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Bachelor Thesis

Country Comparison: Economic and Social Analysis on The Clean Energy Transition Policies of Turkey and Germany's Transportation Sector

In what ways do Germany's and Turkey's economic conditions and social acceptance shape their respective clean energy transition strategies in the transportation sector?

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Abstract:

The global energy transition from fossil fuels to renewable sources is a complicated matter with national variations in social and economic factors. This thesis examines the similarities and differences between Turkey's and Germany's energy transition policies in the transportation sector. Both nations rely on foreign fossil fuels and have comparable populations, but their levels of social and economic development are different. Germany is able to set high goals for renewable energy and make significant investments in clean energy technologies because of its strong environmental values and robust economy. On the other hand, Turkey faces particular difficulties due to its unstable economy and preference for energy security over rapid adoption of renewable energy. Despite Turkey's social and financial obstacles they have made some progress to achieve successful energy transitions in the transport sector by increasing the renewable energy usage and infrastructure projects which are targeted at lowering carbon emissions. In order to achieve successful energy transitions in the transportation sector, this comparative study emphasizes how crucial it is to customize energy policies to national contexts, taking social dynamics and economic capacities into account.

Introduction:

Energy transition refers to the sectoral change from fossil fuel based energy production and consumption to renewable energy sources such as wind, solar, biomass and in some cases nuclear. The main reason for the energy sector's transformation is the global climate risks that threaten humans, animals and the ecosystem (IRENA, 2022). However, energy transition towards renewable sources is a complex process and in order to transition towards cleaner resources, governments or political unions agree to collaborate together to achieve the international goals of climate agreements. The latest climate agreement, The Paris Agreement was drafted in 2015 and it targeted solutions to limit global warming to 1.5°C (United Nations). Therefore, the parties who signed the agreement set binding energy targets under energy transition policies to contribute a shift towards sustainable development, and reduce the impacts of climate change (United Nations).

However, every party sets different energy transition targets which differ in terms of national characteristics and governance choices (Kuzemko et al., 2016, p.96). Countries which are richer in renewable energy sources may have a smoother shift in energy transition compared to countries with limited natural resources, because they can embrace new economic models to diversify the energy market share (Goldthau et al., 2020). Economic factors impact the transition process; wealthier countries often have higher financial budgets to invest in energy transition and have more financial resources to invest in research & development compared to developing countries. Similarly, social factors are also an important factor for shaping the energy transition policies. Societies who have higher environmental values who support climate policies tend to have stricter energy policies (Bumann, 2021).

This thesis report will explore Turkey and Germany's energy transition policies. The reason why these two countries are chosen to be further explored is because they have distinct similarities and differences. When the similarities are taken into consideration, Turkey and Germany have

external fossil dependence and high oil and gas quota. Additionally, both have a similar population. According to Statistica's 2023 data, Germany's population is estimated to be 84.7 million, and Turkey's population is estimated to be 85.2 million people. However, they also have contrasting features such as the economic wealth and social conditions. For example, Germany's strong economy gives them the advantage of being a role model in the energy field (Loffler, et al., 2022). Germany's pioneer position in the field, allows them to have international collaborations with joint energy networks and thus many publications about their energy policies (Federal Ministry for Economic Affairs and Climate Action [BMWK], n.d.). On the other hand Turkey has an unstable economy, and the highest inflation in Europe which makes them an extreme outlier in the region (Yanatma, 2024). Even though Turkey is not a part of the EU, they try to align the energy policies according to the EU targets (Demir, 2012). Hence, having a comparison of the two countries who shape their energy policies in the transportation sector along the EU energy targets, allows the reader to gain a better understanding on how economic and social conditions can influence the formulation and implementation of clean energy policies. The thesis' contribution to the energy field is to produce a country comparison regarding renewable energy policies, specifically focusing on the transport sector. This is different from the existing literature because the comparison of the transportation sector policies focus on the economic and social conditions of Turkey and Germany. The unique perspective of the thesis allows the reader to understand how Turkey and Germany hold some similar features in the renewable energy field but differ in policy making in the transportation sector.

Literature review:

Current Status of Turkey and Germany in Energy Transition

Energy demand in Turkey has been increasing substantially along with the population growth and economic developments since 1980's. Between 2000- 2018 annual electricity consumption increased by 170% from 98.3 GW to 300.109 GW (Kilickaplan & Peker, 2017). In regards to the increasing electricity demand and insufficient domestic reserves, Turkey has been supplying most of its energy from external oil and natural gas sources (Ministry of Foreign Affairs). This is because, even though Turkey has a favorable geographical position which results in a high renewable energy potential, the country has limited renewable energy utilization due to low investments (Basaran et al., 2015). However, the country aims to expand on their usage of natural resources by giving more emphasis on renewable energy capacity (Erat et al., 2020, p.402). Firstly Turkey pledged a 21% reduction in their GHG emissions by 2030. Additionally, the fundamental energy policy of Turkey is based on achieving energy supply security, increasing energy efficiency and optimizing the energy resource mix (Kilickaplan & Peker, 2017). Based on the optimizing energy resource mix, the government has established a 38% renewable electricity target by 2030 (Donat et al., 2019). In addition to the 2030 targets, Turkey's favorable geographical location, which is based on its sunny belt lying between 36N and 42N latitude, and the high estimated production of wind energy from both onshore and off-shore options present Turkey's future renewable energy potential (Basaran et al., 2015). Hence, based on their resource availability they have a high chance of achieving above 80% clean energy transition by 2050.

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However, Turkey is ranked as the 17th country in terms of the utilization of renewable energy, therefore in order to increase resource utilization they aim to increase the solar and wind capacity (Erat et al., 2021). The increase in renewable energy capacity will give Turkey the opportunity to meet the first GHG reduction goal and even go beyond their 21% GHG reduction pledge. Turkey follows a strategy named ‘More Domestic More Renewable’, this means that they aim to reduce the dependence on exported fossil fuels and start to benefit from the natural resources that the country’s geographical location offers (Telli et al., 2020).

On the other hand, Germany has the 3rd largest economy globally with a GDP of 4.121 billion euros in 2023 (World Economics, 2023). Due to Germany’s strong economy and pioneer position in the energy field they have the advantage of setting higher renewable energy targets compared to Turkey (Zuo et al., 2019). According to the Ministry for Economic Affairs and Climate Action, Germany aims to reach a 65% renewable energy mix in the energy production by 2030 and 80% by 2050. Additionally, Germany has introduced an energy term called ‘Energiewende’, where it presents the national energy policies that aim to shift from fossil fuels towards wind, solar and biomass. (World Nuclear Association, 2020).

Even though Turkey and Germany have different targets, they both aim to increase the clean energy share with different approaches. Specifically, when nuclear energy is taken into consideration it is found that both countries have different perspectives:
The German government has decided to shut down nuclear power plants during their energy transition process. Even though phasing out nuclear power has been a controversial process since the 1980’s, after the Fukushima catastrophe in 2011 the German government proposed the closure of eight nuclear power plants and limit the operation of the nine power plants (Schreurs, 2012). Therefore the external events and Germany’s energy transition policy has created a broad political consensus regarding phasing out nuclear power, it gave the opportunity to slowly phase out and eventually stop nuclear power plants in 2022 (Schreurs, 2012).
In addition to phasing out the nuclear power plants, in 2019 Germany has also announced plans to phase out coal electricity generation by year 2038 (Rinscheid & Wüstenhagen, 2019). The phasing out decisions would create changes in Germany’s electricity generation path. Therefore to avoid having shortages in the electricity generation Germany has shifted to increase renewable energy and maintain using natural gas in the renewable energy market share (Rinscheid & Wüstenhagen, 2019). Contrary to Germany’s strict phasing out steps for a cleaner energy system, Turkey has decided to include nuclear power for the first time in 2023 in their energy mix (Telli et al., 2020). However, regardless of following different paths to achieve the energy transition goals both countries have the capability to go beyond the targets they set for transitioning to renewable sources by 2050.

Transport Sector:

In what ways do Germany's and Turkey's economic conditions and social acceptance shape their respective clean energy transition strategies in the transportation sector?

Transportation is a fundamental aspect of life, it enables people to connect with the world. The sector is crucial for maintaining economic growth and social integration among individuals. This is because a high quality transport sector will allow people to better connect with neighboring areas which will increase the employment and education opportunities since people will have a wider area for mobility (Bastiaanssen et al., 2020). In addition to this, there will be limited carbon emission release with reduced use of private automobiles (Jing et al., 2022). Aligning clean energy targets with the transport sector is crucial because according to IRENA's Transportation report, the sector has one of the largest energy consumption worldwide. Due to the high energy consumption, the emissions in the transportation sector had a 29% increase between 2000-2016 (IRENA, 2021, p.6). Therefore, based on IRENA's findings, transport services have a corresponding relationship with urbanization and it can be believed that in developing countries the rising car ownership is connected with urbanization. However, the rapid progress of urbanization caused by an improved transportation sector also leads to various problems such as traffic congestion, increased vehicle emission and limited road capacity (European Court of Auditors, 2020).

Therefore, based on these limitations, the Transport Sector Section will discuss the transportation policies of Turkey and Germany, and the steps that are taken by the two governments to ensure that the transportation system is improved through focusing on environmental perspectives. The section will specifically focus on the Turkish and German government's transportation policies which target the problems caused by the increasing number of vehicles, low use of public transportation due to limited infrastructure (mainly Turkey) and the strategies for reducing CO2 emissions in the transport sector.
As mentioned above the policies for the transport sector can be shaped by different global challenges namely; climate change, which has a direct relation to increasing carbon emissions and air pollution that impose several threats for human health and global economies. According to IRENA, the sustainable transport sector requires a well coordinated and integrated set of policies, and in order to achieve coordinated policies, the government leaders must harmonize the business activities across various types of transportation systems. The coordination of transportation policies across a set of transport systems would address the needs of a wider user target, which would result in a higher positive environmental impact through increasing the availability and efficiency of the sector (IRENA, 2021, p.6).

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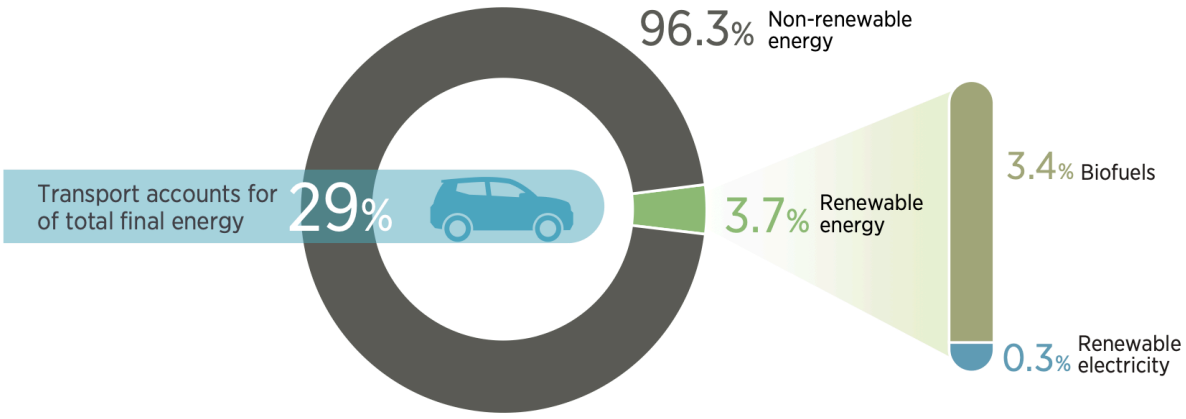

Figure 1: Share of renewable energy in the transport sector- 2018 (IRENA, 2021, p.7)

Figure 1 demonstrates that even though there is a big need for including renewable energy in the transport sector, the share of renewables in the sector is considered to be very low in 2018. According to the report, only 3.7% of market share is generated from renewable energy, and 3.4% of the generation comes from biofuels, where only 0.3% of the sector uses renewable electricity. Therefore, Figure 1 represents the critical situation of the lack of renewables in the global transportation sector. The figure indicates the need to make policy changes in the sector to ensure a cleaner transport system. Based on the critical situation of adapting renewable energy in the transport sector globally, we will further delve into Turkey's and Germany's transportation sector and analyze the policy changes which specifically aim to reduce the carbon emissions and increase the utilization of renewable energy in the national transport sectors of the chosen two countries.

Turkey Transport Policies:

Following the global trends of urbanization in Turkey which specifically focuses on the years between 2010-2024, Turkish cities face the challenges of rapid urban growth. The challenges occur due to the urban screeching, the distance between functional destinations such as the workplaces, schools and residential areas have become longer, which led to the growth of private car-centered mobility **(**European Commission, 2019, p.5). Approximately the number of vehicles increased by almost 10 million in less than 10 years (Durdag & Sahin, 2016, p.24), and according to TUIK in 2022, the total number of vehicles equalled 26,482,847 (TUIK, 2022). The rapid increase in private automobiles indicates that Turkish public transport is not efficient. On the other hand, even though there is a rapid increase in vehicle purchases,(Durdag & Sahin, 2016, p.25) the number of car ownership rates is lower in comparison to the EU **(**European Commission, 2019, p.5) which could be related the high vehicle taxes on private automobiles. In addition to this, Turkey has a higher average of young population comparison to the EU (TUIK, 2021). Which means that Turkey has a higher population who are typically more open for different means of transport, and more informed about environmental issues than the older

generations **(**European Commission, 2019, p.5). Hence, the high youth population gives the government opportunities to promote sustainable urban transport.
According to IEA, the Turkish government has adopted several transport policies to meet the Paris Agreement and EU energy targets. The adopted policies focus on reducing fossil dependency and carbon emissions. Additionally, the government tries to follow the More Domestic More Renewable strategy specifically by including energy security and efficiency among the transport policies (Telli et al., 2020). The main reason for this is because as mentioned earlier the number of privatized automobiles are fast growing, therefore the energy demand in the Turkish transport sector grows in the same ratio. Based on this, the ultimate goal for the government is to ensure energy efficiency and security by reducing the external dependence on imported fossil fuels. To achieve this the government is prioritizing domestic energy exploration and production, specifically focusing on diversifying oil and gas supply sources and infrastructure. However, the priority on sustaining energy efficiency has been posing challenges to decarbonize the energy sector. This is because in order to implement renewable energy in the transport sector the government needs clean energy investments particularly for solar and wind energy (Bank, 2018). Therefore, for a developing country like Turkey additional investments will put a higher financial burden on the economy, and the effects of implementing renewable energy in the sector will be visible in the long term which may not directly affect sustaining energy efficiency in the short term. In the meantime the government had discovered the Sakarya gas field in the Black Sea region of Turkey in 2020, which gave the country the power to diminish the import dependence to some extent (IEA, 2021).
Therefore, in the following part Turkey's transport policies will be discovered. First part will focus on the infrastructure of the transportation sector, specifically focusing on the Osmangazi bridge. Nextly, the national railway improvements and taxation will be discussed and lastly, the citizen accessibility to public transportation will be analyzed

Transport Infrastructure

In addition to diversifying the renewable energy share, the country also aims to update the transport sector by improving the transportation infrastructure. In 2010 the Turkish government set up targets to improve infrastructure (Dinçer, 2016, p.41). The targets were set based on the Global Competitiveness report 2014, the results of the report indicated that Turkey's railroad infrastructure was ranked forty-ninth out of 144 countries (Dinçer, 2016, p.39). Similarly, according to the Global Enabling Trade Report, Turkey ranks at the same level as Thailand and Poland in availability and quality of transport infrastructure (Dinçer, 2016, p.40). Even though the reports were published 10 years ago, the results indicate that Turkey's transport infrastructure sector is underdeveloped compared to the majority of the developing countries. The targets set by the Ministry of Transport mainly consist of expanding the motorways and improving the railway infrastructure capacity (Dinçer, 2016, p.41). From the energy transition perspective, the government's transport policies aim to reduce the distance between cities, and hence reduce the carbon emissions. The new İstanbul-İzmir motorway is an example of the government's infrastructure improvement policy. (figure 2).

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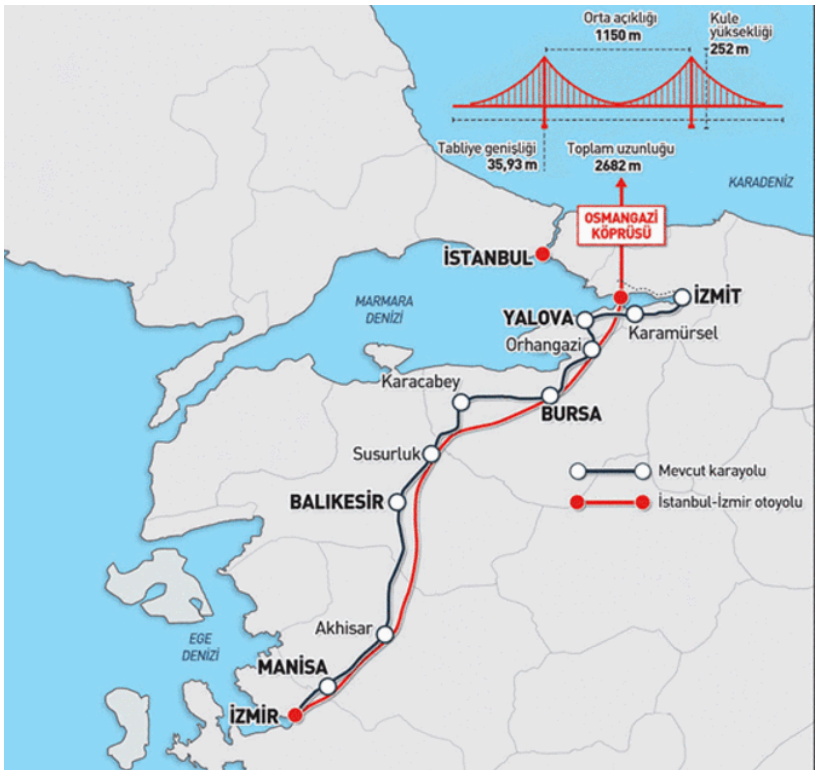

Figure 2: Comparison of the old and new Istanbul-Izmir motorway. Red line is the new and blue is the old road (CNN Turk, 2019)

Figure 2 shows the old and the new motorway that connects Istanbul and Izmir. The new motorway includes a new bridge called Osmangazi which reduces the travel time from 70 minutes to 6 minutes (Daily Sabah, 2018). The significant time reduction of the new motorway has an indirect impact on reducing vehicle emissions through efficient traffic management. On average over 40,000 vehicles benefit from the reduced travel time by increased fuel saving and lower emissions (Road Traffic Technology, 2024). Therefore, the motorway project indicates the government's priority of investing in transportation infrastructure to reduce the travel time for the users, and hence result in less carbon emission release.

Railway

According to Turkish State Railway data, the average age of railway infrastructure is relatively high. This is because the railway policies between the years of 1950-2003 have been neglected mostly due to lack of railway demand (Dinçer, 2016, p.51). Therefore, based on the new transportation policies the government aims to improve the railway lines to ensure that railway transportation is an alternative for cars. The railway policy in Turkey consists of new high-speed trains which prioritize having lower the duration of transport to major cities and improved railway journey quality., (Dinçer, 2016, p.41).

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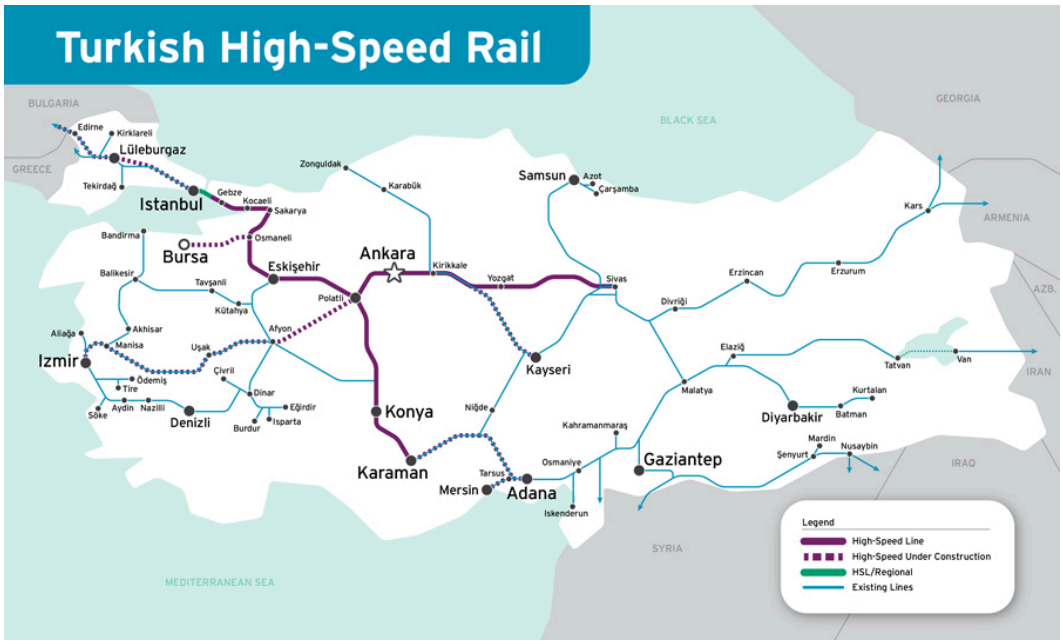

Figure 3: High speed railway lines. (High Speed Rail Alliance, 2023)

Figure 3 demonstrates the map of the railway lines. The high speed railway infrastructure (shown with the purple color) started in 2009 with the Ankara Eskisehir line, soon after the line was connected to Istanbul in 2014. The final railway line from Ankara to Izmir, Kayseri and Adana are expected to be operating by 2025. The new railway policy ensures the reduction of energy spent for electrification by 38%, this is because old railways in Turkey were not fitting in the existing railway structure (High Speed Rail Alliance, 2023). Therefore the new railway infrastructure allowed it to match the electrical requirements to the power supply system. Similarly, the improvement of the railway system gives private car owners who travel to the distances along the railway route a new transport option.

Similar to the improvement of major city connections within Turkey, the Turkish government aims to improve the railway connection between Turkey and the EU with the new railway infrastructure policy system. Currently, Turkey operates one train from Istanbul to Romania (and Bulgaria) once a day. The Europe route is considered to be new but as it is portrayed in Figure 4 the Marmara railway which connects Asia to Europe, is expected to connect to other cities in the European side which would eventually connect to the Europe railway route (Uysal, 2019).

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Figure 4: Marmaray Railway system explanatory map (González et al., 2023)

As mentioned in Figure 4, The Marmara railway connects Asia to Europe through a tube-tunnel technology and bored-tunnel system along a 76.3km line from Gezbe to Halkali (Efe & Cürebal, 2010, p.723). The railway project is aimed to improve the traffic congestion of Istanbul, according to research the Marmara railway has 12 times higher capacity of utilization in total when it is compared to the three bridges that connect the two continents (figure 5) (Efe & Cürebal, 2010, p.723). The increased capacity of transportation, allows to reduce the road congestion. Similarly, the reliance on highways and individual transport vehicles will be reduced (Efe & Cürebal, 2010, p.723). Hence, the railway system will contribute toward the reduction of carbon release in the most dense city of Turkey. The railway system uses domestic electric power that follows the More Domestic, More Renewable strategy, and also contributes financially to the country's budget.

Similarly, the Marmara railway is expected to reduce pollutants and greenhouse gasses (CO,NO and NMHC) by 15,000-25.000 tons between 2010 and 2025 (Efe & Cürebal, 2010, p.723). The government aims to have a CO_2 reduction of 400,000 tons by 2025 (Efe & Cürebal, 2010, p.723) with the Marmara project. The reduction of 400,000 tons of CO_2 is equivalent to taking 87,000 vehicles off the road. Therefore, the emphasis on the railway infrastructure both nationally through high-speed railway system and locally with Marmara railway in Istanbul presents how the Turkish government's transport sector policies align with the More Domestic More Renewable energy strategy by reducing carbon emission release (reduced private automobile utilization).

In what ways do Germany's and Turkey's economic conditions and social acceptance shape their respective clean energy transition strategies in the transportation sector?

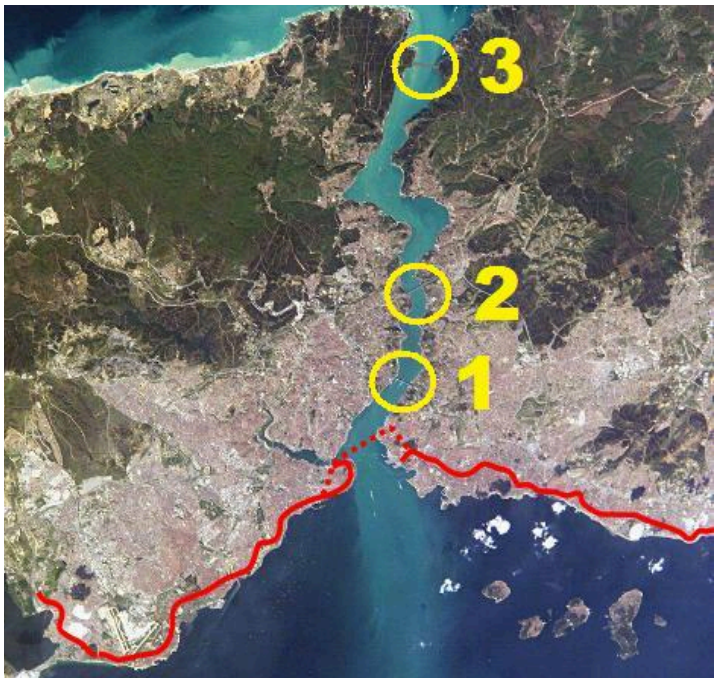

Figure 5: Yellow circles indicate the bridges and red line shows the Marmara railway (NASA Earth Observatory, 2016)

Road Transportation and Taxes

Similar to the government's infrastructure based improvements which have an indirect impact on meeting the energy transition goals, there are also road transportation policies which have a direct impact on energy transition set by the Turkish government. The Turkish transport sector is responsible for 26% of GHG emissions in the country (Güzel & Alp, 2020, p.2191). Transportation sector is heavily dependent on fossil fuels, therefore it is difficult to decarbonize due to limited alternatives. As mentioned earlier, the priority on domestic fossil fuel utilization through the continuous support to power generated from coal and nuclear showcases vulnerability for climate change.

To reduce the vulnerability, the government is aiming to invest in renewing the public transport vehicles where the public vehicles become emission-free or low-emission transportation systems (T.C. Ulaştırma ve Altyapı Bakanligi, 2023). Turkey's first 100% electric bus has started trial runs by the Municipality of Izmir (Izmir Municipality, 2024). Similarly, the government is aiming to increase the availability of micro mobility vehicles including bicycles and electric mopeds (T.C. Ulaştırma ve Altyapı Bakanligi, 2023). There will also be investments to improve the pedestrian roads in national and regional levels. This means that there will be higher bicycle and moped renting spots and improved road infrastructure for pedestrians and cyclists. Moreover, in 2023 Turkey created its first electrical vehicle Togg, which offers up to 60% reduction in vehicle purchase tax (ÖTV). The initiative is aiming to attract more people to purchase electric cars in Turkey (Durmus Senyapar& Tür, 2023). Similar to tax reduction the government is aiming to bring congestion pricing, park and ride pricing to demotivate individuals from using private vehicles (Durmus Senyapar& Tür, 2023). As mentioned above, Turkey had a significant increase in owning private vehicles from 2014-2024, and in order to reduce or

stabilize the car ownership the government is aiming to increase the capacity of public transportation through investments, which has started with the Marmara railway system and high-speed trains.

Accessibility

Lastly, the accessibility of transportation for a bigger target audience is considered to be an essential element in Turkey's transportation policies. Improving the accessibility of public transportation means that citizens are not limited to using private transport vehicles which have higher CO2 emissions per person. Therefore improving public transport and reaching a wider audience equals lower emissions through an indirect effect. The government has several policies to improve the public transport accessibility, firstly by designing public transportation which suits people with disabilities, this includes reserved seating areas, extra leg space, and automatic steps in public buses. In addition to this, the Istanbul mayor has introduced *Anne Kartı* (Mother Card), which offers mothers of children aged 0-4 free public transportation (Istanbul Municipality, 2022). Lastly, by increasing the inclusivity of the different population groups by providing student discounts, and free travel for elderly over the age of 65 (Aile ve Sosyal Hizmetler Bakanlığı, 2024).

Germany Transport Policies:

Germany has always been politically and economically a strong member state of the EU, which allowed Germany to set effective policies in the transport sector, and have given them the advantage of being a leader in energy transition (Zuo et al., 2019). Therefore the country had the financial and social abilities to combine sustainability in the transport sector from an early time period starting in 1980's (Schreurs, 2012). In 2008 the German government introduced the freight transport policy which aimed to make freight transportation more efficient by reducing CO_2 emissions (UN, 2016).

As it is portrayed in figure 6, the country has extensive railway connections which can be related to Germany's economic power and high GDP. Besides the railway system they also have an efficient network of roads and airports (figure 7). The aim of the policy which was introduced in 2008 is to ensure that Germany can maintain the leading position in freight transport by making sure that the German transport sector is not contributing to the climate crisis through emission release (The Federal Government, 2008). Overall, 71% of energy consumed for transport in the EU is dependent on petroleum which puts Germany who has a leading position in the Union under pressure to meet the EU energy targets (The Federal Government, 2008). Germany uses 30% of its final energy consumption in the transport sector and according to UN's data from 2016 nearly 94% of German road transport is based on fossil fuels (UN, 2016), which places Germany the state among 27 EU countries and the candidate states who consume the most energy for the transportation sector (Appendix 1). Therefore, it can be assumed that similar to Turkey who struggles with high carbon emission release due to the increased number of private automation, Germany is also being challenged with carbon emission release in the transport sector which could also be linked to the negative impacts of urban growth where citizens require an automobile for mobility. Hence, even though Germany has been a pioneer in adapting effective renewable energy policies, the transport sector needs further alignments to achieve the

energy transition targets. Therefore, in this section Germany's transport sector policies will be discovered. Firstly, the government's benchmark will be taken into consideration, then the transport taxes and the cap and trade system will be discovered. Lastly, accessibility to public transportation will be analyzed.

Figure 6: A map of rail lines in Germany - bold means "mainline" slender means "branch line" (OpenStreetMap contributors, 2020)

Figure 7: German motorway map (Wikimedia Commons, 2014)

Transportation Benchmarks

The Federal government has three benchmarks for sustainable transportation; firstly it must have economic contribution by creating job opportunities, bring competition in the German economy and have minimal impacts on other land uses (The Federal Government, 2008). Secondly, the transport sector must meet the ecological needs of Germany, the government report states that transportation must be shaped by natural resources by limiting the use of fossil fuels and preserving the future generations (The Federal Government, 2008). Germany's fuel strategy is an important aspect of the transport policy, this is because the strategy aims to reduce Germany's dependence on oil within the transportation sector which would diversify the energy supply and increase low-carbon economy. Lastly, the government set a social benchmark in the transport sector where it presents an inclusive environment through affordable, safe and fair transport in Germany.

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Transportation Taxes

According to the EU objectives, every member state is expected to meet the 55% emission reduction by 2030 (European Commission, 2024). Hence, within the transport sector biofuels play an important role to meet the EU's assigned goal (Di Lucia & Nilsson, 2007). In order to limit the CO_2 release, the German government has introduced CO_2 limitations for passenger cars (UN, 2016). This is achieved through increasing the share of biofuels and introducing carbon and pollutant based motor vehicle tax for newly registered cars. The taxation for a green transport sector in Germany first started in 1999, with the Eco-tax' (UN, 2016). Through the Eco-tax policy, the state aimed to make sure that scarce resources were used sparingly, this policy gave companies the opportunity to have financial benefits from using clean energy (UN, 2016). In 2007, the German state 'updated' the policy and made sure that biofuels were the leading source of gas in the transport sector (UN, 2016). They have achieved this with the obligatory biofuel quota. This obligation has encouraged the industry to blend biofuels with diesel and petrol, when the biofuel act was first introduced the quota was 5.25%. Since 2010, the biofuel quota has been set at 6.25% (IEA, 2015). However, from 2015 the government had set the quota based on the potential for net GHG reduction, this means that biofuels which have a higher GHG reduction will receive a higher support from the government, and this is determined from the Biofuel Sustainability Regulation which measures the environmental compatibility of the biofuels (Federal Ministry for Economic Affairs and Climate Action). Lastly, in 2009 the government announced CO_2 based vehicle tax, conversion of motor vehicle tax to emission based tax is aimed to support the energy transition by providing incentives to buy climate neutral vehicles (UN, 2016).

Existing Transport System - Cap and Trade

As mentioned earlier, Germany is impacted by global trends of urbanization which leads to risks such as the significant growth in traffic levels (Shen et al., 2023). Hence introducing taxation policies to lower CO_2 emissions and energy consumption will not be sufficient to meet the EU's set energy targets. Therefore, the German government pledged to optimize the use of the existing transport infrastructure specifically focusing on the railway sector and apply measures to relieve congestion on the roads (BMDV, 2017). In order to transform the existing transportation system into a climate friendly sector the German government launched its national emission trading system (ETS). Emission Trading System follows a 'cap and trade' system where the federal government sets annual emission limits for transport and heating sectors, which follow the emission targets set by the European Union. The national trading system allows the emission allowances to be transferable through trading among companies. The government uses the cap and trade system for building and transportation sectors, because the two sectors largely rely on fossil fuels such as heating oil, natural gas, gasoline and diesel (Wettengel, 2024). The reason why the government has introduced German-wide emission prices for the two sectors is because they are responsible for more than a third of Germany's greenhouse emissions in 2022 (Wettengel, 2024).

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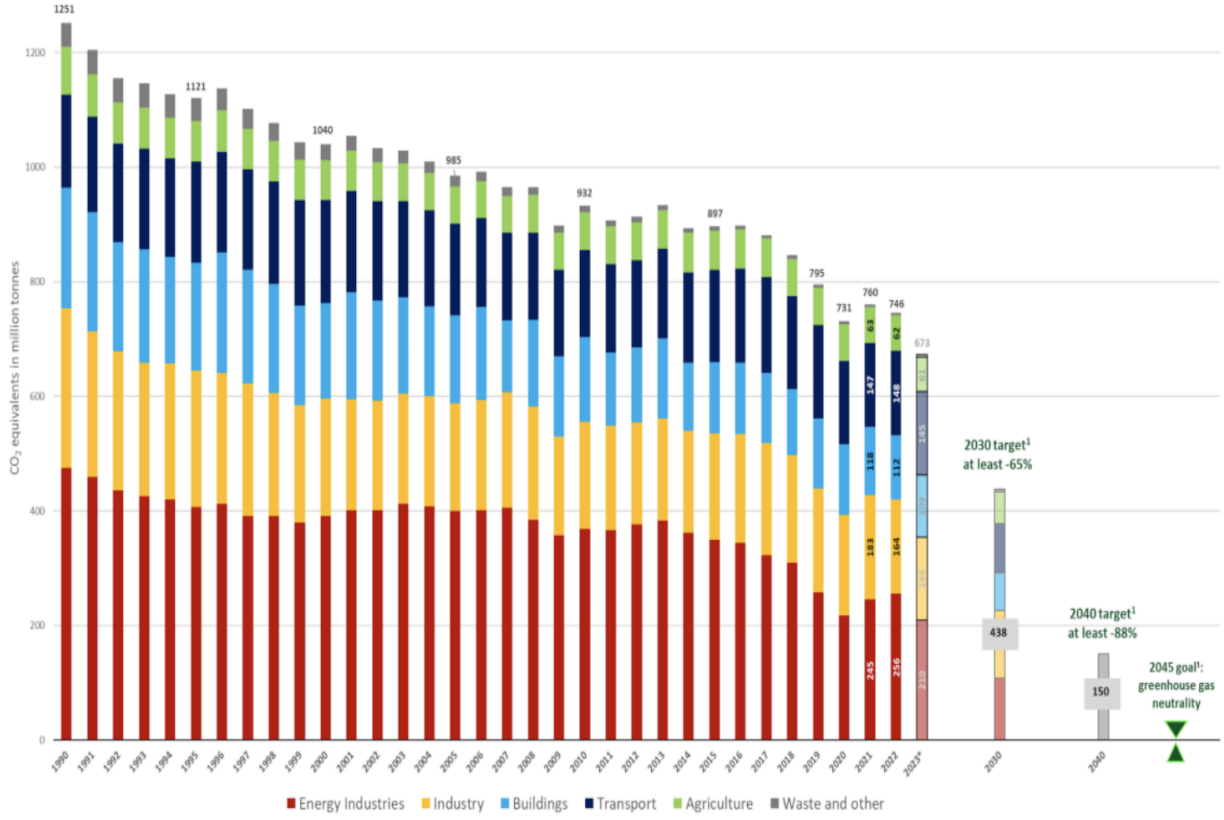

Figure 8: Greenhouse gas emission trends in Germany by sector 1990-2023 (Wettengel, 2024)

The purpose of the emission trading system is to ensure that the sectors are putting a limit (Cap) to the carbon emissions released (ICAP, 2021). As it is portrayed in figure 8, the results after 2022 for the building and transport sector indicate a positive contribution to lower GHG in Germany. For the building industry there is a drastic decrease from 112 to 109 million tonnes of CO_2, and for the transport industry there is a decrease from 148 to 145 million tonnes of CO_2 in 2023. Therefore based on figure 8, it can be assumed that the German government's Emission Trading System for the chosen two sectors is successful in reducing the total emissions released.

Accessibility

As mentioned previously, improving the accessibility of public transport has an indirect effect on reduced GHG emissions through reduced private automobile usage. In order to achieve this

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Germany has some policies which are being implemented, these policies target vulnerable populations who struggle with low income and certain health conditions which aim to increase accessibility for public transportation. They want to achieve developing sustainable mobility and an economically efficient, socially responsible society. According to the state's values, the transportation system is based on connecting people to jobs, markets, and services. It is an important aspect of national and international trade, and citizen inclusion in everyday life (UN, 2016). Therefore, it is important that anyone can use German transportation by making sure that it is accessible and attractive for all groups of people including the low-income group. To achieve this the German government had provided Deutsche Bahn (railway company) 40 billion Euro investment for addressing the country's neglected rail infrastructure that needed capitalization (Bovenizer, 2023). Besides railway investments, they have introduced 'social tickets' which are granted for low-income citizens to use in the public transport. According to the Institute of Transport and Space's report the social transportation tickets have increased the social contact of the low income group and had raised the chances of being employed, which led to reduced unemployment and increased quality of life (Hille & Gather, 2022). Besides the low-income travel tickets, Deutsche Bahn offers special tariffs for students, elderly and unemployed people, which ensures that people from all financial groups can all benefit from public transport. Also, Germany has a barrier-free travel policy which aims to increase inclusivity by ensuring the inclusion of citizens with disabilities. Passenger cars for people with disabilities are exempted from motor vehicle taxes (Dorynek et al., 2022). Besides, they are given the opportunity to travel for free with public transport if they prefer (Dorynek et al., 2022). The government's extensive inclusivity policies for public transport use present how GHG emissions can be lowered indirectly through encouraging public transportation usage for all.

Similarities of Transportation Sector Policies:

Turkey and Germany have policies for improving the transportation infrastructure nationally. Even though Turkey has a wider infrastructure plan which includes improving roads, railways and bridge availability, Germany mainly has policies for improving the railway system. Both countries have a carbon tax policy which aims to encourage citizens to use bio-fuels and energy efficient cars, having a carbon-tax in both country's transportation policy indicates that they are aware of urbanization and how it leads to increased number of private cars regardless of improved public transportation (at least in the short term). Both countries adopt renewable energy sources in public transport. Even though Turkey only has a pilot project in Izmir for carbon-free public buses it indicates that in the future carbon-free public transportation will become prevalent. Lastly, both country's transportation policies aim to prioritize accessibility for wider groups. The German government funds Deutsche Bahn for creating an inclusive railway system through social tickets which are offered for the low-income citizens. Similarly, students, working class and elderly can benefit from discounted traveling in Germany. Turkey holds a similar policy where students travel with discounted prices and elderly travel for free in all public transportation.

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Differences of Transportation Sector Policies:

Turkey and Germany also have differences in their transportation policies. In order to limit the emission release within Germany the country has adapted ETS to cap and trade CO_2 emissions to ensure that the transport sector has an overall decrease in the emissions released. Even though both countries are adopting renewable energy sources in public transport Turkey has a policy for increasing the usage of domestic energy production including natural gas exploration. This policy is related to the country's high energy consumption and financial limitations which indicate that Turkey is a developing country and Germany is a developed country. Besides the carbon tax which is implemented by both countries, Germany imposes biofuel quotas to reduce the usage of natural gas in transportation and measures the environmental compatibility of the biofuel through Biofuel Sustainability Regulation. In conclusion, Turkey and Germany hold some similarities and differences, even though Turkey is trying to adopt sustainability in the transport sector Germany's leading role in the energy transition allows them to set more comprehensive policies.

Results

Economic scenario of Transportation sector policies

Based on the transportation policies of Turkey and Germany, it can be stated that Turkey's ongoing developing position with national income per capita 10.917$ in 2022 can bring complexities in achieving the transportation policies which align with energy transition targets. This is because between 2000 and 2018 the country had a massive increase in the energy consumption from 98.3 GW to 300.109 GW, which is related to the rapid industrial growth, and urban sprawl where the energy demand for housing and transportation increased due to Turkey's developing economic position despite its economic instability.
Besides the increased energy consumption overall, there is approximately a 10 million increase in private automobiles from 2014-2024. This means that energy consumption in the transport sector's usage of traditional oil and carbon emission release will be difficult to control. This is because as a developing country who struggles from a financial crisis, it is financially harder to invest in renewable energy therefore from an economic perspective maintaining the 'More Domestic More Renewable' energy strategy for the transport sector is a more effective approach, because it prioritizes national energy security by focusing on four elements: diversifying the routes and countries of energy supply, increasing the share of renewable energy and including nuclear energy in the energy mix and increasing the national energy efficiency and contributing to energy security. The four step energy plan brings more flexibility in the transportation sector for ensuring energy security and efficiency (Telli et al., 2020). However, as it is portrayed the four step energy strategy does not offer a clear plan for reducing the emissions, on the contrary, the energy security step supports the utilization of natural gas and coal. The priority on energy security, and the economic advantages of using domestic coal has resulted in doubling the usage of coal since 2012 (Uyanik et al., 2024). It is important to mention

that using the domestic fossil fuel sources has a lower financial burden on the Turkish economy, because it requires less investments, and currently Turkey is facing economic instability, which means that the economic policies will increasingly shift towards achieving a more conventional perspective (Cruz & Palao, 2023).
Even though the Turkish government prioritizes energy security and supports the use of fossil fuels in the transportation sector for economic advantages, they have also initiated reforms to improve the infrastructure of the public transport system, which has an indirect impact on reducing the CO_2 emission release through reduction of private vehicle usage. When the economic aspects of transport infrastructure is taken into consideration it is portrayed that the government has chosen to adopt Public-Private Partnerships for the projects (Emek, 2015). This has allowed the distribution of the financial burden of the projects between the government and private companies, which lowered the total costs for the Turkish government (Emek, 2015). Similarly, the government had funding from international organizations such as the World Bank and European Investment Bank for the railway and motorway improvement projects (European Investment Bank, 2023). Even though this has improved the quality of the projects by increased efficiency and reduced infrastructure duration, the high inflation and devaluation of the Turkish currency has caused limitations in repayment policies. For example the Osmangazi Bridge (Figure 2) In order to repay or make profit from the transportation projects The Turkish government had to increase the fees on the public transport investments. For example, in order to use the Osmangazi Bridge project which is a part of the İstanbul-İzmir motorway, vehicles pay an amount between 11.4 € to 36.3 € (based on May 2024 currency rate) for the toll depending on the type of the vehicle (Karayolları Genel Müdürlüğü, 2024). From a financial perspective, a regular use of the Osmangazi bridge has high costs for 1/3 of the Turkish citizens (33.8%) who earn minimum wage (486 €). Therefore, based on the high inflation, the infrastructure projects that are funded by international organizations put a burden on the government's budget, and thus on the citizen’s budget. According to a Turkish journalist, Mr. Kahveci, the bridge project did not meet the guaranteed profit, so the government had to cover 11 billion $ from the public treasury (Kahveci, 2021). Therefore based on the Osmangazi Bridge fees it can be concluded that Turkey’s transport infrastructure policies have low effectiveness, because only a limited number of citizens with high socioeconomic status can benefit from transport infrastructure projects like the Osmangazi bridge. Low effectiveness of the infrastructure policies indicate that reducing the carbon release in the transport sector does not have a high efficiency.

However, when the economic aspects of the German transportation sector is taken into consideration it is portrayed that there is a less financial burden because the existing infrastructure of public transport is extensive and a ‘world leader’. Therefore the infrastructure policies aim to maintain sustainability within the public transportation. Overall Germany’s transportation policies do not hold a big financial burden on the economy because Germany is a developed country that requires minor changes in the existing system to achieve a clean transportation sector. This is because Germany already has a well-developed and efficient transportation infrastructure, including extensive motorways (Figure 7) and railways (Figure 6), so the established infrastructure only requires few fundamental changes for integrating cleaner technologies in the sector.

In what ways do Germany's and Turkey's economic conditions and social acceptance shape their respective clean energy transition strategies in the transportation sector?

Besides the limited integration requirements for Germany, the country is a world leader in automotive technology and Electric Vehicles with leading brands such as BMW, Volkswagen and Daimler which makes Germany the largest investor both in motor vehicle manufacturing and in transportation that accounts for more than 75% of total European R&D (Grosso et al., 2019). Therefore, from an economic perspective The German government's high priority for investing in R&D of the automotive industry presents how the transport policies have a high possibility of aligning with Germany's energy transition plans, because R&D investments accelerates the development of clean automotive technologies, such as electric vehicles (EVs), hydrogen fuel cells, and hybrid systems, which has an direct impact on reducing the transportation emissions.

When compared to Turkey, Germany has less investment costs for the transport sector. This is because the country already has a sufficient amount of public transport networks which are efficient and sustainable. Therefore, in the short-medium term German transport system has a less financial burden to the government. However, in the long term Germany potentially will have increased infrastructure costs to maintain a modern transport system. It is also important to highlight that Germany is considered to be one of the leading states in the EU, so it is essential that they enhance trade efficiency and increase the accessibility to markets, which relies on national freight transport. Besides, being a leader in the Union, the country's critical position in Europe makes it a crucial transit hub, reinforcing the importance of maintaining its transport infrastructure (Maihold, Mair, Müller, Vorrath, & Wagner, 2021).

In conclusion, from an economic perspective Turkey's transport policies are less effective to integrate clean energy policies to the transport sector. This is because the country faces budgetary limitations that restrict the ability to invest in necessary infrastructure without being dependent on international organizations for funding, similarly, as mentioned on Road Transportation and Taxes Section, Turkey has started its first electric bus project in 2023, which indicates that financial limitations may slow down the growth of public transit systems powered by renewable energy, especially when the government is still promoting investments that are directed towards maintaining and expanding fossil fuel infrastructure, which presents how economic dependencies lead to diversion from developing clean energy solutions for the transport sector.

Social scenario of Transportation Sector

Turkey and Germany also portray different social aspects which have an indirect impact on how the energy policies in the transportation sector are formed. According to the Scholarly Community Encyclopedia, social aspects are defined as "patterns of social relationships among individuals, institutions and societies, and how they are influenced by cultural, historical and political norms" (Encyclopedia, 2024).

According to the European Commission's study on social dimensions and environmental policy making, it is important to recognize the connection between the two to avoid having conflicts that can occur when environmental policies impact social aspects negatively or vice versa (Bye et al., 2008). Therefore, to minimize conflict between the environmental and social aspects it is crucial for environmental policy makers to consider social dimensions because it helps to

identify the strengths and weaknesses of a population, which can help to increase the effectiveness of the policies (Bye et al., 2008).
When shaping environmental policies, societies who have higher public awareness on climate change, pollution and biodiversity loss will demand stronger environmental protection from the higher government authorities (Wang et al., 2022). Germany's Environment Agency has conducted a study to measure the environmental awareness of the German citizens. The study consisted of 2073 participants, and the minimum participation age was 14 (Williams et al., 2023). The results of the study showed that 85% of the participants were already experiencing the clear effects of climate change, and 91% of the participants believe that a further economic transformation is needed by the German government to reduce the impacts of climate change (Williams et al., 2023).

Similarly, to measure environmental awareness and people's way of living a study was conducted in the Mediterranean region of Turkey (Özkan & Budak, 2020). The study group consisted of 370 randomly selected participants, and it was found out that 52.4% of participants believe that changing their living habits would not have an impact on solving environmental problems. Only 33.2% of the participants stated that environmental problems have an impact on human health (Özkan & Budak, 2020). In addition to this, 63.5% of the participants claimed to use energy saving bulbs to save energy and lower the electricity bills (Özkan & Budak, 2020). Even though the size of the study groups and questions asked were different, the results from Germany and Turkey show how people perceive the environment. Based on the two studies it can be predicted that German people have higher awareness on environmental issues, when compared to Turkish participants.
However, economic factors do also contribute to Turkish people's environmental behavior, as stated above more than half of the Turkish participants use energy saving bulbs to lower the electricity bills. Therefore, based on the results it can be predicted that German people have direct awareness on environmental matters, whereas Turkish people have awareness on the matter that also impacts their financial budget. So, it can be concluded that German citizens are more likely to demand clean energy policies in the transportation sector for solely environmental purposes, this interpretation is also based on the Turkish government's energy security priority; even though the government states the importance of clean energy, they continue on investing in coal and nuclear energy which is related to financial limitations (IEA, 2021). Therefore Germany's direct awareness on environmental matters are correlated with more efficient clean energy policies in the transport sector.

Similarly, another survey conducted by the European Investment Bank (EIB) in 2021 and 2022 highlights German people's views on climate change in a fast changing world. According to the climate survey 63% of German responders state being in favor of stricter government measures imposing changes on people's behavior in terms of climate change. Similarly the study found that 54% of German citizens believe that changing individual behavior is the best way to fight climate change (EIB, 2021). However people who have left-leaning political views have stronger beliefs in changing individual behavior (65% vs. 46%, a difference of 19 points) (EIB, 2021).
Another Climate study conducted by Konda Research in Turkey interviewed 2595 Turkish citizens and based on the results, Turkish people do not believe in the government's climate

action policies. Only 8% of Turkish society thinks that the Turkish Government is “strongly likely” to take sufficient climate action (Konda Research, 2018).
Additionally, Konda’s study found that only 5.1% of the citizens support coal power plants which are a part of Turkey’s energy transition policies. Alternatively, the citizens stated their strong preference for solar energy (70.5%) and wind energy (52.1%) (Konda Research, 2018).
Therefore, the results from Konda and EIB indicate that the majority of German and Turkish citizens believe that the government is not putting enough effort into shaping environmental policies. However, when the results are compared German citizens have a higher rate of trust in the government in policy making for environmental matters. This is because even though 63% of the German participants claimed that they require stricter government measures, the proportion of Turkish participants who support the government’s environmental action is only 8% which indicates that when two participant groups are compared Turkish participants have extreme dissatisfaction from their government’s environmental policies. This is also supported by the previous findings about Turkish government’s conflicting energy policies (coal investments and Carbon taxes)

In addition to the study results, when the political commitment of Germany and Turkey is taken into consideration, it is portrayed that Germany has a strong political landscape that supports environmental initiatives. The National elections that was held in 2019, showed that German voters do prioritize the environment. According to the European Parliament, The Green Party in Germany had the second highest votes, and has 25/96 seats in the German parliament, the results of the elections indicate that there is a high social demand for sustainability, and environmental protection (European Parliament, 2019).
Whereas for Turkey, the Green Party stopped its operations for the first time due to reduced support in 1994 and reestablished in 2008, however only 4 years later in 2012 the party again stopped operating for the last time in 2012, and the party members merged with the Pro-Kurdish Green Left Party (Sen, 2021). The national elections that took place in 2023, the party did not participate in the elections but supported the biggest opposition candidate who pledged more comprehensive energy policies compared to the current government’s energy plans (Sen, 2021). Hence, the Pro-Kurdish Green Left Party’s direct support for the opposition party is an indication that the current government’s sustainability and energy transition policies do not prioritize clean energy.
It is also important to mention that even though the Previous Green Party was merged with Pro-Kurdish Green Left Party, they have only received 62/600 seats in total which equals to 8.80% of the votes, which predominantly came from Kurdish citizens, because the Pro-Kurdish Green Left Party first priority is the minority rights in Turkey. Therefore, the citizens who voted for the party had mainly voted for their representation in the parliament rather than having more effective policies regarding environmental matters.
Hence, the Turkish parliament does not have a party that solely supports pro-environmental decision making. The limited presence of environmental matters in the parliament could be interpreted in a way that Turkish people have other priorities in politics.
On the other hand Germany’s parliament has a high Green Party presence which indicates that the policies that are formulated are more likely to prioritize sustainability when compared to Turkey.

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However, it is also important to mention that environmental NGOs and activist groups play a significant role in raising awareness and pressuring the government to adopt more sustainable policies. Gezi Park Protests in 2012 which started with protesting the demolition of the Park in the center of Istanbul highlight the growing social demand for environmental protection in Turkey (Farro & Demirhisar, 2014). Similarly, the Akbelen Forest protests in 2020, lasted for more than 2 years and gained national attention about the importance of environmental protection (Christensen & Christensen, 2023). Even though the protests created awareness on environmental matters, and environmental policy making the government stated “They are not interested in environmentalist-looking marginals” and ignored the wishes of the activists. In 2023 60% of the forest was destroyed (Christensen & Christensen, 2023).
This indicates that even though there are growing environmental activists and protests happening, not all end up successful due to the differences between the government and the wishes of the citizens. Hence, based on the Turkish government’s radical behavior regarding the Akbelen Forest, it can be concluded that the government prioritizes financial benefits even if the financial benefits are opposing environmental benefits. Therefore, based on this conclusion it can be assumed that the Turkish government’s clean energy policies in the transportation sector are not always effective and prioritize inclusion of clean energy in the sector. Hence, it can be predicted that Germany who has a higher Green Party presence in the parliament will propose more effective environmental policies including the transport sector.

Discussion

The transformation from fossil fuel based energy resources toward renewable energy resources is essential to combat global climate risks. In order to understand how countries with different economic wealth and social conditions deal with energy transition I have aimed to explore the energy transition policies of Turkey and Germany particularly focusing on the transportation sector to gain insights on how the differences of the countries influence the formulation and implementation of clean energy policies.
The transportation sector has been analyzed by considering economic and social conditions. It has been found that economic wealth plays an important role in how the energy sector’s policies are shaped. Germany’s high financial resources which are linked to its robust economy gives the opportunity to invest in renewable energy technologies and infrastructure. Germany’s long history of economic stability has given them the advantage of being a pioneer in the clean energy policies including the transport sector. For example, Germany has an extensive and effective public transport system, which is also combined with significant EV investments, and biofuel regulations which showcase the country’s ability of adapting clean energy policies in the transport sector.
Turkey has initiated clean energy policies, but the country’s economic instability has caused limitations in further investing in renewable energy technologies. Even though Turkey has renewable energy potential it is hindered with the financial crisis. Turkey’s reliance on international organizations for transportation infrastructure such as the Osmangazi bridge portrays the financial challenges that Turkey faces. Therefore, the Turkish government

prioritizes energy security over aggressive clean energy adoption, hence the priority results in the continuation of coal and natural gas investments.
When the social conditions were taken into consideration, there were some interesting findings for Turkey. It is found that Turkish citizens have a growing environmental awareness related to the citizen's changing environmental habits, however it is important to highlight that the daily economic struggles play an important role in the habit changes. For example the study conducted in the mediterranean region of Turkey found that the participants started using energy-saving light bulbs to reduce their electricity bills which portrays how economic considerations overshadow environmental consciousness. Additionally, the Turkish parliament does not have a strong pro-environment political party which portrays how Turkish citizens may have different priorities from the high authority leaders. Lastly, the current government's stance with the Akbelen forests present how economic considerations outweigh implementing clean energy policies.
On the other hand, German participants presented a relatively high environmental awareness among the public which translates into the citizens demanding stricter environmental policies from the government. In contrast to Turkey, the German parliament has a strong pro-environment political party advocating sustainable and clean energy policies, which emphasizes the public's environmental concerns.

Both Turkey and Germany recognize the need to adapt clean energy policies in the transport sector, and both countries have implemented new strategies to reduce carbon emissions in the sector. For example, both countries have introduced carbon taxes, and Germany initiated a biofuel quota, which emphasizes how Germany follows a stricter strategy which means that German transportation policies are more effective to reduce carbon emissions. Additionally, the ETS plays a central role in reducing carbon emissions in both the transport and building sectors. Meanwhile, Turkey has started to develop its transport infrastructure which has an indirect influence on reducing carbon emissions in the sector. For example, they have initiated projects like the Istanbul-Izmir motorway and upgrading the high-speed railway network to reduce the reliance on private vehicles nationwide. Even though the projects were ambitious, the financial burden on the government has led to increased fees and reduced the effectiveness of the transport infrastructure plan due to reduced accessibility.

Conclusion:

The findings mentioned in the discussion section have several implications for policymakers. Firstly, in order to design successful clean energy policies that focus on the transport sector, the policymakers must adopt a holistic approach where economic, and social dimensions of a country are taken into account. For example, Turkey's economic crisis should have been taken into account when tailoring clean energy policies in the transport sector. The government should have focused on delivering policies that were funded with domestic resources. Additionally, it is crucial to increase public awareness on environmental matters for Turkish citizens to ensure that the citizens demand stricter and effective energy policies.

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For Germany, the government should intend to follow the demands of the public and adopt stricter regulations which match the citizen's demand in environmental matters.

In conclusion, the thesis explored Turkey and Germany's clean energy policies in the transport sector, and revealed that economic and social aspects play an important role in the effectiveness of the policies. Germany's strong economic and relatively high public awareness about environmental matters presented how the government implements ambitious clean energy policies in the transport sector. On the other hand Turkey's economic challenges and different social dynamics present a pragmatic approach to policy implementation in the transport sector. Despite the economic and social differences, the efforts of Turkey and Germany highlight the importance of having tailored and inclusive clean energy policies to achieve effective sustainable energy transitions in the transport sector.
Lastly, the comparative study of Turkey and Germany's clean energy policies in the transportation sector acknowledges several limitations; firstly the study is based on existing literature which does not always capture current trends and facts of the energy policy developments because some of the existing data is from a few years back. Additionally, the Social Scenario of Transport Sector section does not specifically target findings from the transport sector, rather it focuses on environmental awareness of Turkish and German participants and political structure of the two countries. Therefore the future research could include a primary data collection method among Turkish and German citizens regarding the clean energy policies in the transport sector. In addition to this, conducting a separate primary data collection among German and Turkish people who reside in Germany could also give a further indication of whether the social and economic perspectives on environmental matters change when the country of residence is the same.

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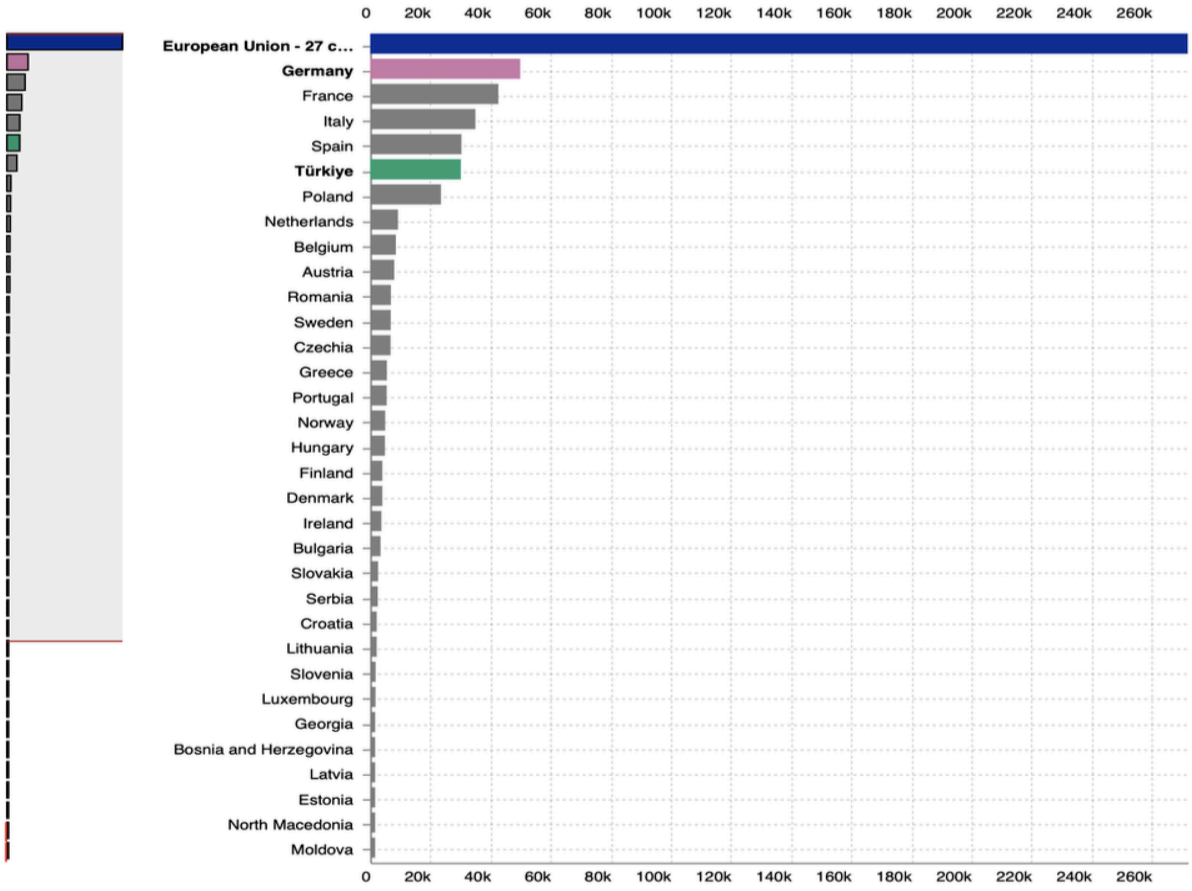
Appendices:

Appendix 1: Final Energy Consumption in Transport by Type of Fuel

In what ways do Germany's and Turkey's economic conditions and social acceptance shape their respective clean energy transition strategies in the transportation sector?

Final energy consumption in transport by type of fuel

Time frequency: **Annual** Energy balance: **Final consumption - transport sector - energy use** Standard international energy product classification (SIEC): **Total** Unit of measure: **Thousand tonnes of oil equivalent**



(Eurostat, 2024)