# THE TRANSITION TO RENEWABLE ENERGY IN TÜRKİYE

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**THE TRANSITION TO RENEWABLE ENERGY IN TÜRKİYE**

Başak Çelik
122674007

Assoc. Prof. Dr. Şadan İnan Rüma
İstanbul Bilgi University

Assoc. Prof. Dr. Can Müslim Cemgil
İstanbul Bilgi University

Assoc. Prof. Dr. Hüseyin Emrah Karaoğuz
Kadir Has University

Date of Approval: 10/1/2024

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**Name Surname:** Başak Çelik

**Signature:**

## ABSTRACT

This study examines the key economic, political, and technical challenges Türkiye faces in its transition to renewable energy. As the sustainability of the current fossil fuel-based energy structure is increasingly questioned, Türkiye’s shift towards renewable energy sources is crucial both for energy security and environmental sustainability. The research seeks to answer the following question: What are the primary obstacles Türkiye encounters in its transition to renewable energy, and how does this shift impact the country's energy security, sustainable development goals, and foreign trade relations? In this context, the study analyzes the transformation of Türkiye’s energy policies, the barriers to renewable energy investments, and the potential effects of this transition on the national economy and external trade. Specifically, it evaluates how reducing reliance on energy imports can improve Türkiye's trade balance and foster new opportunities in the renewable energy sector, such as the export of green technologies. The role of renewable energy in achieving Türkiye's sustainable development goals and ensuring energy security is also assessed. The research focuses on technological advancements in the energy sector, regulatory frameworks, and the effective utilization of financial resources, offering a comprehensive assessment of Türkiye’s path toward its renewable energy targets and its broader impact on foreign trade dynamics.



Keywords: Renewable Energy Resources; Energy Policies; Energy Dependence; Green Energy; Energy Transition; Green Economy

# ÖZ

Bu çalışma, Türkiye'nin yenilenebilir enerjiye geçiş sürecinde karşılaştığı temel ekonomik, politik ve teknik zorlukları incelemektedir. Fosil yakıtlara dayalı mevcut enerji yapısının sürdürülebilirliği giderek sorgulanırken, Türkiye'nin yenilenebilir enerji kaynaklarına yönelimi hem enerji güvenliği hem de çevresel sürdürülebilirlik açısından kritik bir öneme sahiptir. Araştırma, şu soruya yanıt aramaktadır: Türkiye'nin yenilenebilir enerjiye geçişinde karşılaştığı başlıca engeller nelerdir ve bu geçiş, ülkenin enerji güvenliği, sürdürülebilir kalkınma hedefleri ve dış ticaret ilişkilerini nasıl etkilemektedir? Bu bağlamda çalışma, Türkiye'nin enerji politikalarının dönüşümünü, yenilenebilir enerji yatırımlarının önündeki engelleri ve bu geçişin ulusal ekonomi ile dış ticaret üzerindeki potansiyel etkilerini analiz etmektedir. Özellikle, enerji ithalatına bağımlılığın azalmasının Türkiye'nin ticaret dengesi üzerindeki olumlu etkileri ve yenilenebilir enerji sektöründe yeşil teknoloji ihracatı gibi yeni fırsatların ortaya çıkışı değerlendirilmektedir. Ayrıca, yenilenebilir enerjiye geçişin Türkiye'nin sürdürülebilir kalkınma hedefleri ve enerji güvenliği üzerindeki rolü de ele alınmaktadır. Çalışma, enerji sektöründeki teknolojik gelişmeler, mevzuat düzenlemeleri ve finansal kaynakların etkin kullanımı üzerine odaklanarak Türkiye'nin yenilenebilir enerji hedeflerine ulaşma sürecini ve dış ticaret dinamiklerine olan geniş etkisini kapsamlı bir şekilde değerlendirmektedir.

Anahtar Kelimeler: Yenilenebilir Enerji Kaynakları; Enerji Politikaları; Enerji Bağımlılığı; Yeşil Enerji; Enerji Dönüşümü; Yeşil Ekonomi

To my family which gave me the courage to go on and I would like express my gratitude to my advisor, Assoc. Prof. Dr. Şadan İnan Rüma, for him guidance.

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| | |
|---|---|
| CBRT: | The Central Bank of The Republic of Türkiye |
| EBRD: | The European Bank for Reconstruction and Development |
| EGD: | The European Green Deal |
| EIB: | The European Investment Bank |
| EU: | The European Union |
| GDP: | Gross Domestic Product |
| GW: | Gigawatt |
| IPE: | International Political Economy |
| IRENE: | International Renewable Energy Agency |
| NDC: | National Contribution Declaration |
| RA: | Regulatory Approach |
| TANAP: | Trans-Anatolian Natural Gas Pipeline |
| TEIAS: | Turkish Electricity Transmission Company |
| TOE: | Ton of Oil Equivalent |
| UNEP: | United Nations Environment Programme |
| UNFCCC: | United Nations Framework Convention on Climate Change |
| YEK: | Renewable Energy Law |

# INTRODUCTION

It has been written to study to the question that Türkiye's increasing energy imports and the resulting energy dependence problem can be reduced by turning to renewable energy sources. Türkiye's energy landscape has undergone significant changes over the past two decades, particularly in terms of its imports and external dependence. According to the available sources, Türkiye has experienced substantial growth in its energy demand across all sectors (Ozturk, Bezir, & Ozek, 2009) . This increased demand has resulted in a heavy reliance on energy imports, as Türkiye's domestic production of primary energy sources such as oil and natural gas is very limited compared to its consumption needs.

Data from the Turkish Ministry of Energy shows that while per capita energy consumption in Türkiye was 0.94 the ton of oil equivalent (toe) in 1990, it was 1.76 toe in 2020. In 2020, when the distribution of energy consumption by sources is analyzed, 28.7% of oil, 27.6% of solid fuels, 27% of gas and 16.7% of renewable energy sources were consumed (Demirelli, Turan, Ertürk, & Özmumcu, 2023). Over the past two decades, Türkiye has experienced a notable rise in its energy imports due to the ongoing growth in energy consumption. Based on the data of Turkish Ministry of Energy from 1998 to 2006, Türkiye's reliance on foreign sources for energy security has been a significant issue. The level of reliance on external sources for fuels like oil, natural gas, and coal has remained consistently high, ranging from 82% to 96.6%.

This indicates that Türkiye has relied on energy imports to meet its energy needs, making it vulnerable to fluctuations in global energy markets. As per the 2023 Inflation report by Central Bank of The Republic of Türkiye (CBRT), the proportion of GDP represented by energy imports increased from 5% in the years 2013-2021 to a record high of 11% in the third quarter of 2022. Türkiye plays a crucial role in international relations due to its strategic location and diversification of energy sources. The government plays an active role in the transportation of oil and natural gas, establishing itself as a major oil transit hub globally.

Additionally, Türkiye is becoming more engaged in gas pipeline initiatives, which boosts its position as a key gas transit nation. This energy potential and role in international relations have several implications. Firstly, Türkiye's energy potential offers both economic opportunities and challenges. On one hand, Türkiye's energy potential allows for the development of its domestic energy infrastructure and the generation of electricity from renewable sources such as hydroelectric power. (Yüksel, 2009, pp. 100-109) On the other hand, the country's dependence on imported energy resources poses challenges in terms of energy security and vulnerability to geopolitical tensions.

Secondly, Türkiye's energy potential and role in international relations have implications for regional dynamics and cooperation. Türkiye's strategic location between Europe, the Middle East, and Asia positions it as a key energy hub in the region. This allows Türkiye to play a significant role in energy supply diversification and transportation, fostering regional cooperation and enhancing its diplomatic relations with neighboring states.

Additionally, Türkiye's energy potential and role in international relations also have implications for its energy diplomacy and foreign policy. Türkiye has been utilizing its energy resources and strategic location to pursue an active energy diplomacy, seeking to strengthen its ties with energy-producing and consuming countries. Through energy partnerships, pipeline projects, and energy trade agreements, Türkiye aims to enhance its energy security, boost its economy, and increase its geopolitical influence. Türkiye's energy potential has the potential to significantly impact its domestic economy and international relations. By leveraging its energy resources and strategic location, Türkiye could become a major player in regional energy markets and strengthen its position as an energy hub in the global arena. In addition, Türkiye's energy potential and role in international relations also have implications for global efforts towards renewable energy development and sustainability. (Gustav, et al., 2008)

Türkiye could make a big impact on worldwide renewable energy objectives and support sustainable development. Türkiye has the capacity to play a major role in achieving international renewable energy targets and advancing sustainable development. Relying on energy imports is a major factor that poses a significant threat to Türkiye during crises.

Türkiye has been putting in place policies and strategies to boost the growth of renewable energy sources to reach this objective. One example is how Türkiye has been focusing on wind, solar, and hydroelectric power initiatives to increase its renewable energy capabilities. A key factor in this expansion is the favorable regulations and incentives provided by the government to promote investment in renewable energy. The country offers feed-in tariffs, tax breaks, and other financial aids to encourage the development of renewable energy projects.

Renewable energy projects have gained significant momentum in Türkiye, driven by both government initiatives and private sector involvement. (Purvins, 2011) The loan application was implemented with no financial obligation as of October 1, 2023, and will continue until December 31, 2025. This period has been called ‘the transition period’. The European Green Deal targets are an action plan with targets for 2030 and 2050, which is basically a continuation of the Kyoto Protocol and the Paris Climate Agreement and encourages countries to green transformation. The Deal aims at an overall 'green order' with a carbon-neutral target, revolutionizing many sectors individually and nationally. The European Union supports ‘the transition period’ of the EGD with four key components. (The Green Deal , 2019)

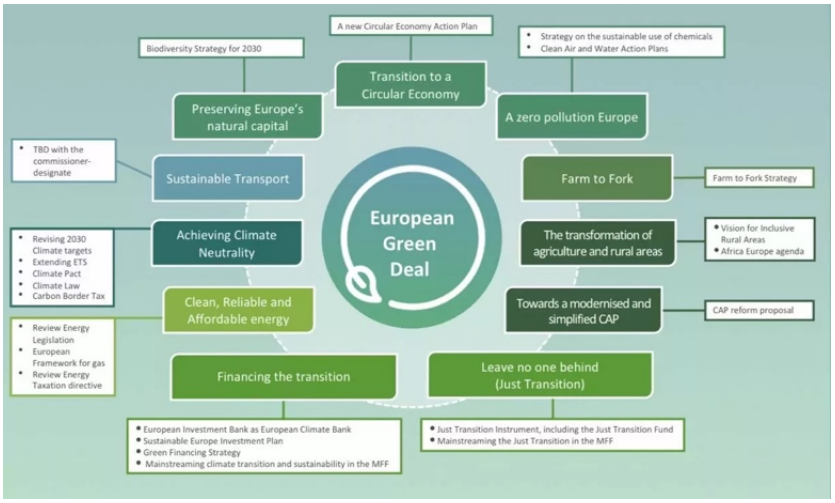
(i) offering monetary assistance,

(ii) establishing fresh goals,

(iii) ensuring that no country is left behind and

(iv) enhancing adaptive capacity. (Merve Ersoy Mirici, 2022)

**Figure 1.1. Goals of European Green Deal**




(Source: *European Council Council of the EU (2019). A diagram on aims*.)

Türkiye's increased investment in renewable energy, in accordance with its objective of enhancing its energy independence, paves the way for closer collaboration with the EU in the energy sector. Türkiye's objective of achieving a 30% share of renewable energy in 2023 is aligned with the EU's energy strategies. This alignment coincides with the EU's energy security strategies, encouraging an increase in power purchase and sale agreements, joint energy projects and technology transfers between the two parties.

To illustrate, Türkiye's solar and wind energy projects are consistent with the European Union's (EU) objectives concerning energy efficiency and the transition to a low-carbon economy. Türkiye's investment in renewable energy projects, with the backing of EU financing institutions such as the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD), serves to reinforce these relationships. Furthermore, there is the possibility of integrating Türkiye's research and development projects in renewable energy with EU research programmes such as Horizon Europe.

Another example of the transition to renewable energy is Türkiye's efforts to align itself with the European Energy Union.

Türkiye's contributions to energy infrastructure projects with the EU, particularly its role in projects such as the Trans-Anatolian Natural Gas Pipeline (TANAP) and the Euro-Mediterranean Energy Corridor, serve to diversify and secure energy supplies, thereby reinforcing Türkiye's energy cooperation with the EU. (Bakanlığı, Avrupa Birliği Emisyon Ticaret Sistemi, 2023) The objectives set forth by Türkiye in its 2030 National Contribution Declaration (NDC) are consistent with the environmental policies of the European Union (EU), thereby facilitating a more unified EU-Türkiye partnership on environmental and climate-related matters. Türkiye's reorientation of its energy policies in accordance with renewable resources serves to diminish energy dependence and fortify the bond between Türkiye and the EU, thereby facilitating the formulation of a more unified strategy to attain shared objectives. This process engenders a dynamic relationship that is mutually beneficial in areas such as energy security, environmental sustainability and economic cooperation.

The transition to renewable energy sources worldwide is significant for Türkiye and the European Union's bilateral relationship. Due to its advantageous position and plentiful renewable energy sources, Türkiye can focus more on moving from fossil fuels to renewable energy for a secure long-term energy future. Significantly, the energy shift occurring in Türkiye is in line with the EU's efforts to decrease reliance on energy and fight against climate change by utilizing renewable energy technologies throughout the region.

Türkiye's beneficial geographical characteristics, including its favorable weather and various landscapes, offer the country plentiful renewable energy sources that can be widely utilized to fulfill the increasing energy needs. As Türkiye continues to focus on growing its renewable energy industry, it appears likely that its relationship with the EU will go through a change. Türkiye's energy transition faces both opportunities and challenges due to the EU's ambitious goals for renewable energy deployment and emissions reductions outlined in initiatives like the European Green Deal.

This research also emphasizes the significant advancements Türkiye has achieved in expanding its renewable energy industry, especially in solar and wind energy fields.

By utilizing plentiful solar and wind resources, Türkiye can lessen reliance on importing fossil fuels and alleviate environmental impacts from traditional energy sources.

Moreover, the literature studies on 'energy independence and security in Türkiye' underscore the intermittent availability and variation in energy intensity of most renewable energy technologies. The importance of improvements in energy storage technologies and grid management systems to guarantee a dependable and consistent provision of renewable energy. It claims that promoting renewable energy technologies is crucial for addressing concerns about energy security, economic growth, competitiveness, and even health.

As a result of this, the literature studies on 'energy independence and security in Türkiye' emphasize the significance of renewable energy as a solution for diversifying Türkiye's energy mix, reducing dependency on fossil fuel imports, and enhancing energy security. Second, Türkiye's energy potential enables it to strengthen its energy security and reduce dependence on external sources, enhancing its economic stability and autonomy in the global energy market.

Third, Türkiye's energy potential, particularly in renewable energy sources, positions it as a key player in global efforts towards sustainability and clean energy transition. Lastly, Türkiye's energy potential also opens opportunities for energy trade and partnerships with other countries, promoting economic cooperation and fostering stronger diplomatic ties. Therefore, Türkiye's energy potential plays a crucial role in shaping its domestic economy and international relations.

Finally, for Türkiye, it is essential to focus on investing in a strong power infrastructure and market. This will allow for effective incorporation and distribution of renewable energy sources, guaranteeing the best allocation and use of renewable energy on a bigger level. The examination of renewable energy sources in Türkiye and the implementation of strategies and initiatives to reduce dependence on external sources will be assessed.

In addition, since sustainability implementation should be made to support environmental sustainability during the consumption of these resources.

In conclusion, prospects regarding the issue of rising use of renewable energy sources in Türkiye, along with potential challenges and proposed solutions, will be presented.

Türkiye has been making great progress in developing and using renewable energy sources to support environmental sustainability.

# LITERATURE REVIEW

The topic of Türkiye's energy independence and security is significant in literature, with several studies exploring different facets of the issue. It highlights the significance of renewable energy as a key factor in safeguarding the energy systems' security in these nations. (Chentouf & Allouch, 2017). Türkiye's energy transition is vital for economic development, social inclusion, and environmental sustainability in the country. It is also mentioned that the potential for renewable energy resources in Türkiye is enormous and can play a significant role in the country's future energy portfolio (Tanil, 2023, pp. 88-101).

## 2.1. Theories of International Political Economy

Theories of international political economy (IPE) provide a valuable conceptual framework for analyzing energy policies and dependency relations. The dependency theory and world-system theory posit that the external dependence of developing countries on energy resources reflects Periphery-Centre relations in economic and political terms. In accordance with these theories, countries occupying a position of energy centrality exert control over peripheral countries through the facilitation of energy trade and the transfer of technology. For developing countries such as Türkiye, this dependence results in the expenditure of considerable sums of foreign currency on energy imports, thereby increasing economic vulnerability. (Wallerstein, 1974)

In contrast, the liberal theory of interdependence posits that states should pursue alternative sources to guarantee their own energy supply security. Within this framework, transforming Türkiye's energy policies and shifting to renewable energy sources will not only diminish external dependence but also fortify economic and political self-sufficiency. By enhancing renewable energy investments, Türkiye is taking steps towards energy independence and could curtail its reliance on central countries. (Hornborg, 2001)

An evaluation of Türkiye's shift towards renewable resources in its energy policies from the perspectives of growth critique and degrowth reveals that the current growth-oriented energy policy is unsustainable in the long term. Türkiye's growth strategy, which is based on the utilization of fossil fuels, has the effect of increasing environmental destruction, increasing carbon emissions and deepening external dependency. The growth critique proposes a reshaping of energy policy that prioritizes not only economic growth but also environmental sustainability.

In this context, Türkiye should transition towards a 'green development' paradigm, which entails the construction of a sustainable energy infrastructure. The degrowth perspective advocates for the limitation of energy consumption and the increased utilization of domestic, renewable resources, with the objective of aligning economic growth and carbon emission reduction targets. This transition could enhance Türkiye's economic resilience by reducing its high import dependence on fossil fuels.

### 2.1.1. The Regulatory Approach

An analysis of Türkiye's transition to renewable energy through the lens of the Regulatory Approach (RA) reveals the pivotal role of the state in this field and the necessity for restructuring the energy market. The RA posits that within the context of capitalist economic cycles and production models, the state is a principal actor in shaping economic development. It is therefore recommended that Türkiye reinforce its regulatory procedures in accordance with its objective of reducing energy dependence and developing a sustainable development model. (Boyer, 2001)

Türkiye's strategy of investing in renewable energy represents a crucial step that will not only provide a safeguard against fluctuations in global energy markets but also free the country from its reliance on imported energy resources.

To more effectively implement Türkiye's policies towards energy independence within the framework of the RA, it is important for the state to increase incentives and support policies, support domestic production and steer the energy market in a balanced manner.

This approach has the potential to achieve the country's economic and environmental sustainability goals in a more enduring and comprehensive manner. (Huber, 2013)

### 2.1.2. The Downsizing and Degrowth Perspective

The downsizing perspective posits that energy consumption and economic growth should be curtailed, and that social welfare should be distributed in a more equitable manner. In countries that are dependent on energy imports, such as Türkiye, limiting energy consumption can facilitate not only a reduction in carbon emissions but also the assurance of a secure energy supply. In this context, Türkiye's adoption of a downsizing perspective in its renewable energy policies underscores the necessity for a reassessment of energy-based economic growth. (Hickel, 2019)

The degrowth perspective posits that high energy consumption is incompatible with Türkiye's sustainable development goals, particularly in the context of economic growth. It is crucial for Türkiye to implement a policy that prioritizes domestic renewable resources overgrowth-oriented energy policies. This is necessary to ensure economic independence and to preserve the ecological balance. (Herbert, 2019)

Türkiye's transition towards renewable energy sources in its energy policies represents a pivotal step towards achieving economic and environmental sustainability when evaluated against the framework provided by international political economy theories and the growth critique. The Regulatory Approach places emphasis on the importance of the regulatory role of the state, whereas the downsizing perspective proposes a sustainable development model. The restructuring of energy policies will not only enhance Türkiye's economic autonomy but will also make a substantial contribution to combating the global climate crisis.

### 2.1.3. The Neo-Marxism

The argument put forth by neo-Marxist theorists is that in the capitalist system, the natural resources of peripheral countries are exploited for the economic benefit of central countries. This exploitation, they contend, gives rise to an asymmetrical dependency relationship between the two groups of countries. This dependence, particularly on fundamental resources such as energy and raw materials, serves to reinforce the accumulation of capital in the central countries, while simultaneously rendering the peripheral countries perpetually reliant on external borrowing and imports. Türkiye's external dependence in the energy sector and fossil fuel imports serve as a mechanism that perpetuates this cycle of dependency.

The importation of energy resources not only results in the loss of valuable economic resources but also constrains Türkiye's capacity for independent foreign policy action and complicates the pursuit of sustainable development. (Burkett, 2005) From the perspective of neo-Marxism, the evolution of energy policies for peripheral countries towards a model that is no longer aligned with the interests of centre countries represents a significant step towards increasing their independence from the global capitalist system.

Türkiye's transition towards renewable energy sources in alignment with its objective of energy independence can be perceived as a transformative process that has the potential to disrupt the existing dependency relationship. By increasing investments in renewable energy and developing domestic production capacity, Türkiye can simultaneously meet its energy needs at lower costs and enhance its economic resilience. From the perspective of neo-Marxist theory, this transformation will serve to weaken the exploitative relationship between the centre and the periphery, while conferring significant benefits in terms of energy independence for Türkiye as a peripheral country. (Newel, 2013)

The objective of energy independence is regarded as a fundamental element of economic and political autonomy within the context of Neo-Marxism. A reduction in Türkiye's dependence on energy imports has the dual benefit of improving the country's foreign exchange balance and contributing to a stronger foreign policy stance.

To illustrate, as the outflow of foreign exchange from fossil fuel imports diminishes, Türkiye becomes increasingly economically independent from the influence of central countries. Such a shift would not only render Türkiye more resilient to the influence of central economies but would also facilitate the development of more sustainable and long-term solutions to global challenges such as climate change. Consequently, Türkiye's renewable energy strategy serves as a means of establishing a framework that reinforces the country's economic and political autonomy, extending beyond the objective of maintaining ecological equilibrium.

Furthermore, as Türkiye's investments in domestic and renewable energy resources increase, it becomes necessary to reconsider the dependency-based production models currently in place in peripheral economies from a neo-Marxist perspective. By reducing their energy import requirements, countries such as Türkiye can direct their attention towards pursuing more endogenous development goals. (Sovacool, 2016) A reduction in energy dependence enables Türkiye to effect not only a transformation of its economic structure, but also of its social and environmental policies. Because of the transition to renewable energy sources, Türkiye will become less reliant on capital flows, which will in turn facilitate the creation of a more inclusive and equitable economy. In this context, investments in renewable energy projects serve not only an economic development purpose, but also challenge the global capitalist system by reducing Türkiye's dependence on the international system.

From a neo-Marxist perspective, Türkiye's transition to renewable energy could represent a turning point in the country's struggle for economic and political independence. The reduction of energy imports has the dual benefit of alleviating the country's external dependence and foreign exchange deficit, while simultaneously contributing to the establishment of a sustainable development model based on Türkiye's own resources.

This transformation presents the opportunity to shape energy policies in accordance with national interests, thereby enhancing Türkiye's resilience to the exploitative system perpetuated by central capitalist countries.

The pursuit of energy independence enables Türkiye to become more autonomous in its foreign policy and to assume a more proactive role in addressing the global climate crisis. The transition to renewable energy sources will ensure environmental and economic sustainability for Türkiye, while also facilitating the creation of an independent development model that offers an alternative to the global system dominated by centralized countries. (Aras, 2015)

# TÜRKİYE'S ENERGY ECONOMY

The importance of renewable energy in achieving energy independence and security in Türkiye is inevitable. They highlight the importance of promoting renewable energy technologies to address issues related to energy security, economic growth, competitiveness, and public health. They acknowledge Türkiye's capacity for renewable energy sources and the importance of utilizing this capacity to vary the country's energy mix and lessen dependence on imported fossil fuels. Investing in renewable energy in Türkiye can also yield substantial benefits for energy security, offering a dependable and sustainable energy source that is not susceptible to price fluctuations and geopolitical tensions related to fossil fuel imports. Nevertheless, Türkiye also needs to tackle issues like harmonizing its renewable energy goals with its increasing energy consumption and guaranteeing the incorporation of renewable energy sources into its current power grid system. (Omar Ellabban, 2014)

## 3.1. Renewable Energy Power of Türkiye

Global geographical factors will also influence the types of infrastructure needed to produce and distribute energy. Türkiye's geography offers considerable potential to produce renewable energy. For instance, Türkiye's extensive coastline and inland waterways provide greater scope for the construction of hydroelectric dams and greater potential for offshore wind farms.

Türkiye benefits from significant solar exposure throughout the year, particularly in its southern regions, while its western and northern coasts experience strong winds. Türkiye enjoys a considerable amount of sunshine throughout the year, with an average annual duration of 2,737 hours and a solar energy potential of 1,600 kWh/m², particularly in the southern regions. The average wind speed reaches 6-8 m/s on the west and north coasts, creating favorable conditions for wind energy generation. (Demirelli, Turan, Ertürk, & Özmumcu, 2023)

These data reinforce Türkiye's advantage in utilizing renewable energy resources. The exploitation of wind, solar, and hydroelectric power plants is contingent upon geographical climatic conditions, topography, and accessibility to water resources. Türkiye's aim to utilize its plentiful water resources for energy is highlighted by the strategic building of dams like the Atatürk Dam on the Euphrates and the Keban Dam on the Murat River. Moreover, hydroelectric power is essential in Türkiye's renewable energy mix, aiding in the nation's energy security and sustainability goals. As Türkiye continues to investigate renewable energy options, the development of hydroelectric power remains a cornerstone of its energy strategy, capitalizing on its geographical advantage and natural resources in an effective manner.

Geothermal energy is gained by bringing the heat from deep within the earth to the surface. These sources in Türkiye play a vital role in lessening the country's reliance on imported fuels, improving energy security, addressing climate change effects, and advancing sustainable development. (Tan, Toku, & Türker, 2016) Some significant geothermal areas in Türkiye include:

*1. Kızıldere Geothermal Field:* Located in Afyonkarahisar, this field is one of Türkiye's largest geothermal energy production areas. It is used for both electricity generation and thermal tourism.

*2. Denizli-Pamukkale Geothermal Field:* This region features geothermal resources used for both electricity generation and thermal tourism.

*3. Manisa-Salihli Geothermal Field:* Situated in Salihli, Manisa, this field hosts projects utilizing geothermal energy for electricity generation and greenhouse heating.

*4. Aydın Germencik Geothermal Field:* Geothermal resources in this area are employed for electricity generation and heating.

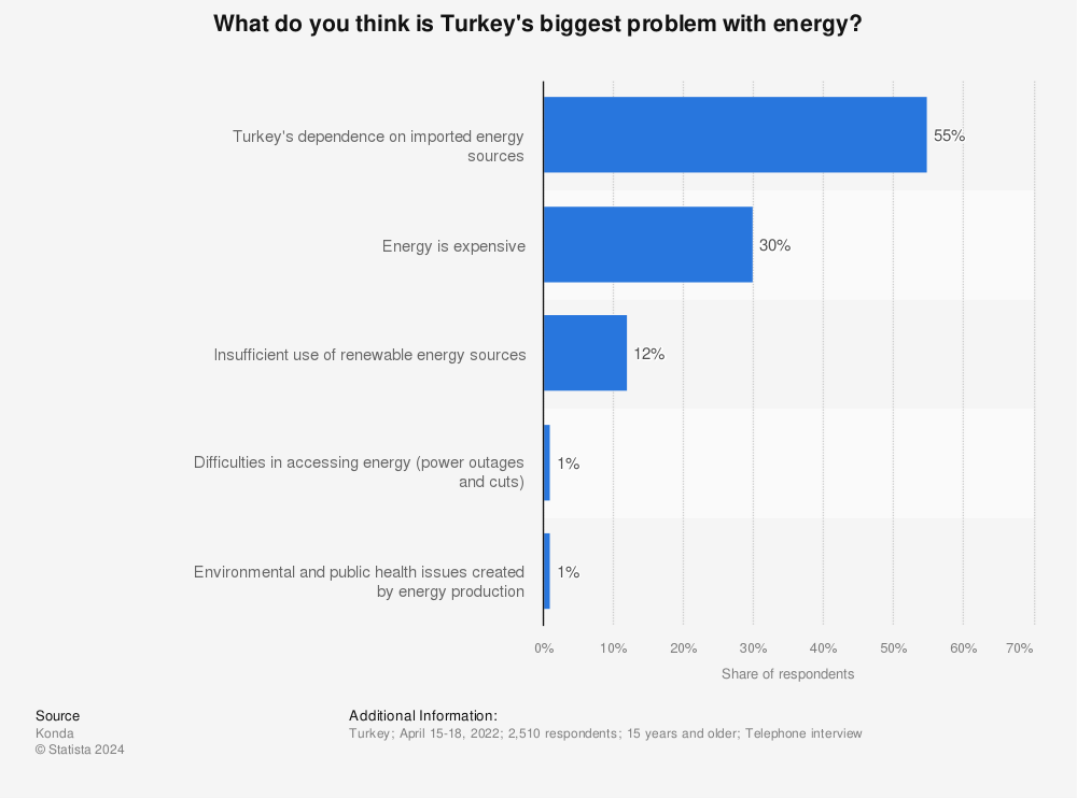
Nevertheless, the presence of rugged terrain and seismic activity may further complicate the development of infrastructure, thereby making energy production more challenging and costly. When evaluated by energy type, it is seen that Türkiye is almost completely dependent in natural gas with 99.09% in 2020. (Yalçın & Doğan, 2023)

Türkiye has been making efforts in the past few years to reduce this reliance and broaden its energy resources. The search can be explained by a mix of reasons, such as Türkiye's expanding economy, rising energy needs, and the unpredictability of energy sources in the area.

### 3.1.1. Energy Deficit of Türkiye

Even though, over recent years, efforts to reduce energy dependence and diversify energy sources have been linked to Türkiye, the country still faces a few challenges in this regard. The increasing in energy demand could result in greater external reliance if the nation's energy supply security were not to be legally guaranteed. Furthermore, at the regional level, the volatility of energy supply may give rise to insecurity in the regions from which Türkiye derives its energy imports, thereby indicating a close link between energy strategies and Turkish foreign policy. International energy market instability and geopolitical risks can also impact Türkiye's push to reduce external dependence in energy policies. The ability of Türkiye to successfully handle the complex challenges mentioned earlier will determine the diversification of energy sources and the shift towards sustainable energy.

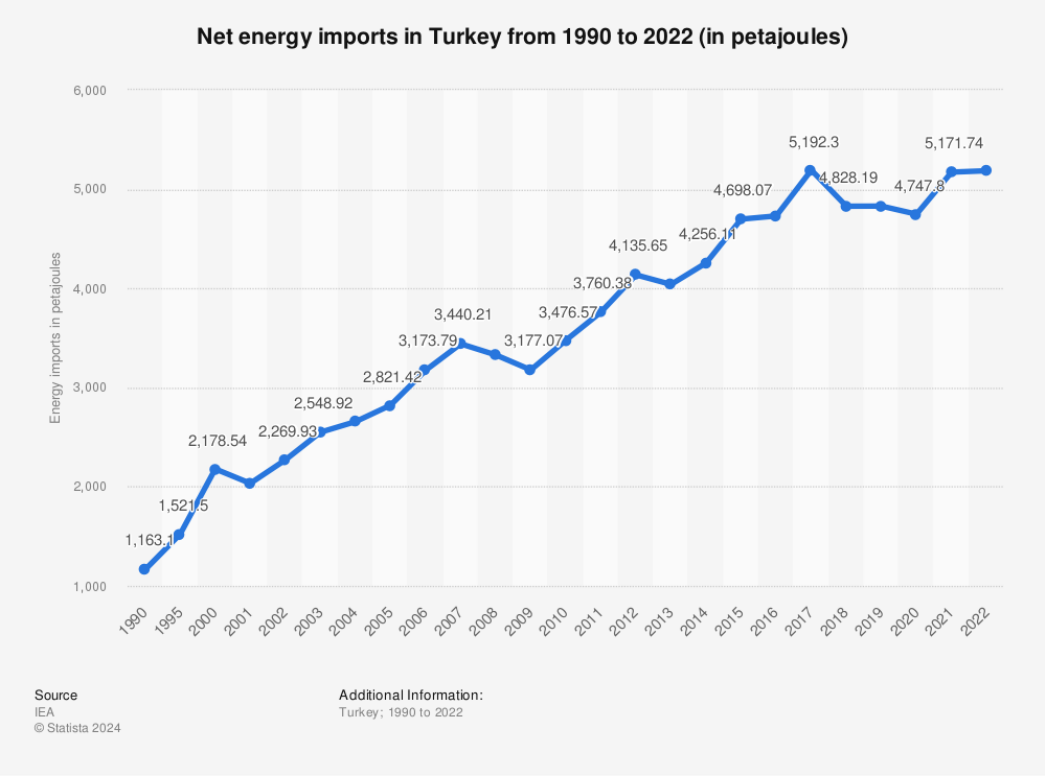
**Figure 3.1. Survey: Türkiye's Biggest Problem with Energy**




(Source: *Zeynep Dierks (2022). Public Opinion on Energy Related Problems in Türkiye*.)

The figure 3.1. shows that the results of the KONDA Energy Consumption and Energy Survey indicate that the Turkish population's primary concern regarding energy is the country's dependence on imported energy resources, followed by the significant increase in energy prices. (KONDA, 2022) Even though Türkiye's position as a country that imports energy leads to changes in its current account balance, the impact of energy imbalances on this balance in 2022 is significantly higher than in the past.

**Figure 3.2. Net Energy Imports in Türkiye from 1990-2022**




(Source: *Zeynep Dierks (2024). Net Energy Imports in Türkiye 1990-2022*.)

The rise in energy demand in Türkiye is directly correlated to the surge in energy supply imports from foreign countries. Based on IEA (International Energy Agency) data from 2018-2022, the energy supply relies on fossil fuel sources like oil, coal, and natural gas. Coal energy supply is decreasing, but oil energy supply is steadily rising, with fluctuations in natural gas energy supply. Non-renewable energy sources still dominate with a supply range of 1,500,000-2,000,000 terajoules compared to renewable energy's range of 500,000 terajoules.

Nevertheless, the nation is striving to decrease its reliance on oil imports for energy production. In addition to the existing potential resources, projects and agreements that will ensure their implementation are important for the utilization of resources.

The most important countries in Türkiye's energy imports are Russia, Iraq, Iran, Azerbaijan and Algeria. It is possible to say that especially Russia holds the global energy export power. The war between Ukraine and Russia has once again shown how important the issue of energy security is. If Russia cuts off or reduces the flow of gas, it will cause a major energy risk for countries that import energy from Russia. (Arman Zafer & Metin, 2023)

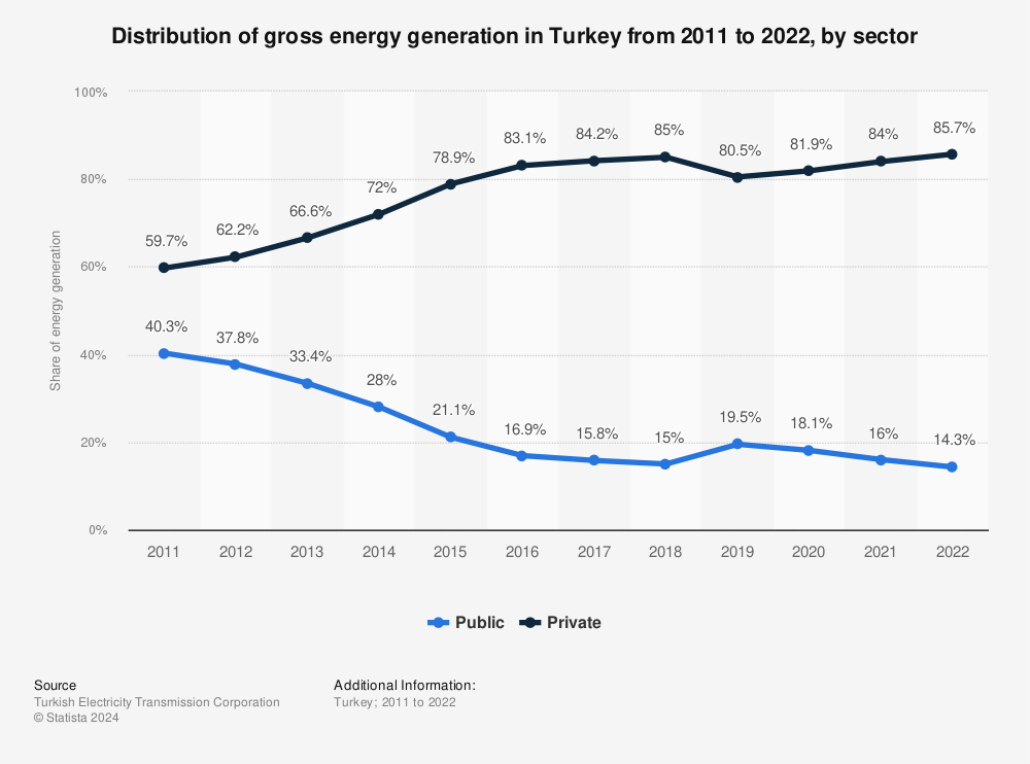
### 3.2. Energy Strategies of Türkiye

Türkiye has introduced various measures and strategies aimed at encouraging the growth and use of renewable energies. The stated policies aim to encourage innovation and investment in renewable energy technologies. This includes setting ambitious goals for the percentage of renewable energy in the total energy consumption, as well as putting in place rules and rewards to promote investment and creativity in renewable energy.

The Turkish government has implemented various policies to support renewable energy projects since 2005 by implementing Renewable Energy Law (YEK). One such policy is the renewable energy production tax credits, which provide financial incentives to companies that generate electricity from renewable sources.

Another program by the government is offering rebates for installing renewable energy systems, encouraging people and companies to invest in renewable energy infrastructure. Setting up markets for renewable energy certificates is a crucial government action that enables companies to exchange and vend renewable energy credits, encouraging more investments in renewable energy initiatives. Türkiye's renewable energy capacity has grown due to these policies, aiding the country in moving towards a more sustainable energy system. These initiatives have not just helped to diversify Türkiye's energy sources but have also produced substantial economic gains for the nation.

**Figure 3.3. Distribution of Gross Energy Generation of Türkiye by Sector**




(Source: *Zeynep Dierks (2024). Share of Gross Energy Generation in Türkiye 2011-2022, by Sector*.)

In addition to the regulatory policies of the state, it will be of great importance to provide incentives to encourage the private sector to invest in renewable energy. The data from the Turkish Electricity Transmission Company (TEIAS) for 2022 indicates that the private sector is the primary contributor to gross energy production in Türkiye.

This is evidenced by the distribution of energy production by sector between 2011 and 2022. The increasing cost of energy and the technological requirements of the sector have led to a significant increase in the share of the private sector in energy production in Türkiye, which reached 85.7% in 2022. It is significant to consider the incentives and policies that the state may implement to encourage the private sector to switch to renewable energy sources to produce energy.

The various forms of support available for those engaged in RE are presented. (Hafize Nurgül Durmuş ŞENYAPAR, 2023) The 2023 Annual Report of the Republic of Türkiye Ministry of Energy and Natural Resources was analyzed with a view to identifying the way performance evaluations were conducted. In accordance with this;

I. *The extent of the energy savings resulting from the projects supported in the field of energy efficiency is as follows:* The targeted indicator value was 15,000, the target was exceeded with a realization value of 24,137.74 at the end of 2023.
II. *The quantity of support provided in the field of energy efficiency is as follows:* While the targeted indicator value was 55, the target was exceeded with a realization value of 100 at the end of 2023.
III. *The number of projects that have been realized through the utilization of renewable energy resources (including those facilitated by the YEKA mechanism and analogous initiatives) is as follows:* Although the targeted indicator value was 1, the target was not achieved, with a realization value of 0 at the end of 2023.
IV. *The completion rate of the energy sector section of the annual greenhouse gas inventory is as follows:* Although the targeted indicator value was 100, the target was only partially achieved with a realization value of 100 at the end of 2023.

Performance indicators for the utilization of renewable energy sources.

I. *Installed electricity capacity based on solar energy:* Targeted indicator value is 11,700, realization value at the end of 2023 is 11,315.
II. *Installed electricity capacity based on hydroelectric energy:* Targeted indicator value is 32,605, end-2023 realization value is 31,964.
III. *Installed capacity based on geothermal energy and biomass energy:* Targeted indicator value 4,088, end-2023 realization value 4,152.

IV. *Installed capacity based on wind energy:* Targeted indicator value 11,883, end-2023 realization value 11,803.

V. *Share of renewable resources in electricity generation:* Targeted indicator value 41.50, end-2023 realization value 42.15.

According to the performance evaluation of the objectives of the Reducing External Dependence in Energy sub-programmed;

I. *Natural gas storage facilities reproduction capacity:* Expected target was not achieved.

II. *Natural gas transmission network input capacity:* The expected target was partially achieved (Target 479, Realized 455).

III. *Natural gas underground storage capacity:* The expected target was not achieved.

IV. *Share of natural gas in electricity generation:* The expected target was partially achieved (Target 20.70, Realized 21.40).

V. *Ratio of technical and non-technical losses in electricity distribution:* The expected target was partially achieved (Target 10.14, Actual 10.46).

VI. *Share of domestic resources in electricity generation:* The expected target was partially achieved (Target 57.70, Actual 56.80).

VII. *Loss rate in electricity transmission:* The expected target was partially achieved (Target 1.90, Realized 1.98).

VIII. *Completion rate of Mersin Akkuyu Nuclear Power Plant construction:* The expected target was achieved.

IX. *Installed capacity of domestic coal power plants:* The expected target was achieved.

X. *Amount of electricity generated from domestic coal:* The expected target was partially achieved (Target 54.70, Realized 46.78).

It is projected that the installed electricity capacity will reach 189.7 GW in 2035, which is double the amount in 2020 at 95.9 GW.

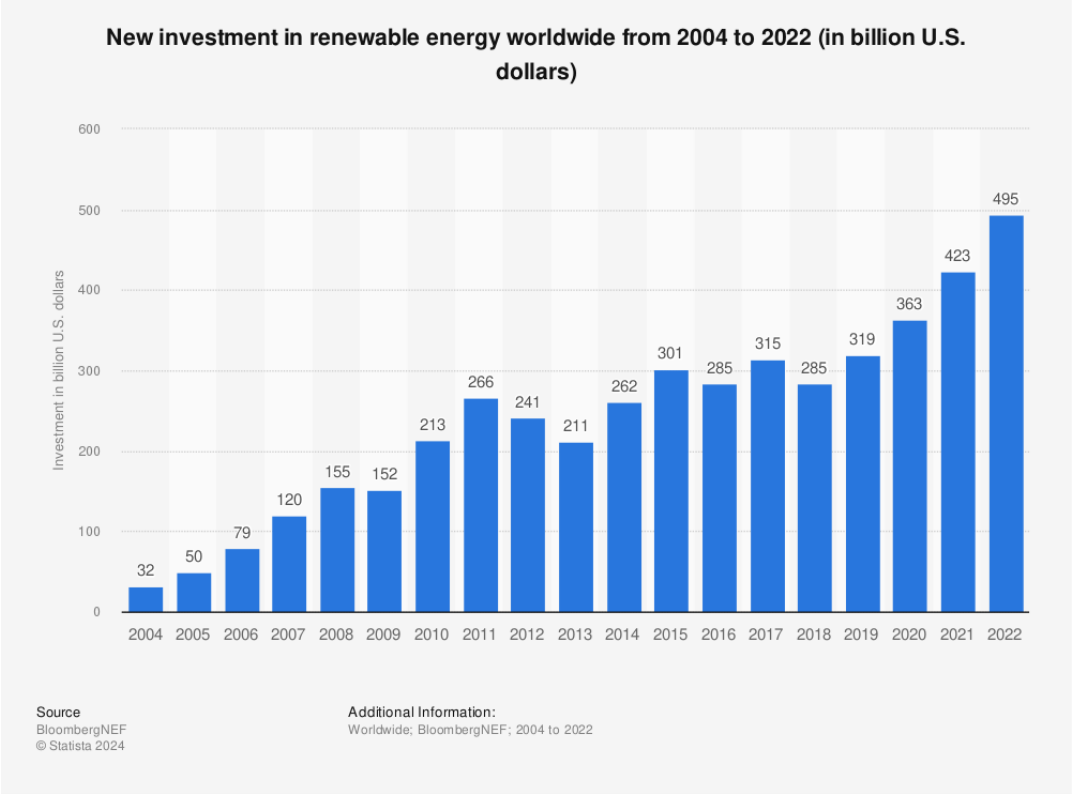
The proportion of renewable energy sources in the total installed capacity is expected to increase from 52.0% in 2020 to 64.7% by 2035. It is anticipated that hydroelectric power plants will reach a capacity of 35.1 GW soon.

The projected wind energy capacity is predicted to reach 29.7 GW, with solar energy capacity expected to rise to 52.9 GW. The combined capacity of geothermal and biomass power plants, categorized as Other, is expected to reach 5.1 GW in total installed capacity. (KPMG, 2023)

The inclusion of targets related to non-renewable energy resources as performance indicator values in the sub-programmed targets of reducing external dependency in energy may indicate a lack of sufficient targets for renewable resources to reduce external dependency.

Upon examination of the renewable energy sub-programme targets, it is stated that the installation power targets based on solar, wind and hydroelectric energy were partially achieved, while the targets for electricity generation based on geothermal energy and biomass energy were exceeded by 0.74. Nevertheless, the target for hydrogen energy was not met within these targets. While the project target for YEKA and similar domestic production is 1, there is no evidence to suggest that this number of projects has been achieved. To achieve the desired level of renewable energy, which would provide a sufficient energy supply and reduce imports, it is essential to make policy decisions and implement strategies with the necessary seriousness. To assess the success of such decisions and strategies, it is necessary to consider the performance targets set and compare them with the realized values.

**Figure 3.4. New Investment in RE Worldwide from 2004-2022**




(Source: *Lucia Fernandez (2024). Worldwide Investment in Renewable Energy 2014-2023*.)

Ultimately, choices were taken that focused on changing energy sources. Additionally, the launch of the Renewable Energy Resource Zones program in 2019 aimed to speed up the development of renewable energy projects in certain regions of Türkiye with significant renewable energy potential. The National Renewable Energy Action Plan, initiated in 2020, aims to raise the proportion of renewable energy in Türkiye's overall energy usage and details approaches for reaching these goals.

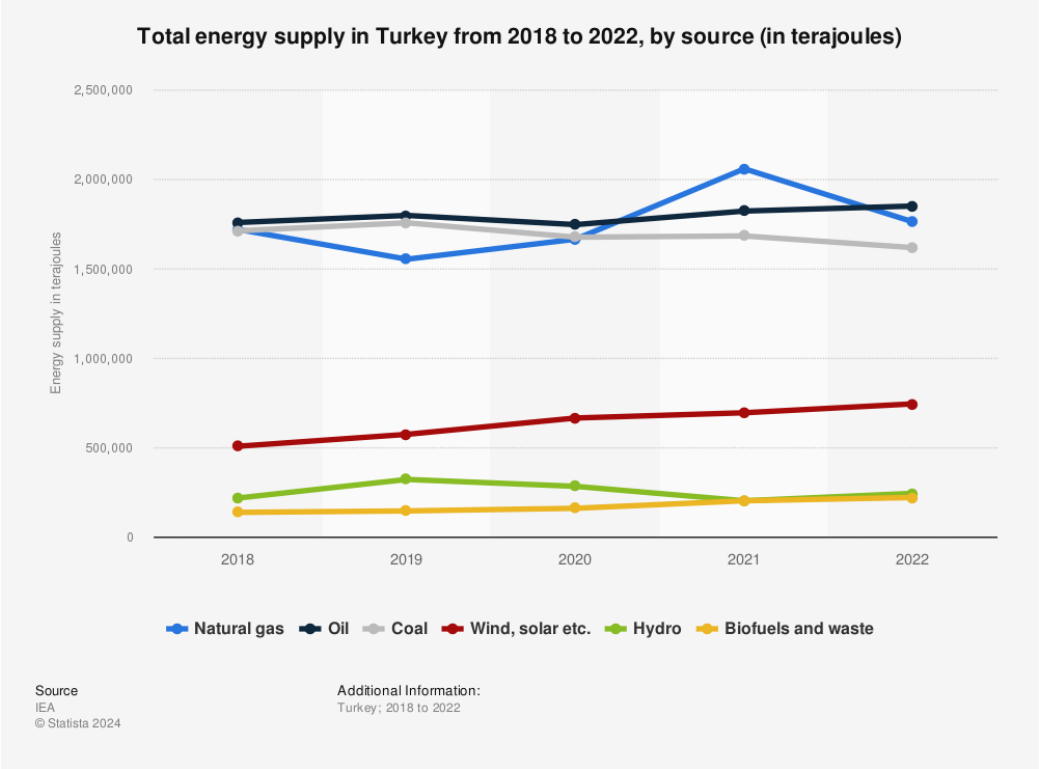
Figure 3.4. dedicates that between 2004 and 2022, the investments in renewable energy resources globally have increased the link between energy and economy, leading to a total investment of 495 billion US dollars in 2022. While one year saw a 17 percent rise, there was a jump of around 105 percent over the 10-year span from 2012 to 2022.

Renewable energy sources play a significant role in Türkiye by aiding in energy diversification, boosting energy security, combatting climate change, decreasing dependence on foreign energy sources, promoting economic growth, and generating employment opportunities. (Kaygusuz & Sari, 2006) Moreover, investing in renewable energy sources will also stimulate economic growth and create job opportunities within the country. (Yılmaz A. O., 2006)

Türkiye, with its increasing energy demands and concerns about environmental impact, has recognized the need to shift towards renewable energy sources. (Yuehong Lu, 2020) This transition aims to encourage the utilization of renewable energy sources like hydropower, wind, bioenergy, and solar power. The results of the 2022 Türkiye Energy Consumption and Economy Survey indicate that solar energy, with 71% of respondents indicating it as their preferred renewable energy source, and wind energy, with 64% of respondents indicating it as their preferred renewable energy source, are the most popular among the renewable energy sources that Türkiye can use to reduce its dependence on foreign energy sources (KONDA, 2022).

According to the data on Türkiye's net energy imports from 1990 to 2022, there is a steady increase. 4,135.65 petajoules of energy imports in 2012 reached 5,171.74 petajoules ten years later in 2022. Analyzing at the data, although a decrease was observed between 2018-2020, there has been an increase again since 2021. It is seen with the increasing values that Türkiye's incentives and projects to reduce energy imports should be more sustainable and permanent. (Türkiye Cumhuriyeti Merkez Bankası, 2023)

**Figure 3.5. Total Energy Supply in Türkiye from 2018 to 2022**




(Source: *Zeynep Dierks (2024). Total Energy Supply in Türkiye 2018-2022, by Source.*)

According to the results of the survey data conducted with 2510 volunteers within the scope of Konda 2022 Energy Consumption and Economy Survey, it is stated that the participants are concerned about Türkiye's dependence on foreign energy and think positively about the use of renewable energy.

Figure 3.5. finds that proves the positive attitude towards renewable energy sources is that half of the society says that they would be willing to pay a certain amount of increase in their bill to use electricity generated from solar or wind (KONDA, 2022). In this direction, the potential and utilization targets of Türkiye's resources for renewable energy generation have been focused.

As outlined in the Electricity Energy Market and Security of Supply Strategy Document (2009), Türkiye's objectives for renewable energy sources by 2023 are as follows:

(i) Raising the portion of renewable energy in the electricity generation sector beyond 30%

(ii) Harnessing the full hydroelectric capacity

(iii) Enhancing the capacity of wind energy installations to reach 20,000 MW.

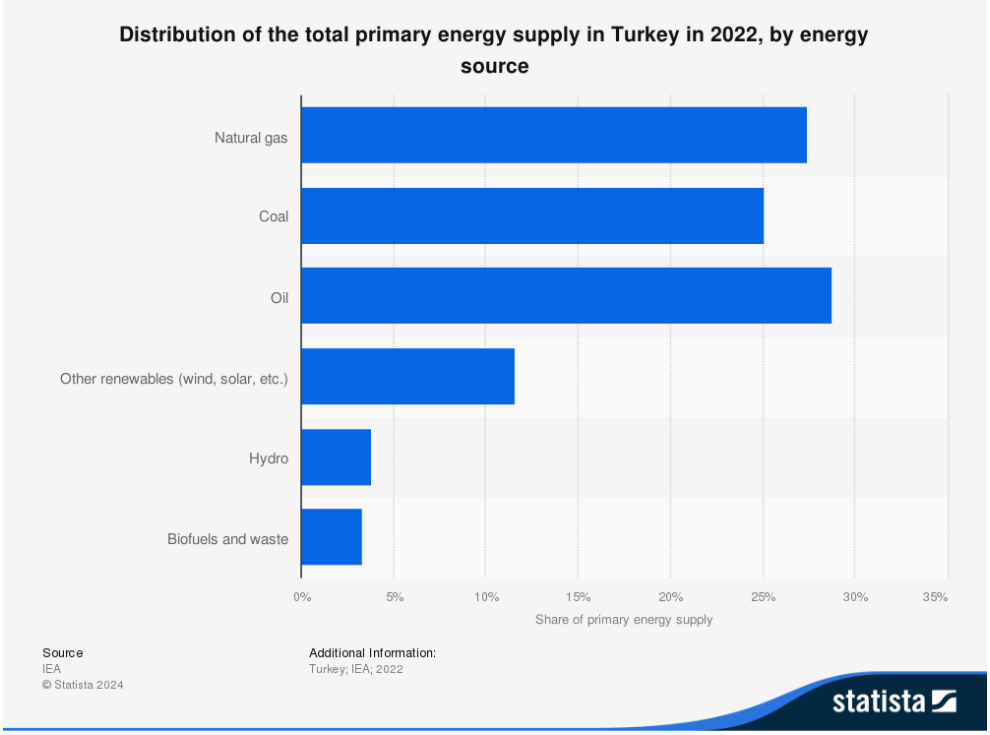
(iv) The entire 600 MW geothermal capacity, deemed appropriate for generating electricity, will be utilized.

(v) Utilizing the maximum solar energy potential.

(vi) Lowering the percentage of natural gas used in electricity production to under 30% by implementing initiatives to promote the utilization of local and sustainable energy sources. (Özsoy, 2015)

In addition, data from 2022 shows that renewable energy sources, such as solar and wind power, make up 11.6% of energy supply in Türkiye. Additionally, hydro energy accounts for 3.8% and biofuel and waste energy represent 3.3%. On the other hand, oil, coal, and natural gas, which are non-renewable energy sources, make up 81.3% of the overall energy supply.

**Figure 3.6. Distribution of The Total Primary Energy Supply in Türkiye in 2022**




(Source: *Zeynep Dierks (2024). Breakdown of Primary Energy Supply in Türkiye 2022, by Source*.)

Figure 3.6. shows the need for introducing more incentives and measures to decrease Türkiye's reliance on non-renewable energy sources in the distribution of energy supply. These results emphasize the continuous obstacles Türkiye encounters in using renewable energy sources to fulfill its immediate energy requirements. Various obstacles hinder Türkiye's advancement in this field, such as inadequate encouragement, particularly for the private industry, an unfinished and incongruent legal structure, technological constraints, and limited initiatives to discover alternative energy sources. To shift towards sustainable energy in the future, firm and thorough policy changes along with more investment in technological advancements are necessary. In addition, researching and utilizing other energy sources like hydrogen could expand Türkiye's energy options and help advance in this area.

# TÜRKİYE'S ENERGY DIPLOMACY

## 4.1. Sustainable Development and The Green Transformation

Following the oil crisis of the 1970s, many global conferences on environmental matters took place. In 1987, the Brundtland Report was published by the United Nations Environment Programme (UNEP), establishing the idea of 'sustainable development'. (Karadaş, 2018) With this report, it has become clear that sustainable economy and environment and therefore energy resources are inseparable. The introduction of sustainable economy into our lives as 'green transformation' in the 2000s laid the foundation for the serious steps to be taken in this field.

Due to the advantages, it brings, it has been a solution to increasing energy consumption, and it has been emphasized that its potential should be revealed worldwide. In 2004, the World Energy Council released a report on the connection between energy and a sustainable economy.

*Energy diversity and energy efficiency:* The use of energy resources includes the utilization of different resources and the efficient use of resources instead of depending on certain resources.

*Energy infrastructure investments, energy prices reflecting the real cost:* To produce energy efficiently and cleanly, necessary infrastructure problems should be eliminated, and cost support should be provided. For these investments to be made, it is important to establish optimum energy prices that will ensure the economy of the investment to be made. Otherwise, failure to make investments may jeopardies the availability of energy in the following years.

*Interventions in the energy market:* In the formation of a free market, it is important that prices reflecting energy costs are formed. Necessary subsidies and interventions should be implemented effectively.

*Reliability of supply:* Ensuring energy supply security and making the necessary investments for this purpose are of vital importance for countries. Diversification of energy resources is also an important energy policy for countries.

*Regional integration of energy systems:* Integration with countries in the region is the right approach in terms of security of energy supply and transportation. It is necessary to ensure the most economical, secure and sustainable supply of energy.

*Climate change policies under market conditions:* To prevent climate change, which is one of the important problems of recent years, countries need to implement the necessary sustainable energy policies. It is necessary to make the necessary investments, sign and adhere to international agreements and take the necessary measures.

*Technological innovations and development of technology:* To ensure sustainable energy policies, advanced technologies should be used for secure energy supply, reduction of the environmental impacts of energy use and efficient use of energy. In addition, necessary investments should be provided for the development of these technologies.

*Ensuring public understanding and trust:* In the energy production and consumption chain, the public should be informed and supported in a transparent manner.

The goals of preventing global warming and reducing carbon emissions (greenhouse gas effect), which are at the beginning of the 'Green Transformation', have gained a legal binding with the Kyoto Protocol initiated by the United Nations in 2005. Within the scope of the Kyoto Protocol, supportive projects have been established for countries to realize their sustainable energy targets by reducing carbon emissions.

The project-based flexibility arrangements of the Kyoto Protocol envisage that the greenhouse gas savings that Annex I countries will achieve through the projects they will implement among themselves or in developing countries outside Annex I will be included in their quotas. (Varlık & Yılmaz, 2017)

Türkiye entered the Kyoto Protocol in 2009. In 1997, due to Türkiye not being a member of the UNFCCC, it was not listed in Annex-I of the Kyoto Protocol, which outlines specific obligations to reduce or limit greenhouse gas emissions under the Kyoto Protocol. (Affairs,

2024). The depletion of fossil fuels from global warming and overconsumption, the need for countries facing energy security issues due to climate change to shift to a sustainable economy, and the compulsory transition to renewable energy and investments are driven by international agreements like the Kyoto Protocol, Paris Climate Agreement, and European Green Deal.

It is evident that renewable energy contributes to economic growth and development based on production, which is arguably its most promising and important long-term impact in reducing a country's dependence on foreign energy. (Demir, 2023) When examining the economic situation of Türkiye, it is evident that the country faces an energy shortfall and relies on external sources to satisfy its increasing energy demands. Not just in Türkiye, but globally as well, the demand for energy is on the rise due to factors such as industrialization, population growth, excessive consumption, and the desire for improved living standards.

### 4.1.1. Sustainable Energy Diplomacy of Türkiye

The political-economic impact of energy in Türkiye is significant. Türkiye is experiencing political and economic impacts due to global crises and wars. The changing dynamics of Türkiye's energy diplomacy over the years can be summarized as follows: Türkiye's energy foreign policy and diplomacy have evolved to prioritize the supply of LNG, shift towards renewable energy, diversify gas supply routes, and forge strategic partnerships in the energy sector.

Türkiye's energy foreign policy and diplomacy play a crucial role in its quest for regional and global influence. (Fotiou & Triantaphyllou, 2010) Türkiye is a country that relies on energy imports to meet its domestic energy needs.

As per information from the International Energy Agency, Türkiye's principal energy importers include Russia, Iran, Iraq, and Azerbaijan. Over the years, Türkiye's political and economic relations with these countries have undergone various changes.

The evolving landscape of Türkiye's energy diplomacy has been shaped by a multitude of factors and events. Türkiye has had to navigate complex relationships with various actors involved in the conflict, including Russia, Iran, and the United States, as well as manage the flow of energy resources and refugees across its borders. Türkiye has experienced a deterioration in its relations with some of its traditional energy suppliers, including Russia and Iran. Among the pivotal moments that have influenced Türkiye's energy foreign policy and diplomacy are the discovery of substantial natural gas reserves in the Eastern Mediterranean, particularly of the coast of Cyprus. Türkiye has consistently expressed its strong opposition to the unilateral exploration and extraction activities of Cyprus, claiming that they violate Türkiye's rights in the region.

These strained relations have prompted Türkiye to diversify its energy sources and seek alternative suppliers, as well as explore opportunities for energy cooperation with other countries. Türkiye has been engaged in active pursuit of energy agreements and partnerships with various countries with the objective of strengthening its energy security and expanding its influence in the region.

The construction of strategic energy infrastructure projects is significant. Türkiye has been actively engaged in the development and construction of strategic energy infrastructure projects, including oil and gas pipelines that connect it to neighboring countries like Azerbaijan, Georgia, Russia and Iran. The Türkiye-Azerbaijan Strategic Partnership Agreement in 2010 involved working together in the energy industry and collaborating on the Baku-Tbilisi-Ceyhan (BTC) oil pipeline in 2006 and the Trans-Anatolian Natural Gas Pipeline (TANAP) in 2018 and 2019 as a two phase. (Koç & Kaya, 2015)

The Baku-Tbilisi-Ceyhan oil pipeline and the Trans-Anatolian Natural Gas Pipeline have strengthened Türkiye's position as an energy transit country, providing both economic and geopolitical power in the region.

The other significant event in the evolution of relations with Russia was the signing of the Türkiye-Russia TurkStream pipeline agreement in 2016. This agreement aimed to deliver Russian gas to Türkiye and Europe via a direct underwater pipeline.

Significant events include the signing of the Türkiye-Greece-Italy Interconnector pipeline agreement in 2017, which aimed to diversify gas supply routes and enhance energy cooperation between the three countries.

The changes consist of transitioning to renewable energy, making energy deals with countries like Russia and Qatar. One of the most recent developments in the strengthening of relations with Arab countries is the signing of the Türkiye-Qatar LNG (liquefied natural gas) agreement in 2020. This agreement includes long-term cooperation in the energy sector and the supply of LNG to Türkiye. The limitations of available energy resources, the challenge of meeting the ever-increasing energy demand necessitates the implementation of a comprehensive and effective energy policy. (Öymen & Ömeroğlu, 2020)

For Türkiye, which is taking steps to reduce external dependency in the energy sector in line with its goals of transitioning to a sustainable economy with green energy, it is a mistake to think of 'growth' only in terms of the economy and creating organizations and projects to support renewable energy, and forming important alliances such as European Union, International Renewable Energy Agency (IRENA) and United Nations Framework Convention on Climate Change (UNFCCC) were necessary.

### 4.1.2. Türkiye and The European Union Cooperation: The Green Deal

The aim of the European Green Deal is to align Türkiye's energy sector and exports with the EU's climate objectives by reducing carbon emissions, increasing the share of renewable energy sources in the energy mix, and promoting energy efficiency measures.

This partnership will require Türkiye to adopt and implement renewable energy laws that are in line with the EU's Renewable Energy Directive, which requires member countries to increase their total energy consumption from renewable sources to 20% by 2020. (UNFCCC, 2023).

Türkiye's incorporation of green transformation in the Medium-Term Program 2023-2025 is a step towards the 2053 plan, highlighting Türkiye's efforts to advance its green economy and renewable energy sector soon. In the realm of a sustainable green economy, Türkiye is a crucial ally for the EU. Developing zero-emission green transformation policies with the EU, which holds the biggest portion of Türkiye's exports, is beneficial for both parties. In this scenario, there are 21 policies and measures aimed at green transformation included in the program. The next article is closely tied to the shift towards green energy:

To facilitate the development of a sustainable infrastructure, funding for green technology research and development projects will be sustained, with a focus on agriculture, industry, transportation, and energy, while also nurturing an investment environment for technologies like green hydrogen and energy storage that aid in reducing emissions.

Along with the 2023-2025 initiative, there are also plans for GHG emission strategies based on the Türkiye Climate Change Strategy 2010-2023 report. As per the report, the short-term targets established for the energy sector are as stated.

- All our internal resources, especially wind and hydraulic systems, will be completely utilized to achieve our objectives of lowering greenhouse gas emissions and ensuring our energy supply. This will be achieved through both domestic and international financing options.
- Solar energy collectors will provide support for systems generating sanitary hot water.
- Projects prioritizing energy efficient building materials and technologies will be identified through industry collaborations. The potential for energy efficiency in buildings will be recognized and fully achieved.
- The necessary infrastructure will be in place to support the implementation of the "Energy Identity Certificate" in older buildings, and initiatives to improve efficiency such as thermal insulation will be encouraged.

- The standard will guide energy management in the building and industrial sectors, executed by energy managers with certification. Research and development will focus on clean technologies and energy resources, with a goal of supporting domestic industry in these areas.
- Encouraging the adoption of low- and zero-emission technologies, such as renewable energy and clean coal technology, including nuclear energy, will be promoted. Encouragement will be given for the advancement of economic tools, along with the promotion of new and alternative fuel usage.
- Current thermal power plants will undergo enhancements, while more effective hydroelectric power plants will be put in place.
- Energy intensity in 2020 is expected to decrease compared to 2004.
- Public institutions' existing structures and amenities will consume reduced amounts of energy.
- By 2023, renewable energy is projected to produce 30% additional electricity compared to the current output. We will utilize all our technical and financial resources to produce 20,000 MW of electricity from wind and 600 MW from geothermal sources within this framework. Promotion of solar energy for electricity generation will be encouraged. The energy sector aims to decrease carbon dioxide emissions by 7% compared to the baseline scenario by 2020.

The program encouraging the use of renewable energy for businesses with high energy consumption began in 2020. The Green Tariff (YETA) was launched on 1 August 2020 as a major move to increase the use of renewable energy sources.

Consumers wanting to use electricity under the YETA can get renewable electricity by sending written requests to supply companies in their area. In terms of solar energy, a type of renewable energy, it is believed that there are around 8 million rooftops in Türkiye that are suitable for the installation of solar panels.

The Citizen's Energy Plants (CEPs) lead in using solar energy and help citizens form energy cooperatives to produce energy for themselves or sell to the grid, on various locations like rooftops of buildings or individually on their own roofs through consumption aggregation. Despite the presence of rewards for using solar power, investors in solar projects have delayed their actions until adequate feed-in tariffs are set up. As a result, the utilization of Türkiye's significant solar energy capacity has been delayed for a future time. The insufficiency of renewable energy adoption and the high initial costs emphasize the need for additional incentives to promote their development.

Investors in renewable energy projects in Türkiye can access financial resources through various methods such as loans, grants, supply agreements, financial leases, crowdfunding, debt securities, and green bonds. Green bonds are financial tools used to gather financial support for projects that benefit the environment, climate, and other aspects of nature.

Nevertheless, the green bond market in Türkiye is advancing at a slower pace compared to other nations. Lastly, the government should work towards creating a favorable investment environment for renewable energy. This includes providing financial incentives for renewable energy projects, streamlining the permitting process, and ensuring a stable regulatory framework to attract investors. It is advised that these policies offer clear instructions and rewards to encourage the growth of renewable energy, as well as tackle obstacles like obtaining financing, connecting to the grid, and acquiring land.

In addition, educating the public about the advantages of renewable energy can help address social resistance and promote acceptance in society. Moreover, it is important for the government to give top priority to enhancing local manufacturing capabilities and supply chains for renewable energy projects.

This strategy would not only boost employment and economic growth but also decrease reliance on imported energy and secure a sustainable energy future for Türkiye. Hence, the obstacles of moving towards sustainable energy in Türkiye are complex. A thorough strategy involving backing from the government, involvement from the public, and careful planning is necessary. One major obstacle in Türkiye's shift to renewable energy is the unequal spread of power plants across the country.

This disparity poses a difficulty in accessing renewable energy sources, as certain areas may have better resources compared to others. Moreover, there are difficulties connected with incorporating renewable energy into the current energy system. The Turkish government must find ways to draw in and motivate private investments in renewable energy projects, while also ensuring funding from international organizations and funds.

The lack of legislative support and systemic obstacles are impeding the comprehensive integration of renewable energy in Türkiye. The lack of a strong legal structure to incentivize and support investment in renewable energy is a major hurdle in Türkiye. The solution lies in creating a strong legal framework that removes obstacles to investing in renewable electricity. The challenge arises from the absence of clear direction and conflicting messages from institutions tasked with advancing renewable energy. (Oniemola, 2015) . This lack of unison and clarity of roles hinders the smooth implementation of renewable energy projects and slows down the overall transition process.

The European Green Deal has brought a new aspect to the partnership, in which Türkiye participates, alongside the economic union. While primarily focused on addressing the climate crisis, the Green Deal also affects various aspects such as the economy, politics, and the environment. The move towards renewable energy on a global scale has important consequences for Türkiye's energy sector and its geopolitical ties with the European Union. Türkiye's shift towards renewable energy could enhance its connections with the European Union, which has supported ambitious climate action and clean energy objectives.

The European Union aims to reach climate neutrality by 2050, and Türkiye's advancements in renewable energy might help align it better with EU rules. Moreover, enhancing the renewable energy infrastructure in Türkiye may facilitate greater economic and technological collaboration between Türkiye and the EU, fostering possibilities for joint investments, technology transfers, and collaborative research and development projects.

Türkiye moving towards renewable energy sources and joining the European Green Deal opens chances for economic collaboration and the development of fresh investment prospects with the EU. Türkiye can receive support from EU funds for renewable energy projects, which can help private companies take advantage of incentives and discounts, leading to the successful implementation of projects tapping into renewable energy potential. This result would help strengthen the economic ties between the two parties. However, the development of infrastructure during the transition to renewable energy requires expensive technological advancements.

If the necessary compliance requirements are fulfilled under the Emission Trading System (ETS), various benefits can be obtained, such as incentives for technology, cost reductions, improved market flexibility, and the chance for global collaboration, all aiding in the shift towards a green transformation. To fully take advantage of these benefits, it is crucial to establish necessary legal frameworks and regulations, create monitoring and reporting procedures, guarantee transparency in emission monitoring distribution methods, set up market infrastructures, carry out operational audits, and adhere to international norms and standards. Since Türkiye is not part of the ETS, it must meet the required harmonization standards within the country.

The EU's requirement for harmonization conditions from Türkiye could lead to higher expenses and negative consequences for various industries, especially given the benefits of the Customs Union. The EU Green Deal is expected to bring in new rules and processes that will affect the exportation of goods and services to the EU. (Diriöz, 2021)

There is a need for standardized laws for the shift to green energy transformation in Türkiye within the framework of ETS requirements. As per the 2023 Carbon Disclosure Project (CDP) report, only 18 out of 81 Turkish cities have transparently shared their environmental data on carbon footprints through the CDP-ICLEI Cities Reporting Platform, which is the sole source for such monitoring and reporting. (Action, 2023) As mentioned in the 2020 report, it is worth noting the extent to which private companies in the 11 provinces participated in the CDP. According to the 2023 report, 114 private companies took part in the CDP Climate Change initiative, providing clear reports.

This indicates a rise of 41% in comparison to last year. The results suggest that private Turkish companies are better at complying with ETS requirements compared to municipalities. The government should think about encouraging private companies by filling in the legal loopholes and ensuring transparency in how municipalities monitor and report emissions.

Countries and firms that comply with the ETS standards in the Green Transformation context will take the benefits of economic collaboration and higher trade levels with the European Union. Due to the need for advanced technology and the significant expenses involved, the state must provide financial support for the infrastructures needed for renewable energy utilization, as well as incentives to aid in their implementation. In this situation, Türkiye should wisely dedicate more of its budget towards shifting to renewable energy sources. Additionally, Türkiye must show transparency and comply with the appropriate laws to be eligible for EU funding.

By modernizing its energy infrastructure and participating in economic cooperation through the Customs Union, Türkiye can further mutual economic interests by importing energy technologies and equipment from the EU to boost trade volumes.

The Green Transformation is important for Türkiye's goal of improving energy security by lowering imports, especially in energy resources. Relying on non-renewable energy sources is a common issue for both the European Union and Türkiye, which could lead to increased cooperation to improve energy security.

Most energy imports for both parties come from Russia, making them vulnerable to geopolitical risks and possible interruptions in energy supply. The Russia-Ukraine crisis is bringing awareness to the issue of energy supply interruptions and price changes for both Türkiye and the EU on a global scale. The European Green Deal plays a crucial role in the EU's plan to lessen reliance on energy and speed up the shift to renewable energy sources. Investing in renewable energy boosts economic and national security by decreasing reliance on energy imports. Türkiye's involvement in this partnership enhances bilateral ties based on shared interests.

The exchanging information and technology with the EU during Türkiye's energy transition will be advantageous for both parties in terms of energy security. By aligning its renewable energy policies with those of the EU, Türkiye aims to strengthen its position as an attractive investment destination for European companies and promote partnerships for technology transfer and knowledge sharing in the renewable energy sector. (Yüksek, Kömürcü, Yuksel, & Kaygusuz, 2006) Implementing policies and eco-friendly practices is essential to decrease greenhouse gas emissions from energy, construction, industry, transportation, and agriculture sectors in Türkiye to reach the European Green Deal's target of reducing carbon footprint by 55% compared to levels in the 1990s.

It is crucial for trade unions to align with the 2030 and 2050 targets to stay in line with the Green Deal in the European Union. Türkiye's updated Nationally Determined Contributions (NDCs) for 2030 targets and this focus on GMG emission reduction by %41, increased renewable energy usage to generate 32-35%of its energy from renewable sources, energy efficiency, sustainable agriculture, circular economy and waste management. 2050 targets focus on achieving net-zero greenhouse gas (GHG) emission with decarbonization of the energy sector. By 2050, all components of the supply chain should aim for comparable objectives under the climate/carbon neutrality goal when exporting products to countries within the EU. (Yılmaz F. , 2022) It is important for the green transformation process to move forward alongside the European Union.

The bureaucratic system in the European Union is why Türkiye also needs a similar administrative structure to handle policies related to the acquis. In addition to renaming the Turkish ministry, the establishment of the Turkish Environment Agency (TUÇA) in 2020 aimed at controlling energy markets. While the Turkish Environment Agency discloses all details about its organizational and management framework, its functionality does not match that of the European Union.

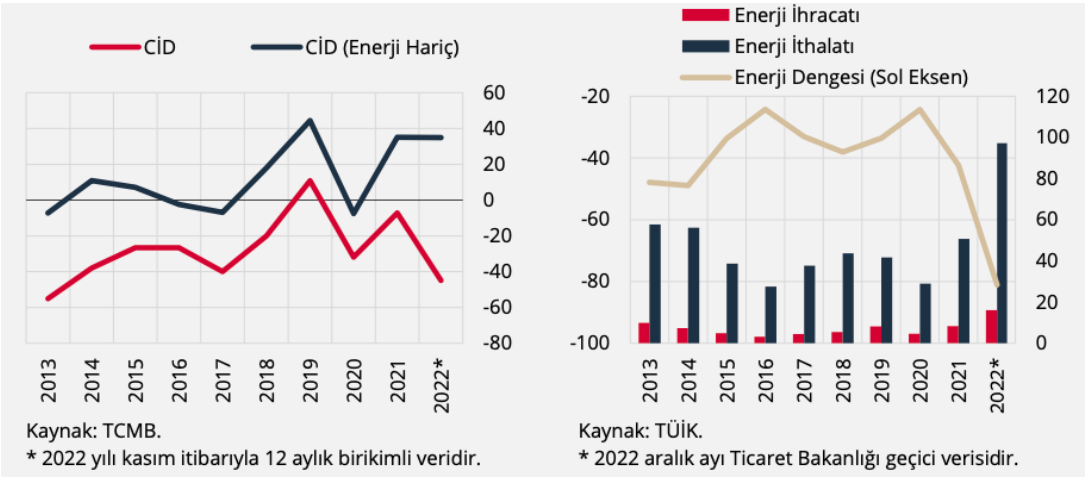
Rather, Türkiye's foreign policy is driven by a rational choice towards developing an independent foreign policy agenda and gaining a respected place among leading countries in the world. (Eleni Fotiou, 2010)

This pursuit of influence has been driven by a variety of factors, including Türkiye's historical and contemporary geopolitical position, its economic performance, and the changes brought about by events.

## 4.2. Economic Aspect of The Green Transformation

The increased expense of supporting sustainable energy sources has led to a rise in the popularity of cheaper non-renewable energy sources like oil, natural gas, and coal. By November 2022, the total current account balance over the past year, not including energy, stayed relatively unchanged from the end of 2021. In comparison, the current account deficit, including energy, rose from USD 7.2 billion in 2021 to USD 45 billion in November 2022. (2023)

**Figure 4.1. Türkiye Current Account Balance and Energy Foreign Trade Balance (Billion USD)**




(Source: *CBRD & Turkish Statistical Institute (TUIK) (2022)*)

Figure 4.1. illustrates a shift in the current account balance, indicated by the red line, from a positive to a negative value.

In contrast, the black line, representing the current account balance (excluding energy), demonstrates an increase from a negative to a positive value when energy is excluded. In the second graph, the level of energy exports, indicated by the red columns, is relatively low and exhibits minimal fluctuations. In contrast, the level of energy imports, indicated by the black columns, displays greater variability and a notable increase in comparison to exports. The increase in energy prices will result in an increase in imports, which will be exacerbated by a decrease in exports due to higher costs. Consequently, the current account balance sheet will inevitably become in deficit.

Therefore, the growing reliance on imported energy represents a significant contributing factor to the current account balance sheet deficit. (Karadaş, 2018, pp. 19-400) According to the IEA March 2024 data, Türkiye's energy imports in 2022 were 5.2 exajoules, representing an increase of almost 9.5% compared to 2021 and the highest level of imports since 1990.

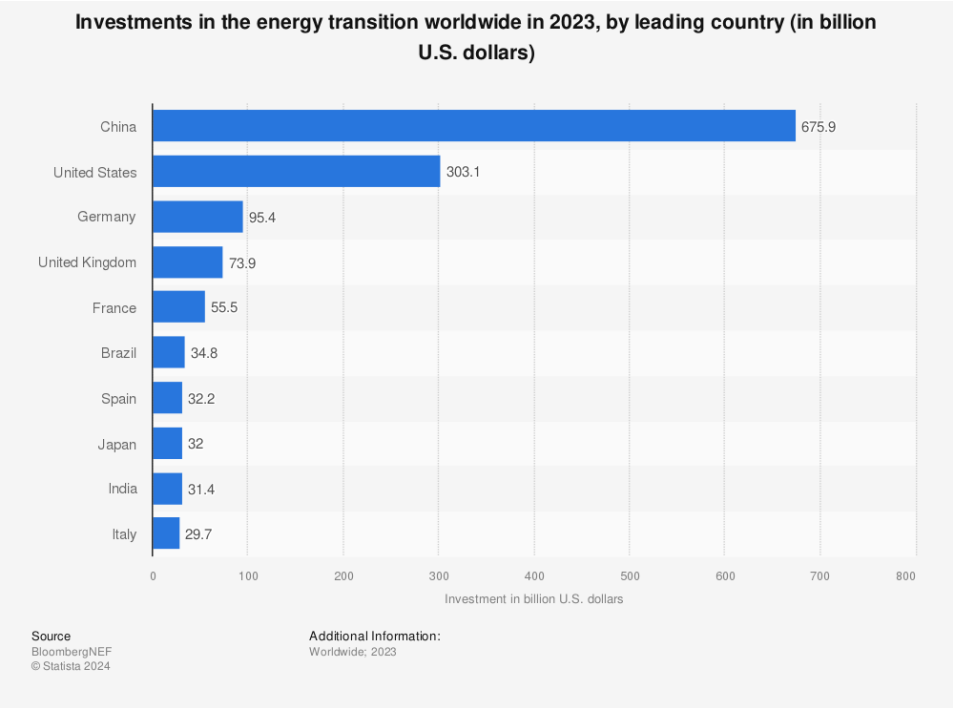
When the current account balance, including energy, is compared with the current account deficit, it can be observed that the former declined rapidly from 2021 to 2022. In 2022, the substantial increase in energy prices led to a surge in energy imports and a notable expansion of the current account deficit. The rise in energy prices serves to illustrate the significance of a diverse energy supply and domestic resource consumption.

As stated by the Minister of Energy and Natural Resources Alparslan Bayraktar in his speech in March 2024, Türkiye's energy demand is increasing daily, and the importance of utilizing renewable energy resources to meet this demand is increasing concomitantly. Türkiye's targets in the field of renewable energy are considerable and ambitious. The country is investing in renewable energy resources and implementing significant projects in this field with the objective of ensuring energy independence and reducing its current account deficit.

In addition, the European Green Deal will help Türkiye become more interconnected with the EU's internal energy market, making it easier to collaborate and trade in renewable energy technologies and resources.

This collaboration will boost the renewable energy sector in Türkiye and contribute to the transition to a more environmentally friendly economy in the region. The Green Deal agreed upon by Türkiye and the European Union will accelerate the development of renewable energy in Türkiye while encouraging the implementation of sustainable policies and practices. By aligning Türkiye's energy sector with the EU's climate goals, the Green Deal will promote investment in renewable energy, facilitate technology transfer, and encourage sustainable practices in Türkiye. A review of the energy sector in the European Green Deal action plans reveals that the transition to renewable energy is a primary focus. To reduce carbon emissions and implement carbon-neutral targets in other sectors, the transition to renewable energy has been of vital importance. Türkiye is endowed with considerable potential for renewable energy resources, given its natural resources and geographical location. Nevertheless, to be able to produce clean energy and to realize this without being dependent on foreign energy, it is necessary to determine the resources that can be converted into energy most easily.

**Figure 4.2. Investment in The Energy Transtion Worldwide in 2023, by Leading Country**



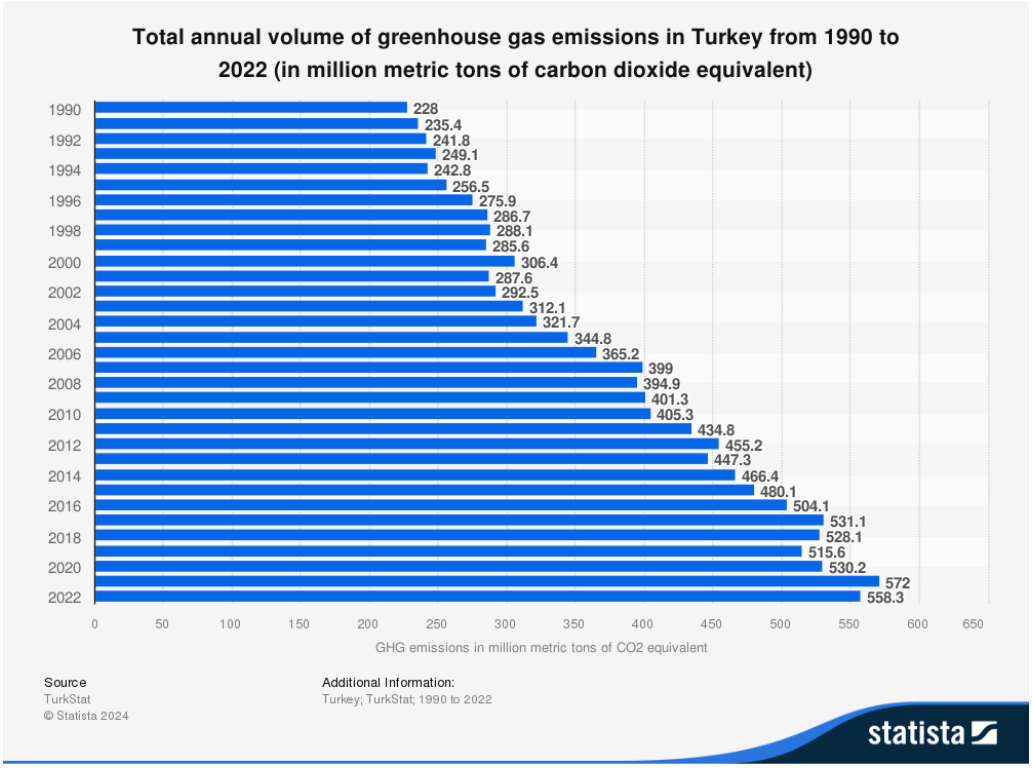

(Source: *Lucia Fernandez (2024). Global Energy Transtion Investments 2023, by Leading Country*.)

Figure 4.2. shows that the 2023 report showed that China leads the global energy transition investment market with around USD 676 billion invested. Germany which is the member of Paris Climate Agreement is take place for third. The Paris Climate Agreement has prompted Türkiye to make significant strides towards renewable energy and reducing carbon emissions in the energy sector, involving both developed and developing nations.

Turkish reliance on renewable energy showcases both economic and political significance as it aims to reduce foreign dependency and strengthen its position in international relations. Although the transition to renewable energy may seem easy and short-term to implement through commercial agreements and the utilization of existing resources, this change is not without its challenges.

However, the rapid increase in demand for energy in the global context and the increasing importance of sustainable economy with the global climate crisis have emphasized the energy sector in the sustainable economy more. The need for other countries' resources to meet their energy needs, especially Türkiye, has made the change in the energy sector inevitable. In this situation, the Emission Trading System (ETS) has emerged as a suitable mechanism for Türkiye to establish its energy strategies. The ETS functions as a "cap and trade" mechanism. The goal of the EU ETS is to lower greenhouse gas emissions in the industries included in the EU ETS by capping emissions at a specified upper limit. (Bakanlığı, Avrupa Birliği Emisyon Ticaret Sistemi, 2023)

**Figure 4.3. Total Annual Volume of Greenhouse Gas Emission in Türkiye from 1990 to 2022**




(Source: *Zeynep Dierks (2024). Total Amount of Greenhouse Gas Emission in Türkiye 1990-2022.*)

Figure 4.3. illustrated that the 2023 Greenhouse Gas Emission Inventory Report claims that it was revealed that Türkiye emitted a total of 564.4 Mt CO2 equivalent in 2021. Total greenhouse gas emissions in 2020 reached 523.9 Mt CO2 equivalent, showing a 7.7% rise from the year before. In the sector-based analysis of the increase in greenhouse gas emissions, it was stated that the energy sector ranked first with 402.5 $CO_2$ value, and greenhouse gas emissions in the sector increased by 9.8% compared to 2020. At this point, 71,3% of greenhouse gas emissions on a sectoral basis originated from the energy sector, and it was the second sector with the highest increase in one-year changes in sectors. In the first place, industrial processes and product use is 10.6% on an annual basis and has a share of 13.3% in greenhouse gas emissions.

**Figure 4.4. Greenhouse Gas Emmission in Türkiye by Sectors 1990-2021**

(Mt $CO_2$ eq.)

| Year | Energy | IPPU | Agriculture | LULUCF | Waste | Total (Excluding LULUCF) | Total (Including LULUCF) |
|---|---|---|---|---|---|---|---|
| 1990 | 139.5 | 22.9 | 46.1 | -66.5 | 11.1 | 219.5 | 153.0 |
| 1991 | 144.0 | 24.6 | 46.9 | -67.4 | 11.3 | 226.8 | 159.4 |
| 1992 | 150.3 | 24.3 | 47.0 | -67.5 | 11.5 | 233.1 | 165.7 |
| 1993 | 156.8 | 24.8 | 47.4 | -66.6 | 11.8 | 240.8 | 174.2 |
| 1994 | 153.3 | 24.1 | 44.9 | -68.0 | 12.0 | 234.4 | 166.4 |
| 1995 | 166.3 | 25.5 | 44.1 | -67.8 | 12.3 | 248.2 | 180.5 |
| 1996 | 184.0 | 26.2 | 44.8 | -67.1 | 12.7 | 267.6 | 200.5 |
| 1997 | 196.1 | 27.0 | 42.5 | -70.4 | 13.2 | 278.8 | 208.4 |
| 1998 | 195.8 | 27.3 | 43.7 | -70.6 | 13.5 | 280.3 | 209.7 |
| 1999 | 193.8 | 25.8 | 44.3 | -71.2 | 13.9 | 277.8 | 206.6 |
| 2000 | 216.0 | 26.2 | 42.3 | -68.1 | 14.3 | 298.9 | 230.9 |
| 2001 | 199.2 | 25.8 | 39.9 | -70.8 | 14.8 | 279.7 | 209.0 |
| 2002 | 206.0 | 26.8 | 37.6 | -69.3 | 15.2 | 285.6 | 216.3 |
| 2003 | 220.5 | 28.2 | 40.6 | -71.2 | 15.6 | 304.8 | 233.6 |
| 2004 | 226.3 | 30.8 | 41.3 | -69.7 | 16.1 | 314.4 | 244.7 |
| 2005 | 244.5 | 34.3 | 42.4 | -71.8 | 16.4 | 337.6 | 265.8 |
| 2006 | 260.5 | 36.8 | 43.9 | -71.5 | 16.8 | 358.0 | 286.5 |
| 2007 | 291.5 | 39.7 | 43.4 | -71.8 | 17.1 | 391.7 | 319.9 |
| 2008 | 288.3 | 41.7 | 41.3 | -67.9 | 17.2 | 388.5 | 320.6 |
| 2009 | 292.9 | 43.1 | 42.0 | -70.8 | 17.2 | 395.2 | 324.3 |
| 2010 | 287.9 | 49.1 | 44.4 | -71.9 | 17.4 | 398.8 | 326.9 |
| 2011 | 310.0 | 54.0 | 46.9 | -75.6 | 17.8 | 428.6 | 353.0 |
| 2012 | 321.6 | 56.3 | 52.7 | -73.4 | 17.6 | 448.2 | 374.8 |
| 2013 | 308.3 | 59.3 | 55.9 | -76.5 | 16.7 | 440.2 | 363.7 |
| 2014 | 326.7 | 60.1 | 56.2 | -76.9 | 16.5 | 459.5 | 382.6 |
| 2015 | 342.0 | 59.7 | 56.1 | -72.8 | 17.1 | 475.0 | 402.2 |
| 2016 | 361.7 | 63.8 | 58.9 | -73.1 | 16.7 | 501.1 | 428.0 |
| 2017 | 382.4 | 66.6 | 63.3 | -75.0 | 16.3 | 528.6 | 453.6 |
| 2018 | 373.4 | 67.7 | 65.3 | -69.8 | 16.6 | 523.1 | 453.4 |
| 2019 | 365.6 | 59.0 | 68.0 | -62.7 | 16.1 | 508.7 | 446.0 |
| 2020 | 366.6 | 68.0 | 73.2 | -56.9 | 16.3 | 524.0 | 467.0 |
| 2021 | 402.5 | 75.1 | 72.1 | -47.1 | 14.7 | 564.4 | 517.2 |

IPPU: Industrial Processes and Product Use
LULUCF: Land Use, Land Use Change and Forestry

(Source: *Turkish Greenhouse Gas Inventory 1990-2021 (2023) National Inventory Report for Submission under the Nations Framework Convention on Climate Change*)

Reducing greenhouse gas emissions is crucial for transitioning to a sustainable economy and utilizing alternative renewable energy sources due to their impact on climate change and the ecosystem. According to the data of the Ministry, the fact that the energy sector has the highest share in greenhouse gas emissions has shown the necessity of green transformation in this area. The reduction and abolition of collection fees over time will lead companies to increase their green energy investments by bringing high fee payments for the carbon emissions they produce.

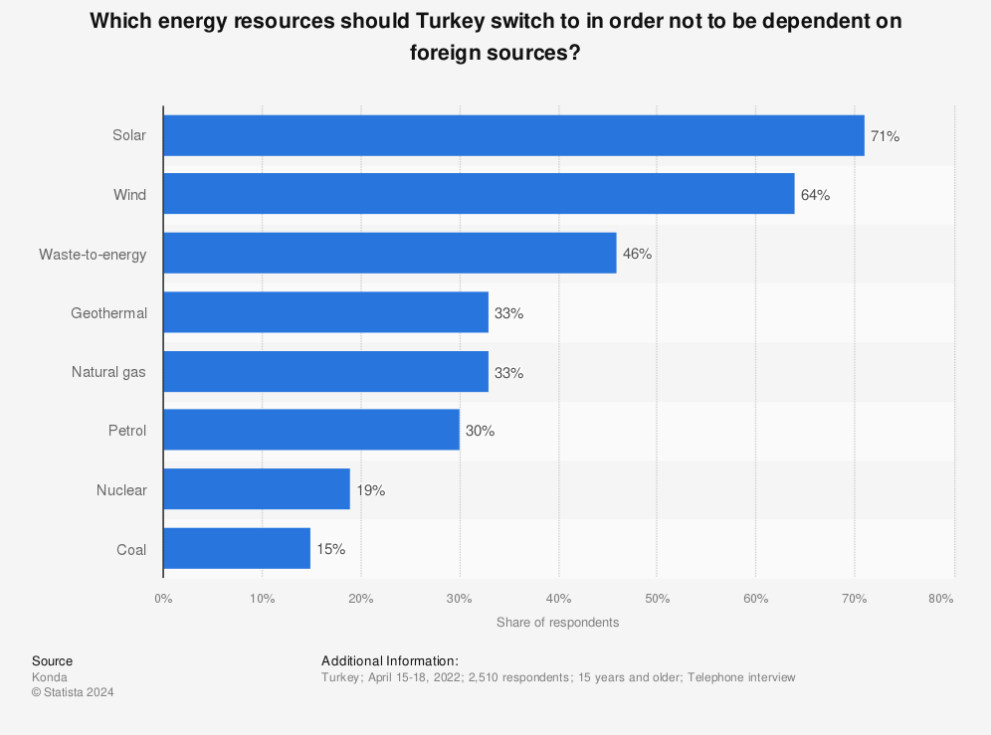
While reporting will be done during the transition period, in the actual implementation, which will start on 1 January 2026, products to be imported into the EU will be required to pay a carbon fee according to the weekly carbon prices in the ETS, taking into account the embedded emissions (Bakanlığı, Avrupa Birliği Emisyon Ticaret Sistemi, 2023). One of the actions taken by the European Union and Türkiye within the scope of the Green Deal in the goal of reducing greenhouse gas emissions is the ETS system, which is a carbon pricing tool, as mentioned above. The system aims to reduce greenhouse gas emissions by 62% by 2030.

While examining Türkiye's energy sector, it is not possible to develop an energy policy without considering these developments related to the EU. In addition, considering the size of Türkiye's exports to the EU, the urgency of this transformation is important for Türkiye's foreign trade (Yalkı & Akıncılar Köseoğlu, 2023, pp. 372-408). In line with the 2050 targets of the European Green Deal (EGD) announced on 11 December 2019, Türkiye has taken actions to create Single Market policies in line with climate change and green transformation targets.

Studies such as the regulations made within the scope of the Carbon Border Adjustment Mechanism and the Sustainable Product Initiative, the draft Waste Shipment Regulation, and the ongoing review process in the legislation on chemicals have a quality that will significantly affect our exports to the EU and the integration provided within the scope of the Customs Union (Bakanlığı, Yeşil Mutabakat).

In this context, it is envisaged that 90 million tons of emission allowances will be removed from the system by 90 million tons in 2024 and 27 million tons in 2026 for once, and simultaneously by 4.3% annually in the 2024-2027 period and by 4.4% in the 2028-2030 period. The free allocations distributed within the system will be reduced and abolished at certain rates in the 2026-2034 period (Bakanlığı, Yeşil Mutabakat).

**Figure 4.5. Survey: Suggested Energy Resources to End Foreign Energy Dependency in Türkiye in 2022**




(Source: *Zeynep Dierks (2022). Which Energy Resources Should Türkiye Switch to in order not to be Dependent on Foreign Sources?*)

Figure 4.5. shows that a 2022 survey conducted by Zeynep Dierks found that most Turkish people believe their country should use more solar and wind power in order to reduce dependence on energy imports. Thirty percent of respondents favored oil as an alternative energy source, and fifteen percent opted for coal. In the next section, it will discussed the potential of these three renewable energy sources and their suitability for a sector-wide transition that would reduce external dependence.

# TRANSITION TO RENEWABLE ENERGY IN TÜRKİYE

This chapter examines the potential of renewable energy resources in Türkiye, with particular attention paid to the impact of incentives and projects in these sectors on the utilization rate. The principal renewable energy sources in Türkiye are solar and wind energy, hydropower, geothermal energy, hydrogen and biomass energy. Türkiye benefits from a significant solar energy potential due to its geographical location and a substantial wind and hydraulic energy potential because of its landform characteristics. It also constitutes 8% of the world potential in terms of geothermal energy (Mutlu, 2012, pp. 33-54). Energy sources are classified as either renewable or non-renewable based on how they are utilized.

## 5.1. Renewable Energy Sources in Türkiye

Renewable energy resources are resources that are constantly renewed because of natural processes. These sources are clean energy sources that minimize the damage to the environment by reducing carbon emissions. These types of energy from natural sources have helped to contribute to the sustainable economies of countries by reducing external dependence on energy while increasing energy security.

**Table 5.1. Renewable and Non-Renewable Energy Sources**

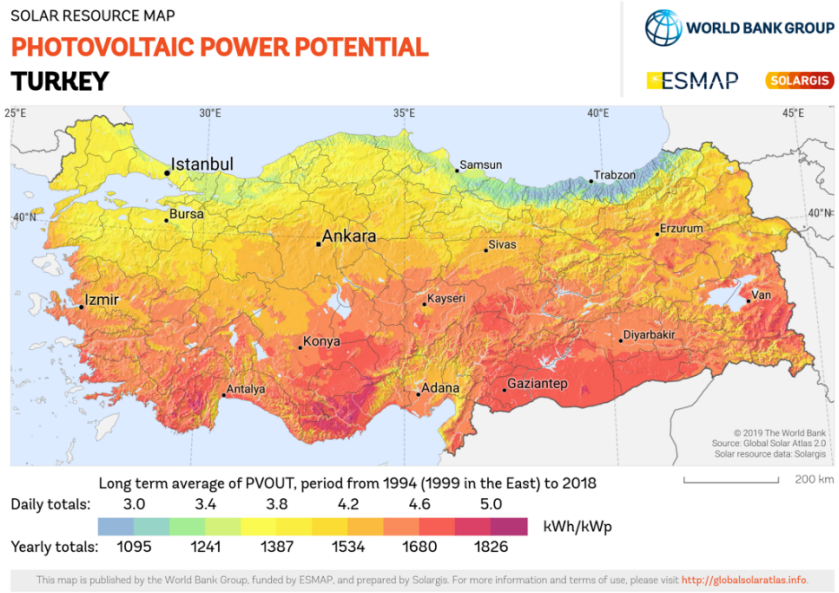
| Non-Renewable Resources | Renewable Resources |
|---|---|
| **Fossil Source** | Hydraulics |
| Coal | Solar |
| Natural Gas | Biomass |
| Oil (LPG) | Wind |
| **Core Welded** | Geothermal |

| | |
|---|---|
| Uranium | Wave, Tidal |
| Thorium | Hydrogen |

### 5.1.1. Solar Energy Sources in Türkiye

Solar energy is the most easily and unlimitedly accessible source of renewable energy sources worldwide. The sun, which forms the basis of living things, is also the basis of energy sources in the world. Solar power plants, which can be installed from large factories to citizens' own homes, are more preferred in terms of usage area and cost. The region between 45° north and south latitudes of the equator and called the 'Sun Belt' is the region where the most ideal energy can be obtained from solar energy in economic terms. (Ağaçbiçer, 2010) Türkiye is situated between 36- and 42-degrees north latitude and 26- and 45-degrees east longitude, which renders it a country with considerable solar energy potential.

**Figure 5.1. Solar Energy Potential Map of Türkiye**

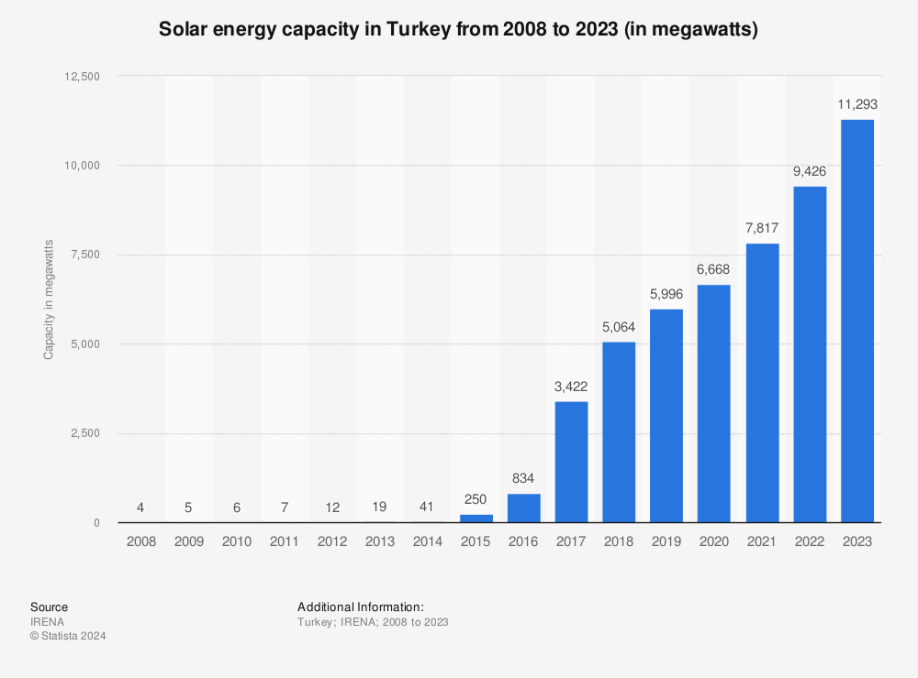



(Source: *SOLARGIS (2021).Solar Resource Map of Türkiye*)

As evidenced by the Renewable Capacity Statistics 2024 report, Türkiye's solar energy capacity has exhibited a consistent upward trajectory since 2015. The data from 2023 indicates that the capacity reached almost 11.3 megawatts, representing a 20% increase compared to the previous year.

Figure 5.1. shows that the solar energy potential map of Türkiye indicates that while the northern regions exhibit low potential, the potential increases as one progresses towards the south. In addition to the rugged terrain of the northern parts, it should be noted that the land suitable for agriculture increases towards the south. Although the use of arable lands for the construction of power plants is a negative factor, areas that are not suitable for agricultural purposes are suitable for the establishment of power plants.

**Figure 5.2. Solar Energy Capacity in Türkiye from 2008 to 2023**

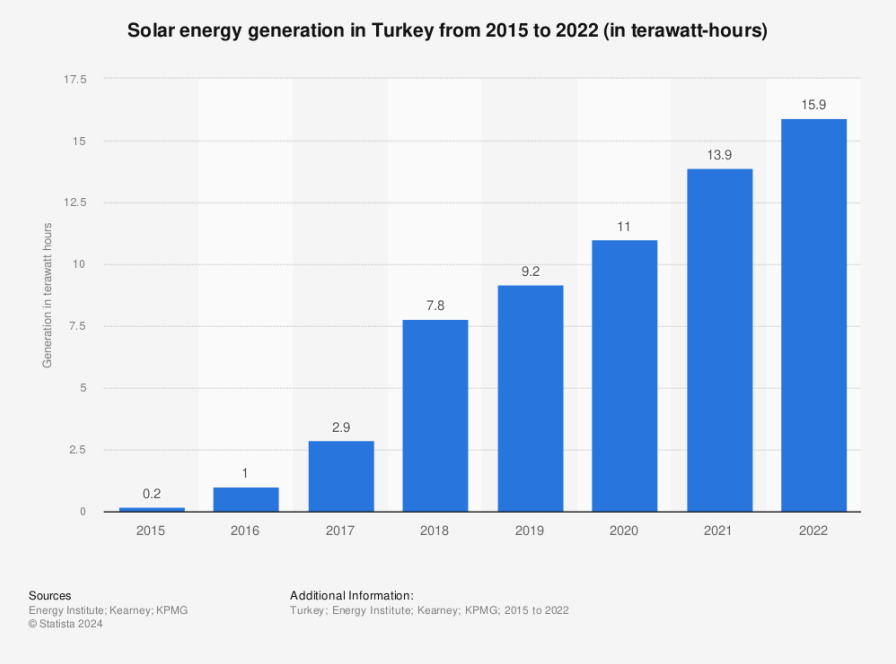



(Source: *Zeynep Dierks (2024).Solar Energy Capacity in Türkiye 2008-2023*)

Figure 5.2. dedicates that solar energy capacity in Türkiye so it is important to have a high number of power plants and a high installed capacity of solar energy to exploit the potential of solar energy.

Figure 5.3. shows that The Ministry of Energy and Natural Resources has reported that as of the end of March 2023, Türkiye's installed electricity capacity reached 104,348 megawatts (MW), while its installed solar energy capacity reached 9,820 MW. Many unlicensed solar power plants are situated in 78 provinces. The city of Konya has the highest installed capacity, at 1,722.2 MW, while the city of Ankara has the second-highest installed capacity, at 520.5 MW.

**Figure 5.3. Solar Energy Generation in Türkiye from 2015 to 2022**




(Source: *Zeynep Dierks (2024).Solar Energy Generation in Türkiye 2015-2022*)

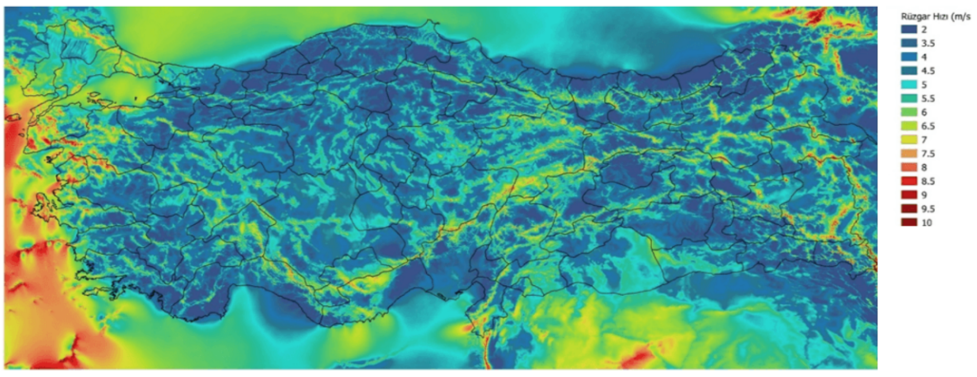
In addition to being a source of heating, the use of solar energy in electricity generation has been the most well-known renewable energy source. Electricity generation from solar energy is made using photovoltaic cells or concentrated solar energy systems. (Özbektaş, Şenel, & Sungur, 2023, p. 333) Türkiye has witnessed a notable surge in the adoption of solar energy in recent years, driven by a multitude of applications and incentive programs. One of the most notable programmes is the "Yenilenebilir Enerji Kaynaklarını Destekleme Mekanizması" (YEKDM), which provides a feed-in tariff to solar energy producers.

This has encouraged a significant number of individuals and businesses to invest in solar panels and generate their own renewable energy. In addition to financial incentives, the Turkish government has also implemented regulations to promote the use of solar energy. The applications of solar energy in Türkiye are diverse, encompassing large-scale solar farms and small residential rooftop installations.

### 5.1.2. Wind Energy Sources in Türkiye

Radiation from the Sun causes changes in the temperature, humidity and pressure of the air on Earth. The movement of air resulting from these changes is called wind. Due to regional differences in geographical structure, the strength of the wind varies. Like solar energy, wind energy is one of the most used renewable energy resources in Türkiye. Basically, wind turbines are needed to generate electricity from wind energy. According to the statistical report of the Turkish Wind Energy Association of January 2024, the Marmara region ranks first in the regional distribution of wind power plants with a share of 40%, followed by the Aegean region and then the Central Anatolia region. Licensed power plants are mainly located in Central Anatolia and Eastern Anatolia. According to the figures, the cumulative installed capacity of power plants in 2022 will increase by 7.59% compared to 2021.

**Figure 5.4. Wind Energy Potential Map of Türkiye**



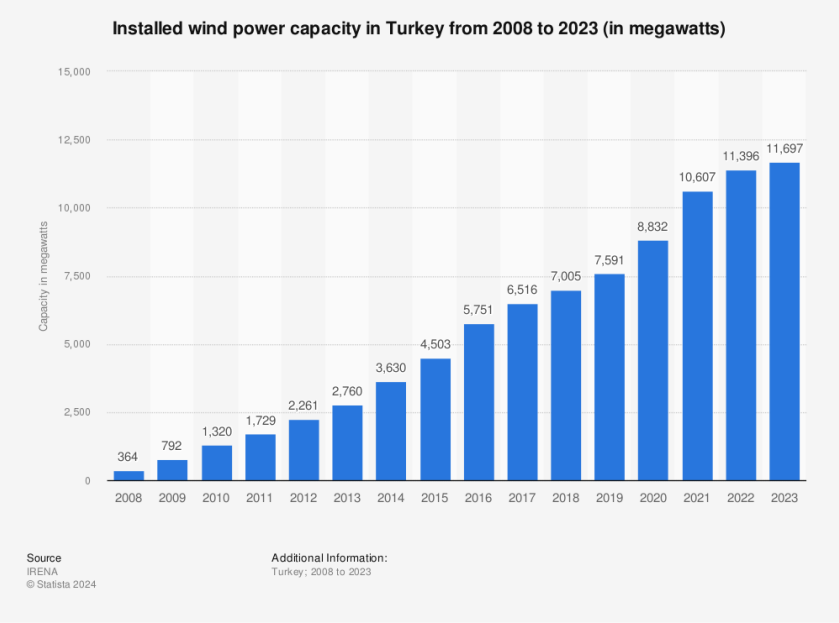

(Source: *Republic of Türkiye Ministry of Energy and Natural Resources (2023).Wind Resource Map of Türkiye*)

The first law on renewable energy and wind energy in Türkiye was the Electricity Market Law of 2001. Instead of promoting wind energy and increasing investment, this law has led to a decrease in investment as the state has abandoned the price guarantee (Karadaş, 2018). As an example of some of the later policies, the Law on the Utilization of Renewable Energy Resources for Electricity Generation No. 5346 of 2005 extended the government purchase guarantee from 7 years to 10 years with a base price of $0.073/kWh. In 2010, Law No. 5346 was amended to increase the incentive amount to $0.075/kWh.

There are seven classes of wind speeds, with class one being the smallest and class seven being the largest. An assessment of wind resources determines the typical wind speeds at a specific area of land (e.g. 50 meters above ground) and categorizes the region based on wind class. Wind turbines function within a specific range of wind speeds.

If the speed of the wind is not right, they cannot rotate, and if it is too fast, they stop working to prevent damage. Wind velocities in categories three (6.7 – 7.4 m/s) and higher are generally required for cost-effective power production.

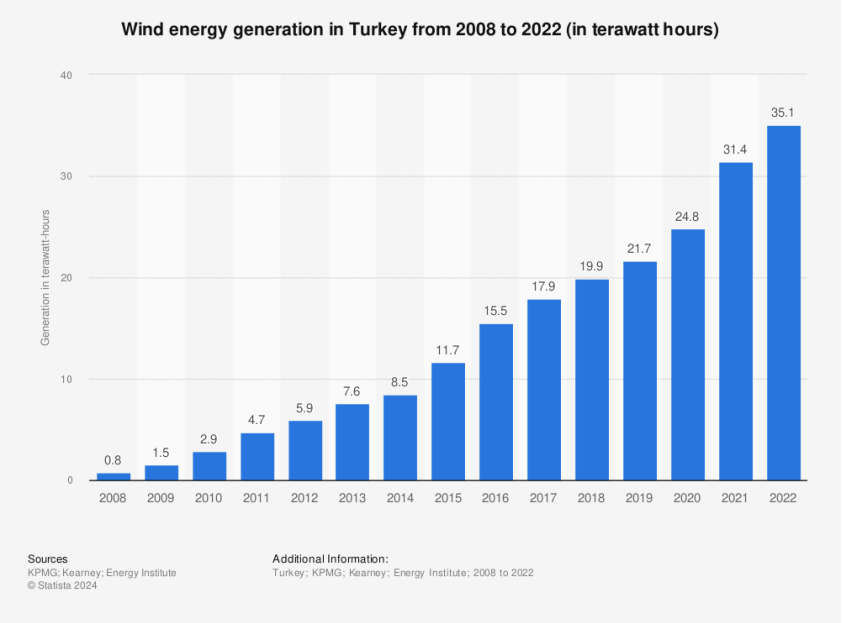
**Figure 5.5. Wind Energy Capacity in Türkiye from 2008 to 2023**




(Source: *Zeynep Dierks (2024).Wind Energy Capacity in Türkiye 2008-2023*)

Figure 5.5. shows that from 2008 to 2023, Türkiye's total installed wind power capacity will rise from 364 megawatts to 11,697 megawatts, reaching the highest point in this period. As per the source, the majority of this originated from land-based wind. The high cost of the turbines that need to be installed to generate electricity from wind power is a disadvantage in addition to solar power plants. In addition, to incentivize domestic production, the total purchase price was set at $0.11/kWh for companies using domestically produced power plants in the installation. With the government incentives and policies, a steady increase in wind energy generation has been observed.

**Figure 5.6. Wind Energy Generation in Türkiye from 2008 to 2022**




(Source: *Zeynep Dierks (2024).Wind Energy Generation in Türkiye 2008-2022*)

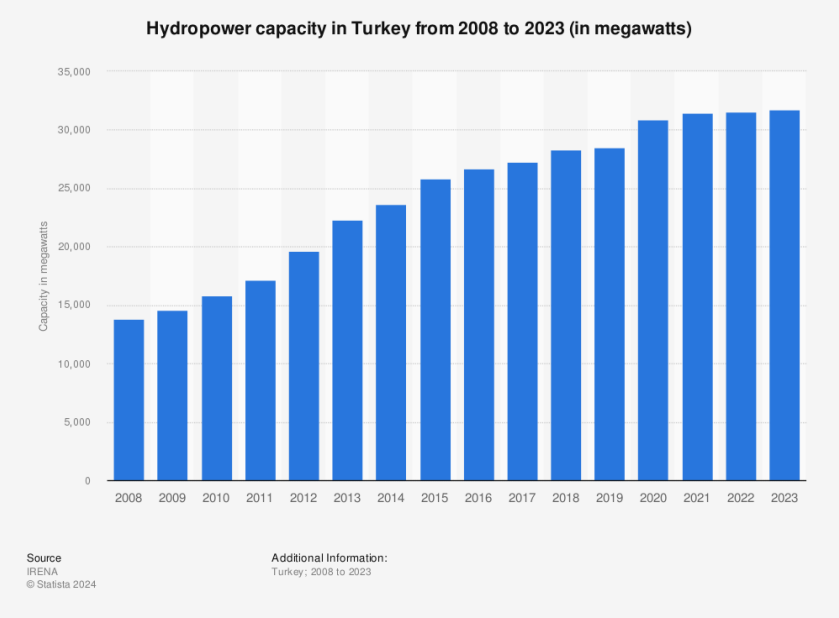
Figure 5.6. indicates that in 2022, wind power production in Türkiye reached its highest point at 35.1 terawatt hours, marking a growth of about 12% from the year before. In the time frame analyzed, there was a 34.3-terawatt hour increase.

### 5.1.3. Hydro Energy Sources in Türkiye

Hydroelectric power plants (HPP) are environmentally friendly, long-lasting, highly efficient, clean and renewable energy sources with very low operating costs and no fuel costs. (Özbektaş, Şenel, & Sungur, 2023) Although the construction of HPPs in Türkiye is generally dominated by public institutions, since the 2000s the private sector has changed mainly due to insufficient public resources.

In addition to privatization, steps have been taken to create a competitive energy market. This will make it easier for the private sector to operate in the energy sector (Topçu & Hayırsever, 2011, pp. 223-242).

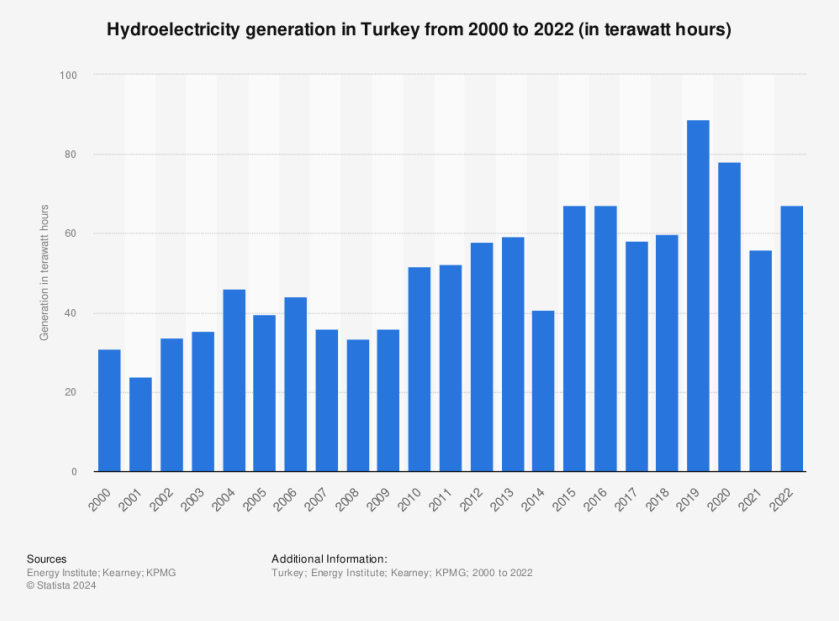
**Figure 5.7. Hydropower Energy Capacity in Türkiye from 2008 to 2023**




(Source: *Zeynep Dierks (2024).Hydopower Energy Capacity in Türkiye 2008-2023*)

According to the International Renewable Energy Agency 2024 report, Türkiye's hydropower energy capacity is given as 31,779 megawatts in Figure 5.7.. Furthermore, International Hydropower Association's 2023 data mentioned that Türkiye ranks tenth in the world with 32.1 gigawatts of cumulative hydropower capacity.

**Figure 5.8. Hydropower Energy Generation in Türkiye from 2008 to 2022**




(Source: *Zeynep Dierks (2024). Hydopower Energy Generation in Türkiye 2008-2022*)

The country ranks second in Europe after Norway in the May 2023 report on the number of operating hydropower plants in Europe, with 78 active plants. Hydropower generation in Türkiye, which is influenced by climatic conditions, fluctuates. In the years when precipitation decreased, there was a decrease in hydraulic energy production. Figure 5.8. shows the data in the Statistical Review of World Energy 2023, there is a fluctuation depending on the year. One of the main reasons for this fluctuation is the utilization rate of dams.

Although hydroelectric power plants are a good alternative way to meet water and energy needs, they have brought many environmental damages. It leads to the destruction of many species by changing the structure of rivers. To give examples

- It threatens livelihoods, especially agriculture, through the corrosive effect of water.
- It leads to the destruction of settlements around dams, increasing migration to cities.

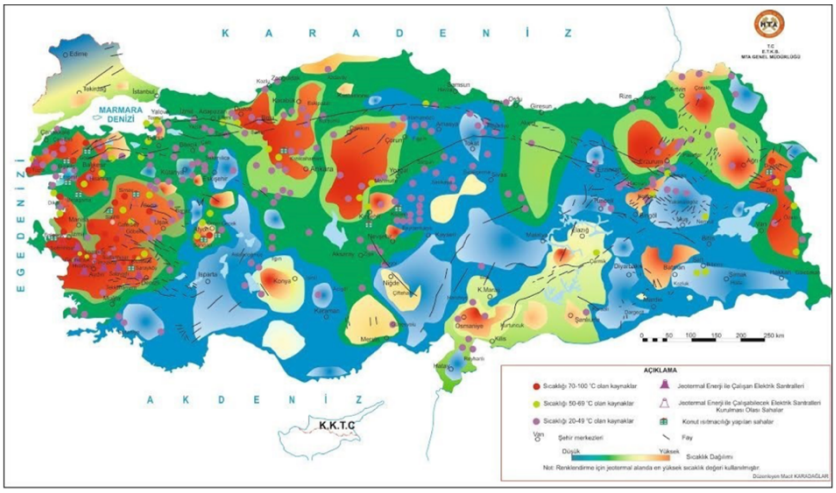
The dams' reservoirs submerge large areas of land, causing groundwater levels. The rise of the water table, the salination of the soil and the release of clean water from the dam through the effect of the shaft kept in the reservoir can cause excessive erosion of riverbeds and banks. Although Türkiye has a rich potential in terms of water resources, the climatic conditions for hydropower and factors such as rainfall affect hydropower production, which may not be sufficient for sustainable energy production.

The global weighted average levelized cost of energy for projects coming on stream in 2021 has increased by 23% compared to 2010, reaching USD 0.048 per kWh. Thus, installation expenses are increasing every year, government support may not be sufficient. Considering the above environmental factors, the contribution of hydropower to the sustainable economy among the renewable energy sources in Türkiye and worldwide cannot be at the desired level.

### 5.1.4. Geothermal Energy Sources in Türkiye

Geothermal energy is heating energy stored in pressurized hot fluids (such as water, steam, gas) and solid rocks that gather at various depths within the Earth because of the planet's formation and the decay of radioactive materials. (Koç & Kaya, 2015) It is utilized for the purpose of heating and generating electricity and located on a tectonically active belt, Türkiye is among the nations with great geothermal possibilities.

**Figure 5.9. Geothermal Energy Potential Map of Türkiye**




(Source: *Republic of Türkiye Ministry of Energy and Natural Resources (2023).Geothermal Resource Map of Türkiye*)

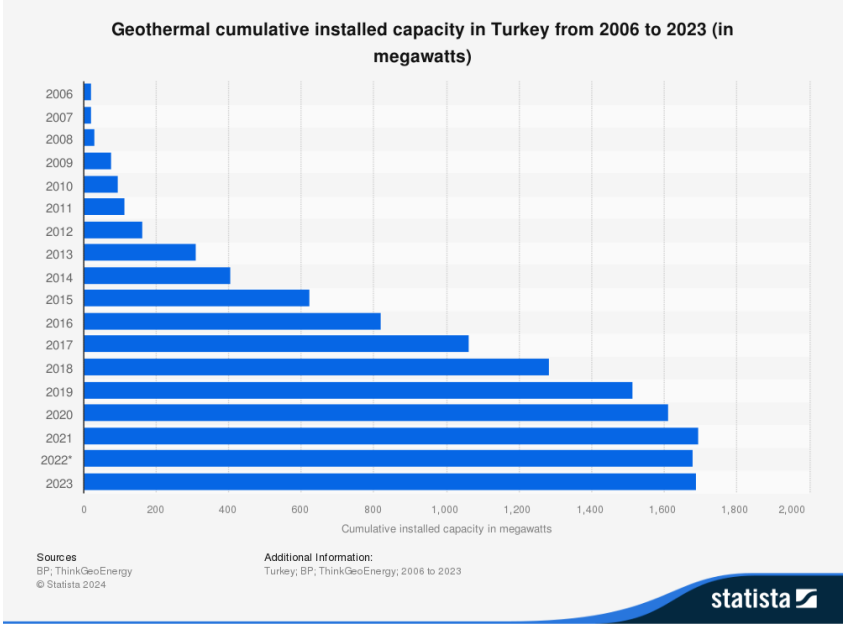
Based on the Geothermal Resources and Exploitation Map from the Ministry of Energy and Natural Resources of Türkiye, most of the geothermal potential areas, 78%, are found in Western Anatolia. Additionally, 9% are in Central Anatolia, 7% in the Marmara region, 5% in Eastern Anatolia, and 1% in other regions. The areas highlighted in red that have high electricity generation flow rates are the Marmara and Aegean regions, along with the coastal regions of Central Anatolia and Southeastern Anatolia. The cities where electricity is produced with geothermal energy are Denizli- Kızıldere, Aydın- Germencik, Çanakkale- Tuzla, Aydın- Salavatlı, Kütahya- Simav, İzmir- Seferihisar, İzmir- Dikili and Manisa- Caferbeyli.

Geothermal energy is classified according to the temperature of the fluid. They are divided into three;

- the lowest fluid temperature (20-70 °C),
- the medium heat (70-150 °C) and
- the high heat (>150 °C).

While low and medium fluid temperature energy is used in areas such as heating, thermal tourism and industry, high fluid temperature energy can be used to generate electricity. However, 90% of this potential is low and medium temperature and is used in direct applications such as heating and thermal tourism, while the remaining 10% is used in indirect applications such as electricity generation. (Özbektaş, Şenel, & Sungur, 2023)

**Figure 5.10. Geothermal Energy Capacity in Türkiye from 2006 to 2023**




(Source: *Zeynep Dierks (2024).Geothermal Cumulative Capacity in Türkiye 2006-2023*)

Figure 5.10. shows that as per the Ministry of Energy's information, geothermal energy has an installed capacity of 1686 MW by the end of 2023, accounting for 1.69% of the total installed capacity. Despite its high potential, the utilization rate of renewable energy sources remains low due to the low temperature threshold required for conversion to electricity, which stands at a mere 10%.

### 5.1.5. Hydrogen Energy Sources in Türkiye

Hydrogen energy is the basic energy source that is formed by reacting with oxygen from the hydrogen element, which has flammable properties. Hydrogen energy types are divided into classes according to their source.

(i) *Grey Hydrogen:* Produced using natural gas or other fossil fuels with the steam methane reformer (SMR) technique.

(ii) *Blue Hydrogen:* Produced by vapour methane reformer (SMR) with carbon capture and storage.

(iii) *Yellow Hydrogen:* Produced by electrolysis of water using solar energy.

(iv) *Pink Hydrogen:* Produced by hydrolysis of water using nuclear energy.

(v) *Green Hydrogen:* It is obtained by electrolysis of water using renewable energy sources.

(vi) *Turquoise Hydrogen:* Produced by the breakdown of methane gas through pyrolysis.

There are different techniques for producing hydrogen gas used in the chemical and petroleum industries;

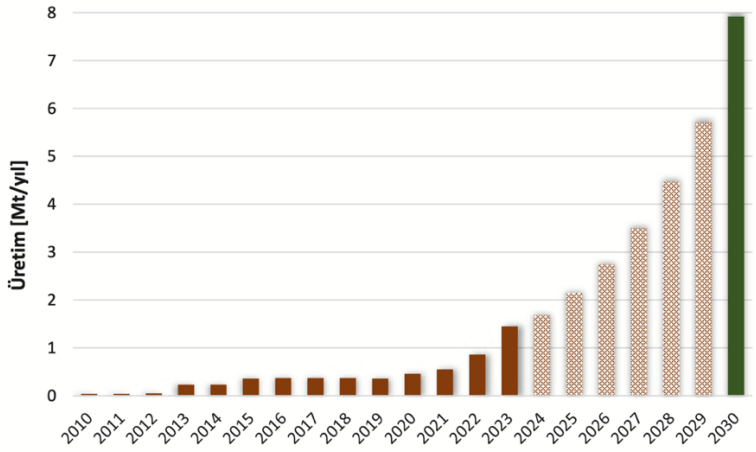
(i) *Thermochemical Method:* The thermochemical method, which allows hydrogen to be obtained from fossil fuels such as coal, natural gas and gasoline, is considered the most accessible method for hydrogen production today, although it causes a high amount of carbon emissions. Hydrogen is produced by subjecting the fossil fuel to high temperature vapor.

(ii) *Electrolysis Method:* The electrolysis method is based on the separation of water into hydrogen and oxygen using direct current. This method, which makes it possible to produce hydrogen from water using electrical energy, is one of the simplest ways to produce hydrogen fuel with sufficient technological equipment.

(iii)*Photoelectrochemical Method:* The photoelectrochemical method, which allows obtaining hydrogen from solar energy, is very similar in logic to the electrolysis method.

Like its use in the world, hydrogen in Türkiye is obtained from fossil fuels, mainly natural gas, and is generally used in non-energy fields due to its high production costs. (Karadaş, 2018) Although hydrogen energy production in Türkiye has been a topic of discussion in recent years, according to 2022 data, it accounts for the largest share of renewable energy production, with 52.3%, while its share of energy used in electricity generation is 20.34%, ranking first among renewable energy sources and third among total energy sources.

**Figure 5.11. Low Carbon Hydrogen Production Quantities and Future Provision**




(Source: *Hidrojen Teknolojileri Derneği (2021).Türkiye için Hidrojen Teknolojileri Yol Haritası*)

Figure 5.11. dedicates that although hydrogen energy production in Türkiye has been a topic of discussion in recent years, according to 2022 data, it accounts for the largest share of renewable energy production, with 52.3%, while its share of energy used in electricity generation is 20.34%, ranking first among renewable energy sources and third among total energy sources. Since 2020, there has been a notable acceleration in the implementation of incentives and policies pertaining to hydrogen energy.

As outlined in the Hydrogen Technologies Strategy and Roadmap Declaration published by Türkiye's Ministry of Energy and Natural Resources, the utilization of hydrogen energy is intended to attain a significant share in electricity generation, while simultaneously offering potential for energy export.

Targets have been established to produce 'green hydrogen' up until 2035 and 2053. It is projected that the cost of producing green hydrogen will be reduced to 2.4 dollars per kilogram of hydrogen by the year 2035. Furthermore, it is anticipated that the installed power capacity of electrolyzes will decrease from 2 gigawatts in 2030 to 5 gigawatts in 2035 and to 70 gigawatts in 2053.

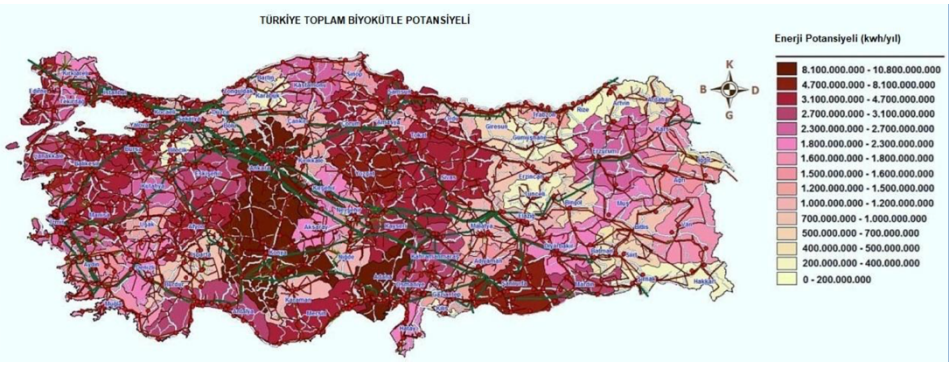
In accordance with the established targets, the pilot green hydrogen plant, situated within EnerjiSA in Balıkesir Bandırma, commenced operations in 2022. This initiative was designed to facilitate public and private sector collaborations, with the objective of stimulating commercial demand and investments. In January 2023, the inaugural phase of the South Marmara Hydrogen Coast Platform Guided Project, Türkiye's inaugural hydrogen valley, was initiated. This EU-funded project is being implemented in collaboration with international organizations (EnerjiSa Üretim, Eti Maden İşletmeleri) and relevant government institutions in Türkiye (Republic of Türkiye Ministry of Industry and Technology).

### 5.1.6. Biomass Energy Sources in Türkiye

The revision to Law No. 5346 regarding Renewable Energy Resource Usage for Power Generation, enacted in June 2016, describes biomass as "materials derived from farming and forestry goods, such as leftover vegetable oils, agricultural residues, processing by-products, discarded tires, as well as industrial and treatment sludges, alongside municipal waste." In essence, biomass energy is derived from natural waste materials. The Biomass Energy Potential Atlas (BEPA), prepared by the Ministry, indicates that the total economic energy equivalent of our waste materials that are collected is approximately 3.9 MTEP/year.

As indicated in the 2024 edition of the IRENA Renewable Energy Capacity Statistics, Türkiye has witnessed a sustained growth in its bioenergy capacity over the years. In 2022, the bioenergy capacity in Türkiye reached its highest level of 2 gigawatts. This represents an increase of 140 megawatts in comparison to the previous year.

**Figure 5.12. Biomass Energy Potential Map of Türkiye**

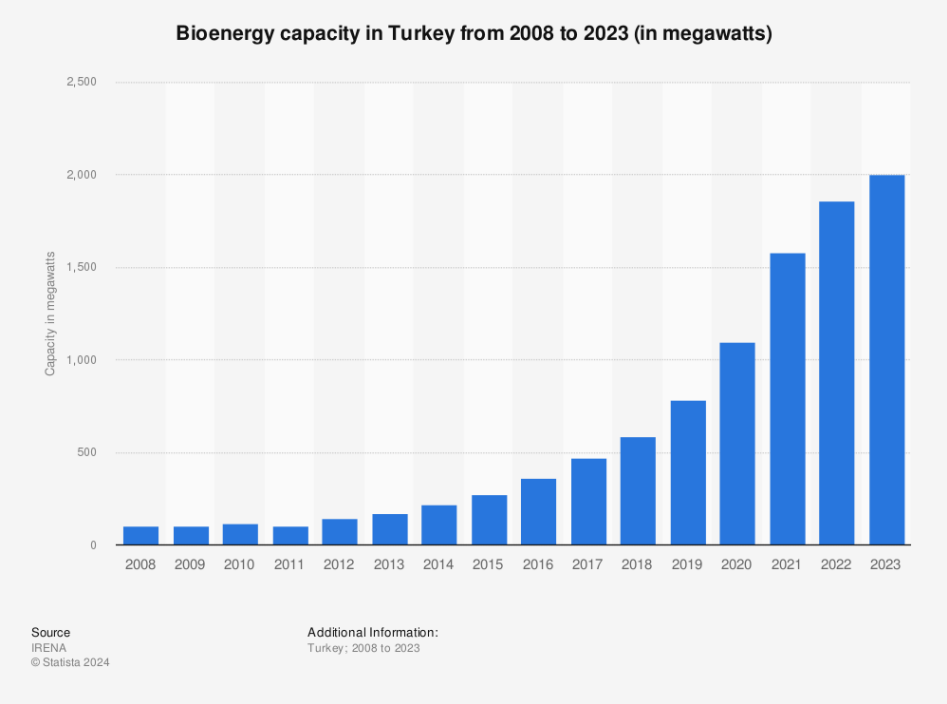



(Source: *Republic of Türkiye Ministry of Energy and Natural Resources (2023).Biomass Resource Map of Türkiye*)

Figure 5.12. shows that the map of Biomass Potential Distribution by Provinces in Türkiye, although Türkiye is a country with a high potential, as you go to the western parts, density is observed especially in the Central Anatolia region. It has been observed that the biomass potential is also high in cities with high population rate.

A review of the biomass energy resources in Türkiye reveals a multitude of potential sources, including agricultural industry residues and byproducts, wood and non-wood forest products, animal wastes from animal breeding and slaughtering, and solid waste generated by urban and domestic populations, particularly in cities with high rates of public housing. The utilization of these resources for the generation of alternative fuels is a viable option, provided that appropriate conversion techniques such as gasification, fermentation, and anaerobic digestion are employed (Kapluhan, 2014, pp. 97-125).

**Figure 5.13. Biomass Energy Capacity in Türkiye from 2006 to 2023**




(Source: *Zeynep Dierks (2024).Bioenergy Capacity in Türkiye 2008-2023*)

The 2021 Energy Atlas indicates that 172 registered biogas, biomass, waste heat, and pyrolytic oil power plants are currently operational in Türkiye. The Istanbul Metropolitan Municipality Biomass Power Plant, which has an 86 MW installed capacity, is the biggest electricity producer out of them all. In 2021, biogas, biomass, waste heat, and pyrolytic oil power plants in Türkiye produced a total of 7,371,770,000 kilowatt-hours of electricity in Figure 5.13.. The generation of waste products during the production of bioenergy may have a detrimental impact on the environment.

Furthermore, the gases generated during the storage and separation of garbage and similar wastes used for production are flammable gases, which presents a risk of explosion. Conversely, bioenergy, which can be an unlimited renewable energy source such as solar and wind energy, prevents environmental pollution problems by utilizing waste.

When obtained through agriculture, it can reduce soil erosion and increase the area of green vegetation. According to the 2021 IEA data, bioenergy, which can be produced in a variety of ways, has a usage rate of 2.4% among renewable energy sources.

For Türkiye, which aims to reduce its dependence on foreign energy, bioenergy is a good alternative to renewable energy sources by reducing environmental pollution. Transition to renewable energy in Türkiye includes reducing the costs of renewable energy technologies through research and development, promoting financing mechanisms that make renewable energy more affordable for consumers, and improving access to renewable energy in remote and underserved areas.

## 5.2. Renewable Energy Integration

The final stage of transition to renewable energy is widespread adoption and integration. In this phase, renewable energy sources are incorporated into the global energy system as a major part. They are no longer considered alternative or niche choices, but instead are the main sources of energy. (Verbruggen & Lauber, 2009, pp. 5732-5743).

These sources of energy are integrated into the existing infrastructure and supply chains, providing a reliable and sustainable source of power for various sectors including residential, commercial, and industrial (Akella, Saini, & Sharma, 2009, pp. 390-396). This widespread adoption and integration of renewable energy is facilitated by advancements in technology, improved efficiencies, and continued policy support. To sum up, the transition to renewable energy involves multiple interconnected stages, each requiring concerted efforts from governments, industries, and communities.

The global shift to renewable energy can be sped up through public awareness, technology improvements, international collaboration, investments, and sustainable development, resulting in a more sustainable and resilient energy future worldwide. The transition to renewable energy in Türkiye has been slowly progressing, impacted by diverse socio-economic, political, and environmental elements.

With the rise of global worries about climate change and dwindling fossil fuel reserves, there is an escalating demand to shift from conventional power production to renewable energy sources. This change includes multiple phases. The initial step towards shifting to renewable energy involves consciousness and comprehension.

People at the individual, community, and governmental levels are recognizing the necessity of moving towards renewable energy sources and comprehending the advantages and consequences of making that shift. This phase frequently includes informing the public about the advantages of renewable energy for the environment and economy, as well as highlighting the drawbacks of fossil fuels.

In the following stage is that demonstration and implementation which means renewable energy technologies that have been developed and tested in research laboratories are scaled up and deployed on a larger scale for practical applications. This stage involves setting up pilot projects and demonstration sites to showcase the viability and effectiveness of renewable energy sources. These demonstrations help to build confidence in renewable energy and encourage further investment and adoption of these technologies.

The following step involves providing policy and regulatory assistance. In this phase, governments and regulatory authorities are instrumental in developing favorable policies and regulations to facilitate the shift to renewable energy. These measures might consist of rewards, financial assistance, and requirements to encourage the adoption of renewable energy and discourage the dependence on fossil fuels. Governments can set goals for renewable energy, introduce feed-in tariffs, and develop infrastructure to help include renewable energy in the current power grid.

Additionally, regulatory authorities can establish standards and rules to guarantee the quality and safety of renewable energy systems. Once supportive policies and regulations are in place, the next stage of transition involves market development. (Akella, Saini, & Sharma, 2009, pp. 390-396)

During this stage, efforts are made to create a vibrant and robust market for renewable energy products and services. This involves encouraging investment in renewable energy projects, fostering competition among suppliers, and educating consumers about the benefits of renewable energy sources. As the market for renewable energy continues to develop, it becomes increasingly important to focus on ensuring affordability and accessibility.

The next stage is research and development. During this stage, significant research and development efforts are carried out to explore, innovate, and improve renewable energy technologies. Scientists and engineers work on developing more efficient and cost-effective solar panels, wind turbines, biomass fuels, and other forms of renewable energy.

In addition to technological advancements, research is also focused on addressing issues such as energy storage and grid integration to ensure a smooth transition to renewable energy sources. According to the sources provided, the transition to renewable energy in Türkiye has been a subject of debate and has faced uncertainties. The long-term impacts and infrastructure changes required for the transition have made it a complex and time-consuming process.

Türkiye has been actively engaged in partnerships with countries that have advanced renewable energy technologies and expertise, such as Germany and China. Because of these partnerships, Türkiye has been able to access technology transfer, knowledge sharing, and financial resources to support the development of its renewable energy sector. Another foreign policy decision taken by Türkiye to increase renewable energy is the implementation of effective regulatory frameworks and incentives. Türkiye has implemented policies and incentives with the objective of attracting private investment and promoting renewable energy projects. These policies include feed-in tariffs, long-term power purchase agreements, tax incentives, and the establishment of renewable energy zones.

In addition, Türkiye has also implemented steps to simplify the procedure of acquiring permits and licenses for renewable energy projects, facilitating investors in navigating the regulatory process. Moreover, Türkiye has put emphasis on varying its energy sources by encouraging local production of renewable energy. The government has introduced measures to support the growth of domestic renewable energy initiatives, including offering financial aid and subsidies to producers and developers. These investments require significant financial resources, and Türkiye may face challenges in securing the necessary financing for these projects.

Political and policy challenges also pose significant barriers to the transition to renewable energy in Türkiye. The current policy landscape in Türkiye is influenced by fossil fuel imports, which creates a dependency on non-renewable energy sources. This dependency on fossil fuels hampers the development and implementation of policies that support renewable energy sources. Thus, the key to decreasing reliance on fossil fuels starts with shifting towards renewable energy sources. To achieve this, sufficient financial support and a permanent applicable regulation are needed. Essentially, meeting these two needs can be made possible through agreements made with various institutions and state support.

### 5.2.1. Challenges of Transition to Renewable Energy

Certainly, the obstacles and difficulties experienced in the transformation to green energy should not be ignored. The remedies put into place during these challenges could result in reliance on fossil fuels and consequently dependence on foreign energy sources. The Turkish government needs to adjust its energy policy and investments to reach a greater proportion of renewable energy provision. 'One specific challenge that Türkiye faces in its transition to renewable energy is the need to increase its investments in hydropower, wind, solar, and geothermal energy' (Işıksungur, Regulatory Framework for Development of Renewable Energy Generation in Turkey, 2019).

Transitioning to renewable energy in Türkiye presents several challenges that need to be addressed for successful implementation. One of the main challenges of transitioning to renewable energy in Türkiye is the presence of market failures; positive externalities of underprices and negative externalities from fossil fuels, lack of consumer awareness, uncertainty in technological efficiency, grid modernization, energy storage and disincentives for investment and development in the renewable energy sector. The high up-front cost of renewable energy infrastructure is a significant barrier to widespread adoption. The high up-front cost of renewable energy infrastructure is a significant barrier to widespread adoption. (Held, Boßmann, & Förster, 2017, pp. 34-53)

Türkiye's reliance on foreign materials for renewable energy technologies, like photovoltaic (PV) panels, rare earth elements, lithium-ion batteries or wind turbines, poses a major obstacle to its shift towards a renewable energy economy. Comprehensive solutions are required due to the complexity of the transition. One major challenge Türkiye faces in shifting to renewable energy is the sporadic nature of renewable energy sources. The sporadic quality of renewable energy sources like solar and wind power poses a difficulty to maintain a steady and dependable electricity supply. Conversely, Türkiye encounters obstacles concerning infrastructure and grid integration.

Türkiye's current infrastructure and grid system are mainly built to support conventional power generation from fossil fuels. This presents difficulties in efficiently integrating and distributing renewable energy sources. Moreover, there are obstacles in regulations and policies that must be tackled. Türkiye also encounters challenges in terms of financing and investment. The high cost of renewable energy infrastructure, coupled with limited access to raw materials, presents a significant challenge for Türkiye in attracting the necessary investment and financing for renewable energy projects.

Another challenge that Türkiye faces is a lack of information. There is a lack of awareness and understanding among the public, as well as policymakers, about the benefits and potential of renewable energy sources. Furthermore, Türkiye also faces challenges related to access to raw materials for renewable energy production.

The high cost of renewable energy infrastructure is a significant barrier to widespread adoption (Held, Boßmann, & Förster, 2017). Another challenge is the lack of technological readiness and expertise in renewable energy technologies within Türkiye. Türkiye's limited access to raw materials for renewable energy production. As Türkiye strives to achieve its objective of transitioning to renewable energy, it is confronted with a multitude of challenges that necessitate resolution. One of the most significant challenges is the aged and inadequately maintained infrastructure, which contributes to elevated levels of pollution. This impedes the advancement of renewable energy initiatives and underscores the necessity for infrastructure enhancements.

The financial aspect of transitioning to renewable energy is a significant hurdle in Türkiye. Substantial funding is required for renewable energy infrastructure, R&D (research and development), and the education of qualified workers. This involves establishing distinct goals and rewards for the utilization of renewable energy, simplifying the authorization process for renewable energy initiatives, and offering financial aid and rewards for investing in renewable energy.

Additionally, the government needs to allocate funds for improving and broadening the energy infrastructure to facilitate the incorporation of renewable energy sources. This involves enhancing the grid infrastructure to manage the sporadic characteristics of renewable energy and integrating smart grid technologies. Next, the government needs to focus on advancing renewable energy technologies through research and development. (Prastawa, 2000, pp. 1700-1703). This involves financing research facilities and offering rewards to encourage private industry investment in renewable energy advancements.

Moreover, the government must give importance to public awareness and education campaigns to encourage public support and involvement in the shift to renewable energy. Furthermore, the Turkish government ought to form alliances and work together with international organizations like the European Union to secure funding and technical support for renewable energy initiatives. (Apak, Atay, & Tuncer, 2012, pp. 1700-1703). Another challenge is the inability of consumers to bear the cost of subsidies (Işıksungur, 2019, pp. 159–179). This challenge can be addressed through targeted subsidies and financial incentives for consumers to adopt renewable energy technologies.

To sum up, the short licensing duration for renewable energy projects in Türkiye poses a challenge. This challenge can be addressed by streamlining the licensing process and providing longer-term licenses for renewable energy projects. Transitioning to renewable energy in Türkiye faces several significant challenges. The obstacles consist of developing a legal framework to support renewable energy investment, unclear responsibilities among institutions promoting renewables, costly infrastructure and funding issues, inadequate transmission capabilities, consumer inability to cover subsidies, and brief project licensing durations for renewable energy. (Oniemola, 2015)

# CONCLUSION

An analysis of the primary energy supply in Türkiye in 2022 reveals that non-renewable energy sources occupy the top three positions, with 27.4% of the total derived from natural gas, 25.1% from coal and 28.8% from oil. Nevertheless, the rising cost of energy and the importance of energy imports demonstrate the mass of considering the weight of renewable energy sources at both the economic and political levels. The over-consumption of non-renewable energy resources has led many states to implement significant measures to utilize renewable resources, which can facilitate the transition to a sustainable economic model. The policies and agreements made in this field demonstrate the necessity for a global transformation. In addition to the climate crisis and economic considerations, this situation has also been a matter of concern in the field of foreign policy in Türkiye.

It is evident that Türkiye has been significantly impacted by crises that have occurred in recent years, particularly in the context of foreign trade. The urgent issues of climate change and economic stability, the political turbulence that has recently occurred in Türkiye has also been a significant concern in the context of foreign policy. The effects of climate change are rendering Türkiye increasingly vulnerable regarding energy and food security. This is leading to a range of consequences, including a reduction in water resources, a decline in agricultural production and an increase in the frequency of natural disasters. This situation serves to accelerate the policy of reducing energy dependence and shifting towards renewable energy sources.

In consequence of the impact of the energy crisis, Türkiye is adopting a more proactive stance in its foreign policy to diversify its energy sources and ensure energy supply security. Concurrently, the prevailing political crises, including those pertaining to energy reserves in the Eastern Mediterranean and the Syrian crisis, are influencing the formulation of Türkiye's energy strategies and diplomatic relations.

The importance of relations with energy-exporting countries has increased, with energy corridors and pipeline projects becoming a central aspect of regional cooperation and alliances. Investing in renewable energy technologies and collaborating internationally in this field has resulted in Türkiye's foreign policy placing more importance on sustainability and climate-friendly policies.

This change also results in fresh dynamics in Türkiye's ties with the European Union, allowing Türkiye to take on a more involved position in combating climate change. Energy security have become a significant worry for the people of Türkiye. Recognizing the potential of renewable energy resources in policymaking and the private sector is crucial, and implementing support measures is necessary to facilitate their optimal development. The findings of the research indicate that Türkiye is unable to utilize renewable energy resources sufficiently to meet its energy need in the short term.

I. Inadequate incentives and discounts are not provided to the private sector, where most of the energy production occurs.
II. The issue of renewable energy resources should not be considered solely within the context of environmental policy, but rather as a matter that encompasses environmental, economic, and policy considerations.
III. A lack of a stable and lasting set of laws regulating the use of renewable energy sources is a major barrier to progress in this area.
IV. The absence of sufficient technology to convert potential renewable energy sources and the need to import technical equipment are major barriers to the advancement of renewable energy sources.
V. While the emphasis on solar, wind, and hydraulic energy sources is praiseworthy, there has not been sufficient exploration of hydrogen as a potential long-term energy source.

Türkiye's transition towards renewable energy sources presents significant opportunities, both in terms of energy security and in the context of diplomatic and economic relations. This thesis provides an analysis of the key economic, political, and technical challenges Türkiye faces in its transition to renewable energy.

As a country heavily reliant on fossil fuels, particularly imported natural gas and oil, Türkiye's dependence on these energy sources has significant negative impacts on both economic sustainability and its foreign trade balance.

In this context, Türkiye’s shift towards renewable energy is not only crucial for ensuring energy security but also for addressing its trade deficit. However, this transition process presents a range of difficulties.

From an economic perspective, the high costs of renewable energy investments and the lack of sufficient financing to support the development of this sector are major obstacles. Despite Türkiye’s rich renewable energy potential, especially in wind, solar, and hydropower, the country struggles to attract enough domestic and foreign investments to fully realize this potential. As a result, short-term reliance on fossil fuels is likely to continue.

Moreover, Türkiye's energy imports constitute a large part of its trade deficit, increasing the economic pressure on growth. The findings suggest that increased investments in renewable energy would reduce dependence on energy imports, leading to a positive impact on the trade balance.

Politically, the transformation of Türkiye’s energy policies in favor of renewable energy has been slow due to bureaucratic barriers and insufficient regulatory reforms. The thesis highlights the need for expanding incentive mechanisms to support the renewable energy sector and strengthening legislative measures to accelerate its development. The findings indicate that Türkiye’s energy policies are still largely oriented towards fossil fuels, which hinders the acceleration of renewable energy investments.

Additionally, increasing competition in the energy market and implementing more effective energy efficiency policies are essential. A greater focus on renewable energy investments would not only enhance energy supply security but also improve Türkiye’s competitiveness in international markets. From a technical standpoint, Türkiye faces significant challenges in developing and implementing renewable energy technologies due to infrastructure deficiencies. The limited capacity for domestic production in the renewable energy sector increases the country’s reliance on foreign technology.

Technological advancements need to be closely followed, and the development of domestic technologies in renewable energy should be encouraged. The thesis findings reveal that Türkiye's investments in energy technologies would contribute not only to the energy sector but also to the broader economic growth of the country. Developing domestic technology would lower energy costs and strengthen Türkiye's potential to become a regional leader in renewable energy.

Regarding foreign trade, Türkiye's transition to renewable energy has the potential to reshape its position in international energy markets and contribute significantly to its trade balance. By reducing reliance on energy imports, Türkiye can lower energy costs and increase opportunities for domestic production and export.

The development of renewable energy technologies and their potential exportation can bring new dimensions to Türkiye's foreign trade. Furthermore, Türkiye's potential to become a regional energy hub would be further bolstered by investments in renewable energy. In this process, energy cooperation with the European Union and other international partners could also expand Türkiye's trade volume. Renewable energy will not only positively impact Türkiye's trade balance but also enhance the country's reputation in global energy markets.

In conclusion, Türkiye's transition to renewable energy is a strategic necessity, both for economic growth and energy security. The economic, political, and technical challenges encountered in this process can be overcome through the more effective and sustainable implementation of renewable energy policies. Investments in renewable energy will decrease Türkiye's energy dependence, reduce its trade deficit, and improve its competitive position in international markets.

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