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TÜRKİYE'S RENEWABLE ENERGY LANDSCAPE: CURRENT STATUS AND FUTURE PROSPECTS THROUGH SWOT AND PESTLE ANALYSIS

TÜRKİYE'NİN YENİLENEBİLİR ENERJİ GÖRÜNÜMÜ: SWOT VE PESTLE ANALİZİ İLE MEVCUT DURUM VE GELECEK BEKLENTİLERİ

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ABSTRACT

Türkiye's strategic location in the Earth's sunbelt, along with its diverse geographical features, makes it a great place to harness renewable energy sources like hydropower, wind, solar, geothermal, and biomass energy. At the end of 2024, Türkiye's renewable energy capacity reached approximately 68.5 GW, accounting for 59.4% of total capacity, reflecting an 8.5% growth compared to the previous year. During the same period, electricity production from renewable energy sources increased by 15.8% compared to the previous year, reaching 159.7 TWh, and accounted for 45.8% of total production. According to Türkiye's National Energy Plan, it is expected that by 2035, the share of renewable energy sources in total installed capacity will rise to 64.7%, reaching 122.7 GW, while the share of renewable energy in electricity generation will increase to 54.8%, accounting for 279.7 TWh. This paper explains the current state and future prospects of Türkiye's renewable energy sector, employing SWOT and PESTLE analyses to provide a comprehensive assessment. With its abundant renewable resources, Türkiye has the potential to enhance energy security and sustainability by increasing the share of renewables in electricity production and reducing fossil fuel dependence.

Keywords: Türkiye's energy capacity, renewable energy, SWOT, PESTLE, sustainable development

ÖZET

Türkiye'nin dünyanın güneş kuşağında bulunan stratejik konumu ve çeşitli coğrafi özellikleri, hidroelektrik, rüzgar, güneş, jeotermal ve biyokütle enerjisi gibi yenilenebilir enerji kaynaklarından yararlanmak için ideal bir yer olmasını sağlamaktadır. 2024 yılı sonunda Türkiye'nin yenilenebilir enerji kapasitesi yaklaşık 68,5 GW'a ulaşmış ve toplam kapasitenin %59,4'ünü oluşturarak bir önceki yıla göre %8,5 artış göstermiştir. Aynı dönemde yenilenebilir enerji kaynaklarından elektrik üretimi %15,8 artarak 159,7 TWh'ye ulaşmış ve toplam üretimin %45,8'ini oluşturmuştur. Türkiye Ulusal Enerji Planı'na göre, 2035 yılına kadar toplam kurulu kapasite içinde yenilenebilir enerji kaynaklarının payının %64,7'ye çıkarak 122,7 GW'a ulaşması, elektrik üretimindeki payının ise %54,8'e yükselerek 279,7 TWh olması beklenmektedir. Bu çalışma, SWOT ve PESTLE analizlerini kullanarak Türkiye'nin yenilenebilir enerji sektörünün mevcut durumunu ve gelecekteki gelişme potansiyelini kapsamlı bir şekilde değerlendirmektedir. Türkiye, bol miktardaki yenilenebilir enerji kaynakları sayesinde elektrik üretiminde bu kaynakların payını artırarak enerji güvenliği ve sürdürülebilirliğini güçlendirme potansiyeline sahiptir.

Anahtar Kelimeler: Türkiye'nin enerji kapasitesi, yenilenebilir enerji, SWOT, PESTLE, sürdürülebilir kalkınma

INTRODUCTION

Recent global events, such as the energy crisis and natural disasters, have highlighted the critical role of energy in supporting economic growth, promoting social development, and improving life quality. In the last century, traditional fossil fuels have supplied nations with electricity and supported the financial stability (Osakede et al.,

2025; Akan, 2024; Hassan, Algburi, et al., 2024; Hoang et al., 2021; Halkos & Gkampoura, 2020). The share of global energy consumption rises at an average rate of approximately 3% per year due to the increasing energy demand in both developed and developing countries. However, there are major social, economic, and environmental effects of their use (Ahmad & Zhang, 2020). Greenhouse gases, such as carbon dioxide (CO_2), are released into the atmosphere when fossil fuels are burned. Figure 1 shows the per capita CO_2 emissions from fossil fuels and industry over the years, illustrating a steady increase from the 1900s to the present (Our World in Data, 2024a). Climate change and global warming are caused by these gases' ability to trap heat in the atmosphere. The increase in the average temperature of the planet is a contributing factor in the occurrence of extreme weather events and ecological disturbances. Besides, the emissions released during the combustion of fossil fuels can directly affect the health of nearby communities. Additionally, relying on imported fossil fuels can expose governments to the risk of supply disruptions and price fluctuations (Azni, et al., 2023). To address these effects, there is a worldwide effort to shift towards cleaner and more sustainable energy sources. Renewable energy sources like hydropower, wind, and solar are crucial in addressing environmental, economic, and social challenges. CO_2 and other pollutants that are responsible for global warming can be reduced by transitioning from fossil fuels to renewable energy technologies (Sharma et al., 2025; Hassan,Viktor, et al., 2024; Strielkowski, et al., 2021; Klepacka, 2019; Azarpour, et al., 2013). Besides, renewable energy sources, in contrast to fossil fuels, are both sustainable and capable of natural replenishment. The current transition towards renewable energy is a crucial element of a more sustainable and eco-friendly energy system (Jurasz, et al., 2020; Panwar, et al., 2011). Electricity serves a vital function in all sectors of modern life and contributes to social and economic progress. The accessibility of unlimited electricity enables the growth of industries, transportation, and agriculture for countries. As of 2023, the global installed electricity capacity was 9.1 TW, marking a 6.5% increase compared to the previous year. The global renewable energy capacity reached 3.9 TW, accounting for 43.0% of the total capacity. Over the past two decades, global electrical energy consumption has more than doubled, reaching approximately 27064 TWh in 2023. To meet this demand, a total of 29479 TWh of electricity was generated worldwide in the same year, with 8914 TWh coming from renewable resources (U.S. Energy Information Administration, 2024). Figure 2 shows the per capita electricity generation by energy source worldwide in 2023 (Our World in Data, 2024b).

As shown in Figure 2, fossil fuels remain the primary source of global electricity generation, and both fossil-based and renewable electricity capacity and output are expected to continue rising with increasing industrialization and energy demand. Energy consumption in the form of electrical energy in Türkiye is steadily rising each year as a result of population growth and industrial development (Cetin, et al., 2018; Gökmenoğlu & Taspinar, 2016; Ozturk & Acaravci, 2010). Türkiye has implemented measures that increase the amount of renewable energy sources within its overall energy portfolio. There is a lack of recent and comprehensive research on Türkiye's overall renewable energy status; however, there are some case studies on different aspects of Türkiye's energy potential in recent years (Kilickaplan et al., 2017). A study compares two scenarios, one based on Vision 2023 using renewable resources and another relying on fossil fuels, revealing that although renewables have higher upfront costs, they offer significant long-term environmental and economic benefits, including $2.175 billion annual savings from carbon taxes (Melikoglu, 2013b). Another study examines the relationship between renewable energy consumption and GDP in Türkiye from 1990 to 2015, using cointegration and causality tests. The results show no significant relationship between the two, likely due to the low share of renewables in Türkiye’s total energy consumption, highlighting the need to expand renewable energy use to advance economic growth, environmental protection, and energy independence (Bulut & Muratoglu, 2018). In a study focused on Türkiye’s renewable energy priorities, the IF-TOPSIS method is used to evaluate and rank the most suitable renewable energy sources for Türkiye’s sustainable development, based on seven options and 25 criteria. The results identify solar energy as the most favorable option, with capital/investment cost emerging as the most critical evaluation criterion (Bilgili, et al., 2022). This study investigates the effects of financial development, economic growth, and energy prices on renewable energy consumption in Türkiye using VECM and ARDL methods over the 1980–2019 period. The results show that financial development positively impacts renewable energy use, suggesting that effective financial strategies can enhance renewable investments and support sustainable development, while also helping mitigate global warming (Mukhtarov, et al., 2022). A study by (Uddin, et al., 2021) presents a comparative analysis of renewable energy development in Pakistan and Türkiye, highlighting that while both countries rely heavily on imported fossil fuels, Türkiye has made more progress in using diverse renewable resources, including wind, solar, and geothermal energy. The findings emphasize the underutilization of geothermal energy in both countries and suggest policy recommendations to promote renewable technologies for energy decentralization and improved rural electrification. A recent study (Cesur, et al., 2024) identifies and compares the key criteria for the use of renewable energy technologies (RETs) in buildings in Türkiye, emphasizing the importance of these criteria in the decision-making

process. By employing a recommendation model based on the Analytic Hierarchy Process (AHP), the study provides a framework for selecting the most appropriate RETs in building design. Another recent study (Pamuk, 2024) designs a hybrid renewable energy system for Karaburun and Urla districts in Izmir using Homer PRO, assessing penetration rates and grid sales constraints. The optimal system configuration is identified, with smaller systems proving more suitable for high-sales constraints. The goal of this paper is to present the current energy status and provide an overview of renewable energy sources in Türkiye, employing SWOT and PESTLE analyses to offer a comprehensive assessment. Through these strategic tools, the present study is important to evaluate renewable energy potential for investors to make concrete decisions regarding energy sustainability in Türkiye.

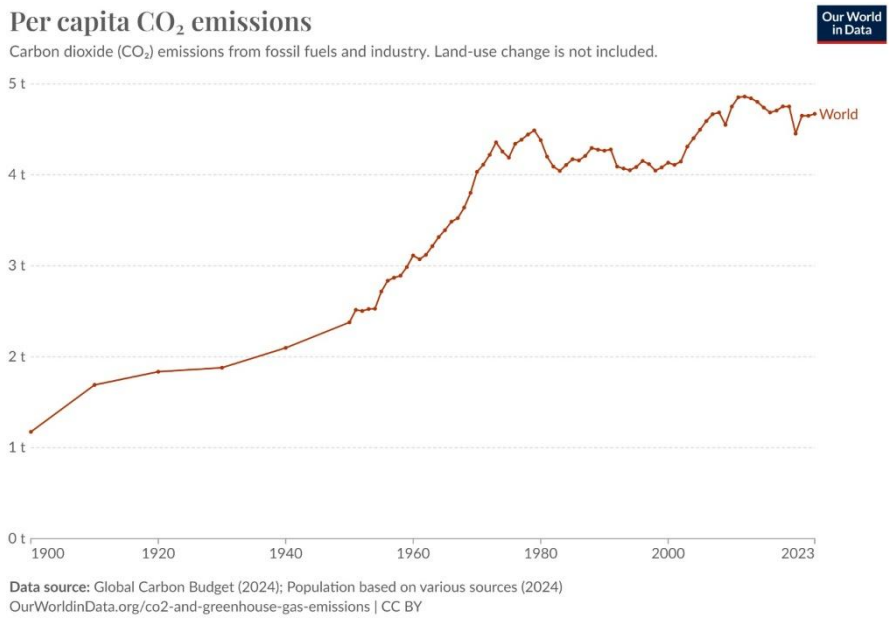

Figure 1. Per Capita CO_2 Emissions from Fossil Fuels and Industry over the Years

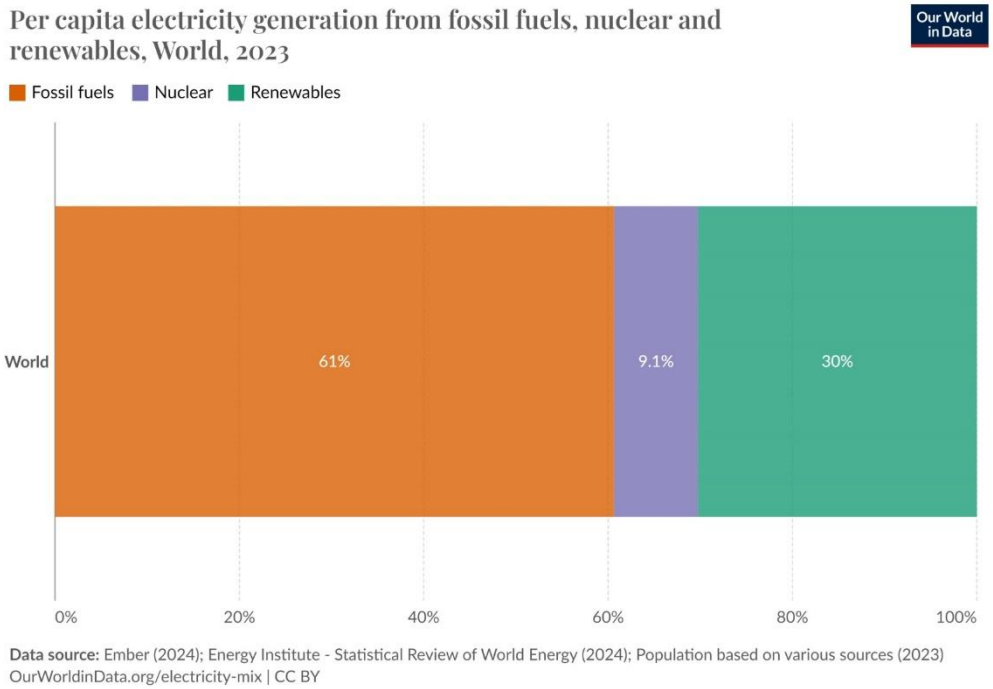

Figure 2. Per Capita Electricity Generation by Energy Source Worldwide in 2023

CURRENT ENERGY STATUS IN TÜRKİYE

With an impressive economic recovery and a young population, Türkiye is one of the world's fastest-growing countries. Over the past two decades, Türkiye has experienced substantial growth in its population and economy, as depicted in Figures 3 and 4, respectively (World Bank Group, 2024a, 2024b). In 2023, the nation's population surpassed 85 million, and its economic volume based on gross domestic product (GDP) reached approximately 1.1 trillion dollars, which makes the country the 17th largest economy in the world.

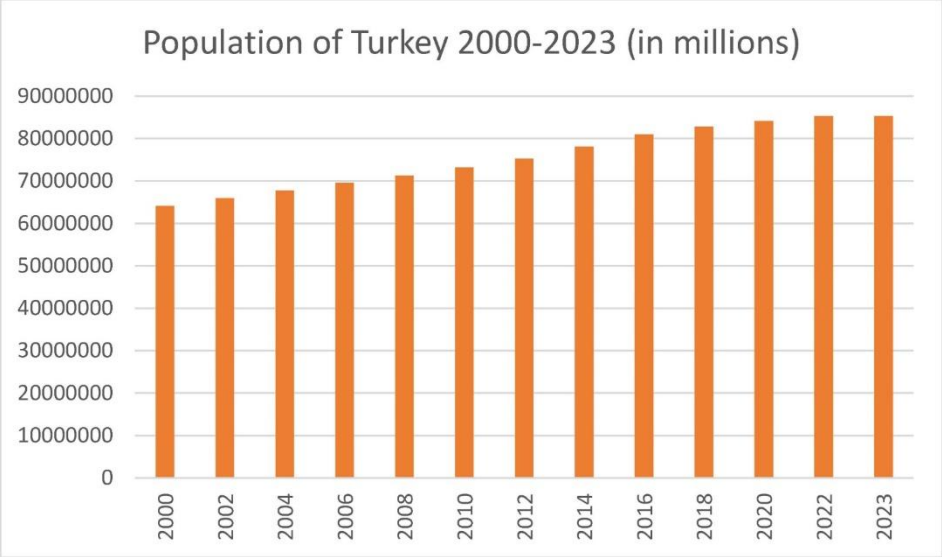

Figure 3. Population Change in Türkiye over the Past Two Decades

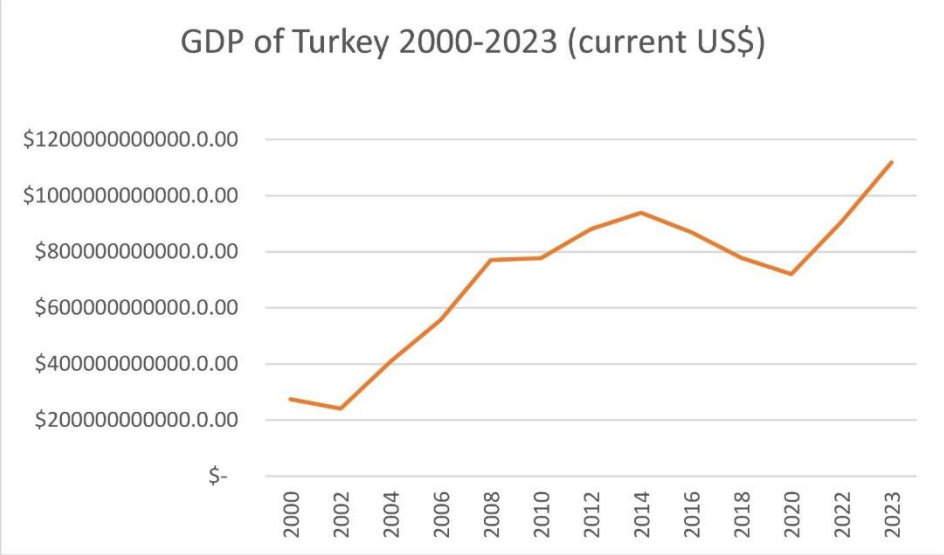

Figure 4. Gdp Change of Türkiye over the Past Two Decades

Türkiye's annual energy consumption has increased by almost 35% over the past ten years, with electricity consumption reaching 347.9 TWh in 2024 (Türkiye Elektrik İletim A.Ş., 2024). Despite the presence of a huge amount of renewable energy sources, the use of coal and natural gas remains significantly important in Türkiye's electricity generation. Therefore, the government is implementing measures to decrease the country's reliance on fossil fuels and promote sustainable energy (Ocal & Aslan, 2013). In recent years, Türkiye has experienced a significant increase in its energy production capacity. Figure 5 displays the distribution of Türkiye's installed electricity capacity and gross electricity generation by primary energy resources in 2024, revealing that the country's energy potential consists largely of renewable energy sources (Elektrik Piyasası Düzenleme Kurumu, 2025). Compared to 2023, Türkiye's installed electricity capacity increased by 4.1%, reaching 115.3 GW, while electricity production increased by 6.8%, totaling 348.9 TWh. The share of renewable energy in total installed electricity

capacity reached 68.5 GW, while the amount of renewable energy in the total electricity supply reached 159.7 TWh. Approximately 45.8% of the country's electricity demand was met by renewable energy sources. As of the end of January 2025, Türkiye operates a total of 34104 active electric power plants, including 765 hydropower, 70 coal, 378 wind, 66 geothermal, 332 natural gas, 32027 solar, and 466 other types of power stations (Republic of Türkiye Ministry of Energy and Natural Resources, 2025).

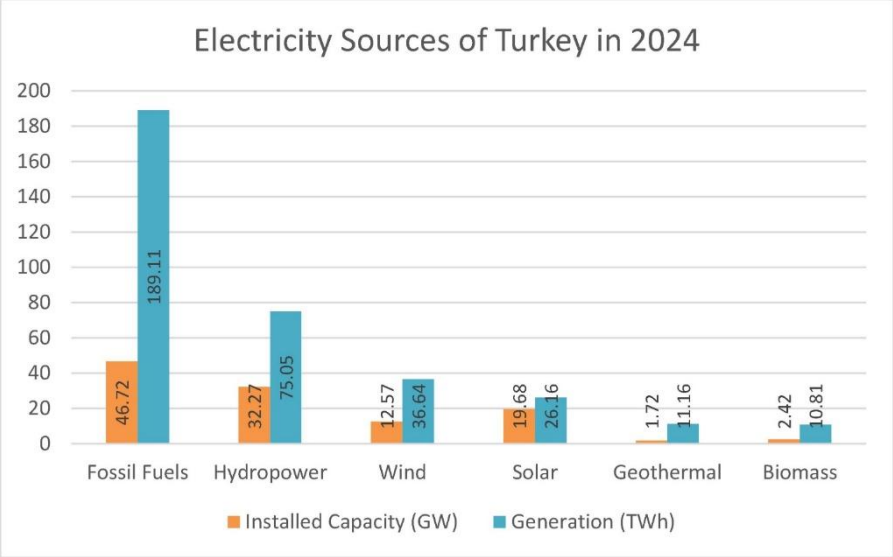

Figure 5. Türkiye's Electricity Sources in 2024

RENEWABLE ENERGY SOURCES IN TÜRKİYE

Türkiye has been aiming to diversify its energy sources and decrease its reliance on imports. The country is therefore investing in energy projects, including renewable energy. Türkiye has abundant renewable energy sources, including hydropower, wind, solar, geothermal, and biomass (Erdil & Erbıyık, 2015; Toklu, 2013). Currently, renewable resources play a substantial role in Türkiye's energy supply, representing around 45.8% of the country's energy demand. The percentage of renewable energy in total primary energy supply in Türkiye has been increasing over the past 20 years, similar to the average trend in European Union countries, which is a result of investments in renewable energy, as shown in Figure 6 (Our World in Data, 2024c).

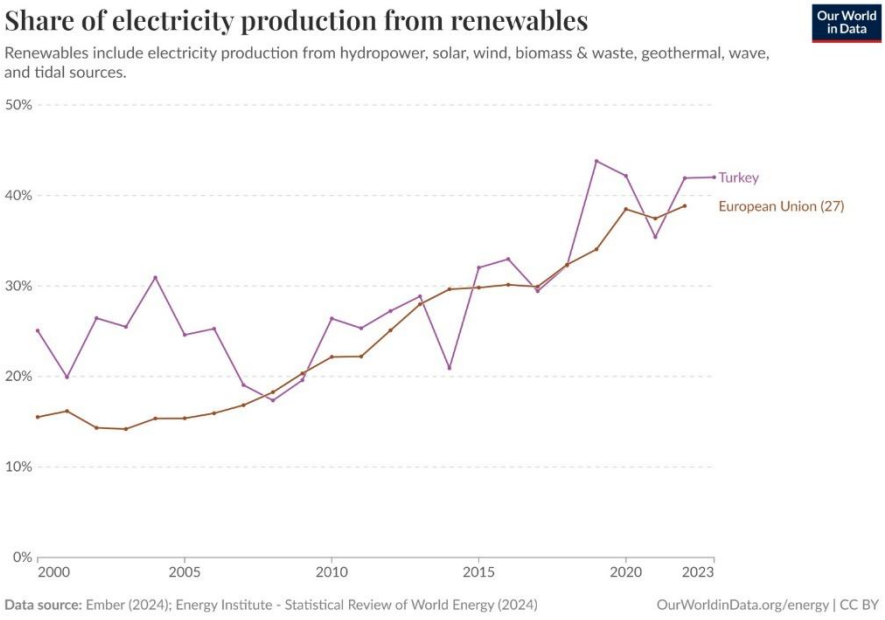

Figure 6. Share of Electricity Production from Renewable Energy Sources in Türkiye over the Years

Hydropower

The generation of electricity using hydropower plants has been a long-standing method in Türkiye. A large number of rivers and water resources throughout the nation are used for hydropower development. Hydropower plants that are clean, efficient, long-lasting, and have low operating costs with no foreign dependence have become particularly popular among other energy sources over the past 50 years (Melikoglu, 2013a). In 2024, hydropower energy reached a capacity of 32.2 GW, accounting for around 27.9% of Türkiye's total installed electricity capacity. In the same year, it contributed 75 TWh, which represents 21.5% of the country's overall energy generation. Figure 7 depicts the installed capacity change in hydropower in Türkiye during the past decade (Türkiye Elektrik İletim A.Ş., 2024). The main reason for the increase in hydropower capacity is the new projects and the upgrades to existing plants. There are ongoing efforts to achieve a balance between the environmental impact and sustainability of hydropower in Türkiye.

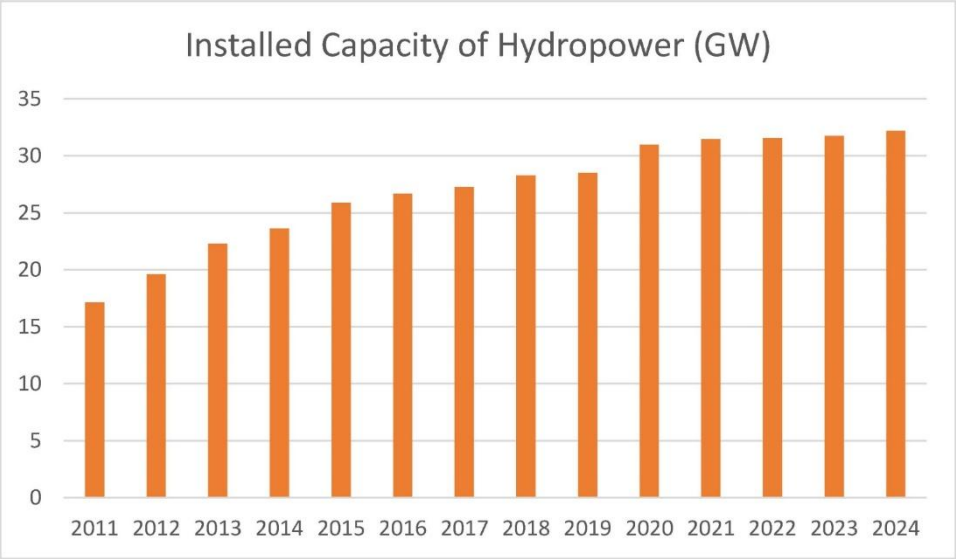

Figure 7. Installed Capacity of Hydropower in Türkiye over the Years

Wind energy

Türkiye possesses substantial wind energy capacity, particularly in areas such as the Aegean and Marmara regions (İlkiliç, 2012). Due to the continuous investments in wind power projects since 2008, wind power now accounts for an important part of the nation's energy portfolio. The Turkish government has set targets for increasing the share of wind energy in the total electricity generation. The earth's surface heats differently, which results in variations in air pressure, temperature, and humidity. These variations in pressure also force the air to move. Wind turbines are the main parts of wind power stations. They convert the kinetic energy of moving air into mechanical energy, which is then transformed into electrical energy. In 2007, a research center was founded to evaluate Türkiye's wind energy potential. Based on a height of 50 meters above ground, it has been proven that areas with wind speeds of 7.5 m/s and above are suitable for the installation of a wind power plant with a power density of 5 MW per square kilometer. According to the latest estimates, it has been determined that the maximum potential for wind energy in Türkiye is about 100 GW, and depending on the developments in wind turbine technologies, this amount is expected to rise to 150 GW. Within 20 years, wind energy is expected to meet 25% of the country’s electricity consumption. Türkiye’s wind energy potential atlas and the change in the installed capacity of wind energy during the last ten years are shown in Figure 8 and Figure 9, indicating the presence of strong winds in the western regions of the country and an increasing trend in installed wind power, respectively (Republic of Türkiye Ministry of Energy and Natural Resources, 2007; Türkiye Elektrik İletim A.Ş., 2024). The installed capacity of wind energy reached 12.5 GW in 2024, representing a 10.9% share. In the same period, wind energy generated 36.6 TWh, accounting for 10.5% of our total electricity generation.

Solar energy

Türkiye has a huge amount of solar radiation, particularly in the interior and southern regions. The country receives 2741 hours of sunshine on average per year, and its annual total incoming solar energy is 1527.46 kWh/m^2 (Celik &

Özgür, 2020). The photovoltaic power potential and installed capacity of solar energy in Türkiye over the years are shown in Figure 10 and Figure 11, respectively (Türkiye Elektrik İletim A.Ş., 2024; Global Solar Atlas, 2019).

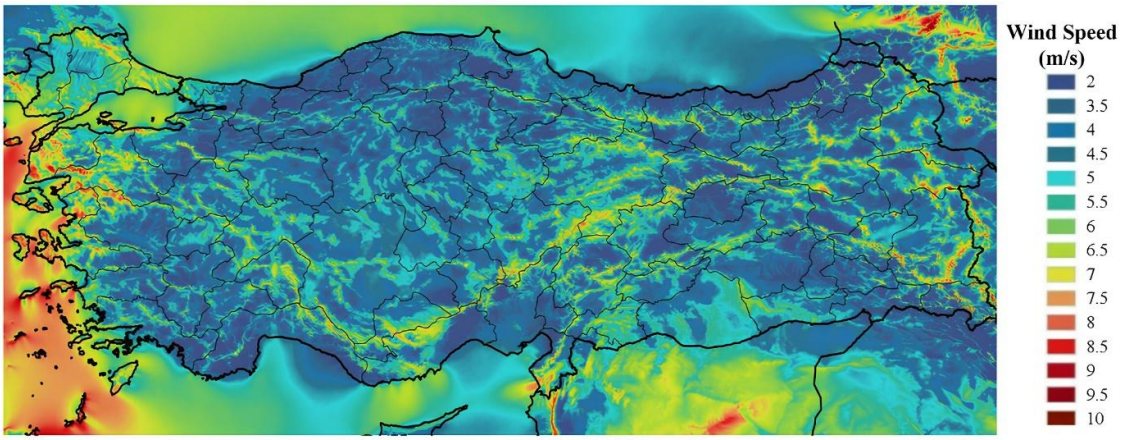

Figure 8. Türkiye's Annual Average Wind Speed at 100 m

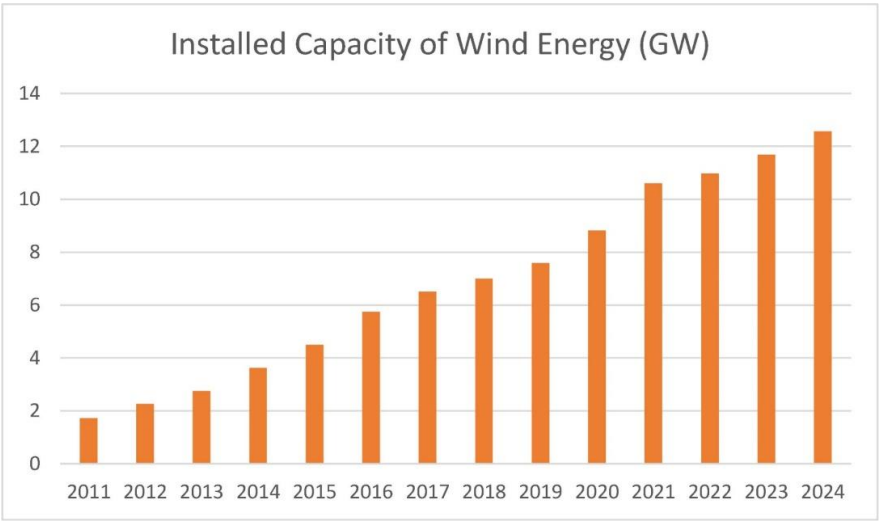

Figure 9. Installed Capacity of Wind Energy in Türkiye over the Years

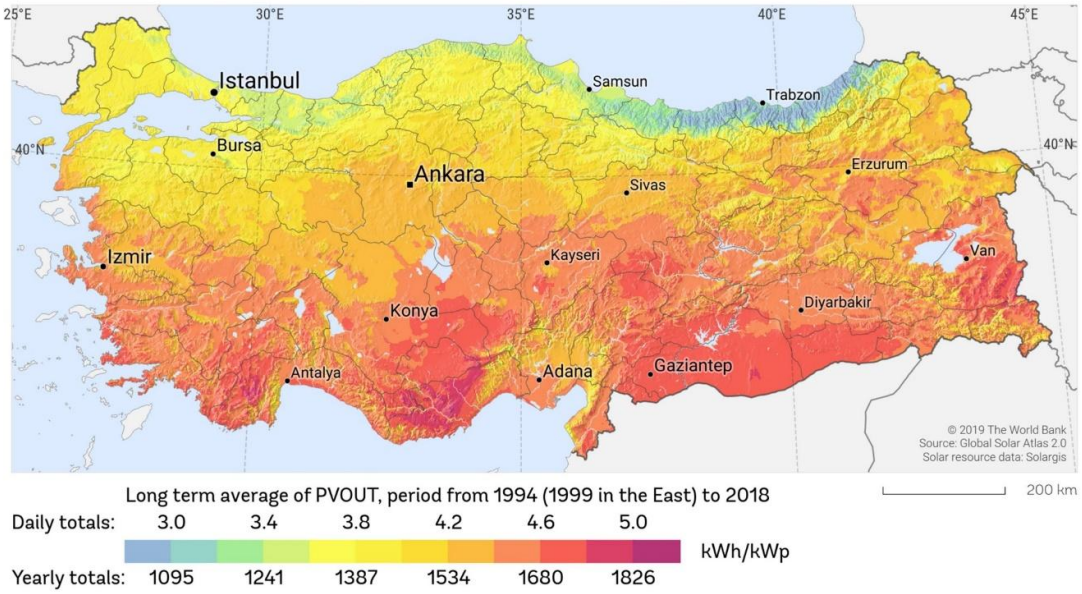

Figure 10. Photovoltaic Power Potential of Türkiye

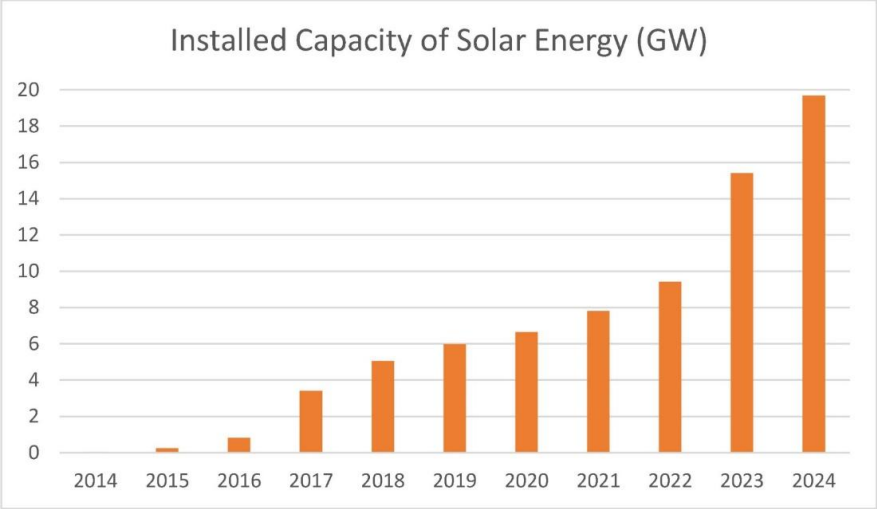

Figure 11. Installed Capacity of Solar Energy in Türkiye over the Years

It is clear that the solar energy potential decreases from the southern to the northern regions. Due to its location on the map, the Black Sea region has the lowest levels of solar radiation and sunshine duration, in contrast to the Southeastern Anatolia region, which receives the highest amounts. Solar energy generation capacity was less than 0.1 GW in 2014 but grew in the following years mainly due to the government's incentive laws in the solar energy sector. In 2024, the solar energy capacity reached 19.6 GW, representing 17% of the total installed capacity. The electricity generated from solar energy amounted to 26.1 TWh, accounting for 7.5% of the total electricity generated.

Geothermal energy

Türkiye has significant geothermal energy potential, with Western Anatolia alone contributing 78% of the country's total capacity, as shown in Figure 12, and geothermal resource areas are concentrated in the western, central, and eastern regions of the country (Mineral Research and Exploration General Directorate, 2018). Due to Türkiye's geological characteristics, it has abundant geothermal resources compared to other nations (Erdogdu, 2009). There are about 1000 active geothermal resources with a wide range of temperatures in Türkiye. Approximately 90% of geothermal resources consist of low and medium-temperature sources that are well-suited for direct applications such as heating, thermal tourism, and mineral extraction. The other 10% are better suited for indirect applications, specifically electricity generation. In 2024, geothermal energy accounted for 1.5% of the total installed capacity with 1.72 GW and 3.2% of the total electricity generated with 11.1 TWh. The majority of this capacity is located in the Aegean region, particularly in provinces like Aydın, Denizli, Afyonkarahisar, and Manisa. Türkiye possesses the highest geothermal potential among European countries and ranks fourth globally in terms of installed capacity. Figure 13 indicates the installed capacity of geothermal energy in Türkiye over the years. As can be seen clearly, the installed capacity is progressively growing on an annual basis (Türkiye Elektrik İletim A.Ş., 2024).

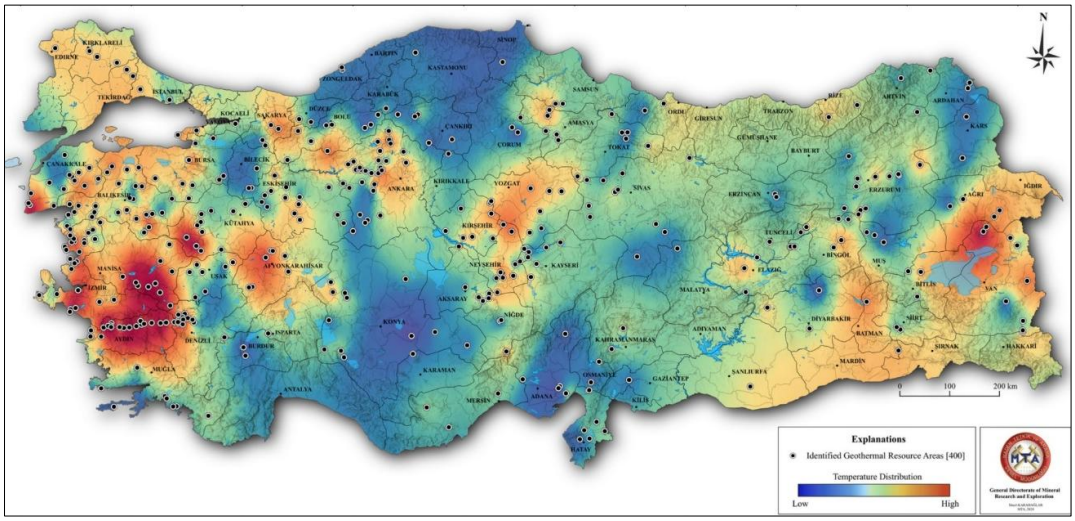

Figure 12. Geothermal Map of Türkiye

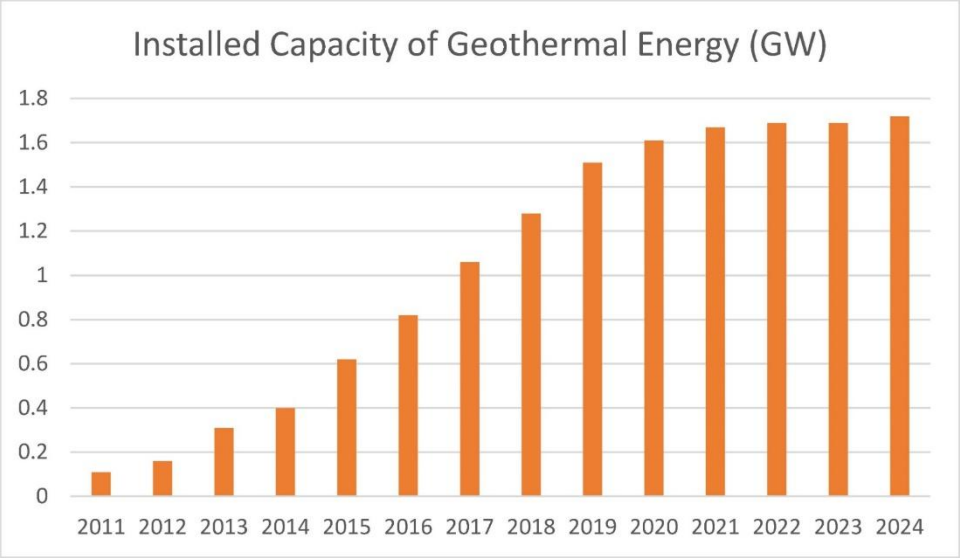

Figure 13. Installed Capacity of Geothermal Energy in Türkiye over the Years

Biomass energy

Biomass is a substance derived from recently living organisms that is used for heating, electricity generation, and as a transportation fuel. There are various ways to use biomass as a renewable energy source. It can be burned to generate thermal energy, transformed into electrical energy, or refined into liquid biofuels like ethanol and biodiesel. Figure 14 illustrates the installed capacity of biomass energy in Türkiye over the years, showing a continuous increase (Türkiye Elektrik İletim A.Ş., 2024). In 2024, biomass energy accounted for 2.1% of the total installed capacity with 2.4 GW and 3.1% of the total electricity generation with 10.8 TWh. In Türkiye, biomass energy production is often more common in big cities due to the high amount of organic waste potential, waste management ability in urban areas, and government policies (Toklu, 2017).

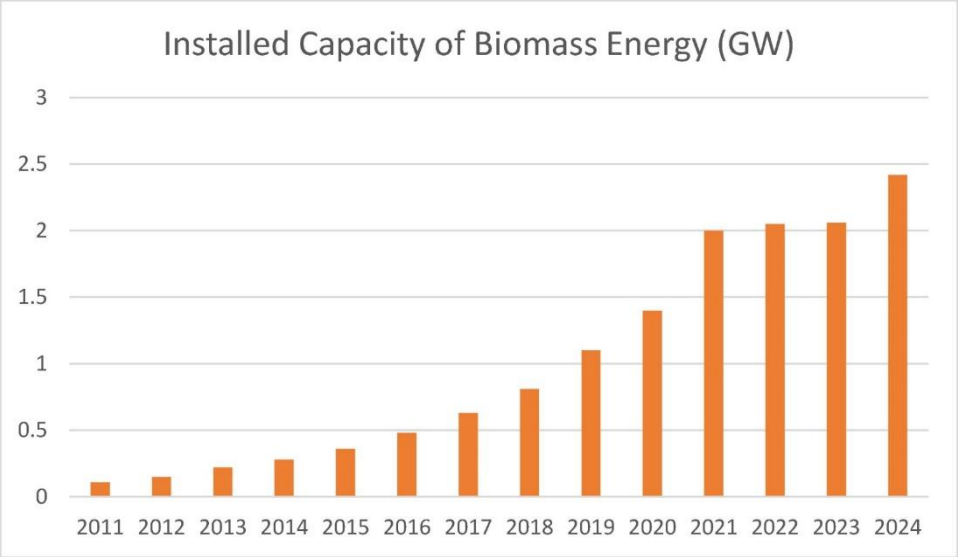

Figure 14. Installed Capacity of Biomass Energy in Türkiye over the Years

RENEWABLE ENERGY IN TÜRKİYE: SWOT AND PESTLE EVALUATION

To provide a clearer explanation of our methodological approach, we first examined the key drivers and challenges shaping the status and prospects of renewable energy sources in Türkiye, considering the country's substantial potential in hydropower, wind, solar, geothermal, and biomass. This assessment involved identifying both enabling factors and the obstacles limiting full utilization of this potential, including economic conditions, energy security concerns, technical barriers, financial constraints, and policy-related issues. In addition, broader challenges such as

dependence on foreign energy, the need for technological advancement, and the lengthy technology-localization process were taken into account. Building on this comprehensive contextual analysis, we conducted SWOT and PESTLE analyses to systematically evaluate the strengths, weaknesses, opportunities, and threats, along with the political, economic, social, technological, legal, and environmental factors influencing Türkiye's renewable energy sector. This structured analytical framework forms the basis of our methodology and allows for a more comprehensive understanding of Türkiye's renewable energy landscape.

SWOT analysis

Türkiye's greatest strength lies in its diverse range of energy sources, including hydropower, wind, solar, geothermal, and biomass. For these reasons, its geographical location makes it one of the few countries with high potential in these areas (Ağırkaya, 2022; Ozdemir, 2021). The country is home to one of Europe's largest renewable energy capacities. The government has implemented supportive policies and incentives to boost renewable energy investments (Karatop, et al., 2022). As a result of these, it is advancing towards self-sufficiency due to rising investment in its renewable energy. Moreover, Türkiye's commitment to the Paris Agreement as well as the 2053 net-zero emissions goal is also encouraging. However, key weaknesses include infrastructure dependency on foreign technology, inefficient inter-agency collaboration, a lack of coordination across industry that hinders innovation, and low public participation (Tırmıkçı, 2021).

In particular, reliance on imported technology and components for renewable energy infrastructure remains a major concern (Dindar, 2022). The evolving government policies and rising social initiatives for increasing the use of renewable energy are opportunities for the growth of this sector. These encompass localization of renewable technologies and regional collaborations, topped with improved R&D spending. Foreign dependency can also be reduced by localizing the components of renewable energy technologies (Karatop, et al., 2022). Besides these, emerging technologies such as hydrogen energy, energy storage systems, and smart grids can expand Türkiye's energy diversification options. However, threats like the slow adoption rate, high initial investment costs, limited funding, economic instability, and currency fluctuations may significantly hinder progress. Legal and regulatory challenges also pose significant barriers for developers, limiting the pace and scope of project implementation (Dindar, 2022; Tırmıkçı, 2021).

PESTLE analysis

Türkiye's involvement in international agreements, including the Paris Agreement, reflects the nation's political commitment to transitioning toward renewable energy sources (Erat, et al., 2021). Politically, the government's supportive policies toward renewable energy, such as the Renewable Energy Resource Area (YEKA) project, incentivize efforts to reduce fossil fuel dependency. However, due to geopolitical tensions and an overreliance on imports, the security of the energy supply remains at risk. Moreover, increasing energy demand driven by economic and population growth is further boosting interest in renewable energy production (Tutar & Atas, 2022). However, inflation and fluctuations in foreign exchange rates increase project costs. To address this challenge, local production and green financing mechanisms are being promoted, while long-term sustainability is encouraged. From a sociocultural perspective, support for renewable energy is growing due to increasing environmental awareness and the desire for greater energy independence (Karatop, et al., 2022). In many places, there is still a gap in energy access between urban and rural areas. This shows the need for community education programs to increase public involvement. On the technology side, investment in local energy systems and storage is important for a stable and efficient energy grid. New technologies are also needed in areas like wave energy, which is still very new in the country, and in making current renewable energy sources more efficient. Progress in these areas depends on continued research and development (Dumrul, et al., 2024). The renewable energy sub-sector is positively encouraged by legal instruments such as incentives and subsidies for its investments and developments (Artkın, 2018). Thus, newly established policies have facilitated the installation of large-scale energy storage systems, which are beneficial for the stability of the grid. In addition, adapting to certain environmental regulations, such as Environmental Impact Assessments (EIA), is important for the development of renewable energy (Doğan & Uludağ, 2018). Türkiye uses renewable energy sources as part of its strategy to mitigate the adverse impacts of climate change and promote sustainable development (Keleş & Bilgen, 2012). In the environmental category, the negative effects of mining on ecosystems and the growing concerns over hydroelectric power projects have become key drivers for adopting a green policy framework within Türkiye's strategic energy goals. Moreover, global environmental objectives align with Türkiye's commitment to reducing greenhouse gas emissions. The methodological block diagram presented in Figure 15 combines SWOT analysis with the PESTLE framework, offering a clearer picture to support decision-making and strategic planning. Türkiye is still in the process of realizing its full potential in renewable energy through

extensive infrastructure and supportive policies. While the initial installation costs of renewable energy investments remain high, government incentives and the increasing domestic production of technological components are expected to lower these costs in the long term. Additionally, integrating renewable energy into regional grids requires robust infrastructure, and efforts in this area are currently underway. Overcoming these challenges will support the development of effective policies and strategies, enabling Türkiye to reach its energy goals and fulfill its global environmental responsibilities. Table 1 presents the key points of the SWOT and PESTLE analyses for Türkiye's renewable energy sector.

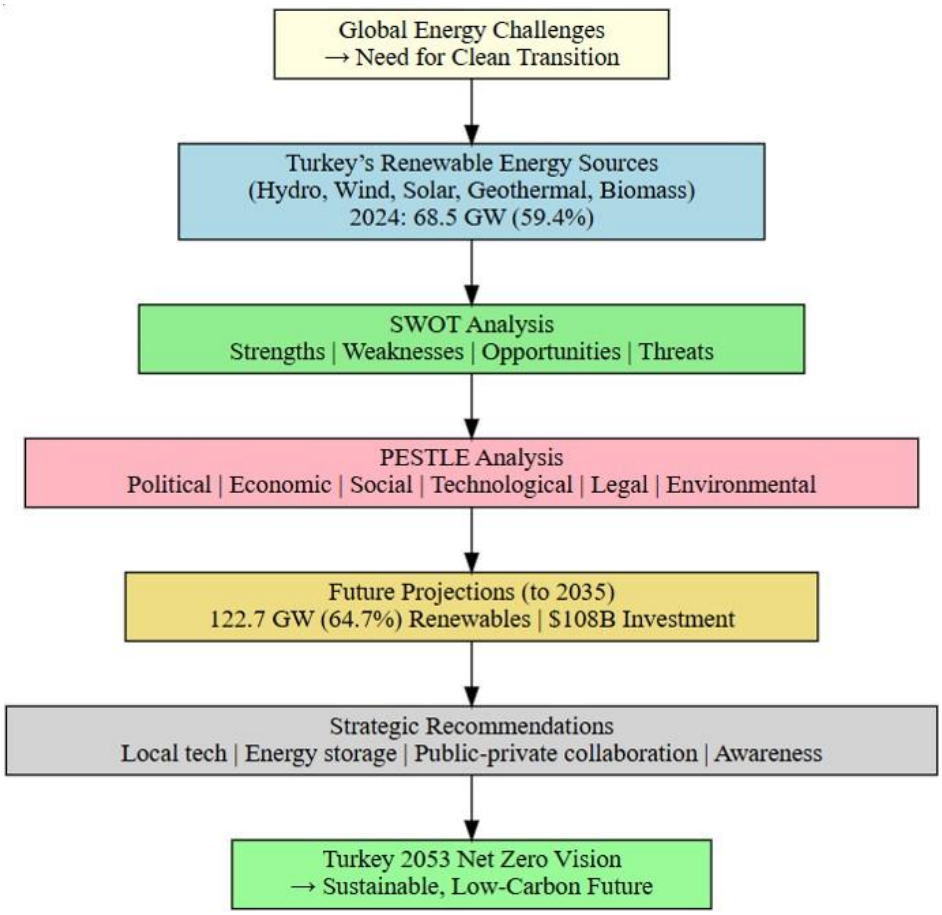

Figure 15. The Methodological Block Diagram for Comprehensive Strategic Evaluation

Table 1. SWOT and PESTLE Overview of Türkiye's Renewable Energy Sector

Category	Key Points
SWOT Analysis	Strengths: high renewable energy potential (hydro, wind, solar, geothermal, biomass), supportive policies, Paris Agreement & net-zero commitment; Weaknesses: dependence on imported technology, limited coordination, low public participation; Opportunities: localization of technologies, R&D, emerging technologies (hydrogen, storage, smart grids), growing public support; Threats: high costs, funding limits, regulatory barriers, energy security risks.
PESTLE Analysis	Political: supportive policies, YEKA projects, EIA compliance; Economic: rising demand, green financing, local production; Social: increasing public awareness, urban-rural energy gaps; Technological: investment in storage and efficiency, innovation; Legal: compliance with regulations, incentives for renewable energy; Environmental: sustainability, reduced environmental impacts, alignment with climate goals.

FUTURE PROSPECTS

Türkiye's renewable energy sector has grown considerably in recent years, mainly because of strategic investments, suitable geography, and supportive government policies. Over the past 20 years, Türkiye's growing economy and population have led to a sharp increase in energy use and import dependence. Between 2000 and 2024, electricity consumption rose from 128 TWh to 347.9 TWh, with an average annual growth rate of 4.4% (Türkiye Elektrik İletim A.Ş., 2024). According to the Türkiye National Energy Plan study, the country's electricity consumption is expected to reach 380.2 TWh in 2025, 455.3 TWh in 2030, and 510.5 TWh in 2035 (Republic of Türkiye Ministry of Energy and Natural Resources, 2025). To meet this rising demand, the Ministry of Energy and Natural Resources proposes boosting installed capacities in solar, wind, hydropower, and geothermal energy sources. In October 2024, plans to quadruple the nation's wind and solar energy capacity to 120 GW by 2035 were announced by Türkiye's Energy and Natural Resources (Republic of Türkiye Ministry of Energy and Natural Resources, 2024). This ambitious expansion necessitates an investment of approximately $108 billion from both public and private sectors. Notably, in February 2024, Türkiye met 60% of its energy needs from renewable resources, marking a significant milestone in its sustainable energy journey (TRT World, 2024). TEİAŞ releases a demand forecast report that outlines three different growth scenarios: low, base, and high. These projections are based on data from distribution companies and licensed Organized Industrial Zones. The most recent report, published in December 2021, presents electricity demand forecasts for Türkiye over the next 10 years as listed in Table 2 (Türkiye Elektrik İletim A.Ş., 2021). In 2022, Türkiye's annual electricity demand totaled 328.7 GWh. This figure fell below TEİAŞ's high scenario projection for the year but was slightly above the base scenario forecast of 324.5 GWh.

Table 2. TEİAŞ Electricity Demand Forecasts (2022-2031)

Year	Low Scenario		Base Scenario		High Scenario	
	Demand (GWh)	**Growth Rate (%)**	**Demand (GWh)**	**Growth Rate (%)**	**Demand (GWh)**	**Growth Rate (%)**
2022	308.903	3.1	324.536	3.8	340.810	7.9
2023	317.755	2.9	335.819	3.5	354.446	4
2024	329.911	3.8	350.716	4.4	371.927	4.9
2025	344.265	4.4	367.792	4.9	391.806	5.3
2026	357.757	3.9	383.426	4.3	409.551	4.5
2027	369.703	3.3	397.438	3.7	425.790	4
2028	378.902	2.5	408.872	2.9	439.739	3.3
2029	389.682	2.8	421.925	3.2	455.387	3.6
2030	400.825	2.9	435.418	3.2	471.572	3.6
2031	415.042	3.5	452.210	3.9	491.224	4.2

Figure 16 shows a significant rise in Türkiye's projected sector-based electricity consumption for 2025, 2030, and 2035, mainly driven by economic growth and an increasing population (Türkiye Elektrik İletim A.Ş., 2021). Notably, an annual average increase in power consumption is expected to be 3.7% in the industrial sector, 2.3% in residential buildings, and 2.2% in the services sector, reflecting the overall rising demand for energy in Türkiye's industries and households (Dindar, 2022). At this point, renewable energy sources can be considered a viable solution to address this energy demand. In addition to the positive environmental effects of shifting to alternative energy sources, this transition also has a significant impact on economic growth. Figure 17 presents a map of Türkiye illustrating both ongoing and planned renewable energy projects. The map shows the current and projected distribution of initiatives across different renewable resources, including hydropower, wind, solar, geothermal, and biomass. These initiatives aim to provide cleaner energy, reduce national greenhouse gas emissions, and contribute positively to the country's sustainable development (Republic of Türkiye Ministry of Energy and Natural Resources, 2025).

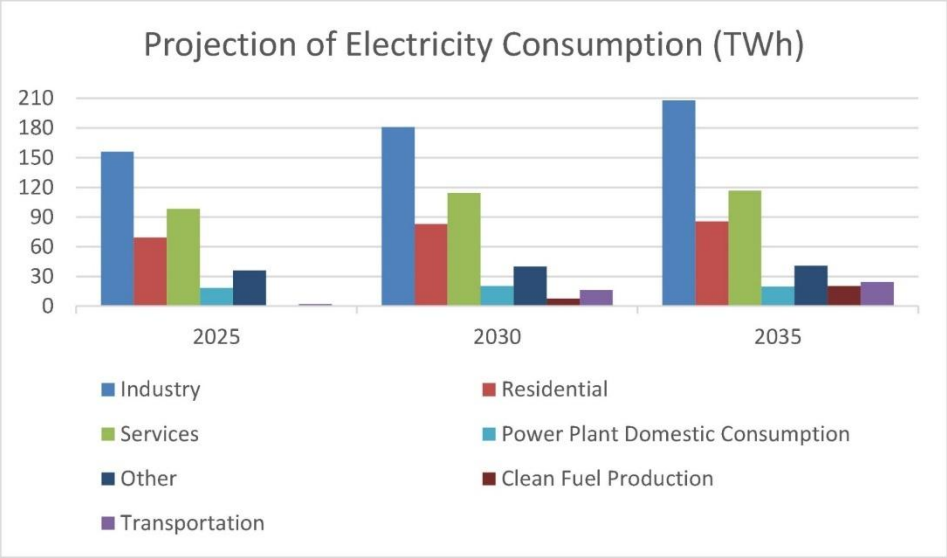

Figure 16. The Projected Sector-Based Electricity Consumption in Türkiye (2025, 2030, and 2035)

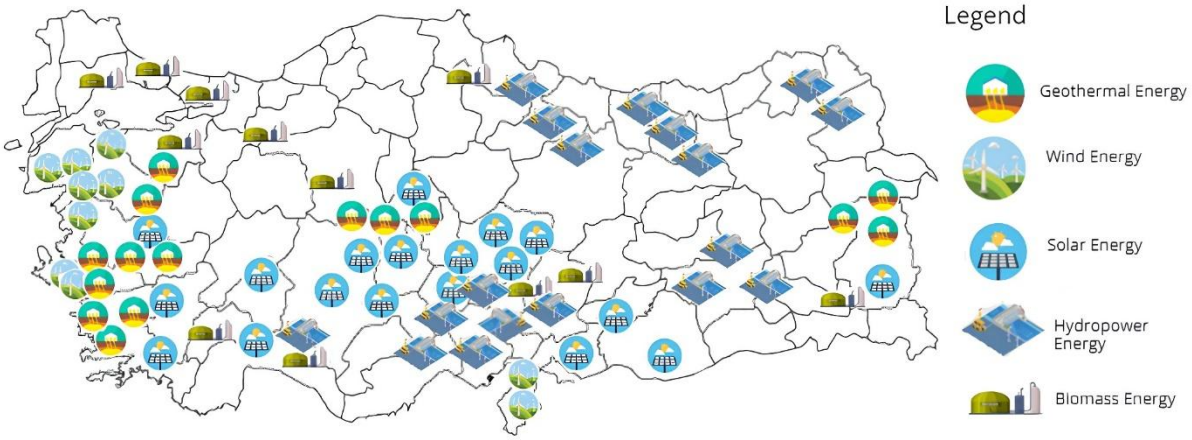

Figure 17. A Map Representation of Türkiye's Renewable Energy Sources Projects

CONCLUSION

Türkiye's renewable energy sector holds significant potential for sustainable growth, supported by its diverse resources and favorable geographic conditions. The SWOT and PESTLE analyses indicate that while the country benefits from strengths such as abundant renewable resources and supportive policy initiatives, persistent challenges, including regulatory barriers, financing limitations, and infrastructure deficiencies, must be addressed to realize this potential fully. To overcome these obstacles, several specific policy measures are recommended. First, regulatory frameworks should be simplified to reduce permitting delays and encourage private sector participation. Second, incentive mechanisms such as targeted subsidies, low-interest green financing, and tax reductions should be expanded to encourage investment in renewable technologies. Third, grid infrastructure must be upgraded to integrate higher shares of variable renewable energy, supported by storage technologies and smart-grid applications. Additionally, stronger regional and international cooperation is necessary to facilitate knowledge transfer and joint investment opportunities. Enhancing public awareness and integrating environmental and social considerations into energy planning will further support long-term sustainability. By implementing these targeted policies, Türkiye can accelerate its energy transition and advance its commitment to achieving net-zero emissions by 2053 as part of the Green Development Revolution.

Artificial Intelligence Contribution Statement

Artificial intelligence tool was used only for language editing and text polishing. All scientific content, including text, data analysis, and figures, was produced and verified by the authors.

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