodiversity loss. In response to these challenges, governments founded three 'Rio Conventions' related to each other at the 1992 Earth Summit in Rio de Janeiro, Brazil (United Nations, 1992). These are the United Nations Framework Convention on Climate Change (UNFCCC, also known as UN Climate Change), the Convention on Biological Diversity (CBD, also known as UN Biodiversity), and the United Nations Convention to Combat Desertification (UNCCD) (UNFCCC, 1992). The three Rio Conventions aim to develop similar sustainable development solutions for the environment (UNFCCC, 1992). The UNFCCC came into force in 1994 with 198 countries as members, known as Parties to the Convention. Its main goal is to prevent harmful human interference with the climate system. Moreover, The Kyoto Protocol was adopted on 11 December 1997 (UNFCCC, 1997). Due to a complex ratification process, it was officially implemented on 16 February 2005. Today, there are 192 Parties to the Kyoto Protocol. The protocol aims to commit industrialized countries in transition to limit and reduce greenhouse gas (GHG) emissions with their goals by UNFCCC (UNFCCC, 1997).

Per UNFCCC (2015), the Paris Agreement is a binding international treaty addressing climate change. 196 parties were ratified during the COP 21 summit of the UNFCCC on December 12, 2015, and it started to be applied on 4 November 2016. This agreement has been announced as good news for the significant level of the international response to the threat of climate change. Also, the Paris Agreement has been a prominent issue on the international agenda and a primary consideration in decisions related to environmental sustainability (Mele, Paglialunga and Sforna, 2021). This legally binding agreement provides a long-term temperature goal of keeping global mean temperature increase well below 2°C and taking action to limit it to 1.5°C compared to the pre-industrial period. This leads to the acceleration of the mitigation actions (Salman et al., 2022). That is why the Paris Climate Agreement is

the most remarkable global climate treaty to date. All countries should set emissions-reduction commitments in line with this agreement. In other words, objectives are legally binding for countries to combat climate change.

The European Union (EU) announced the EU Green Deal in December 2019, and it aims to be a net zero continent in 2050. The EU primarily focused on a cross-sectoral approach with climate-related goals and created multidisciplinary packages covering climate, environment, energy, transport, industry, agriculture and finance, and other sectors. Also, the EU Green Deal is a package of policies that aim to green transition and achieve climate neutrality by 2050. On the path to 2050, the EU first aims to decrease GHG emissions by at least 55% compared to 1990. The EU has created policy packages and revisions covering sectors like energy, transport, industry, agriculture, environment, and sustainable finance to contribute to climate-related goals. During this period, the EU launched new regulations and revised its legislation and laws (European Council, 2023a).

The EU Green Deal, a significant commitment, includes many policy initiatives and legislative actions to reach climate neutrality by 2050, transforming various economic and societal sectors. Industries take action in their emission reduction targets, increasing renewable energy initiatives, developing energy-efficient technologies and waste reduction options, adopting circular economy principles, developing electric vehicles, charging infrastructure and environmentally friendly solutions, and complying with new regulations and standards. Moreover, the Green Deal created job opportunities in renewable energies and energy efficiency technologies. The Green Deal also benefits industries in the EU. It may make them more competitive in global markets with cleaner and more sustainable practices. In particular, the international market and consumer demand for environmentally friendly products can increase. On the other hand, industries with high emissions or processing fossil fuels may face challenges in the transition period while applying the new regulation requirements and sustainable practices.

Conversely, non-EU countries that export materials and services to the EU countries are also faced with the EU Green Deal and have to apply actions related to the Green Deal target. Firstly, non-EU countries in trading activities can be affected by measures

and compliance costs related to carbon tariffs. Moreover, the EU countries can shift their product demands to sustainable alternatives produced by more environmental solutions. So, non-EU countries also have to change their processes or legislations of their industry. It also causes competitive pressure on non-EU countries that export goods and services to the EU. The Green Deal also impacts resource exporter countries because the EU will reduce fossil fuel usage in their industry and increase cleaner energy sources. This can affect the economies of resource-dependent countries. Concerning these changes, these countries need to adjust their supply chain for their products, diversify their market outside the EU, and adapt their production processes. In addition, they are required to revise their policy and legislation to comply with the EU. The effect of the Green Deal on non-EU countries will vary depending on the industry and economic structure of countries, trade relations with the EU, and their regulations and policies. Therefore, the Green Deal includes opportunities and challenges for non-EU countries.

Türkiye is not a member of the EU but is also one of its critical trading partners. Thus, the Green Deal directly affects Türkiye's industry, economy, and regulation during the EU's net zero emission target period by 2050. In the current situation, Türkiye has started to take action in parallel with the EU Green Deal. The energy sector is among the most affected by the EU Green Deal because GHG emissions from fossil fuels are the primary source of climate change. Refining petroleum is a crucial part of the energy sector. Petroleum refineries have different options to significantly mitigate emissions, like energy efficiency projects, new technological developments, and investments.

Under the Green Deal, "*Energy Efficiency, the EU Emission Trading System (EU ETS), Carbon Border Adjustment Mechanism (CBAM), European Climate Law, Energy Taxation, Renewable Energy, and Alternative Fuel Infrastructure"* are the central policies that impact the strategies of the oil refineries depending on the trade dynamics and global energy market demands.

This study aims to assess the potential impact of the EU's Green Deal on Turkish refineries by evaluating net-zero emission strategies through expert interviews. Turkish refineries have implemented various strategies, but the feasibility and timing of these applications, as discussed by sector experts, are crucial. This research provides

insights into how the EU Green Deal might affect Turkish refineries, focusing on net-zero emission and decarbonization targets. The findings are intended to inform strategic planning and policy-making, highlighting necessary adjustments and opportunities for alignment with market and regulatory changes.

This study aims to answer the following two research questions:

- "How will the European Union's Green Deal impact Turkish oil refineries' decarbonization and net-zero emission targets?
- “What strategies can be developed for these refineries to align with the EU Green Deal requirements?

This thesis includes 6 chapters. *Chapter 1* is the introduction, which demonstrates the research background, the study's aim, and the research questions. *Chapter 2* consists of a comprehensive literature review. In this chapter, it is stated that the package of Green Deal targets, policies, the aim of net zero goal of the EU, oil refining processes, global petroleum refinery industry, strategies and roadmaps of the oil refineries align with the EU Green Deal. *Chapter 3* demonstrates the methodology of the study. It includes qualitative research with expert interview methods and literature observation. Experts were preferred as experienced persons from the refinery, academic, government consultancy, and private sectors working on climate change. Then, *Chapter 4 contains the* Green Deal actions of Türkiye and Turkish refineries' net zero emission targets. *Chapter 5* contains the findings and discussion. It includes findings and evaluation of the interviews and literature review results. It also demonstrates the impact of the Green Deal on Turkish refineries, including net zero emission targets, strategies, and current and potential implementations. Finally, *Chapter 6* is the concluding section of the thesis. It shows that the Green Deal affects Turkish refineries and recommends further studies and research.

CHAPTER 2: LITERATURE REVIEW

The literature review includes topics focusing on the EU Green Deal, its requirements and actions, the position of Türkiye on the EU Green Deal, and strategies of oil refineries for emission reduction. Different sources were used in the literature review. These sources were selected from Science Direct, International Energy Agency, European Commission, World Bank documents, Ministry documents in Türkiye, and oil refinery sustainability reports. The research was limited by using keywords such as 'EU Green Deal,' 'decarbonization oil refinery', 'Ne zero oil refinery,' 'EU energy transition', 'CBAM oil refinery', 'environmental issues facing oil refinery', and 'ETS allowance'.

The necessity for climate mitigation actions has led fossil fuel companies to initiate implementation for actions a green transition. Throughout a lengthy series of international climate events, spanning from Rio in 1992 to Kyoto in 1997, Copenhagen in 2009, Paris in 2015, and Glasgow in 2021, interest in climate change has grown with each passing year (Midttun et al., 2022). Moreover, as stated by Midttun et al. (2022), petroleum refineries are significant energy consumers and contribute substantially to GHG emissions. Furthermore, the oil refineries represent the third largest source of global GHG emissions (Da Silva, Rochedo and Szklo, 2022). According to the latest IEA data for May 2023, 5.1 billion tonnes (Gt) of CO_{2eq} in 2022 will be caused by oil and gas operations. The energy sector's contribution to global GHG emissions was around 40 Gt CO_{2eq} in 2022, meaning that the oil and gas industry was directly responsible for nearly 15% of energy GHG emissions. Emissions from oil operations were 3.5 Gt $CO_{2eq,}$ and natural gas operations were 1.6 Gt CO_{2eq} (IEA, 2023b). Nurdiawati and Urban (2022) stated that due to its significant GHG ratio, the refinery sector is under considerable pressure to transform its sustainability practices. The industry must adjust to evolving market dynamics and implement decarbonization technologies as it transitions towards a low-carbon economy. The study on decarbonizing the refinery industry demonstrated that as the pressing importance of combating climate change increases, the petroleum refining industry faces difficulties in meeting changing demands for energy and chemical products while striving to meet climate targets. The oil refining industry is confronted with challenges similar to those

encountered by other sectors that are difficult to decarbonize (Nurdiawati and Urban, 2022). Griffiths et al. (2022) identified these challenges related to the implementation of decarbonization technologies. These challenges include inadequate financial incentives for investing in such technologies, competing demands for funding from revenue-generating projects, a shortage of highly skilled personnel and institutional expertise needed to implement interventions, and a lack of interest from decision-makers in adopting new and emerging technologies. These challenges are becoming more pronounced as regulatory frameworks change in response to the Paris Agreement and nationally enforced decarbonization targets. Nurdiawati and Urban (2022) highlighted the importance of requirements in decarbonization technologies to reduce emissions in the sector. Also, Johansson et al. (2012) mentioned, moving towards low-carbon production technologies is necessary for the refinery industry to reduce CO_2 emissions. Changes in fuel demand, improvements in fuel quality criteria, and increased indirect energy demand, such as hydrogen production, will likely offset some of the potential for CO_2 emission reduction.

In addition to implementing technology, Rissman et al. (2020) stated that enacting policies is an essential component in the transition towards low-carbon development. India and China have adopted progressive policies to decrease their industrial sectors' energy consumption, enabling their industries to close the gap with the most advanced commercially accessible technologies.

On the other side, Griffiths et al. (2022) emphasized the cost of decarbonization implementations. According to the study, the oil refining industry is confronted with considerable obstacles in its decarbonization and energy transition period. Refineries have long operation times and limited incentive opportunities to deploy new technologies that may disrupt their operations and be costly to implement. The process of industrial decarbonization is not solely dependent on the adoption of technologies, and many operational measures can be implemented in the refinery processes, such as energy efficiency implementations and process flow optimizations. The implementation of decarbonization measures in oil refineries presents several potential advantages. These include reduced GHG emissions, energy and carbon savings and decreased air pollutants, as identified by Griffiths et al. (2022).

The literature revealed that the imperative to decarbonize the petroleum refineries represents a fundamental challenge. The industry faces the prospect of either evolving into a new form, potentially ceasing to exist, or adapting into a hybrid model to align with the shifting energy transition. Undeniably, the industry holds a critical and strategic position in the ongoing transformation of the energy sector (Griffiths et al., 2022).

As previously stated at the outset of this section, climate change actions represent a primary driving force for each industry's decarbonization activities. The Green Deal is also a significant agreement in combatting climate change. This agreement accelerates the implementation of decarbonization strategies across all industries. Section 2.6 presented a detailed analysis of potential strategies and implemented technological actions for decarbonization in oil refineries, as described in the literature.

2.1. The EU Green Deal Targets and Its Application

The average global temperature increase is around 1.2°C, above pre-industrial levels. The increasing global temperature significantly leads to extreme weather events in many parts of the world, such as heat waves and droughts. As mentioned in the World Energy Outlook Report of the International Energy Agency (IEA), different scenarios are explained and evaluated about the trends of CO_2 emissions. As stated by IEA (2023a) in this report, global CO_2 emissions related to energy rose to an all-time high of 37 Gt CO_2 in 2022. The report also stated that the emissions remain largely the same until the late 2020s and then decline slowly to 30 Gt CO_2 in 2050, as mentioned in the Stated Policies Scenario (STEPS). In addition, the report Announced Pledges Scenario (APS) outlined that emissions are projected to decrease by approximately 2% annually. Then, emissions will reach 31 Gt CO_2 by 2030 and decline to 12 Gt CO_2 by 2050. On the other hand, according to Net Zero Emissions by 2050 (NZE) Scenario, emissions will be mitigated by more than 5% each year to 24 Gt CO_2 in 2030 and then be net zero in 2050 (IEA, 2023a).

To combat the increasing CO_2 emission level and climate change effects, the European Commission launched the European Green Deal in December 2019. It was presented as a communication to the European Parliament and adopted as a Joint Resolution by

a majority in January 2020. A team led by Frans Timmermans, Executive Vice President of the European Commission for the EU Green Deal, designed the EU Green Deal (Almeida et al., 2023).

According to the European Council (2024), the EU Green Deal focuses on the need for a holistic and cross-sectoral approach in which all relevant policy areas contribute to the ultimate climate-related target. It involves several policy types, targets, and initiatives related to climate, the environment, energy, transport, industry, agriculture, and sustainable finance.

Almeida et al. (2023) also stated that all initiatives have fundamental goals of a climate-neutral continent by 2050 and a 55 % reduction in carbon emissions by 2030 compared to 1990. The EU Green Deal is also the world's first public commitment to mitigate GHG emissions levels and achieve climate neutrality.

The initiatives are classified into 12 main titles. These are 'Fit for 55', 'European Climate Law', 'EU Strategy on Adaptation to Climate Change', 'EU Biodiversity Strategy for 2030', 'Farm to Fork Strategy, European Industrial Strategy', 'Circular Economy Action Plan', 'Batteries and Waste Batteries', 'A Just Transition', 'Clean Affordable and Secure Energy', 'EU Chemicals Strategy for Sustainability', 'Forest Strategy and Deforestation-free Imports' (European Council, 2024). Even though the content of these initiatives is generally a legal instrument prepared by the European Commission, the Green Deal informs the guidelines and targets of national actions. In other words, it covers technically binding actions and derivative laws that will create legal impacts through implementation by each country in the EU (Almeida et al., 2023). Each title includes different improvements for sectors and actions to decrease emissions from responsible sectors.

Figure 1. EU Green Deal Targets

Fit for 55 is a package of proposals to revise climate, energy, and transport legislation and create new legislative initiatives to align EU laws with the EU's climate goals (European Council, 2024). The main aim of this package is to mitigate net GHG emissions by a minimum of 55% by 2030 and to ensure that EU legislation is consistent with the 2030 target (European Council, 2023a). Shifting from fossil gas to renewable and low-carbon gasses, reforming the EU emissions trading system (ETS), Towards more sustainable transport, Carbon Border Adjustment Mechanism (CBAM), Increasing usage of greener fuels in the aviation and maritime sectors, Toughening CO_2 emission standards for cars and vans, EU Plan to Revise Energy Taxation, EU plans to boost renewable energy and become more energy-efficient are the main critical topics in Fit for 55 (European Council, 2023a).To achieve these objectives, EU member states must implement specific actions to lower emissions and transition to a low-carbon economy. Adopting new regulations and revising existing EU laws are necessary to facilitate the transition to sustainability (European Council, 2023b).

- **The European Climate Law** title covers the regulation required for the EU to reach climate neutrality by 2050, a legal obligation. This regulation aims to decrease GHG emissions by at least 55% by 2030 compared to 1990s levels and reach climate neutrality by 2050 for the EU and its member states

(European Council, 2024).

- **The EU's strategic approach to adapting to climate change** involves a comprehensive, long-term plan to transform the EU into a society that is resilient to climate challenges and fully prepared to address the inevitable consequences of climate change by the year 2050. The EU environment minister approved this strategy (European Council, 2024).
- The EU Commission aims in its **EU Biodiversity Strategy 2030** to improve Europe's biodiversity by 2030 with benefits for people, the climate, and the planet (European Council, 2024).
- The **Farm to Fork Strategy** aims to transform the EU's food system into a sustainable model. The EU also seeks to create a circular system of production and consumption for economic growth (European Council, 2024).
- The **Circular Economic Action Plan** is another action for the Green Deal to achieve the EU's climate neutrality by 2050 and sustainable growth (European Council, 2024).
- **Batteries and waste batteries are** another topic in the Green Deal. The EU's target is to achieve a more sustainable and circular battery lifecycle because battery production currently has a high environmental footprint (European Council, 2024).
- **Just Transition, which also aims to reach climate neutrality by 2050,** can challenge sectors like carbon-intensive industries with many employers. As a result, the European Union initiated the just transition mechanism to offer financial and technical assistance to regions facing the most significant impact of the transition to a low-carbon economy (European Council, 2024).
- Energy production and use are among the primary sources of GHG emissions. Decarbonizing the energy sector is a significant step towards the 2050 goals for the net-zero continent. So, the EU is responsible for providing **clean, affordable, and secure energy** in the scope of the EU Green Deal (European Council, 2024).
- The Green Deal includes targets for the **EU chemical sustainability strategy** to protect human health and the environment (European Council, 2024).
- **Forest strategy and deforestation** are critical to reducing GHG emissions (European Council, 2024).

Under the scope of the Green Deal, specific strategies and action plans have been considered by defining more specific objectives and initiatives to accomplish them. Until now, about 20 strategic documents related to the Green Deal have been adopted. Recent policies that have started to be implemented are the Circular Economy Action Plan, the EU Biodiversity Strategy for 2030, the Farm to Fork Strategy, the Action on Critical Raw Materials Supply, and the European Climate Law. To reach the Green Deal's energy and climate targets in 2030, investments with an estimated 260 billion euros annually (about 1.5% of EU, 2018 GDP). Green Deal Investment Plan was launched in 2020, and it mentioned that public and private sectors should be integrated into the financial system to deal with climate and environmental risks. Ursula von der Leyen, President of the European Commission, announced the EU Green Deal: "*The European Green Deal is our new growth strategy. It will help us cut emissions while creating jobs"* (European Council, 2024).

The EU Green Deal declaration outlines a plan to enhance resource efficiency by transitioning to a clean, circular economy, halting climate change, restoring biodiversity, and preventing pollution. As the European Commission (2019) stated, the EU Green Deal includes targets for all sectors, including the economy, transport, energy, agriculture, buildings, steel, cement, chemicals, and textiles. It demonstrates the requirements for these sectors to ensure a just transition, what type of investments are needed, and what financing tools are available.

According to Panarello and Gatto (2023), Energy policy is a fundamental part of the Green Deal. It aims to achieve sustainable economic recovery, decrease consumption of fossil fuels, accelerate energy efficiency, target renewable energy implementations, manage energy sources, reinforce energy security, and mitigate climate change. Hainsch et al. (2022) stated that the energy roadmap scenarios for 2050 are centered on ensuring the sustainability, competitiveness, and security of the EU energy system. Decarbonization routes in the Energy Roadmap revolve around four critical technological developments: energy efficiency, renewable energy, nuclear energy, and carbon capture and storage.

On the other hand, it is for more than just Europe. With the Green Deal targets in the global area, several new implementations are required, like climate diplomacy, global

trade, carbon tariffs, and transitional investment relationships. Furthermore, the target of the EU Green Deal is not solely to uphold its position as a dominant force in the global economy but also to enhance the geopolitical standing in the face of rival entities within an increasingly interconnected world (Almeida et al., 2023).

2.2. Petroleum Refineries

Griffiths et al. (2022) state commercial oil processing began after the mid-19th century in Europe and the United States. In the early days, petroleum refineries had small and straightforward processes that were primarily batch distillation facilities to produce a limited number of oil fractions. The size and complexity of refinery processes then increased significantly during the 20th century. This expansion was accelerated by two main factors: the growing demand for gasoline to power motor vehicles and the rising need for fuel across various modes of transportation.

Crude oil refining is one of today's most significant and crucial industries. The products from refineries play a vital role, providing gasoline for vehicles, diesel fuel usage in roads and railways, aviation fuel for aircraft, bunker fuel for ships, lubricating oils, feedstocks for diverse chemicals, and numerous other essential products. Petroleum is unique among fossil fuels. It is a critical ingredient in most industrial chemicals, including pharmaceuticals, agricultural chemicals, petrochemicals, and plastics. It is used to create about 90% of these chemicals. The significance of oil in both the transportation and industrial sectors has positioned it at the core of geopolitical events, influencing the formation of nation-states, sparking international conflicts, and contributing to the emergence of influential national companies (Griffiths et al., 2022).

Total number of refineries in the world is 732. Most oil refineries operate in Asia. North America and Europe follow Asia. Asia is also the region with the highest number of upcoming refinery expansion initiatives. Primarily fueled by consumer demand from economic giants such as China and India, almost 90 refining facilities are currently in the planning stages or actively under construction (Statista, 2024a). The distribution of petroleum refineries by region is given in Figure 2.

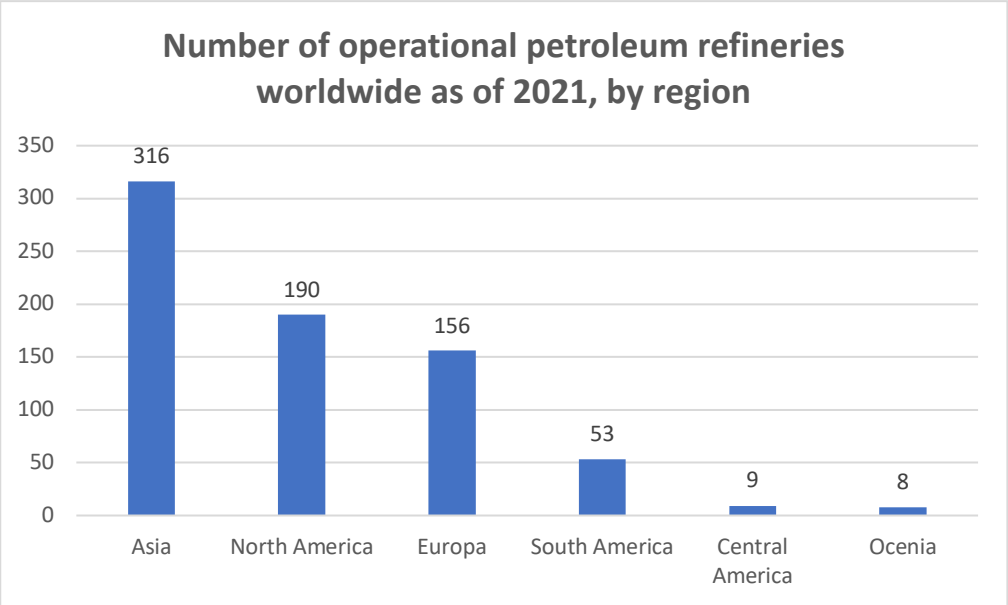

Figure 2. Number of operational petroleum refineries worldwide as of 2021, by region (Source: Statista, 2024a)

Refining and transforming crude oil into usable goods is crucial in the oil and gas industry's midstream sector. Typically, the primary output from a barrel of crude oil is motor fuel, especially gasoline. Following processing, crude oil serves various purposes beyond fueling transportation, acting as a significant raw material in petrochemical manufacturing, and forming the foundation of plastics production. Global crude oil refinery capacity exceeds 100 million barrels per day. China has recently significantly expanded its refinery capabilities, with the China Petroleum and Chemical Corporation (Sinopec) boasting one of the world's largest distillation capacities.

Nevertheless, despite China's advancements, the United States remained the leading oil refining nation as of 2022. That year, U.S. oil throughput reached 14.2 million barrels per day, slightly up from the levels seen in 1990. In 2022, ExxonMobil, the largest oil company in the United States, processed approximately 4 million barrels of oil per day in its refineries (Statista, 2024b).

Germany has the highest number of oil refineries in Europe. Germany possessed a total of 16 oil refineries in 2023. These are both state and private facilities. With 11 refineries, Italy is in second place (Statista, 2024c).

2.3. Petroleum Refinery Processes

The petroleum refining process usually comprises a sequence of unit operations to transform crude oil (along with other input materials) into various final products. The composition of these end products depends on several factors, including the properties of the input materials, the refining processes and supporting facilities within a specific refinery, and the operational strategy of the refinery, which is primarily dictated by market requirements. Refinery facilities can differ in structure and intricacy, but atmospheric distillation is a prevalent unit operation found in most refining plants (Griffiths et al., 2022).

Refineries can be categorized as complex or straightforward. More energy-intensive refineries are generally considered complex. The classification also depends on the refinery's configuration, process, and capability. The first step of the refining process is distillation. After this physical separation process in the distillation column, fuels like gasoline, jet fuel, and diesel fuel send related units to finish the products. These cracking isomerization, hydrotreater, and coking units are the central process units of a refinery (AFPM, 2024).

Crude oils can be determined as lighter or heavier. Higher crude oil contains high Sulfur content, and due to regulatory requirements for fuels with lower sulfur content, refineries need higher energy consumption to decrease the sulfur content in the products. Moreover, Crude oil types also impact refinery energy consumption. Energy intensity is related to a refinery's GHG emissions (Abdul-Manan, Arfaj, and Babiker, 2017).

2.4. Decarbonization Strategies of Oil Refineries

According to IEA (2023a), in the last two decades, oil demand has peaked by 18 million barrels per day(mb/d). The increasing demand for road transport is the reason for this rise. Over the past two decades, the worldwide number of automobiles has increased by more than 600 million, while road freight operations have seen a nearly 65% rise. Road transportation is responsible for approximately 45% of global oil consumption, surpassing all other sectors. The petrochemicals industry, the second in

terms of oil usage in their production, only accounts for 15% of the total oil demand. The emission mitigation action can be separated into 2 titles: on-site and off-site CO_2 emission reductions. On-site mitigation options are energy efficiency measures, fuel shift (natural gas or biomass), and CO_2 capture. Of-site mitigation strategies use excess heat for district heating or biomass drying and process integration between adjacent industries. Due to net zero emissions and the EU Green Deal targets, oil refineries should take action to reduce their GHG emissions (IEA, 2023b). According to IEA Reports, five key implementations can be used to reduce emission intensities in oil refineries. These are decreasing CH_4 emissions, preventing flaring except for emergency operation, electrifying upstream facilities with low-emissions electricity, investing in carbon capture utilization and storage (CCUS), and deploying low-emissions electrolysis hydrogen units in refineries. Reducing Scope 1 and 2 emissions from oil and gas is the widely implemented and lowest-cost option (IEA, 2023b). Moreover, Nurdiawati and Urban (2022) stated that advanced biofuels, green hydrogen, and carbon capture and storage (CCS) are identified as crucial decarbonization technologies for reducing emissions in the industrial sector. Nevertheless, these alternatives are currently in the initial stages of technological advancement.

In other words, Midttun et al. (2022) stated that biofuel, blue hydrogen with CCS/U, and green electricity are the most prominent business models for investing in existing resources and capabilities for green transition in the oil industry. However, new models require new technological solutions and may raise new problems. For example, the development of biofuels may rely on new synthetic feedstock or more robust treatment of organic waste, including residue from forestry. Significant expansion of wind energy, mainly offshore, seems feasible. Still, it hinges on substantial advancements in grid infrastructure and innovative breakthroughs in elements crucial for system stability, such as batteries and hydrogen. However, blue hydrogen necessitates significant infrastructure development for transport and storage.

Refinery processes currently lead to intensive GHG emissions. Due to the requirements for oil-based fuels, such as reduced sulfur content, GHG emissions from oil refining have been steadily increasing. For instance, eliminating fuel sulfur content necessitates hydrotreatment procedures (Da Silva, Rochedo, and Szklo, 2022).

Furthermore, refineries require large amounts of energy to remove Sulphur content in hydrotreater units, primarily hydrogen, used to upgrade and treat oil products. This energy requirement is also directly related to a refinery's GHG emission amount. Moreover, around 40 Mt of hydrogen is used in refineries to upgrade and refine oil globally, which is more than two-fifths of global hydrogen demand. This process results in the emission of 200 Mt CO_2 annually (IEA, 2023b). In addition, as mentioned by Johansson et al. (2012), heavy fuel oil products have been decreasing, and transport fuels have increased in line with the market demand. Legislation for governing product quality and environmental requirements like Sulphur content are also essential factors in developing processes for refineries because the extension of desulfurization capacity is required and, in other words, increased hydrogen utilization since hydrogen is the primary feedstock of hydro processing units. As a result, refinery processing intensity, energy use, and CO_2 emission increase. After being included in the EU ETS in 2005, petroleum refineries have extra costs for their CO_2 emissions in the EU. On the other hand, the requirement of 'Directive 2003/17/EC' on the low Sulphur quality of petrol and diesel fuels results in more Sulphur reduction processes in a refinery. Thus, this process leads to significant CO_2 emissions from refineries. For example, the largest petroleum refinery in Scandinavia implemented new process units: a hydrogen production unit and a hydrocracker unit. Therefore, the extra hydrocracking capacity enables the refinery to desulphurize all diesel and light fuel oil components. Also, the hydrocracker requires large amounts of hydrogen produced in the new hydrogen production unit. Hydrogen can be produced using raw naphtha, butane, or natural gas materials. Using natural gas would emit less CO_2 per unit of hydrogen produced compared to the other two options. In addition, large amounts of CO_2 will inevitably be produced when hydrogen is produced using a cracking process on butane, naphtha, or natural gas (Holmgren and Sternhufvud, 2008). Moreover, Nurdiawati and Urban (2022) stated that advanced biofuels, green hydrogen, and carbon capture and storage (CCS) are identified as crucial decarbonization technologies for reducing emissions in the industrial sector. Nevertheless, these alternatives are currently in the initial stages of technological advancement.

Electrolysis hydrogen will play a minor role in reducing oil and gas emissions by 2030 but will be a crucial factor for significant reductions in the future. Globally, five significant projects produce hydrogen from electrolysis. Four are being constructed

and developed by oil and gas companies or will supply hydrogen to a refinery. Oil and gas companies globally are participating in nearly 50 electrolysis projects, with a combined capacity exceeding 1.6 GW. Among these projects are a 260 MW electrolyzer for hydrogen production at a refinery and a 200 MW electrolyzer at a coal-to-chemicals plant in China, as well as another 200 MW electrolyzer in the Netherlands to substitute hydrogen obtained from a natural gas reformer (IEA, 2023b). Green hydrogen, while still in the early stages of commercialization, is projected to become a trillion-euro market by 2050, according to the EU. Currently priced at double the cost of conventionally produced hydrogen, green hydrogen costs are expected to decrease as renewable energy prices go down. It is estimated that by 2030, green hydrogen could become cost-competitive. Collaboration within industries like transport, steel, and refineries is expected to boost demand for hydrogen because the absence of hydrogen infrastructure, encompassing storage and distribution, poses a significant barrier to developing hydrogen technology in Sweden. Substantial financial commitments are required for hydrogen projects, and it is improbable that the private sector alone will be equipped to address these challenges. In Sweden, the HYBRIT initiative aims to establish green hydrogen-based steel production by 2035, with partners including steel producer SSAB, mining company LKAB, and energy company Vattenfall (Nurdiawati and Urban, 2022).

Shell operates its 10MW electrolyzer in Germany and collaborates as a joint-venture partner in a 20 MW electrolyzer (with Shell's interest at 47.5%) in China. These facilities can produce 1,300 and 3,000 tones of hydrogen annually using renewable electricity. Additionally, Shell has recently extended its network of hydrogen refueling stations, making it easier for hydrogen-powered vehicles to refuel across a wider area. In 2022, there were about 50 Shell-branded hydrogen refueling stations in the USA, Canada, Germany, and the Netherlands. In 2022, Shell decided to construct Holland Hydrogen I in the Netherlands, Europe's largest renewable hydrogen facility, when completed in 2025. This 200 MW electrolyzer is projected to generate up to 80 tones of renewable hydrogen daily, primarily for use at the Shell Energy and Chemicals Park Rotterdam. The facility will play a role in the partial mitigation of CO_2 emissions due to the production of energy products such as petrol, diesel, and jet fuel. The plant will be fueled by renewable energy harnessed from the Hollandse Kust offshore wind farm, of which Shell holds an 80% ownership stake (Shell, 2022a).

Decreasing flare non-emergency activities is another necessary solution for GHG emissions of refineries. Shell is focusing on reducing flaring, which is inefficient and contributes to climate change. In regular refinery operations, gasses are sent to flare if it is impossible to use the gas or reinject it into the well. This accelerates their commitment of 2015 to end routine flaring as a signatory to the World Bank's Zero Routine Flaring (ZRF) by 2030 initiative (Shell, 2022a). The World Bank launched ZRF in 2015. The initiative commits governments and oil companies to ending routine flaring by 2030 and promotes cooperation between all parties involved in identifying and implementing solutions to stop the regular practice of gas flaring (World Bank, 2015).

The system's electrification is a low-carbon option for the oil and gas sector. However, there are additional operational costs. Therefore, regulatory incentives are required to implement these investments, and this could be carbon pricing. For example, as seen in Norway, tax incentives or partial exemptions on electricity tariffs have been implemented. Building a shared clean electricity infrastructure through collaboration can significantly reduce costs and improve project economics. This can be achieved by selling surplus renewable electricity, or crediting avoided CO_2 emissions (IEA, 2023b).

CCUS technology has already been implemented in oil and gas companies and boosted deployment to cut their emissions. For example, three refineries in Canada and the United States each year capture approximately 1 Mt CO_2. CO_2 emissions from the hydrogen production can be captured. Hydrogen production facilities generate a predominantly pure CO_2 stream, frequently released into the atmosphere, comprising 60% of the total CO_2 emissions a steam methane reformer produces. The capture of this CO_2 is a feasible process. In addition, emissions from catalytic crackers, heat plants, and refinery power generation can be reduced with CCUS (IEA, 2023b).

By the end of 2022, Shell's Quest CCS project at Scotford in Canada (Shell's interest at 10%) had achieved a significant milestone. Since its operation in 2015, the project has successfully captured and securely stored over 7.5 Mt of CO_2. This tangible achievement underscores Shell's commitment to environmental responsibility. In Australia, the Gorgon CCS project (in which Shell holds a 25% interest and is operated

by Chevron) reported storing over 7 Mt of CO_2 by October 2022, further contributing to Shell's global carbon capture and storage efforts (Shell, 2022a).

Gorgon commenced operations in 2019 and is the world's largest CCS operation. The joint venture plans to invest 40 million in lower-carbon projects in Western Australia. In 2022, the Northern Lights CCS joint venture (in which Shell holds a 33.3% interest) in Norway inked a letter of intent to furnish Yara, a crop nutrition company, with CO_2 transport and storage services. Shell also mentioned their sustainability report about agreements with various companies and governments to improve together in CCS projects in Japan, China, Brunei, Malaysia, South Korea, the USA, and Western Australia (Shell, 2022a).

To manage carbon emissions, Preem, a Swedish refiner, completed the largest pilot facility for capturing CO_2 in 2021 at the refinery in Gothenburg. Preem has successfully implemented and tested the pilot project, and it has shown positive results. Throughout 2022, efforts were dedicated to further developing the facility, explicitly optimizing logistics chains to enhance the continuous capture of CO_2 emissions. Preem focuses on creating a full-scale carbon capture, transport, and storage solution. Providing secure transport and storage are Preem's next steps. Preem is also working on ZEROC and Northern Lights projects for CO_2 storage off Norway's West Coast (Preem, 2022).

In Sweden, GHG emissions from refineries are 5% of total GHG. %70 GHG emissions result from energy use. The combustion of natural gas is responsible for approximately 30% of total emissions generated during hydrogen production. Three players in the refinery industry in Sweden are Preem, Nynas, and ST1. The cost of renewable electricity continues to decline in line with climate change actions; as a result, political and business momentum for low-carbon hydrogen has also been triggered strongly at the international and national levels. Oil refinery companies are considering the potential of green hydrogen due to their climate policies. As a large industrial hydrogen consumer, they are well placed to contribute significantly to the transition to a low-carbon economy. The other alternative to reduce CO_2 emission is CCS. In Sweden, Preem is currently investigating the implementation of CCS and green hydrogen. In addition, adopting new climate policies and expanding renewable energy, electric

vehicles, and refineries diversify their business as new profitable opportunities. Preem has set a goal to produce at least 3 billion liters of renewable fuel by 2030. Meanwhile, St1 concentrates on renewable energy and has various functional facilities. They offer a comprehensive range of renewable energy services, including biofuels, wind energy, and geothermal heat businesses (Nurdiawati and Urban, 2022).

EU Climate policy as a front-runner and market conditions for petro-industrial operations are central factors shaping the climate adaptation of the European petroleum industry. In the second decade of the 21st century, the petroleum sector is under increasing pressure due to the rising sustainability, taking fossil fuels out of the economy, and the requirement of lower CO_2 emissions for fossil-based industries. Therefore, the European oil industry determined a clean petroleum agenda. Their annual reports contain decreasing flaring, reducing CH_4, and raising the relative weight of gas in the portfolio to lower CO_2 levels. Additionally, the reports include sections on biofuel, CCUS, and the involvement of the company in the development of renewable energy sources, such as wind and solar. For example, Eni considered its annual report 2014 as reducing its GHG emissions by %50 from gas flaring in the next four years and optimizing water reuse. Eni also announced in this report their focus on biofuels. Moreover, in its 2022 annual reports, Shell has announced its commitment to engaging in biofuels, carbon capture and storage. However, Shell's primary focus was on natural gas, the cleanest fossil fuel, and its long-term business strategy (Midttun et al., 2022).

In essence, Shell is prioritizing low-carbon initiatives to reduce its carbon emissions. This involves implementing new investments and projects to enhance energy efficiency in current operations. Furthermore, the company is transforming its remaining integrated refineries into low-carbon energy and chemicals parks, including decommissioning plants. Shell is also increasing its use of renewable electricity to power its operations and improving CCUS technologies at its facilities (Shell 2022c). The refinery industry has the potential to significantly contribute to global low-carbon transitions by providing low-carbon products and fuels for industries such as marine transport, aviation, and petrochemical manufacturing, where alternatives to liquid hydrocarbons are tricky to substitute. The Swedish refining industry has increased collaboration with other sectors through strategic partnerships to facilitate research,

development, and production of biofuels. In addition, collaborations with the automotive industry and other customers, such as the aviation sector, have been pursued to expand the market for renewable fuels (Nurdiawati and Urban, 2022).

Shell is a prominent global entity engaged in trading and blending biofuels on a significant scale. In 2022, the total volume of biofuels incorporated into Shell's petrol and diesel operations globally reached 9.5 billion litres. A primary objective of Shell is to enhance its capability in producing low-carbon fuels. Notably, the construction of one of Europe's most extensive biofuel production facilities is underway in the Netherlands, with an anticipated annual capacity of up to 820,000 tonnes of low-carbon fuels derived predominantly from waste feedstocks. The facility is projected to commence operations in 2025. Shell is currently focused on expanding its production capacity, investing in new technologies, and increasing the use of SAF. In 2022, Shell signed a non-binding agreement with Lufthansa to supply SAF to its airports' aero planes. Additionally, Shell started providing SAF in Singapore, making it the first company to do so for Southeast Asian customers. In partnership with Accenture and American Express Global Business Travel, Shell also launched one of the earliest blockchain solutions for SAF to help companies reduce the environmental impact of their corporate air travel (Shell, 2022a).

BP and the European oil companies accepted the requirement of more comprehensive transition action instead of business-as-usual strategies. European petroleum companies adopt the EU policy goals to net zero CO_2 emissions by 2050. According to Midttun et al. (2022), Danish Ørsted (the Danish Oil and Gas Consortium, DONG) and Finnish Neste (formerly Neste Petroleum) implemented the transition from petroleum to renewables in three steps. Danish Ørsted first purchased several electricity companies and extended the focus area from petroleum to a generic energy company. After that, with the parallel expansion of oil, coal, and renewable facilities, it realizes a strong green transition while divesting its petroleum portfolio and concentrating on renewables. Finally, it started upstream offshore wind to leave its downstream electricity business. The other example is Neste, a Finnish petroleum refinery. It turned to bio-refinery processing multi-feedstock. Moreover, it has continued its petroleum refining process by drawing extensively on Russian oil and retailing as part of its business model. Therefore, it is vital in bridging the fossil and

renewable energy spectrum (Midttun et al., 2022).
Shell determines climate targets to have net zero emissions by 2050. Their targets are decreasing Scope 1 and Scope 2 by 50 % by 2030 compared to 2016. The company has a targeted plan in the short, medium, and long term to decrease its carbon intensity, measured using our net carbon intensity metric (Shell, 2022a).

Moreover, new projects have been implemented to reduce the emissions in Shell refineries. For example, in their Scotford site in Canada, they have implemented projects that reduce energy use and improve efficiency by using analyzers to optimize fuel usage in 2022. In 2021, at the same facility, they completed energy usage minimization and developing efficiency projects by installing new equipment and enabling the reduction of steam usage. Furthermore, in Shell's Rheinland site in Germany, maintenance schedules changed to improve efficiency and install more efficient equipment projects completed in 2021 to decrease energy use and develop efficiency (Shell, 2022b).

Also, as Nurdiawati and Urban (2022) mentioned, governmental climate objectives and emission regulations like the Paris Agreement and the Swedish Climate Law sparked interest in CCS technology in Sweden. Nevertheless, the commercial market for CCS has not yet fully materialized. Despite the successful demonstration of all technological components of the CCS system at an industrial level, the limited number of large-scale CCS projects indicates a significant barrier: the absence of clear and stable policies that incentivize companies to undertake the financial risks associated with CCS investments. Additionally, the present carbon pricing structure in the EU is insufficient to stimulate the development of a viable CCS market. On the other hand, policy initiatives about biofuels, hydrogen, and CCS at the EU and national levels in Sweden are essential topics for companies. Because of these reasons, Preem and ST1 refineries shaped their business strategies to deal with low carbon transition. In 2019, Preem determined targets to be a climate-neutral petroleum company by 2040 and a net zero company from its supply chains by 2045. Other global oil corporations such as BP, Total, Equinor and Shell are repositioning themselves as 'integrated energy companies' by integrating renewable energy ventures into their portfolios.

CHAPTER 3: METHODOLOGY

This section demonstrates the study's research methodology. Based on the defined research questions and the aim of the study, a detailed sector-based literature review and expert interviews were used. The experts were explicitly chosen from the refinery industry, consultancy firms, and academicians experienced in the refinery industry, sustainability, GHG monitoring, and regulation. Eleven experts participated in interviews. A significant proportion of the interview participants held senior positions within their respective organizations. The face-to-face interview method was also applied.

Interviews were conducted using a semi-structured interview method. This type of interview is a common qualitative method. An interview guide is developed to collect similar data types from all participants and create a sense of order. Semi-structured interviews are commonly characterized by open-ended questions that provide flexibility to the interviewer and the respondent. Though using predetermined questions in a specific sequence facilitates comparability across respondents, it may also impose limitations. Embracing a more flexible approach can facilitate the identification of patterns within responses while still enabling comparisons among interview participants (Doody and Noonan, 2013).

Following Kühn and Witzel (2000), when conducting interviews, the interviewer encourages respondents to provide their subjective perspectives on the issue with transparency and openness regarding the flow and context of the interviews. The study framework and literature review were conducted according to the research questions before the expert interviews. The interview questions are shaped to describe the critical point, followed by questions focused on more specific topics. Consideration of the interviewer's experience with research participants emerges as a significant element of the study, providing context to the findings (Czernek-Marszałek and McCabe, 2024). Therefore, the experts were explicitly chosen for refinery, consultancy, and academic sectors, and they are professionals in refinery processes and EU Green Deal actions, sustainability, and environmental action in the energy sector, especially refinery. The details of the experts can be seen in Table 2.

Firstly, experts were informed about this study by phone and e-mail. The information included the thesis's aim and the research questions' main ideas. Before the interviews, ‘volunteer participation for the research form’ and ‘participant information form’ were sent to participants. E-mails were sent to the department heads or those in equivalent positions, such as supervisors, specialists, engineers, and academicians, to organise interview schedules and conduct interviews. Some experts rejected the request during the interview because of the company policies. At the end of this process, 11 interviews were arranged. In the interview, open-ended questions were asked, and no right or wrong answers were not expected. The expert interviews were conducted during February and March 2024 in places where participants feel at ease, such as their offices, out-of-office, or online meetings. Online meetings were conducted with Microsoft Teams or Zoom meetings. The duration of the interviews was between forty-five minutes and one hour. Detailed notes were taken during the interviews, and all notes were carefully analyzed. The interview questions were open-ended, and no right or wrong answers were expected. Interviews were conducted in Turkish-native language and then translated into English for this study. Every effort was made to preserve the meaning of the original questions and answers when translating them into English. There were 15 questions, and some included sub-questions to focus on more detailed answers.

Interview questions were derived from a literature review and developed to provide more details about the topic. Moreover, the interview was conducted to address the research question presented in the thesis. Furthermore, some questions were added or spontaneously added during the interview to help understand the experts' answers. Also, additional questions were added during interviews if participants needed help or an additive explanation to answer the questions.

The Green Deal is an extensive topic that includes several policies. This research has been conducted to centre ETS, CBAM, and net zero targets of petroleum refineries and aspects of the Green Deal in this framework. Figure 3 shows the progress of expert interview research.

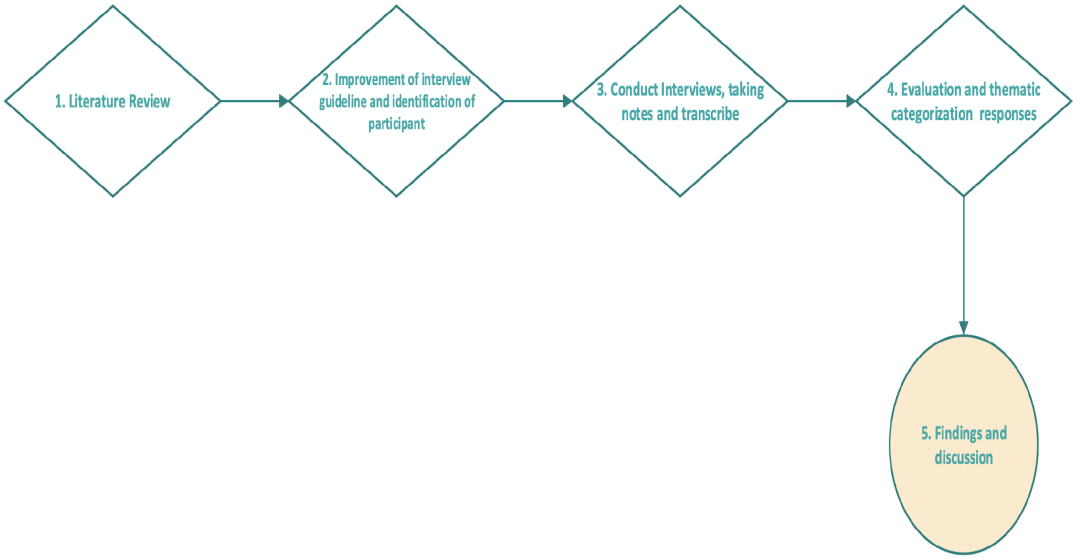

Figure 3. Progress of expert interview research

Interview questions included 6 following themes:

Part 1 Includes general questions about the background of participants to understand expert status

Part 2 Questions about general information of EU Green Deal focusing on the scope of the Green Deal, the impact of the Green Deal on EU members and non-EU members

Part 3 Questions about the participation of Türkiye on the EU Green Deal

Part 4 Questions about the EU Green Deal effects on petroleum refineries in Türkiye, strategies of Refineries in Türkiye, benchmarking of Turkish refineries and other refineries

Part 5 Question about the preparation of ETS in Türkiye and the importance and role of incentive mechanisms from government to industries

Part 6 The final section question about the importance part of the interview

The consequences of interviews are evaluated by combining previous literature and divided into thematic topics.

Figure 4 illustrates the structured progression of the research and expert interview from a general overview of the EU Green Deal to the specific net-zero emission targets for Turkish refineries. The research begins with a broad context of the Green Deal, narrows to its impact on Türkiye, and finally focuses on the detailed analysis of net-zero emission targets in the Turkish refinery sector.

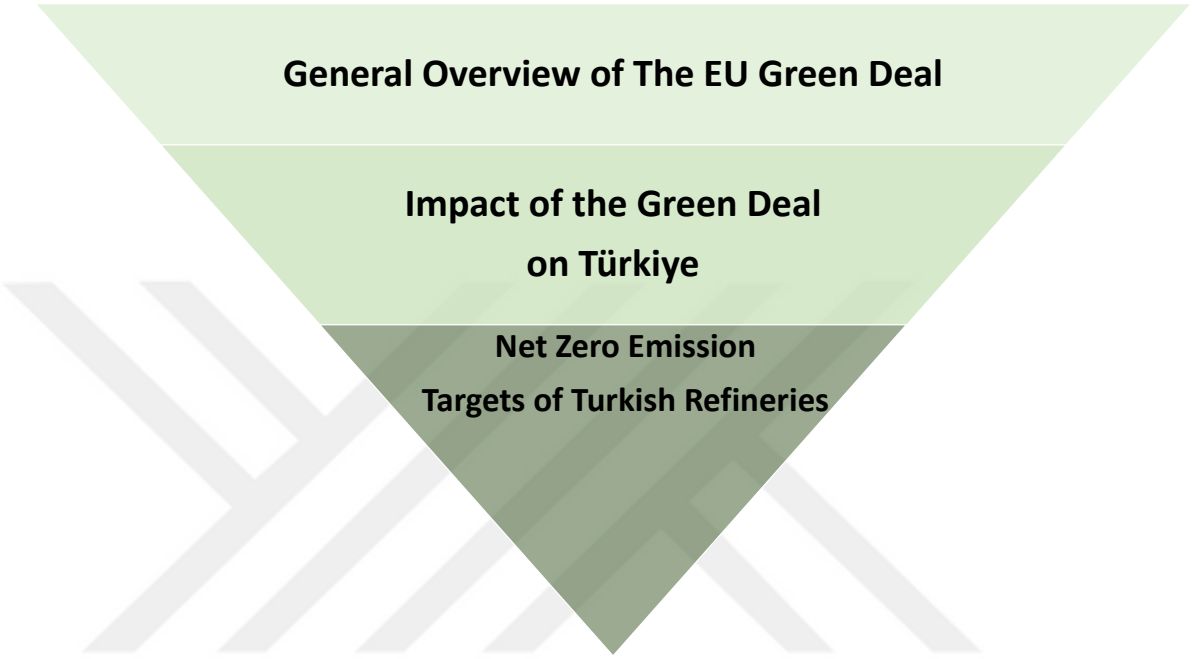

Figure 4. Hierarchical Overview of the Research Focus on the EU Green Deal's Impact on Turkish Refineries

Table 1. List of participants

Expert Number	**Title of Expert**	**Experience**	**Gender**
Expert 1	Department Manager	Refinery and Petrochemical Industries	Female
Expert 2	Department Manager	Refinery (2 company) and Petrochemical Industries	Male
Expert 3	Department Director	Refinery and Petrochemical Industries (Türkiye- Azerbaijan)	Male
Expert 4	Department Supervisor	Refinery and Petrochemical Industries	Female
Expert 5	Vice President	Refinery and Petrochemical Industries	Male

Table 2 (Continued). List of participants

Expert 6	Consultant of Ministry	Climate Change, GHG Monitoring, Reporting and Verification	Male
Expert 7	Department Manager	Refinery and Petrochemical Industries	Male
Expert 8	Department Supervisor	Refinery and Petrochemical Industries	Female
Expert 9	Company Owner, Consultant	Climate Change, Sustainability, GHG Monitoring, Reporting and Verification for industries	Male
Expert 10	Academician	Sustainability, Biohydrogen, Environmental biotechnology	Female
Expert 11	Department Supervisor	Refinery Industry	Male

CHAPTER 4: TÜRKİYE'S EU GREEN DEAL ACTIONS AND NET ZERO EMISSION TARGETS of TURKISH REFINERIES

The Paris Agreement is a significant opportunity for Türkiye to achieve a fair and lasting shift towards sustainability while supporting the integration of mitigation and adaptation strategies into the agreement. Additionally, Türkiye is a candidate for EU membership, closely following EU policies and developing legislation on climate change and environmental issues to comply with EU regulations. Türkiye's approach to climate change is influenced by various sector-specific, regional, and national policy papers, strategies, and initiatives that cover mitigation and adaptation actions. Consequently, Türkiye acknowledges the significance of adaptation, integrating it as a complementary section within its updated Nationally Determined Contributions (NDC). The first climate council of Türkiye was convened in Konya in February 2022 under the coordination of the Ministry of Environment, Urbanization, and Climate Change. A draft of the Climate Change Law was carried out with the participation of each sector's stakeholders. The draft climate law includes establishing the legal framework for achieving mitigation and adaptation goals, creating a national ETS, developing planning and implementation strategies in alignment with sustainable growth and the 2053 net zero target for addressing climate change, and enhancing the legal foundation for impactful climate initiatives in Türkiye (RTMEUCC, 2023).

4.1. Republic of Türkiye Updated First Nationally Determined Contribution (NDC)

Nationally Determined Contribution (NDC) is a comprehensive database of governments' net zero commitments, including their legal status and target year. The aim is to create a valuable resource for governments, industries, and civil society organizations to understand national climate targets better. By September 2023, 195 Parties to the UNFCCC had submitted 168 NDCs, with nearly 90% being updated (IEA 2023a).

Türkiye presented its first NDC, which has been updated within the framework of the 'Glasgow Climate Pact' adopted by the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement during the 26th

Conference of the Parties. Through this submission, Türkiye committed to reducing GHG emissions by 41% by 2030 (equivalent to 695 Mt CO_{2eq} in 2030), compared with 2012 as the base year in the Business as Usual (BAU) scenario. Türkiye's target date for peak emissions is no later than 2038. This updated mitigation target represents a significant increase in ambition based on scientific principles and equity considerations. It means a step towards the long-term goal of reaching a net zero target by 2053. The Turkish government is instituting extensive and resilient new policies and strategies across various sectors to attain its net-zero targets. The NDC demonstrates a framework of long-term planning and sustainable development priorities (RTMEUCC, 2023).

4.2. Türkiye's Green Deal Action Plan

Establishing a resource-efficient and sustainable circular economy is essential to achieve the goal of net-zero emissions by 2053, as well as environmental protection and competitiveness. In line with this, Türkiye's "Green Deal Action Plan" (GDAP) was released on July 16, 2021. This action plan outlines 32 objectives and 81 initiatives across nine primary categories, focusing on the green transition of Türkiye's industries and the implementation of measures, particularly in trade and industry sectors. The GDAP includes actions in 9 main titles. These are '*Combating Climate Change', 'a Green and Circular Economy', 'Green Finance', 'Carbon Border Adjustments', 'Clean, Affordable, and Secure Energy Supply', 'Sustainable Agriculture', 'Sustainable Smart Transportation', and 'Diplomacy to facilitate the green transformation toward a low-carbon', 'Resource-efficient, and Circular Economic Structure'* (Ministry of Trade, 2021).

In addition, as reported by the NDC report of Türkiye, carbon pricing mechanisms are effective strategies for cost-effective emissions reduction measures. Implementing an ETS in Türkiye is a crucial objective within the Medium-Term Programme (2023-2025) and Türkiye's Green Deal Action Plan. The schedule will include sectors with high emissions. The implementation principle involves setting an emissions cap based on a specific reduction target during the cap-setting process, thereby limiting emissions within the scheme to a predetermined level. Mitigation efforts will be allocated based on market principles, prioritizing cost-effective actions. Allocation strategies and

policies will be developed considering sector-specific abatement costs, mitigation alternatives, and interconnected policy areas (RTMEUCC, 2023).

4.3. Emissions Monitoring of Turkish Refinery

The energy sector is the primary source of GHG emissions in Türkiye. Fuel combustion is the significant driving force in the energy sector. This sector's emissions cover oil refineries, public electricity production, and solid fuels in Türkiye. As of 2021, emissions from the energy sector account for 71.3% of total emissions, excluding Land Use, Land-Use Change, and Forestry (LULUCF). In 2021, the share of CO_{2eq} emissions from oil refineries in the energy sector was 4.9%, which decreased from the 6.2% recorded in 1990 (TÜIK, 2023). The total emission amount from petroleum refineries is given in years in Figure 4.

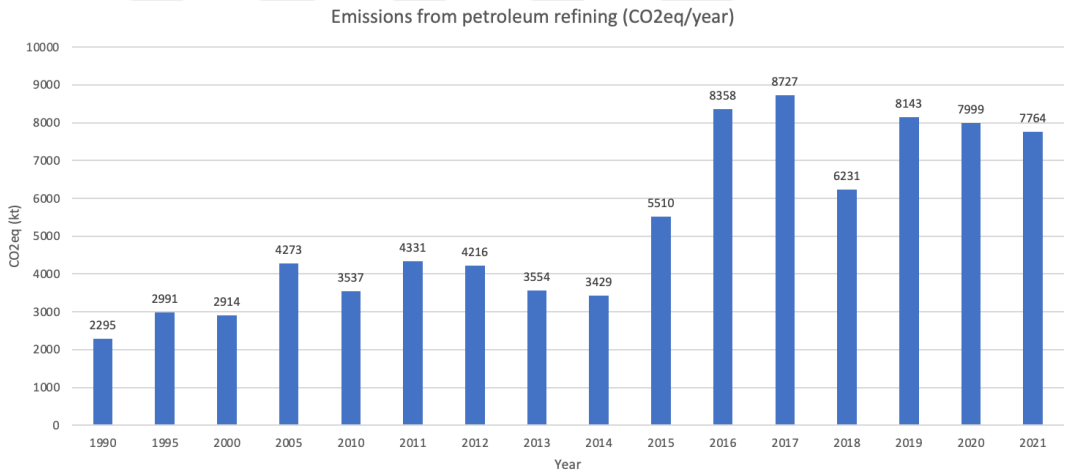

Figure 5. Emissions from petroleum refining (Source: TÜIK, 2023)

GHG emission monitoring is conducted by the Ministry of Environmental, Urbanization and Climate Change in Türkiye. There are four principal regulations '*Monitoring and Reporting of Greenhouse Gas Emissions Notification and Verification of Greenhouse Gas Emissions Reports (MRV) '*and *'Accreditation of Verification Organizations Notification'*. These regulations are currently only Scope 1 for industries in Türkiye (RTMEUCC, 2021).

The scope of MRV is GHG emissions from key sectors in Türkiye, such as the combustion of fossil fuels, oil refining, iron and steel, ferrous and non-ferrous metal

production, primary aluminium production, mining industry, pulp and paper production, chemical industry, and acid production. The regulation has been applied since 2015 in Türkiye. Approximately 50% of Türkiye's total GHG emissions have been accounted for by submitting emissions reports and monitoring plans of more than 700 facilities (RTMEUCC, 2023).

Refinery industries must also calculate and declare their annual CO_{2eq} to the Ministry as part of the MRV scope. Refineries need to develop monitoring plans, accurately assess their emissions, and declare an annual emission report yearly. There is an MRV System under these regulations. According to the system, initially, refineries should calculate their emissions from CO_{2eq} from combustion and production processes. Then, a verification body is assigned by the Ministry of Environmental, Urbanization, and Climate Change, and they review and recalculate all calculation documents. After the verification, the emission report is submitted to the web-based platform of the Ministry of Environmental, Urbanization, and Climate Change (RTMEUCC, 2021).

4.4. Turkish Refinery Industry

Oil remains the primary energy source utilized in Türkiye's total final consumption (TFC), the second largest source in total supply. The transport sector is responsible for most of the oil consumption in Türkiye, and the increase in energy needs within this sector has caused a significant rise in overall oil consumption. Diesel fuels are especially prominent in Türkiye's oil consumption patterns. As a result, efforts focused on decreasing demand and shifting to alternative fuels in the transport sector will be essential in preventing further growth in oil consumption. Crude oil and refined products are imported into Türkiye. Crude oil production in Türkiye is a developing country, but its share of the total supply is still small. Oil and products have been supplied through several routes. Pipelines and tankers supply crude oil, providing maritime and road products. The domestic production of crude oil in Türkiye is limited, with the Turkish Petroleum Company (TPAO) holding most existing licenses and acquiring all new licenses in recent bidding rounds. Five refineries have an 860 kb/d Total capacity as of January 2020 in Türkiye. These cover nearly 80% of the total oil product demand in the country (IEA, 2021).

Table 3. Refineries operating in Türkiye (Source: IEA, 2021)

	Capacity	Location	Company	Year of Construction
İzmir Refinery	257.000	İzmir	Tüpraş	1972
İzmit Refinery	244.000	Körfez/Kocaeli	Tüpraş	1961
STAR Refinery	214.000	Aliağa/İzmir	SOCAR	2018
Kırıkkale Refinery	115.000	Kırıkkale	Tüpraş	1986
Batman Refinery	30.000	Batman	Tüpraş	1955

Following IEA (2021), crude oil loading is operated in oil terminals received by maritime tankers in İzmir, İzmit, and STAR refineries. Meanwhile, the Kırıkkale refinery receives its supply through a pipeline from Türkiye's Mediterranean oil hub in Ceyhan. Batman refinery crude oil comes from a pipeline network and road tankers from several small oil areas in Batman Province. The STAR refinery is the newest in Türkiye and started operations in 2018. It is a venture worth USD 6.2 billion by the State Oil Company of Azerbaijan Republic (SOCAR).

Tüpraş is the largest oil refiner company in Türkiye, with four refineries nationwide. These refineries have a total crude oil processing capacity of 30 million tons/annual. These four refineries are in İzmit, İzmir, Kırıkkale, and Batman. With this capacity, Tüpraş is Türkiye’s largest industrial company and one of the prominent companies in the energy sector. Additionally, Tüpraş is the seventh largest refinery company in Europe and operates one of the most complex refineries in the Mediterranean basin (Tüpraş, 2024a). Tüpraş's four refineries produce an impressive 53 different types of petroleum products. The company's many products significantly contribute to the energy demand in Türkiye. These products are diesel, LPG, gasoline, naphtha, jet fuel, fuel oil, bitumen, and machine oils, distributed domestically and exported to international markets (Tüpraş, 2023).

MRV Regulation plays a crucial role in monitoring GHG Emissions. In line with this, Tüpraş reports and monitors Scope 1 emissions, demonstrating its commitment to environmental compliance. In addition to Turkish regulation, the company's Scope 1 and Scope 2 emissions are verified by third-party, independent verifiers with ISO

14064-1 (Greenhouse Gas Emissions Verification and Reporting Standard). The ISO 14064 verification was realized between 2017 and 2021 for the company's Scope 1 and 2 emissions (Tüpraş, 2022).

Table 4. Tüpraş refineries GHG emission amount (Source: Tüpraş, 2022)

	2017	**2018**	**2019**	**2020**	**2021**	**2022**
Scope 1 ($tonCO_{2eq}$)/year	7.249.964	6.103.645	6.172.574	5.724.407	5.865.652	6.396.648
Scope 2 ($tonCO_{2eq}$)/year	79.386	37.872	32.953	24.518	48.403	55.625

SOCAR Türkiye was established in 2008 by privatizing Petkim in Türkiye. The STAR Refinery is a core part of SOCAR Türkiye and is in İzmir, Aliağa. The construction phase of STAR Refinery was started in 2011. STAR Refinery and Petkim are the first and only integrated facilities between the refinery and the petrochemical industry in Türkiye. After the construction phase, STAR Refinery started operation in 2018 and reached full capacity in 2019. STAR refinery has an annual 12.1 Mton crude oil processing capacity. The company produces diesel, jet fuel, LPG, pet coke, and sulfur products. STAR Refinery meets %25 of Türkiye's oil product demand and contributes to decreasing Türkiye import demand (SOCAR Türkiye, 2023).

Scope 1 GHG emissions are monitored per national regulations in SOCAR Türkiye. In compliance with regulatory requirements, GHG emissions are systematically monitored, reported, verified by accredited verification bodies, and submitted to relevant authorities. SOCAR Türkiye has developed a monitoring strategy aligned with our enduring sustainability objectives, categorizing Scope 1 GHG emission sources based on their respective classifications in the refinery-petrochemical complex. The company follows this strategy, which involves monthly calculating GHG emissions and assessing its adherence to predetermined goals (SOCAR Türkiye, 2023).

Table 5. STAR Refinery GHG emission amount (Source: SOCAR Türkiye, 2023)

	2020	**2021**	**2022**
Scope 1 (tonCO_{2eq})/year	1.914.451	2.010.170	2.457.521
Scope 2 (tonCO_{2eq})/year	432.560	428.453	403.472

4.5. Net Zero Emission Targets and Strategies of Turkish Refineries

4.5.1. Net Zero Emission Targets of Tüpraş

Tüpraş in 2023 published the first Integrated Report 2022. In this report, they announced their Strategic Transition Plan. According to Koç Holding's vision, Tüpraş significantly focuses on combating the climate change and move towards a low-carbon economy The EU Green Deal's effect and regulation have been evaluated and monitored. In this vision, Tüpraş has determined a roadmap to becoming carbon neutral by 2050 with new technologies and becoming the sector leader. Specifically, the main four topics of this roadmap are **green hydrogen, biofuels, sustainable refining, and zero-carbon electricity.** According to the roadmap, Tüpraş aims to mitigate its Scope 1 and 2 emissions from operational processes by 27% by 2030, 35% by 2035, and 49% by 2040 compared to its base level in 2017. Since 2017, the company has reduced its Scope 1 and 2 emissions by 12%. Additionally, 73,199 tonnes of CO_{2eq} have been eliminated by implementing 52 energy efficiency projects (Tüpraş, 2022).

Tüpraş plans to invest approximately USD 2.3 billion in energy efficiency, modernization, decarbonization, and value-added product production projects by 2035. The company also has a biofuel production target to reach carbon-neutral energy company by 2050. It plans to produce biofuel by annually processing 400,000 tonnes of bio-based waste (vegetable and animal) raw materials. Tüpraş also invests in SAF production technology. The company signed a license agreement with Honeywell UOP for SAF. This agreement is to be used by UOP Ecofining™ Technology in Tüpraş İzmir Refinery. It is expected to be completed in 2027 (Tüpraş, 2022).

Moreover, the report states that with the implementation of SAF technology, Tüpraş is the first company to implement SAF technology in Türkiye. The company has a plan

for Green Hydrogen investments, and Tüpraş is a member of Hydrogen Europe. As part of the Green Hydrogen production investment of Tüpraş, the 'Electrolyzer Working Group' was established.

Tüpraş also demonstrates in their 2022 Integrated Report that the company will start production of Green Hydrogen with a 20 MW electrolyzer by 2030. Then, Tüpraş plans for the electrizer capacity to increase to 400 MW. The company aims to start trading green hydrogen in logistics and heavy transportation by 2030, operating in different areas in the green hydrogen value chain, serving many sectors, especially transportation, and becoming a key player by utilizing its export potential. At the end of this construction and operation process, the company aims to set zero emissions from Hydrogen generation in 2040. Furthermore, in 2022, Tüpraş purchased ENTEK, which includes eight hydroelectric, one wind, and one natural gas combined cycle power plant with a combined capacity of 442 MW (Tüpraş, 2022).

Tüpraş also develops R&D projects to reach net zero targets. For example, under the coordination of Tüpraş, 21 partners from 4 countries applied to Horizon Europe's 'Hydrogen Valley' call with ETERNITY - Demonstrating the First Green Hydrogen Valley in Türkiye project. Another example is that Within the scope of TÜBİTAK ARDEB 1003 "Micro-Jet - Microalgae Based Sustainable Bio-Jet Fuel" project, it cooperates with organizations such as Boğaziçi University, Koç University, Turkish Airlines, THY-Teknik, THY OPET. Tüpraş refineries won awards for their projects in various fields in the 'Energy Efficiency Competition in Industry (SENVER-22)' organized by the Ministry of Energy and Natural Resources. Izmir refinery, Izmıt, and Kırıkkale refineries are awarded in this organization by applying energy efficiency projects. The scope of the strategic plan of Tüpraş is that the company is working on R&D studies on CCUS (Tüpraş, 2022).

Tüpraş implements several actions in their refineries to mitigate their emissions. Clean fuels are utilized to minimize emissions from refineries, and emissions are regulated to comply with national laws and international standards. Low NO_x emission burners are used in energy production for refinery operations. Moreover, Flare gasses are recovered and used as fuel in the furnaces of refinery units. LDAR technologies are used to detect VOC emissions. Sampling systems are closed to prevent VOCs. Double-

walled floating roofs are operated in the tank sites to reduce VOCs originating from tanks (Tüpraş, 2022).

4.5.2. Net Zero Emission Targets of SOCAR

The last sustainability report of SOCAR Türkiye for 2022 was published in 2023. In this report, SOCAR Türkiye stated short-, medium-, and long-term plans with four titles: decarbonization, circular economy, green finance, and Opportunity-Providing Operation Model for their strategies. According to this plan, the company aims to decrease its CO_2 emissions by 1% annually. This annual %1 decreasing target covers 2021–2025-year emissions. To reach the target, emissions are calculated monthly and verified by a third-party verification firm dedicated to the Ministry of Environmental, Urbanization, and Climate Change. SOCAR Türkiye also stated in their sustainability report that they will be a net zero emission company for scope 1 and scope 2 emissions by 2050, including some activities, such as energy efficiency, electrification, resource management, and decreasing flare emissions, will be implemented to reduce their emissions. They focus on energy efficiency projects to reach these emission reduction targets (SOCAR Türkiye, 2022).

Moreover, they work on value-creation projects and their sustainability effects on refinery and petrochemical facilities. In 2022, they explained some projects and their reducing emission values; for example, the implementation of optimizing the AVF fuel gas pressure control valve set in the refinery TGTU unit, and the refinery CO_2 emission of refinery increased by approximately 2 tons. Moreover, reducing the methane slip value in the Hydrogen Production Unit reformer furnace projects will decrease natural gas consumption. So, 9 tons of CO_2 emission have been prevented. In addition, flare gas reduction, steam optimization, and reducing electric consumption projects are implemented, and their emission and water consumption values are monitored and reported (SOCAR Türkiye, 2022).

CHAPTER 5: FINDINGS AND DISCUSSION

This section presents an investigation into the potential impact of the Green Deal on Turkish refineries. It categorizes findings derived from expert interviews and an analysis of the insights gathered from these interviews, which have been compared with the literature.

5.1. Effects of EU Green Deal on non-EU Members

In the first part of the analysis, the impacts of the Green Deal on non-EU members are derived. As mentioned in the literature, all experts agreed that countries exporting to the EU are the most affected. The EU Green Deal significantly impacts the sustainability of the environment and economy. This agreement is significant for the EU member states and countries engaging in commercial activities with the region. It establishes substantial standards with the objective of compelling trading partners to adhere to them (Türker and Aydin, 2022). Therefore, the Green Deal's transformational effect will affect European countries and their trade partners. Under the EU's leadership, EU members and non-EU countries should engage in broad activities to support the Green Deal in reaching its targets.

Furthermore, European emissions account for less than 10% of the global GHG emissions. Therefore, the EU needs to reach agreements focusing on trade partners to decrease their GHG emissions and impact on global warming. In addition, broad participation in the Green Deal and ensuring fair competition in economic relations are significant topics. Consequently, the EU prepared an action plan in 2020. The proposed plan encompasses a diversity of industries that employ substantial resources to comply with regulatory standards and minimize their detrimental effects on the environment (Türker and Aydin, 2022).

Concerning the EU Green Deal initiatives, countries engaged in trade relations with the EU have initiated preparations for regulations, a carbon tax, and the implementation of new technologies in industrial sectors to reduce their negative environmental impact, representing an additional cost for governments and companies.

Experts also considered the effects on trade relations and cost requirements, and this effect was evaluated both negatively and positively. Governments and companies must improve their technologies or investments to reduce environmental effects and comply with the Green Deal requirement. Also, regulations have been revised in line with the EU Green Deal. In addition to these, the requirement of a Green Deal for their trade partner of the EU, countries would have to change their market destination from the EU to other countries. Experts claimed that issues as follows:

"Every country that exports to the EU would be affected. However, there is a risk that countries and sectors may turn to different markets. The biggest impact would be the cost impact on the trade side. Also, everyone reduces their impact on the environment, controls it, creates a system, and brings it into line with the EU requirements. Those who don't will be financially impacted. We can say that it is both an advantage and a disadvantage." (Expert 1)

"Everyone who cooperates with the EU will be affected. Countries with which we have no relations will also be affected by new opportunities. It may require new investments for non-EU countries… Companies can expand into other markets. Can invest in other countries." (Expert 4)

Companies can expand into other markets. Can invest in other countries. (Expert 4)
The Green Deal not only concerns environmental and climate issue and greatly affects trade. (Expert 6)

Since the EU has completed a certain level of development, it will have an advantage over less developed countries like ours. Technological know-how comes from the West. EU will leave countries in a corner where they have to sell the technology and bear some costs if other countries cannot use this technology (Expert 3)

These new policy requirements also improve **employment**. The phase-out of fossil fuels has the potential to stimulate the creation of new businesses, which in turn could facilitate the development of new job areas and occupations. Additionally, the EU expected that while the employment impacts of the transition to green technologies may be limited, there are expected to be significant changes in the distribution of jobs

across various sectors, companies, job types, and geographic areas (Vandeplas A. et al., 2022). Expert 4 also highlighted that:

"It can contribute to employment. For example, it may create new business opportunities when directed to non-EU countries or for sales there. Or it can provide the technological infrastructure that the EU wants." (Expert 4)

In addition to the points mentioned above by Experts 1 and 4, which would lead to obligations for the EU and non-EU countries. If these countries cannot implement the Green Deal policies, it could negatively influence them. On the other hand, this negative effect could become an advantage because if the market route changes from the EU to developing countries, these would be advantages for developing countries, leading to their development of economies. Expert 5 explains this situation as follows:

"Non-EU members will also be affected. The climate future affects companies with regulatory changes, so it will affect countries with low regulation. At the same time, these changes may put disadvantaged countries in an advantageous position. For example, when the EU removes diesel vehicles from its countries, they will go to African countries and develop those countries so that it may be an advantage."(Expert 5)

Clora, Yu, and Corong (2023) state that **CBAM** is one of the most crucial topics of the Green Deal. The CBAM aims to prevent carbon leakage and concerns about competitiveness in international trade between EU and non-EU states. Based on the European Council (2022b), CBAM can be defined as a safeguard against carbon leakage for industries with substantial GHG emissions to move their production operations outside the EU to areas with weak climate regulations than those within the EU. The main goal of this strategy is to mitigate GHG emissions globally and provide fair competition among all markets. The EU has already implemented its ETS since 2005. Thus, trade partners of the EU that do not implement their own ETS or carbon tax have led to carbon leakage for the EU.

Consequently, the EU planned to start CBAM for trade partner countries by the end of 2023. It started with a transition phase between 2023 and 2026, so this pilot transition

phase is an opportunity to prepare both EU and non-EU business government authorities and stakeholders like importers, producers, and authorities. In addition, it is the learning period of the first phase of CBAM. It is implemented in iron, steel, fertilizers, cement, electricity, aluminum, and hydrogen industries. Today's EU provides sectoral information with webinars and published documents for all responsible sectors. These industries were determined for the first phase because the production of these facilities is carbon-intensive, and these are possible industries that lead to carbon leakage. After the transitional period ends and it is completely implemented in all sectors, it will be expected to capture more than 50% of the emissions in ETS-covered sectors (European Council, 2024). In this respect, one of the respondents explained that:

"After the Green Deal was published, the EU started to take some actions. The most prominent of these actions is the CBAM, which was put into effect as of October 2023 to prevent carbon leakage and increase the competitiveness of established industrialists in the EU. With this regulation implemented to prevent carbon leakage, the main target is countries outside the EU. This practice currently targets facilities that import into the EU and is only implemented in the hydrogen, iron and steel, cement, fertilizer, electricity, and aluminum sectors, which may impose financial liability on the facilities in question. It will be implemented without financial obligation for the next 2 years. It is expected to raise awareness about emissions for the facilities during the process where the facilities will only report their direct and indirect emissions." (Expert 6)

Regarding CBAM, experts mentioned the financial effect on companies, both EU and non-EU members. Some companies or producers change the location of facilities due to the carbon tax. EU countries and other countries have started to prepare their own ETS regulations and applications. According to respondent in Expert 2:

"It is a process implemented not only with the concern for a green future but also with financial concerns, as in CBAM. When the EU introduced ETS, its own iron, steel, and cement producers left EU countries. Because the EU's emission amounts of cement production would be subject to a much higher carbon tax burden with the ETS, they turned to countries that did not yet have legal regulations on this issue."

"Similar to the recently published demi-steel cement, fertilizer, aluminum, electricity, and hydrogen sectors, it has been expanded to include countries exporting to the EU as of October 2023. The aim also shifts to financial issues. EU CBAM was established for these sectors for the first 3 years and then expanded to different emission-intensive sectors such as oil & gas and plastic… In addition to the EU, China is implementing ETS. There is a similar ETS-like application in America. The EU took this one step further and started to implement it." (Expert 2)

As discussed in the literature, all experts also claimed that non-EU countries that have trade relations with the EU are definitely affected by the EU Green Deal because The EU's Green Deal includes measures such as the **CBAM,** which aims to prevent carbon leakage by imposing tariffs on imports from countries with less stringent environmental regulations. Non-EU countries may face increased trade barriers or pressure to adopt similar environmental standards to maintain access to the EU market. It is also an opportunity for non-EU countries for technology transfer, investment opportunities, and new job areas.

5.2. Effects of the EU Green Deal on Türkiye

Türkiye is a significant trading partner of the EU, and essential commercial agreements exist between the EU and Türkiye, so the EU Green Deal is important for Türkiye to maintain and develop its economic condition. Therefore, it is crucial for both Türkiye and the EU to demonstrate how prepared Türkiye is for the Green Deal (Türker and Aydin, 2022). In addition, a large volume of products is exported to the EU. Carbon prices determined by the EU are significant for producers because they affect producers, from raw materials to end products and their operations. Experts also emphasize the volume of exports, carbon prices, and the cost effect of the Green Deal on Türkiye. According to respondents in Expert 6 and 7:

"Its effects are undeniable in a country like Türkiye, which exports 40% of its exports to the EU. In addition, carbon pricing instruments need to be put into effect to protect the facilities in our country against high carbon prices." (Expert 6)

"I think it will definitely create a wave that will also affect Türkiye. In particular, the

trade volume between Türkiye and the European Union reached 200 billion dollars in 2023. Likewise, the EU received a 40.6% share of Türkiye's exports with 103.1 billion dollars in 2022. The biggest competitive trump card here is the price advantage, as prices in Türkiye are cheap. In a possible future tax, for example, in fuel oil, there is talk of around 10 per ton CO_2, but in a possible tax that will be exceeded, I am talking specifically about 2026, Türkiye may lose its competitive advantage in the taxation per product. Therefore, we have such a risk." (expert 7)

As mentioned in the previous section, CBAM could affect Turkish exports to the EU if they do not meet the EU's Green Deal requirements. Under the Green Deal, Turkish industries are required to adapt to these new regulations, possibly through investments in new technologies.

"I think it will affect all non-EU countries. In the first place, before this business grew so much, the EU was only following and implementing its own regulations. But now, there is an issue called carbon leakage in the EU. When they implemented the regulations in the EU, it caused industries in the EU to go out. This caused the EU's industry to weaken. This requires all trading partners to comply with their own regulations. Since Türkiye is one of them, we will definitely be affected to maintain financial and commercial cooperation." (Expert 8)

As mentioned in the literature, the first phase of CBAM covers 5 main sectors: iron and steel, aluminum, hydrogen, electricity, and fertilizer. These sectors are also a massive part of the export of Türkiye to the EU. Additionally, it is expected to expand the number of sectors after 2026. Expert 2 demonstrated this as below;

"Türkiye will definitely be affected because it exports more than 50% of its products to the EU. Türkiye exports iron and steel, aluminum, textile, and leather products. Therefore, when we consider the existing sectors and the sectors that will be included in CBAM and Green Deal in the future, Türkiye will definitely be affected." (Expert 2)

Moreover, awareness level is another impact of the Green Deal. The EU awareness started in the 90s, before the Green Deal. Important points of this awareness of sustainability for the EU were underlined by Experts 7 and 2 as follows:

"One of the sub-items of the Green Deal in the EU is raising awareness of sustainability in schools and raising this awareness from a young age. We have just started this. The EU started this in the 1980s and 90s. Yes, they made the Green Deal in 2019, but their steps toward the environment correspond to the 1990s…Therefore, there is this awareness in Europe. They will also have an end-to-end carbon monitoring system and a carbon label on the products they buy; I guess in the future; every product will have a carbon label used to produce it. For example, you will buy a food product, and on the label, it will be written that in the production of this product, this much CO_2 has been produced. Regarding this point, people in the EU want to pay more money, and I should buy a more environmentally sensitive product. It is not like us; we do not have this point of view; there are some, but not many. Therefore, producers may not accept raw material inputs with high carbon chains. Because the man will work there, he will try to produce everything green; he will come and buy plastic from Türkiye, and he will reset that carbon." (Expert 7)

"Previously, consumers had two criteria for purchasing products: quality and cost. Now, the EU is trying to add a third criterion to this: the sustainability impact. One of these is Extended Producer Responsibility, which means that the producer will now be responsible for producing the product from more sustainable materials, making the product more durable, making recycling easier, and using recycled materials. So, from a life cycle assessment perspective, we will be responsible for our product from cradle to grave. The contents of the products we purchase will not be indicated by percentages of materials such as cotton but rather by stating how much-recycled material has been used in the product. Labels will be required to provide information such as the water footprint of cotton and others." (Expert 2)

Consequently, Türkiye must maintain and closely follow the upcoming Green Deal policies and regulations for its products that are traded to the EU if it is to remain competitive in the global market.

5.3. The Green Deal Actions of Türkiye

The Green Deal is endorsed by policymakers and non-governmental organizations in Türkiye (Türker and Aydin, 2022). Green Deal actions are pursued under the leadership of the Ministry of Trade in Türkiye. The Ministry of Trading published the 2021 Green Deal Action Plan for Türkiye. Expert 6 emphasizes the main target topics of the Green Deal Action Plan:

"Following the announcement of the EU's Green Deal, a Green Deal Action Plan has been released in our country, detailing the actions to be taken under 9 main headings These are Border Carbon Adjustments, Green and Circular Economy, Green Financing, Clean, Economical and Safe Energy Supply, Sustainable Agriculture, Sustainable Smart Transportation, Climate Change Mitigation, Diplomacy and Information, and Awareness Activities." (Expert 6)

This Green Deal Action Plan determined the scope of targets and improving areas. Besides, Green Deal working groups were established and separated into main topics. A respondent from Expert 1 stated that:

"The Ministry of Trade is the main authority. They established Green Deal working groups. They created the Green Deal Action Plan. Working groups include sector representatives. The most critical action is ETS. It will be compatible with our MRV. Our regulations are also fully compatible with EU regulations. The Ministry of Environment operates ETS and works on forming a system for legislation and ETS. Sub-sector representatives also take part in the working groups. When ETS is established in full compliance with the MRV system, we will minimize the cost risk. If we can convince the EU with the system we have established, the financial risk will be eliminated. The most critical issue will be the establishment of ETS in Türkiye. It's called the end of this year." (Expert 1)

Additionally, Türkiye improves awareness activities about environmental issues and promotes sustainable practices through education campaigns, programs, and environmental education initiatives aligned with the Green Deal actions. The Ministry of Environment, Urbanization, and Climate Change also gives training. It organizes

webinars and workshops for stakeholders about Green Deal actions, such as circular economy, ETS, CBAM, climate law, etc. NGOs and private sectors organized working group activities. Expert 2 and Expert 6 explained such activities:

"The main coordination of the Green Deal in Türkiye was given to the Ministry of Commerce. The Ministry of Trade prepared a Green Deal Action Plan. All sectors were assigned duties in the prepared Green Deal Action Plan. An action list has been prepared. For example, TSE prepares the Green Organized Industrial Zones criteria and starts certification for this. Circular Economy action plans are worked on with the leadership of the Ministry of Environment, Urbanization, and Climate Change. It was stated that the Ministry of Trade and Environment should prepare guides to evaluate the effects of the Green Deal on a sectoral basis, direct our companies, and contact them to inform them about the effects of the Green Deal and increase awareness. The Ministry of Environment was tasked with enacting the climate law regarding ETS by October 2024. Institutions such as NGOs, the Sustainable Development Association, the Istanbul Chamber of Industry, TSE, etc., are working to raise awareness through reports and events. The private sector, the umbrella organizations of companies that are currently subject to CBAM, and unions organize workshops and training for member institutions to raise awareness of this issue." (Expert 2)

"Under the coordination of the Directorate of Climate Change, various informative activities are being conducted with EMRA, Borsa İstanbul, and other stakeholders through the Carbon Pricing Department."(Expert 6)

Türkiye revised the NDC report, which was announced in COP 27. The Ministry of Environmental, Urbanization, and Climate Change explained that the target for emission reduction was determined % by 41 from the base year 2012 to the target in 2030. This revised NDC was submitted in April 2023. It also evaluated the NDC target, and the projects are coordinated with EU partners by Expert 6:

"After Türkiye became a party to the Paris Agreement, it stated that the NDC would be reduced by 41% according to the Business-as-Usual scenario by 2030. Although there is an increase in NDC, this is not compatible with the EU's emission reductions

and is insufficient, according to the IPCC's latest reports. An IPA project (DEEP Project) is also being carried out to transition to a circular economy, and a circular economy action plan is being prepared. Moreover, the Climate Change Presidency and the Environment Agency have been established, and projects and initiatives related to taxonomy, harmony, and adaptation are being carried out. In addition, the EU Environmental Integrated Adaptation Strategy (UCES) was published to harmonize the environmental policy in our country with the environment and climate change acquis during Türkiye's harmonization process with the EU." (Expert 6)

In contrast with the other experts, targets demonstrated by the Turkish government cannot be implemented perceptibly. Expert 3 claims that:

"The state creates many groups as ministries and tries to include the private sector. But these always remain in the program; I don't remember much about taking action. We generally determine a program. We are on the side of enacting legislation regarding these. We haven't seen anything concrete yet." (Expert 3)

The Expert 9 provided positive and negative progress for Green Deal actions and reaching targets:

"Türkiye is taking action on this matter. It has issued a Green Deal Action Plan. Progress has not been very rapid after the issuance of this action plan. As far as I can see, progress is being made behind the scenes. Of course, some targets were not met, but I think the biggest impact of the action plan was on this division of responsibilities. Whether it's greenhouse gas emissions or other issues, there has been a division of responsibilities within the government regarding which ministry will be responsible for which issue." (Expert 9)

All experts have knowledge about the Green Deal actions of Türkiye and the importance of how ready Türkiye is for the Green Deal. Moreover, as mentioned in litreture, experts highlighted that policymakers and non-governmental organizations have worked on Green Deal actions.

While Türkiye is undeniably taking action on the Green Deal, these actions are being

monitored by responsible working groups under the guidance of the Ministry of Trade. This collaborative approach is practical in managing actions and institutional studies.

5.4. Preparation of ETS in Türkiye

Following Hintermann (2010), the EU ETS, the largest emission market in the world, and it is implemented for nearly half of the CO_2 emissions of the EU. It has been applied in the EU since 2005, before the Green Deal. It works as a critical tool for the EU to reduce GHG emissions. The EU ETS covers around 10,000 companies in the industrial electricity and heat sectors, energy-intensive industries (e.g., oil refineries, steel, cement, glass, and paper), and commercial aviation. Under this system, a price is assigned for industry carbon emissions, and entities covered by the ETS must purchase "allowances" corresponding to their emissions annually. A limit is determined for each year on the number of allowances available, and this cap decreases over time, incentivizing companies to reduce emissions (European Council, 2022a).
Turkish government, intuitions, private sectors, and stakeholders have accelerated the workings of ETS for Türkiye. The Ministry of Environment has prepared draft regulations on ETS Climate Law. It is expected that ETS will be started in October 2024. Türkiye focused on eliminating the CBAM tax obligation for exporters to the EU. A respondent from Expert 2 stated that:

"Work on the ETS in Türkiye has accelerated. The Climate Law is likely to be enacted around October, and the ETS is expected to be put into effect within the pilot period. The aim here is that if countries like Türkiye establish their own ETS, create a tax system on carbon in their own country, and make it equivalent to the EU when we export, our importers in the EU will not have to pay a tax. Thus, the money will stay in our own country. This is actually the purpose of our acceleration, not to create costs for us in vain and send this money to the EU. To summarize, if a carbon tax system is established, there will be no need for costs for exports to the EU, and the money will stay in the country through domestic carbon taxation." (Expert 2)

In addition, Expert 6 focused on the method of ETS and MRV systems that are used in monitoring GHG emissions in Türkiye and Expert 6 states that:

"In Türkiye, there is currently no climate law in place. With the enactment of a climate law, the initiation of a national emission trading system is envisaged. Additionally, along with the ETS, C category facilities, which account for 90% of GHG emissions monitored in the MRV system since 2015, are planned to be subject to the historical emissions-based allocation method (grandfathering)." (Expert 6)

Hintermann (2010) stated that it is another important topic in ETS to classify the allowance price actors for each market at the beginning. Allowances can be allocated by *grandfathering,* as mentioned by Expert 6, and a benchmarking method can also be used. Moreover, following Howie and Atakhanova (2022), if the benchmarking method is used for allowances, it can be changed for industries when they use carbon-efficient methods like new technological investment, Best Available Technologies, and changing fuel sources to reduce CO_2 emissions.

"Actually, a national ETS is planned to be implemented in Türkiye, which is slightly different from the ETS in Europe. While the EU ETS is based on Directive 2003/87/EC, the existing Regulation on the Monitoring, Reporting, and Verification of Greenhouse Gas Emissions only covers GHG monitoring, reporting, and verification. Therefore, firstly, the enactment of a climate law, the publication of a regulation for ETS, and the determination of the framework for implementation are required…The ETS in our country will start with a setup for the allocation of historical emissions (grandfathering). In the next 5-10 years, a transition will also be made to the benchmark method currently being implemented in the EU ETS. Although there are advantages and disadvantages, I believe that the benchmark, despite its challenges, is a more ambitious approach compared to grandfathering. Free allocations are planned to be distributed during the transition period. Therefore, I don't think it will impose financial obligations on companies." (Expert 6)

The differences between EU ETS and planned Türkiye ETS are evaluated by Expert 9:

ETS work in the background is going very fast. MRV has greatly accelerated the work because the ETS system needs to be integrated with the MRV system. It did not happen so fast in Europe because the MRV system and the ETS started together in Europe but

not in our country. Our biggest advantage in Türkiye is that we have been using MRV for many years and have acquired a great deal of know-how in MRV. Therefore, Europe's start and interpretation of the ETS differed from ours. We will be much faster and better because we have very good experiences with MRV, and secondly, we will have case studies with Europe. However, the biggest difference between MRV and Europe-based ETS was this: In Europe, carbon intensity is used in the kg of CO_2/ton of a product, but we calculate the total amount of CO_2 emission. We do not currently provide this intensity data and are not in a structure to provide it. Therefore, the ministry updated the MRV system in the first phase. It is trying to bring it to a system that will be more compatible with the ETS. We will see these with pilot studies, especially in the last quarter of 2024. In addition, as far as I know, the ministry is also carrying out various projects with various foreign companies within the scope of the ETS. Therefore, we can say that the ministry continues to develop itself rapidly both in terms of software and knowledge.

Therefore, Türkiye already has an MRV monitoring system, and ETS would be compatible. This has accelerated the studies of Türkiye. In addition, ETS provides the cost advantage when CBAM is realized since the ETS carbon tax will be in the country. Moreover, Türkiye ETS will differ from the EU regarding CO_2 calculation and allowance allocation methods. As mentioned in the literature, communication and engagement with the stakeholders are essential to achieving industries and government decisions (Howie and Atakhanova, 2022). Experts also highlighted that the Turkish government should continue the communication and stakeholder engagement meetings and workshops.

5.5. Potential Effect of Green Deal on Turkish Petroleum Refineries

Petroleum refineries are carbon-intensive industries. Thus, the EU Green Deal actions should be implemented by refineries. In addition to emissions, refineries cause environmental effects, so they must implement environmental regulations. Regarding the Green Deal, most policies would be related to refinery operation activities. There are 2 petroleum refinery companies in Türkiye. These are STAR Refinery and Tüpraş. Tüpraş has four refineries, which are older than STAR Refinery. Expert 6 indicates that refineries are potential emission-reduction industries:

"It is expected that the emissions-intensive refinery sector will reduce its emissions compared to previous years…The refinery sector has a significant share in Türkiye's emission reduction targets, and it is planned that emissions in the refinery sector will also be reduced with the ETS." (Expert 6)

Moreover, in the EU, refineries are within the scope of the EU ETS. Previous literature demonstrates that refineries operating old technologies have more improvement processes to eliminate emissions. ETS creates pressure on refineries, like other industries, to mitigate their emissions. The Green Deal also requires deploying clean fuel in the aviation sector. Thus, refineries expand their fuel production to biofuels or SAF.

"For the time being, as far as I know, the refinery sector is included in the EU ETS, so a carbon price is paid per tonnes of CO_2 in the refinery sector. Reducing free allowances within the framework of the EU's emission reduction targets will also push the industry to more significant challenges in mitigation. However, in addition to the ETS already implemented in the EU, ETS 2 is planned to cover the buildings and road transport sectors. In this case, a certificate fee to be applied to road transport may also have a negative impact on the refinery sector. In addition, encouraging the switch to SAF fuel as aviation fuel in aircraft may also push the refinery sector to produce more sustainable fuels." (Expert 6)

In addition to these statements about the substitution from fossil fuels to clean fuels like hydrogen, biofuel, etc., Expert 7 emphasizes the opportunity for refinery petrochemical integration:

"I think that refinery and petrochemical plants will be inevitably affected. Although most of the refinery plant productions (Gasoline, Diesel, Jet A-1, DMA) are seen as one of the main product sources for transportation, it has become inevitable that they will be replaced by electricity, hydrogen, and synthetic fuels in the future. Most of the refineries that cannot be integrated with petrochemicals and alternative production methods will be out of operation due to supply and demand imbalance and inability to keep stocks. The best example of this is the shutdown of Tüpraş due to the end of the JET A-1 product storage capacity due to the pandemic. In addition, the carbon

footprint of the final product will be followed up from the raw material stage. Their contribution to green energy and decarbonization will be used as a reputation aspect with the rising consumer awareness, eliminating the competitive advantage of companies that do not invest in green energy and continue to emit high carbon emissions as before." (Expert 7)

CBAM is the other key policy for the Green Deal. The EU has determined sectors for the first phase, but refineries are not involved. It is expected to be in the second phase of CBAM. Products will be subject to CBAM's carbon tax if the refinery sector is included. However, Türkiye has not exported many fuel products to the EU. Expert 2 illustrated the impact of the Green Deal on refineries:

"It will impact refineries in Türkiye because we also export the products. Türkiye does not have a large share with the EU as fuel products. When we look at gasoline, the STAR refinery does not produce gasoline. Tüpraş meets Türkiye's needs, and there is not much export in gasoline. Also, refineries in Türkiye import diesel and the diesel capacity of refineries in Türkiye is not sufficient. When an opportunity comes, it is utilized... Our by-products, pet coke, Sulfur are not enough to saturate the markets in Türkiye, but they are exported when the opportunity arises…It will be affected when there is a regulation on CBAM. The issue to be affected is general global issues, such as emission limitation affecting refineries. When ETS comes, it will affect the refineries in Türkiye. In addition to this, it will have effects within the scope of the regulations that will come within the scope of the Green Deal." (Expert 2)

Experts generally acknowledged the effect of CBAM, especially on refineries. Expert 3 also focuses on the indirect **socio-economic** effect of the Green Deal on employees of companies:

"What will force us is that we have very high carbon-producing facilities, and we are emission-producing facilities. Therefore, we will be seriously affected by this, and CBAM unit prices will seriously affect us because we are also an exporter. We sell the products to the domestic market, and we also sell them to foreign markets. While these regulations are being made, these companies are very large and places where many people work. There is also a socio-economic impact; it should not be seen only as the

emission effect. What happens when the companies cannot cope with this coercion? What will happen to those who work here should also be focused on that." (Expert 3)

Moreover, **investment in new technology** provides a valuable opportunity to implement Green Deal criteria. For instance, STAR refinery was started up in 2018 and established by using BAT:

"The Green Deal will impact refineries as it will impact every industry. Refineries are not in the first phase for CBAM. It is expected to be included in the second phase in 2026. Since the STAR refinery is a new refinery in Türkiye, I think it will not affect STAR Refinery much. If techniques such as BATs have been implemented in STAR Refinery, they will have less effect." (Expert 1)

Conversely, it can be advantageous and challenging for refineries with outdated technology. Expert 3 emphasizes that:

"For refineries, there is an advantage like this: in recent years, refineries have sold at an incredible margin and are very profitable. If they use this money for themselves in this transformation, supporting emission reduction topics that support the Green Deal will always be advantageous if they turn to the best technologies. Refineries that use the old technology should renew themselves to be advantageous. Suppose a refinery with outdated technology is late to invest. In this case, the company should allocate resources towards updating its refinery technologies as soon as possible." (Expert 3)
Expert 4 states an option. If refineries cannot implement the Green Deal policies or are not able to afford it adequately, they can search for new markets or change their direction no-EU countries:

"It will affect refinery facilities, especially our export products, e.g., diesel and kerosene. It will have an impact on production and sales. Different market searches can be made, or products will be brought to the standards required by the EU." (Expert 4)

"Yes, it will have an impact. As a refinery, we minimize our impact by carrying out transformation projects. We will not be able to sell products when the taxes come. It

will be a motivation for our transformation. If we cannot sell to the EU when the taxes come, we can sell to the domestic market in Türkiye. It may cause an evolution in the markets." (Expert 5)

Refineries may be able to apply CBAM necessities because Türkiye has a geopolitically advantageous position. Moreover, studies demonstrate that Türkiye is preparing for the CBAM requirements, but evolving market conditions may force Turkish industries to trade with other countries. Till now, experts have emphasized the emissions and Carbon tax sides and their cost effects on refineries. On the other side, Expert 8 conducted the reputational impact of the Green Deal for refineries:

"The first thing that comes to mind here is the environmental side. Because the environmental side is affected the most. In our ESG assessments, carbon emissions are a critical factor. Refineries are the most energy-intensive facilities. Therefore, we need to use our energy most efficiently to reduce our emissions because if we do not reduce our emissions, this will be reflected in our margins when any carbon tax comes. There is also the reputational side of this. The new generation no longer wants to work in refineries and petrochemical plants. They see these plants as cumbersome facilities. Therefore, it has a social impact as well as an environmental impact. In addition to emissions, wastewater, discharges to the sea, waste management, and water consumption are other effects of refineries. We consume water as much as we consume energy. Therefore, I think it will directly and seriously affect our refinery facilities." (Expert 8)

Moreover, Türkiye monitors the GHG emissions Scope 1 and 2 emissions, but the scope of the Green Deal is more detailed. Tüpraş and SOCAR reported this emission in their sustainability report. Expert 9 estimated that:

"When we look at the legislation, Scope 1 and Scope 2 emissions are calculated, but when we look at the calculation of Corporate Carbon Footprint, we encounter a tremendous emission on the raw material side. We look at all countries that extract crude oil here. The refinery sector and crude oil companies will always be very prominent. Here, refineries will indirectly suffer losses for the Green Deal as well. It should not be considered only as direct emissions; refineries need to conduct

comprehensive examinations throughout the Green Deal scope compared to other companies." (Expert 9)

In summary, the Green Deal would impact refineries, particularly in the context of decarbonization implementations and associated policies. The fulfilment of these requirements encourages the refineries to take action to mitigate their environmental impact. Besides the environmental effect, they accelerate their investment and process revision to stay competitive and eliminate the cost effect from CBAM or ETS. Also, the transition of fuel consumption of transport will lead to the adoption of refineries to clean fuels, biofuel, and SAF investment. Adaptation of the Green Deal is also a reputational issue. Refineries have new technologies like BAT, which may be considered advantageous compared to old refineries.

5.6. Roadmap and Strategies of Turkish Refineries towards Net Zero Emission

As mentioned in the previous section, refineries are responsible for complying with the Green Deal policies. In their last sustainability and integrated report, Tüpraş and SOCAR announced their strategic roadmaps. For example, Tüpraş announced in the 2022 Integrated Report that it would become a leading carbon-neutral energy company by 2050. In addition to this target, the company estimated 4 significant topics. These are ***green hydrogen, sustainable refining, biofuels, and zero-carbon electricity.*** SOCAR has also determined goals to mitigate annual total scope 1 and scope 2 emissions and to be a net zero emission company by 2050. Also, SOCAR increases the implementation of ***energy efficiency, electrification, and resource management and decreases flare emissions.*** Thus, Turkish refineries are working on challenges to mitigate their environmental effects, significantly reducing their emissions. In addition, ministries made several legislative revisions related to the Green Deal. They also create challenges and opportunities for the refineries to implement their necessities. As related to this causality pressure of the Green Deal is stated by Expert 9 that:

"Certainly, the Green Deal can create an opportunity for refinery facilities. There will be some legislative changes that can create an opportunity for them. Of course, there needs to be a causality regarding green transformation for refinery facilities. In fact,

the Green Deal provides this causality, enables the public to create some regulations, and allows refineries to benefit from these regulations. For example, in the coming period, how these green issues can be provided and under what conditions they can be provided will actually be determined. Therefore, the investments made by refinery facilities, reaching credit, will also provide convenience at a more favorable price because they will use it for green investments. At the same time, the Green Deal carries great causality for both corporate culture and companies to budget for these activities to work in this context." (Expert 9)

Expert 6 also supports the previous statement of Expert 9; Green Deal is an encouragement for the refinery actions:

"It's an opportunity for refineries to encourage the production of more environmentally friendly solutions. For example, I believe that producing sustainable fuels will enhance competitiveness." (Expert 6)

Moreover, Expert 9 stated the importance of Corporate Carbon Footprint:

"When we look at the legislation, Scope 1 and Scope 2 emissions are calculated, but when we look at the calculation of Corporate Carbon Footprint, we encounter a tremendous emission on the raw material side. We look at all countries that extract crude oil here; the refinery sector and crude oil companies will always be very prominent. Here, refineries will indirectly suffer losses for the Green Deal as well. It should not be considered only direct emissions; refineries must conduct comprehensive examinations throughout the Green Deal scope compared to other companies." (expert 9)

Tüpraş also stated that in its 2022 Integrated Report.
In 2022, Tüpraş had its GHG emissions verified by an independent third-party verification body per the ISO 14064-1 Standard for Verification and Reporting of Greenhouse Gas Emissions (Tüpraş, 2022).

With the Green Deal action, strength policies can create challenges for refineries, but if they adopt the strategies with these policies, it is turned into an opportunity when

they are compared to those that do not. Thus, they can be prior in the market. For example, Tüpraş wants to become the leader in the sector and work on its targets. Expert 4 states the importance of development strategies:

"For refineries, the Green Deal is an opportunity. There is time to prepare. If Türkiye can establish the infrastructure to meet these standards, it can strengthen its position in the market and increase its brand value. There will be areas of challenge. They will need to develop their strategy, reassess their investments, strengthen their position in the market, and redefine their position. The opportunity will benefit the sector and the country as a pioneer; it will create value and as a leading company." (Expert 4)

Expert 7 emphasized the importance of adopting new strategies:

"I think it could have a two-sided impact. For those who engage in competition, it could be an opportunity for those who start investing early, while I believe it could turn into a complete disadvantage for the rest who fall behind in the process." (Expert 7)

Expert 8 also states that there are targets for both refinery companies and suggests a more achievable target determination:

"I see the targets of Tüpraş and SOCAR as ambitious. It may not be very realistic to achieve them now because a lot has changed in the world, including the Ukraine-Russia war, energy crisis wars, pandemic, etc. The game is changing a lot and continues to change. We need to consider the risks a little more, act a little more agilely as we imagine, and go back and renew the plans." (Expert 8)

The large amount of GHG emissions from crude oil refining causes the pressure. Thus, they are forced to decarbonize their processes and products to mitigate their emissions and become part of the low-carbon market (Nurdiawati and Urban, 2022). Net zero targets are a crucial aspect for refineries. According to the IEA, five main ways to reduce their emissions exist. Firstly, reducing scope 1 and scope 2 emissions from refineries is a low-cost option that is widely implemented in industries. Secondly, decreasing methane emissions and eliminating flaring activities, except in

emergencies, can also help reduce emissions. Investing in CCUS and deploying the electrolysis hydrogen technology can effectively achieve net zero targets (IEA, 2023b).

As discussed in the literature, experts stated that the hydrogen production unit is a vital component of refineries because it removes sulfur from products like naphtha, kerosene, diesel, etc., during the hydrotreatment process. Hydrocracker units require large amounts of hydrogen, typically produced using natural gas or naphtha as a raw material. Unfortunately, this results in substantial CO_2 emissions for refineries. If the usage of natural gas and naphtha is reduced in hydrogen production, the CO_2 emissions in a refinery will decrease. Therefore, green hydrogen can be an option in the sector. Currently, there is no facility to produce green hydrogen in Türkiye. However, Tüpraş is declared the Green Hydrogen target in its Integrated Report. Tüpraş has completed the engineering studies of the 20 MW pilot electrolyzer, and the project evaluation has continued.

The importance of hydrogen production and the contribution of CO_2 emissions and the situation of Turkish refinery companies is described by Expert 2:

"When we look at refineries, a refinery with a crude oil processing capacity of 10 million tones has greenhouse gas emissions of around 3.5 million tones or 4 million tones (when we look at the total as scope 1 and 2). Between 25-35% of this emission comes from hydrogen units. Refineries in Türkiye use natural gas for hydrogen production. So, our CO_2 amount increases. This results in approximately 25-35% of the total CO_2 amount of the refinery. That is why Tüpraş has targeted Green Hydrogen production. They plan to produce hydrogen from natural gas and renewable energy…Other refineries may also consider this. Except for Tüpraş, no one has declared this yet." (Expert 2)

Green Hydrogen investment is an expensive option for refineries. As Nurdiawati and Urban (2022) mentioned, the current cost of green hydrogen is approximately twice that of traditionally produced hydrogen, based on an assumed electricity price of around 35 €/MWh in Sweden. Moreover, some examples have been started because green hydrogen is a solution for the decarbonization target of refineries in the EU. In

global refinery industries, companies have started to invest in Green Hydrogen. For instance, Shell operates Green Hydrogen facilities in Germany and China. Also, Shell has started an investment in Holland Hydrogen I in the Netherlands; it is expected to be completed in 2025 and aims to reduce the production of diesel and jet fuel in Shell Energy and Chemical Parks Rotterdam. Shell also has different initiatives for green hydrogen in several locations (Shell, 2022a). As indicated in the literature, experts stated that Green Hydrogen has cost, storage, and distribution challenges, but it is possible to operate if the Hydrogen Hub is established in Türkiye. Also, experts stated that different sectors that consume hydrogen in their processes can be invested together:

Green Hydrogen production is currently very expensive. Related facilities have started to be established in the EU but are not very widespread. The number of facilities installed and commissioned in the world is quite small. They have just been commissioned in a petrochemical plant in China and Shell's refinery plant in the Netherlands. Türkiye wants to position itself as the main hub of Green Hydrogen in the future. Especially from the Aegean region, there is a goal to create an opportunity for itself by sending the Hydrogen it can produce from the eastern Marmara region to the EU. (Expert 2)

"In order for Green Hydrogen to be produced and used, user facilities must be united. Thus, serious investments in green hydrogen production can be rewarded in a serious way because the cost of green hydrogen will be at least 4-5 times the cost of the hydrogen we currently produce in the refinery. This has to come from somewhere. This should be shared by the places that consume a lot...There are hydrogen priority regions right now, Çanakkale and İzmir; between the two, the south of Marmara and the İzmir region are at the forefront here, and it is thought that the state will encourage it." (Expert 3)

"Hydrogen production via pyrolysis and electrolysis methods over current production is expected to have very high unit costs. With a simple cycle, the price of hydrogen produced from natural gas triples the price of natural gas, while green production can increase up to 10-15 times. I find it difficult for Turkish refineries to achieve production at the desired level without lowering the product's unit price due to this

production. In the initial stage, companies will shape their investments in areas such as efficient energy use, waste heat, and electricity generation with renewable energy." (Expert 7)

"Focusing on hydrogen could be a logical step, but there may be challenges in terms of storage. To invest in green hydrogen, you need to make many cost calculations, for example, cost calculations for production and storage areas." (Expert 10).

As mentioned in the literature findings and expert interviews, the insufficient presence of hydrogen infrastructure, encompassing both storage and distribution systems, is a significant barrier hindering the progress of green hydrogen development. In addition, expert responses support the findings in the literature. For example, In Sweden, a prominent initiative focusing on hydrogen is HYBRIT, a collaborative effort involving SSAB, LKAB, and Vattenfall. This endeavor seeks to establish green hydrogen-driven steel production on a commercial scale by the year 2035 (Nurdiawati and Urban, 2022).

Furthermore, **energy efficiency projects** are quick-win projects in terms of reduction of emissions. Tüpraş and STAR refinery implement energy efficiency projects in their operations. In Tüpraş 2023 Integrated Annual Report, it was stated that in the scope of the company's sustainable refining target, 52 energy efficiency projects were realized in 2023. 113.544 to CO_{2eq}. Emissions decreasing was provided (Tüpraş, 2023b). STAR Refinery also realized the energy efficiency project, as mentioned in their 2022 Sustainability Report. Expert 2 and Expert 8 also emphasize the implementation of energy efficiency projects:

"Energy efficiency projects are currently being implemented as quick wins and priority projects in value creation projects. Refineries are turning towards energy efficiency projects that will reduce emissions with process monitoring without creating additional cost, such as reducing pressure steam with process monitoring, steam, charge, pressure ratios, steam production with waste heat, efficient use of pumps, water saving or energy saving in cooling towers, either by creating a very small CAPEX or by process monitoring without creating CAPEX." (Expert 2)

"We are already two companies in Türkiye. I know that Tüpraş is more focused on energy efficiency. STAR refinery also focuses on energy efficiency because carbon does not currently have a price." (Expert 8)

The literature presented energy efficiency initiatives as an emission reduction method for refineries, such as heat integration, waste heat recovery, combustion efficiency improvements, etc. (Johansson et al., 2012). Expert interviews also support the findings in the literature. It was observed that **SAF** is the other option for adaptation to the Green Deal. Decarbonizing the aviation industry has led to an increased need for bio-jet fuel, thereby encouraging the refining industry and other relevant stakeholders to invest in biofuel production. Refineries typically produce jet fuels derived from fossil fuels during their regular operations. With the Green Deal, the EU has started the policy on the aviation sector. Under the Green Deal, the EU has a regulation about the ReFuelEU aviation initiative to realize sustainable air transport and decrease the environmental effects of aircraft (European Council, 2023c). It can be seen in the examples of global companies like Shell. Tüpraş has a target for SAF and declared that primary engineering studies were completed for the SAF unit in the İzmir refinery. Tüpraş planned to process 400.000 tons of vegetable and animal waste oil as a raw material in this unit by 2030, and then its production capacity is targeted to be tripled by 2035 (Tüpraş, 2022). Expert 2 response supports this:

"For SAF, TÜPRAŞ has stated that they will start an investment in 2026 at the İzmir refinery and aim to reach a biofuel SAF capacity of 400 thousand in total. They aim to generate income from SAF and increase its capacity. Tüpraş seems to have taken a step in this regard, but it has not started in the field yet. They say they plan to produce the first SAF at the end of 2026 or 2027." (Expert 2)

In addition to Expert 2, Expert 3 emphasized that if the obligation of using SAF in aviation is met, refineries will start to produce SAF.

"When SAF becomes mandatory in airlines, refineries will be compelled to produce it. This will reduce our emissions and be among the practices we must implement to remain competitive in the market. This will also mandate investments." (Expert 3)

Shell is adopting a cooperative approach to SAF. The company collaborated with Lufthansa to provide SAF for its aircraft at airports globally. Additionally, it commenced supplying SAF in Singapore, becoming the inaugural company for customers in Southeast Asia. Furthermore, in collaboration with Accenture and American Express Global Business Travel, Shell introduced one of the world's earliest blockchain solutions for SAF, aimed at aiding companies in reducing the carbon footprint of their corporate air travel (Shell, 2022a). In parallel to this, Expert 5 underlined the collaboration between refineries and aviation companies for SAF:

"This progress is not something that companies can achieve individually; collective action is needed. For example, Turkish refineries and aviation companies need to come together to share SAF resources. If investments can be made quickly and the scale rapidly increases, it can become an opportunity." (Expert 5)

Furthermore, Nurdiawati and Urban (2022) stated that refining firms in Sweden are actively seeking to increase their presence in the biofuels market by engaging in strategic partnerships with technology companies and the forestry sector to produce bio-oils that can be refined into the product. No expert has addressed this issue for Turkish refineries in interviews.

Experts 4 and 6 also emphasize the importance of SAF production and investment:

"We need products like SAF that contribute to sustainability. We need to focus on these." (Expert 4)

"Encouraging the transition to SAF in aircraft can also incentivize the refinery sector to produce more sustainable fuels." (Expert 6)

On the other hand, an adequate amount of raw materials for SAF and biofuel production can be an issue for refineries. Midttun et al. (2022) stated that new models require new technological solutions and may raise new problems. For example, the development of biofuels may rely on new synthetic feedstock or more robust treatment of organic waste, including residue from forestry. In addition, significant obstacles to biofuels are the absence of clear environmental limitations or sustainability standards

for feedstocks and the lack of consistent regulations regarding residual biomass (Nurdiawati and Urban, 2022). Expert 1 also emphasized the importance of raw materials and feedstock for SAF production and supported the literature:

"There are concerns that there will be a shortage of biofuels in Türkiye, so there may not be much feedstock for SAF." (Expert 1)

GHG emissions from the aviation sector are monitored according to the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). It aims to regulate the principles and procedures for monitoring GHG emissions from international aviation activities (SHGM, 2020). The Directorate General of Civil Aviation has issued an SAF instruction, marking a significant step towards sustainable aviation. As per the scope of these instructions, all aircraft operators within the jurisdiction are required to progressively increase the use of SAF blend to jet fuel. The rates are set at 1% for 2025 and 2026, 2% for 2027, 3% for 2028, 4% for 2029, and 5% for 2030 for international flights departing from Türkiye (SHGM, 2020).

"The Directorate General of Civil Aviation monitors GHGs resulting from aviation activities. Similarly to the MRV system, emissions related to airline activities are monitored and reported here. Additionally, as far as I know, airline companies in Türkiye are obligated to report their emissions under CORSIA. Therefore, I am aware that transitioning to sustainable aviation fuel is among the top priorities for airline companies as well." (Expert 6)

As mentioned in EIA, **CCUS** is the possible mitigation action for the refineries. On the other hand, there are several challenges, such as storage areas for captured carbon and transportation of the carbon. Supply of captured carbon may require infrastructure or transport organization (Johansson et al., 2012). Globally, carbon capture is facilitated by three refinery or upgrader facilities in Canada and the United States that each capture around 1 Mt CO_2 per year (IEA, 2023b). At the end of 2022, Shell's Quest CCS project at Scotford in Canada successfully captured and stored over 7.5 million tonnes of CO_2 since its operation in 2015 (Shell, 2022a). There is no CCUS facility in Türkiye. However, in the scope of Tüpraş's target of becoming carbon neutral by 2050, the R&D Center carries out studies for the development and transfer of CCUS methods

to reduce emissions and to ensure refinery integration (Tüpraş, 2023b). As mentioned in the literature, Expert 3 also highlighted the investment cost and storage area obstacles for CCUS:

"Carbon capture can be implemented, but its storage part doesn't seem very sensible. We need to find technologies that will utilize and use it, and we need to convert those carbon compounds into something else again because we don't have such large storage areas…Their investment costs are also incredibly expensive. Instead of storage, there may be systems to use what is captured. I haven't seen a model that can be applied to Türkiye. Technological advancement is also needed. Because incredibly large facilities are needed to capture emissions from refineries. There are places in the world where pilot projects are being implemented. I had been to the one in France; there is an iron-steel industry, but there is a small pilot plant, and now they are trying to build the real one next to the pilot plant. Also, it's not just one company. It's several companies in a consortium form, all of them." (Expert 3)

Furthermore, the EU published its CCUS strategy in February 2024. Türkiye is currently preparing a roadmap for CCUS (RTMEUCC, 2021). Expert 6 also knew the regulation dimension:

"In recent days, the Industrial Carbon Management Strategy for carbon capture, utilization, and storage (CCUS) was published by the EU; however, there is no regulation on this matter in our country." (Expert 6)

Experts evaluated CCUS technology, a very new development for mitigating CO_2 emissions. Thus, detailed analysis and engineering studies are required to establish a CCUS facility. Before the investment, a cost-benefit analysis should be conducted to ascertain the potential gains and losses of the proposed venture.

"CCUS technology is very new worldwide and is a high-cost technology. Especially in refinery and petrochemical complexes, carbon production points occur not from a single area but in different locations over a large area. Therefore, implementing a comprehensive carbon capture system for a complex would be extremely challenging for companies due to the difficult engineering and investment required for a distribution system across the entire complex." (Expert 7)

"Carbon capture will be necessary to achieve net zero. It is a very new technology, both technologically and in terms of efficiency. Looking at net zero maps now, they already indicate that facilities will reach net zero around 2040-2045. Facilities can easily say this now, but when the time comes, they will reconsider. At that point, facilities will consider carbon capture. However, for them to undertake carbon capture projects, there needs to be a reason for them to do so. This requires a system, which is the ETS. With ETS, if the cost of carbon increases, refinery facilities, like all industrial facilities, will make comparisons. They will say, "I am spending x amount of money under ETS. If I am also investing x amount of money in my capital expenditure (capex) or if my operating expenditure (OPEX) covers the money I would pay for CO_2, or if they are equal, why wouldn't I invest?". That's why there needs to be pressure and causality on the other side for refinery facilities or other facilities to build carbon capture units." (Expert 9)

In conclusion, according to expert and literature, refineries can optimize quick-win energy efficiency projects like steam, electricity, and waste heat for their net-zero emission targets. These projects provide both value creation from energy efficiency and mitigation of emissions. In addition, ***green hydrogen*** is the second decarbonization option because refineries use large volumes of hydrogen in their refining processes. Nonetheless, there are associated expenses with investing in and operating green hydrogen because natural gas is more cost-effective than hydrogen. As a result, companies should consider integrating other facilities like refineries, petrochemicals, or iron steel. A hydrogen hub can also be a solution for Türkiye. The other option is the ***SAF production***. It is necessary for the next few years because the EU aims to substitute aviation fuel with sustainable fuels. Türkiye also started using SAF in their planes. In the current situation, Tüpraş conducts a project with the Honeywell UOP. Aviation and refinery company collaboration can accelerate the process of transitioning the SAF. ***CCUS*** is a very new decarbonization technology that can be implemented in refineries. Like green hydrogen, it is a costly technology.
Also, storage areas and transportation of captured carbon are obstacles to the CCUS. Globally, pilot implementation and investments are observed from literature and expert interviews. The EU also continues its policies on net zero emission technologies under the Green Deal. Türkiye is at the beginning of the strategies. The Green Deal

action plan has been published, and preparations for regulations are ongoing. However, published legislation must implement these actions in the private sector and institutions. Refineries also work on the implementation and determine their strategic plans. Refineries have prioritized net zero emission targets in these plans. They continue studies of the new investments for the mitigation of emissions and adaptation of the Green Deal.

5.7. Critical Topics During the Transition

During interviews, experts emphasized the critical headlines. One of them is that refineries conducted the studies and **workshops organized by the ministries** because refineries are the key industries of the energy sector. Their participation in stakeholder meetings is also essential for implementing the phase of regulations and driving sectoral dynamics.

"Refineries participate in stakeholder meetings. With these studies, the absolute emission will be determined, and the amount of carbon emission per tonne and reduction will be determined. Still, the refineries are working on this issue on a case-by-case basis. Refineries are working in different cases to see what the cost reflections will be in the coming period if they provide this much reduction from me and the carbon price is this." (Expert 2)

"Meetings are frequently held with ministries and the civil aviation authority. We are also negotiating within the scope of ETS." (Expert 7)

"…the Carbon Pricing Department frequently organizes stakeholder information meetings both online and face-to-face." (Expert 6)

It is also important to mention that the **new technologies** that can be implemented should be scrutinized before the company invests. Infrastructure and operation costs must be calculated compared with the carbon taxes that may come with ETS and CBAM. Türkiye also requires technologies from abroad when it uses new technologies. In addition, the time to implement investment should be determined in strategic reports. These can also be clearer and more rapidly adapted to changes in the

world.

The transfer of technologies to our country at an affordable price is among the important points. Large-scale technologies we will acquire from abroad, such as SAF, Green Hydrogen, and Electrolysis, are crucial because we currently lack the infrastructure to develop these technologies in our country. This will also reduce the amount of money going abroad for carbon taxes. (Expert 2)

"The most important point is to make a good technical projection. In the background, refinery facilities need to conduct very technical studies. What should we do to reduce our emissions? After making a technical projection, it is necessary to determine the penetrations that will enable this transformation. For example, how much CO_2 saving will I achieve if I achieve this efficiency, but when should I do this? The timing of when to do this is very important. This should be determined in net zero maps. How much will CO_2 prices be, how much will crude oil prices be, and what will be the opex and capex of the units I will develop to reduce carbon emissions? I need to blend and model all of these and draw a roadmap for which step to take in which year." (Expert 9)

Financial sources and subsidies are significant issues for companies when determining a roadmap. Incentive programs and credits encourage companies to take the initiative and invest in developing their processes and technologies. Moreover, providing incentives under the EU Green Deal to countries where they expect action would be a supportive step for governments and companies. Expert 2 emphasizes this subject as follows:

"Most importantly, I believe finding the financing for these efforts is crucial. If the world wants to do this and everyone's intentions are good, then there needs to be a global effort globally regarding financing... Since the Industrial Revolution, calculating the emissions made and which country is responsible for them could be one way to go about it. When we talk about the UN and EU, if we're going to do something like this, everyone should take responsibility." (Expert 3)

In addition, **incentives from the Turkish** government can be implemented. There are already applications in practice, but focusing on new technologies to mitigate

emissions may be more effective.

"We are doing a few R&D projects to accelerate this transition process, but I think there should be more incentives to produce a technological product because when we work on a project, whether it is green electricity generation, electrification, insulation or producing new products, the point we are most stuck on is its feasibility. Technically, we can do it; we can find the source and the customer, but it is not feasible because the investment costs are very high." (Expert 8)

"Most importantly, the government has to be the driving force because this affects the economy of the state. In this regard, companies will need to get support from consultancy firms that are familiar with EU legislation and have experience in both legal, technical and technological aspects." (Expert 11)

"Studies on energy efficiency are a bit more quick-win. That is, there are incentives for projects whose return we see immediately. Projects with very low payback periods and relatively large investment amounts, such as the SAF project and green hydrogen, are not very large…The state provides support and grants for waste heat recovery, energy efficiency pumps, heat pump projects, and initiatives. However, in larger projects that will reduce emissions, the state's support in the refinery petrochemical sector will be tax-exempt in relation to technological transfer. In this economic environment, providing financial support with options such as interest-free or low-interest loans in the long term will support refineries to be implemented locally." (Expert 2)

In addition, both Tüpraş and SOCAR have R&D studies with universities to develop projects. Tüpraş has worked on innovative projects with R&D and innovation in the transition to a low carbon economy in line with the company's Strategic Transformation Plan. SOCAR Türkiye R&D Center also conducts projects with universities focusing on sustainability. It can be seen in global implementation that Shell implements many new technologies, initiatives, and activities, and they continue the R&D activities to reach their net-zero emissions target. Furthermore, it can be stated as good practice in Shell. The Shell Energy Transition Campus Amsterdam of Shell was opened in 2022. It is formerly one of Shell's six Technology Centers. This

campus includes offices, laboratories, and testing facilities to foster collaboration among startups, research institutions, academia, and companies, aiming to develop solutions for lower-carbon energy. Approximately 1,000 individuals from 50 countries are engaged in various projects at the campus (Shell, 2022a). Furthermore, R&D projects have led to national and international knowledge-sharing networks (Nurdiawati and Urban, 2022). The importance of the R&D studies was stated by Expert 10:

"*Tüpraş and SOCAR are constantly applying for R&D projects. They collaborate with academics as much as possible. This is a very good trend, as is first completing the R&D at the university with academics. After that, it is implemented as a pilot in the refinery. It makes sense to start with university-industry collaborations and then move to a pilot plant." (Expert 10)*

In conclusion, refineries are already preparing for draft legal regulations related to the Green Deal policies, adapted to Turkish regulations. At that moment, ETS was a prior topic, like other sectors, refineries participated in stakeholder meetings and workshops about national ETS. Incentives are also essential to promote investment in technologies with fewer emissions. Ministries already have some incentive programs, but the support of government and global institutions is essential when investing in the private sector in new and significant technologies like CCUS and green hydrogen. Collaborating with universities to conduct R&D studies for pilot projects would be beneficial. Currently, both SOCAR and Tüpraş expand R&D studies.

CHAPTER 6: CONCLUSION

The EU published the Green Deal to be a net zero continent by 2050. In the first step, the EU aims to mitigate their emission %55 by 2035 and publishes the Fit for 55, depending on the Green Deal (European Council, 2024). Adapting the EU Green Deal will take a long time for both EU and non-EU states because it includes broad environmental, economic, and social policies. Due to previous studies and experience, the EU is more resilient than non-EU states. Non-EU states have to scale up their legal regulations and industry participation in this phase. Türkiye is one of the countries most affected because of the broad trade relations with the EU. Through qualitative research with expert interviews, this study aimed to address the potential effect of the Green Deal on Turkish refinery companies by evaluating the Net-Zero Emission Strategies of refineries. The study commences by providing a comprehensive review of the EU Green Deal, then by exploring its impact on Türkiye. Then it focused on a detailed investigation of implementing net-zero emission goals in Turkish refineries. Interviews were conducted with representatives from the refinery sector and academic and consultant companies specializing in climate change and energy. During the interviews, 7 main topics with several questions. *(1) Effects of the EU Green Deal on non-EU Members, (2) Effects of the EU Green Deal on Türkiye, (3) The Green Deal Actions of Türkiye, (4) Preparation of ETS in Türkiye (5) Effect of The Green Deal on Turkish Petroleum Refineries (6) Roadmap and Strategies of Turkish Refineries (7) Critical Topics during Transition.* During the interviews, participants emphasized trade relations between the EU and Türkiye, so Turkish exporters are affected by the Green Deal policy. This impact was considered both an opportunity and a challenge for the industries. Although the Green Deal includes many obligations, companies could use these actions to advance their technologies to mitigate emissions or be competitive. On the other hand, if companies cannot change with the market variable and do not fulfil the requirements of the Green Deal and regulations, it may be a risk for their position in the market and decrease their competitiveness.

The study presents a detailed analysis of the participants' responses to the Green Deal policies that are predicted to impact Türkiye. As a result of the trade relationship, CBAM will influence the industries in Türkiye. The EU has started the CBAM in the

pilot phase for 5 sectors, hydrogen, iron-steel, fertilizer, electricity, and aluminum, to prevent carbon leakage when these sectors export their product to the EU. In the second phase, it is expected to be included in other carbon-intensive sectors, including refineries. CBAM can be defined as a carbon tax for producers. Therefore, Türkiye has started preparing the ETS to manage taxes from emissions inside the country. If the Turkish ETS is compatible with the EU ETS, Turkish industries will give allowances in their countries. ETS is also a part of the Green Deal, and the EU started ETS in 2005. However, the EU plans to expand the scope of ETS with the second phase.

Furthermore, this study reveals that Türkiye has started Green Deal actions, and the Ministry of Trade published the Green Deal Action Plan in 2021. The coordination lead is the Ministry of Trade, and each institution has been separated into working groups. Each institution has different responsibilities in building Green Deal necessities. For example, the Ministry of Environment, Urbanization, and Climate Change coordinates the publishing of Climate Laws. It is expected to start ETS in October 2024, and work has been accelerated.

Moreover, Türkiye announced a revised NDC that the target for emission reduction was determined 41% from the base year 2012 to the target year 2030. Türkiye already has an MRV system for its emission monitoring. Thus, the *grandfathering* allocation method is planned for ETS allowance. When ETS is started in Türkiye, it is expected that there will be a free allocation pilot period. It is an advantage for industry and government to achieve the target of ETS and learn the system.

Refineries are carbon-intensive industries. Besides carbon emissions, refineries also have several environmental aspects. This study demonstrate that Turkish refineries are responsible for the Green Deal actions of Türkiye, and it should be implemented in the energy transition to stay in competitive markets globally. As evidenced by Türkiye preparatory work, the evolving regulations in alignment with the Green Deal will significantly impact refineries, particularly in terms of emission reductions to ensure compliance with these regulations and policies.

Turkish refineries have started to prepare for the requirements of regulations adapted

to the Green Deal. They have determined strategies and roadmaps for their refineries, focusing on decarbonization in their sustainability and Integrated reports. However, these strategies are still in the planning stage and need to be developed. Turkish refineries are monitoring Scope 1 and Scope 2 emissions. Both companies have implemented measures to decrease their emissions based on the current regulations Currently, emissions from refineries are approximately %2 of the total emissions of Türkiye. ETS will also include refineries introducing more stringent emission reduction targets. So, there will be pressure on refineries to reduce their emissions. Therefore, refineries must implement decarbonization technologies to reduce their emission and ensure the ETS under the Green Deal. CBAM is another critical topic for the EU exporters regarding the Green Deal. Refinery products meet domestic demand and export products to the EU, so if the refinery sector included the 2nd phase of CBAM, they would be affected. In addition, revision or new regulation related to the Green Deal would be challenging for refineries, and they would need to adapt their operations. The CBAM and the ETS will necessitate new investment costs for refineries and require them to pay taxes and allowances on their emissions. Expert interviews indicated that several decarbonization technologies can be applicable in fulfilling the Green Deal requirements, including **energy efficiency practices, CCUS, green hydrogen, and SAF.** Companies can evaluate such initiatives as potential investments and technologies to be included in strategic plans. Each option can mitigate emissions by refining processes and products. However, implementing these technologies requires technical know-how, investment cost, storage areas, and transportation of products. In other words, the investments will financially impact refining companies. In addition, companies will be required to enhance their technical proficiency. That is why refineries would require technical studies to determine the feasibility of projects and the correct implementation time for them.

These investments would be potential strategies of Turkish refineries for the scope of net-zero emission targets. Tüpraş announced in the 2022 Integrated Report that it will become a leading carbon-neutral energy company by 2050. In addition to this target, the company estimated 4 significant topics. SOCAR has also determined goals to mitigate annual total scope 1 and scope 2 emissions and to be a net zero emission company by 2050. The Green Deal creates an opportunity to develop strategies and causality for refinery facilities to reach their targets. According to the interviews and

companies' reports, these companies' targets and strategies coincided with the findings. Tüpraş and STAR Refinery have realized energy efficiency projects in their operations, which mitigate their Scope 1 and 2 emissions. Green hydrogen is part of the strategy of Tüpraş. However, green hydrogen investment is an expensive option for refineries, and it has investment and operation costs, as well as storage and distribution challenges. The Turkish refineries can develop their green hydrogen strategies in collaboration with different sectors that consume hydrogen, and establishing a hydrogen hub can be an alternative solution to share the cost and distribution challenges. In addition, SAF is the other potential option to decrease emissions from the aviation sector and refining products. ReFuelEU aviation initiative under the Green Deal aims to promote sustainable air transport and decrease the environmental effects of aircraft. The Directorate General of Civil Aviation published SAF instructions and determined the target of SAF usage in future years under the influence of the Green Deal. Tüpraş has a target for SAF and declared that primary engineering studies were completed for the SAF unit in the İzmir refinery. SAF must supply raw materials. Moreover, cooperation of aviation companies and refineries could encourage SAF production investment. Therefore, Turkish refineries can invest strategically in SAFs by developing cooperative relationships with the aviation sector in their strategic planning. Furthermore, CCUS is a possible emission mitigation action for refineries, but it is a very new technology with challenges in the storage and supply of captured carbon. There is no CCUS facility in Türkiye yet. However, in the scope of Tüpraş's target of becoming carbon neutral by 2050, the R&D Center carries out studies. Indeed, a roadmap for CCUS for Türkiye has been prepared. Refineries can determine their strategic approaches per prospective regulatory frameworks, R&D studies and global practices of CCUS.

The study reveals representatives' perceptions on critical topics for policymakers and refinery companies in Türkiye. Refineries are already preparing for draft legal regulations related to the Green Deal policy, which is adapted to Turkish regulations. At that moment, ETS is a prior topic for refineries, thus participating in stakeholder meetings and contributing to draft regulations for the future implementation of these regulations. National and international incentives and credits are essential to promote decarbonization of industries. Incentives have been implemented, but incentives for large-volume projects like green hydrogen, SAF, and CCUS are required.

Furthermore, it can be advantageous to further collaborate with academic institutions on pilot projects, therefore, Turkish refineries can focus on R&D studies in their strategies.

Based on the findings of this study, refineries in the EU are one step further. If it is considered Türkiye, both companies determined net-zero emission targets, but Tüpraş has more precise and detailed targets. However, STAR Refinery is a new technological refinery that was established using BATs. Thus, STAR refinery is considered more advantageous, and Tüpraş could need more investment to reach net-zero emissions targets. Moreover, this study indicates that both refineries are just beginning to move into the implementation phase and are waiting for the regulations to be published. Thus, Turkish oil refineries would be required to regulate their strategies, primarily based on emission regulations and policies, competitive pressure, investment opportunities, technological collaboration, supply chain adjustment, and market diversification. Also, they must adapt to changing market conditions and the Green Deal requirements to remain competitive and sustainable in the long term.

Finally, this study was conducted using various sources, including action plans, draft legal regulations and refinery strategies. It examined the effects of the EU Green Deal on Turkish refineries, with a specific focus on net-zero emission and decarbonization targets. Insight of this information, the probability of the determined strategies in the refinery industry, and the current situation were analyzed. The findings demonstrate that the Green Deal will affect the Turkish refineries in a manner that strategies could be developed to align with market variables and recent updates of the Green Deal and Turkish regulations.

Further studies could explore the long-term economic impacts of the EU Green Deal on the Turkish refinery sector, assess the effectiveness of implemented strategies over time, and investigate the social implications for workers and communities. Comparative analyses with other non-EU countries affected by the Green Deal could provide broader insights into global industry adaptations. Further studies could also be conducted after the regulatory phase is completed and new regulations and projects are implemented to evaluate their practical impacts and outcomes. Comparing these future studies with the findings of this study could highlight changes.

REFERENCES

Abdul-Manan, A.F.N., Arfaj, A., A. and Babiker, H. (2017) *Oil refining in a CO_2 constrained world: Effects of carbon pricing on refineries globally.* Energy, Vol. 121, pp. 264–275.

Almeida, D.V., Kolinjivadi, V., Ferrando, T., Roy, B., Herrera, H., Gonçalves M., V. and Hecken, G., V. (2023) *The "Greening" of Empire: The European Green Deal as the EU first agenda.* Political Geography, Vol. 105, p. 102925.

AFPM. (2024). *How refineries work* [Online]. Available at: https://www.afpm.org/industries/operations/how-refineries-work. (Accessed: 3 May 2024).

Clora, F., Yu, W. and Corong, E. (2023) *Alternative carbon border adjustment mechanisms in the European Union and international responses: Aggregate and within-coalition results.* Energy Policy, Vol. 174, p. 113454.

Czernek-Marszałek, K. and McCabe, S. (2024) *Sampling in qualitative interview research: criteria, considerations and guidelines for success.* Annals of Tourism Research, Vol. 104, p. 103711.

Da Silva, G.N., Rochedo, P., R., R. and Szklo, A. (2022) *Renewable hydrogen production to deal with wind power surpluses and mitigate carbon dioxide emissions from oil refineries.* Applied Energy, Vol. 311, p. 118631.

Doody, O. and Noonan, M. (2013) *Preparing and conducting interviews to collect data,* Nurse Researcher, Vol. 20(5), pp. 28–32.

European Council. (2022a). *Fit for 55: reform of the EU emissions trading system.* [Online]. Available at: https://www.consilium.europa.eu/en/infographics/fit-for-55-eu-emissions-trading-system/. (Accessed: 3 May 2024).

European Council. (2022b). Fit *for 55: how does the EU intend to address the emissions outside of the EU?* [Online]. Available at: https://www.consilium.europa.eu/en/infographics/fit-for-55-cbam-carbon-border-adjustment-mechanism/ (Accessed: 3 May 2024).

European Council. (2023a). *Fit for 55* [Online]. Available at: https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55/. (Accessed: 3 May 2024).

European Council. (2023b). *Fit for 55: how the EU will turn climate goals into law*

[Online]. Available at: https://www.consilium.europa.eu/en/infographics/fit-for-55-how-the-eu-will-turn-climate-goals-into-law/. (Accessed: 3 May 2024).

European Council. (2023c) *Fit for 55: increasing the uptake of greener fuels in the aviation and maritime sectors* [Online]. Available at: https://www.consilium.europa.eu/en/infographics/fit-for-55-refueleu-and-fueleu/ (Accessed: 3 May 2024).

European Council. (2024). *Carbon Border Adjustment Mechanism.* [Online]. Available at: https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en#sectoral-information. (Accessed: 3 May 2024).

European Council. (2024). *European Green Deal* [Online]. Available at: https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55/. (Accessed: 3 May 2024)

Griffiths, S., *Sovacool B., K.,J., Bazilian,M. and Uratani, J.,M.* (2022) *Decarbonizing the oil refining industry: A systematic review of sociotechnical systems, technological innovations, and policy options.* Energy Research & Social Science, 89, p. 102542.

Hainsch, K., Löffler K., Burandt, T., Auer, H., Pedro, P.,C.,G., Pisciella, P. and Zwickl-Bernhard S. (2022) *Energy transition scenarios: What policies, societal attitudes, and technology developments will realize the EU Green Deal?,* Energy, Vol. 239, p. 122067.

Hintermann, B. (2010) *Allowance price drivers in the first phase of the EU ETS*, Journal of Environmental Economics and Management, Vol. 59(1), pp. 43–56.

Holmgren, K. and Sternhufvud, C. (2008) *CO_2-emission reduction costs for petroleum refineries in Sweden.* Journal of Cleaner Production, Vol. 16(3), pp. 385–394.

Howie, P.W. and Atakhanova, Z. (2022) *Assessing initial conditions and ETS outcomes in a fossil-fuel dependent economy.* Energy Strategy Reviews, Vol. 40, p. 100818.

IEA (2021). *Türkiye 2021 Energy Policy Review.* [Online] Available at: https://iea.blob.core.windows.net/assets/cc499a7b-b72a-466c-88de-d792a9daff44/Turkey_2021_Energy_Policy_Review.pdf (Accessed: 1 May 2024)

IEA. (2023a). *World Energy outlook 2023.* [Online] Available at: https://iea.blob.core.windows.net/assets/ed1e4c42-5726-4269-b801-97b3d32e117c/WorldEnergyOutlook2023.pdf (Accessed: 1 May 2024)

IEA. (2023b). *Emission from Oil and Gas Operations.* [Online] Available at: https://iea.blob.core.windows.net/assets/2f65984e-73ee-40ba-a4d5-

bb2e2c94cecb/EmissionsfromOilandGasOperationinNetZeroTransitions.pdf (Accessed: 1 May 2024)

Johansson, D., Rootzén J., Berntsson, T. and Johnsson F. (2012) *Assessment of strategies for CO_2 abatement in the European petroleum refining industry.* Energy, Vol. 42(1), pp. 375–386.

Kühn, T. and Witzel, A. (2000) *Using a text databank in the evaluation of Problem-Centered interviews.* Vol. 1, No. 3, Art. 18

Mele, A., Paglialunga, E. and Sforna, G. (2021) *Climate cooperation from Kyoto to Paris: What can be learnt from the CDM experience?* Socio-economic Planning Sciences, Vol. 75, p. 100942.

Midttun, A., Khanieva, M., Magne, L. and Wenner E., (2022) *The greening of the European petroleum industry*, Energy Policy, Vol. 167, p. 112964.

Ministry of Trade. (2021). *Yeşil Mutabakat Eylem Planı*. [Online] Available at: https://ticaret.gov.tr/data/60f1200013b876eb28421b23/MUTABAKAT%20YE%C5%9E%C4%B0L.pdf (Accessed: 5 May 2024)

Nurdiawati, A. and Urban, F. (2022) *Decarbonising the refinery sector: A socio-technical analysis of advanced biofuels, green hydrogen and carbon capture and storage developments in Sweden.* Energy Research & Social Science, Vol. 84, p. 102358.

Panarello, D. and Gatto, A. (2023) *Decarbonising Europe – EU citizens' perception of renewable energy transition amidst the European Green Deal.* Energy Policy, Vol. 172, p. 113272.

Preem. (2022), *Sustainability Report 2022* [Online] Available at: https://cms.preem.com/Content/documents/rapporter/hallbarhetsredovisningar/2022/preem_sustainability-report-2022.pdf (Accessed: 5 May 2024)

Rissman, J., Bataille, C., Masanet, E., Aden, N., Morrow, W.R., Zhou, N., Elliott, N., Dell, R., Huckestein, B., Cresko, J., Miller, S.A., Roy, J., Fennell, P., Cremmins, B., Koch Blank, T., Hone, D., Williams, E.D., de la Rue du Can, S., Sisson, B., Williams, M., Katzenberger, J., Burtraw, D., Sethi, G., He, P., Danielson, D., Lu, H., Lorber, T., Dinkel, J. and Helseth, J. (2020) *Technologies and policies to decarbonize global industry: Review and assessment of mitigation drivers through 2070,* Applied Energy, Vol. 266, p. 114848.

RTMEUCC. (2021). *İzleme ve Raporlama Tebliğ Yıllık Emisyon Raporlama Kılavuzu*. [Online] Available at: https://iklim.gov.tr/db/turkce/dokumanlar/yillik-emisyon--

8230-60-20220921093516.pdf (Accessed: 10 May 2024)

RTMEUCC. (2023). *Republic of Türkiye Updated First Nationally Determined Contribution.* [Online] Available at: https://unfccc.int/sites/default/files/NDC/2023-04/T%C3%9CRK%C4%B0YE_UPDATED%201st%20NDC_EN.pdf (Accessed: 10 May 2024)

Salman, M., Long X., Wang G. and Zha, D. (2022) *Paris climate agreement and global environmental efficiency: New evidence from fuzzy regression discontinuity design.*Energy Policy, 168, p. 113128.

Shell. (2022b). *Annual Report and Accounts.* [Online]. Available at: https://reports.shell.com/annual-report/2022/strategic-report/our-journey-to-achieving-net-zero/climate-related-metrics-and-targets/other-regulatory-disclosures.html. (Accessed: 3 May 2024).

Shell. (2022c). *Energy Transition Progress Report.* [Online]. Available at: https://reports.shell.com/energy-transition-progress-report/2022/our-performance/absolute-emissions.html. (Accessed: 3 May 2024).

Shell. (2022a). *Sustainability Report 2022* [Online] Available at: https://reports.shell.com/sustainability-report/2022/ (Accessed: 3 May 2024).

SHGM. (2020). *Uluslararası Havacılığa Yönelik Karbon Denkleştirme Ve Azaltma Şeması Uygulama Talimatı [Online] Available at: https://web.shgm.gov.tr/documents/sivilhavacilik/files/mevzuat/sektorel/talimatlar/2020/SHT-CORSIA.PDF* (Accessed: 3 May 2024).

SHGM. (2022). *Sürdürülebilir Havacılık Yakıt Talimatı [Online] Available at: https://web.shgm.gov.tr/documents/sivilhavacilik/files/mevzuat/sektorel/taslaklar/2022/SHT-SAF.pdf* (Accessed: 3 May 2024).

SOCAR Türkiye. (2022). S*ocar Türkiye Sustainability Report 2022.* SOCAR Türkiye

Statista. (2024a). *Global number of oil refinery facilities by region 2021.* [Online]. Available at: https://www.statista.com/statistics/973609/oil-refineries-by-region-worldwide/. (Accessed: 3 May 2024).

Statista. (2024b). *Global oil refinery industry - statistics & facts.* [Online]. Available at: https://www.statista.com/topics/7286/global-oil-refinery-industry/#topicOverview. (Accessed: 3 May 2024).

Statista. (2024c). *Oil refineries in Europe 2023, by country*. [Online]. Available at: https://www.statista.com/statistics/1327214/europe-oil-refineries-by-country/#statisticContainer. (Accessed: 3 May 2024).

The European Commission. (2019). *The European Green Deal sets out how to make Europe the first climate-neutral continent by 2050, boosting the economy, improving people's health and quality of life, caring for nature, and leaving no one behind* [Online]. Available at: https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6691. (Accessed: 3 May 2024).

TÜIK. (2023). *Turkish greenhouse gas inventory 1990 - 2021.* [Online] Available at: https://data.tuik.gov.tr/Bulten/Index?p=Greenhouse-Gas-Emissions-Statistics-1990-2021-49672&dil=2 *(Accessed: 3 May 2024).*

Tüpraş. (2022). *2022 Integrated Report.* Tüpraş. [Online] Available at: https://www.tupras.com.tr/assets/all-pdfs/tupras-integrated-report-2022.pdf (Accessed: 3 May 2024).

Tüpraş. (2023b). *2023 Integrated Annual Report.* Tüpraş. [Online] Available at: https://www.tupras.com.tr/assets/img/sustainability/tupras-2023-integrated-annual-report.pdf (Accessed: 3 May 2024).

Tüpraş. (2024). *Hakkımızda* [Online]. Available at: https://www.tupras.com.tr/tr/hakkimizda. *(Accessed: 3 May 2024).*

Türker, Y., Ö. and Aydin, A. (2022) *How ready is the Turkish Legislation for the green deal?.* Energy and Climate Change, Vol. 3, p. 100084.

UNFCCC. (1992). *What is the United Nations Framework Convention on Climate Change?* [Online]. Available at: https://unfccc.int/process-and-meetings/what-is-the-united-nations-framework-convention-on-climate-change. (Accessed: 3 May 2024).

UNFCCC. (1997). *What is the United Nations Framework Convention on Climate Change?* [Online]. Available at: https://unfccc.int/process-and-meetings/what-is-the-united-nations-framework-convention-on-climate-change. (Accessed: 3 May 2024).

UNFCCC. (2015). *What is the Paris Agreement?* [Online]. Available at: https://unfccc.int/process-and-meetings/the-paris-agreement (Accessed: 3 May 2024).

United Nations Climate Change. (1992). *The Rio Conventions* [Online]. Available at: https://unfccc.int/process-and-meetings/the-rio-conventions. (Accessed: 3 May 2024).

United Nations. (1992). United *Nations Conference on Environment and Development, Rio de Janeiro, Brazil, 3-14 June 1992* [Online]. Available at: https://www.un.org/en/conferences/environment/rio1992. (Accessed: 18 May 2024).

Vandeplas A., Vanyolos I., Vigani M., and Vogel L. (2022) *The Possible Implications of the Green Transition for the EU Labour Market.* Publications Office of the

European Union. Luxembourg.

World Bank. (2015). *About the "Zero Routine Flaring by 2030" Initiative [Online]. Available at:* https://www.worldbank.org/en/programs/zero-routine-flaring-by-2030/about. (Accessed: 3 May 2024).

APPENDICES

Appendix A-Interview Questions

1. Firstly, could you briefly describe your experience and positions?

2. As you know, relations between the European Union (EU) and Türkiye exist in many fields, including the Green Deal. Do you have any idea about the Green Deal? What are your general views on it?

3. Will only EU countries be affected, or will non-EU countries like Türkiye also be affected?
   - What kind of impacts do you foresee for non-EU countries (focusing on emission reduction, decarbonization, and circular economy targets)?
   - Do you think it will affect Türkiye?

4. What actions is Türkiye taking regarding the Green Deal? Do you have any idea about it?
5. Do you think the Green Deal will impact refineries in Türkiye? In which areas do you think refineries will be affected?

6. Is the Green Deal an opportunity for refineries in Türkiye? Will this process be complicated for them?

7. Emission reduction targets are among the important topics for the Green Deal. Which steps are being implemented in the Turkish refinery sector to reduce emissions?

8. Refineries in Europe and worldwide have started implementing energy efficiency, implementation, and investment in new technologies for emission reductions, carbon capture, processing, and storage (CCUS), green hydrogen, and sustainable aviation fuel applications towards net zero and emission reduction targets. Some also announced that they will start. On the other hand, important steps are also being taken towards using renewable energy sources.

Refineries in Türkiye have also started to set such targets and have practices towards these targets. When I analyzed Tüpraş 2022 Integrated Report and the 2022 SOCAR Sustainability Report, I observed that strategies and targets have been set in refineries in Türkiye. What do you think about the applicability of these targets and the steps to be followed?

For example,

- *Tüpraş states that its 2050 target is to become a carbon-neutral energy company. Tüpraş states that the company focuses on four business areas: sustainable refining, biofuels, zero-carbon electricity, and green hydrogen in Tüpraş 2022 Integrated Report.*

- *In its 2022 Sustainability Report, SOCAR stated that within the scope of its decarbonization strategy, it has implemented studies in energy efficiency, electrification, and resource management to reduce carbon emissions by an average of 1% annually until 2025. It stated a 40% emission target in 2035 and a net zero emission target in 2050.*

9. Do you think the Green Deal has been a driving force for these objectives? Or would the facilities have been working on these targets and strategies even without the Green Deal?

10. The Emission Trading System (ETS), currently being implemented in Europe and is planned to be established in Türkiye in October 2024 as a part of the Green Deal. Do you know about the studies conducted by the Ministry of Environment, Urbanization, and Climate Change with sector stakeholders?

11. Are there any preparations for the ETS in Turkish refineries? Is there a road map for the developments? Are any collaborative activities being carried out with sector stakeholders as part of the preparatory work by the Ministry of Environment, Urbanization, and Climate Change? (Climate Law, ETS Regulation draft studies opinion process, stakeholder evaluation meetings, etc.)

12. What differences do you see when we compare the refineries in Türkiye and worldwide in relation to the Green Deal targets? Which countries could we

follow as an example?

- What should Turkish refineries do to stay one step ahead? Are there any better practices and strategies to be determined?

13. Which investments should be implemented for the net-zero and emission-reduction strategies of refineries in Türkiye? Do you think that government incentives are essential for these investments? Do you know of any incentives for the improvements implemented so far?

14. What was the most important issue we discussed at the end of the interview?

15. Do you have any further questions or suggestions?

Appendix B -Ethics Committee Approval

SAYI: B.30.2.İEÜ.0.05.05-**020**-*347* 02.02.2024

KONU : Etik Kurul Kararı hk.

Sayın Prof. Dr. Mehmet Efe Biresselioğlu ve Arzu Akdağ Kerimov,

"Avrupa Yeşil Mutabakatı'nın Avrupa Birliği üyesi olmayan ülkelerde bulunan rafineriler için etkilerinin, Türkiye'deki rafineler için değerlendirilmesi" başlıklı projenizin etik uygunluğu konusundaki başvurunuz sonuçlanmıştır.

Etik Kurulumuz 29.01.2024 tarihinde sizin başvurunuzun da içinde bulunduğu bir gündemle toplanmış ve Etik Kurul üyeleri projeleri incelemiştir.

Sonuçta 29.01.2024 tarihinde **"Avrupa Yeşil Mutabakatı'nın Avrupa Birliği üyesi olmayan ülkelerde bulunan rafineriler için etkilerinin, Türkiye'deki rafineler için değerlendirilmesi"** konulu projenizin etik açıdan uygun olduğuna oy birliğiyle karar verilmiştir.

Gereği için bilgilerinize sunarım.
Saygılarımla,

Prof. Dr. Murat Bengisu
Etik Kurul Başkan