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Review Article

Türkiye's energy sector between systemic constraints, power ambitions, and sustainability efforts

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Abstract: The energy sector in the twenty-first century is simultaneously characterised by high interdependency and frequent destabilisation stemming from international crises and conflicts. In this context, a middle power like Türkiye needs to navigate the uncertainties and constant shocks of the energy domain by adopting consistent long-term strategies. The Turkish energy sector is marked by limited domestic energy resources, dependence on external supplies, proximity to both energy-rich and highly energy-consuming countries, and steadily increasing domestic demand, driven by population and GDP growth. To stabilise the country's energy sector, Ankara has, over the past twenty-five years, adopted several policies to diversify and strengthen it. Firstly, it has exploited its geostrategic location to become a crucial energy hub connecting all the regions around its territory, especially Russia, the Caucasus, the Middle East, and Southern Europe. Secondly, it has invested in its renewable energy sector to boost its self-sufficiency, decrease its dependence on external fossil fuel supplies, and meet the responsibilities undertaken at the international level through the ratification and announcement of ambitious sustainability goals, of which the net-zero carbon target by 2053 and the adherence to the 2016 Paris Agreement represent the most outstanding examples. Despite the important results achieved in the renewable energy domain, both investments and institutional maneuvers to meet the set objectives have proved discontinuous, and much remains to be done to achieve the net-zero target. Nevertheless, given the intertwining of domestic energy supply shortages, high exposure to climate change-related consequences, and increased vulnerability stemming from external dependence on power supplies, Türkiye has much to gain from sustained implementation of policies promoting the use of sustainable and renewable energy sources.

Keywords: *Türkiye's energy sector, renewable energy sources, fossil fuels, nuclear power plants, sustainability.*

1. Introduction: Energy, the lifeblood of nations

Energy has historically constituted a key driver of economic development, geopolitical power, and national security. Having direct access to energy sources allows nation-states to boost industrial capacity, enhance technological development, strengthen military power, and exert political and diplomatic influence abroad. By definition, a country that displays energetic self-sufficiency (i.e. "the capacity of a country to meet its energy demand with its resources") (Demir & Barış, 2025), or gets very close to it, finds itself in a privileged, more powerful position compared to those who do not. The energy sector of the twenty-first century is simultaneously characterised by

rapid shifts and transformations, on the one hand, and continuous, profound destabilisation stemming from conflicts and international crises, on the other. The international community's efforts toward sustainability and renewable energy transition, the longstanding and new tensions over resource competition and geographical inequalities, and the frequent shocks to the energy market caused by wars, strait closures, and diplomatic tensions highlight a supply chain that is both more integrated and more fragile than ever.

At the international level, the shared objectives and commitment to tackle climate change, its roots and consequences, represented by the agreements and annual meetings precisely taking place among nations to discuss the issue (such as the 2015 Paris Agreement and the yearly United Nations Conferences of Parties, or COP, unfolding since 1995), underscore the importance of directing long-term energy investments toward more sustainable and climate-friendly solutions. However, given the undeniable link between energy and power, countries seeking to expand or consolidate their influence are always more interested in securing crucial energy sources to reduce their dependence on external actors, often at the expense of sustainability considerations. In the increasingly multipolar great-power competition of the twenty-first century, countries such as the United States, China, and Russia are actively shaping their foreign policies, economic investments, and infrastructure projects to secure long-term energy supplies and boost self-sufficiency, thereby influencing the world's energy market as a whole. In this context, middle powers like Türkiye need to navigate these shifts and uncertainties while accounting for domestic needs, potential international frictions arising from resource competition, and sustainability concerns.

Türkiye's energy landscape is characterised by (1) increasing domestic demand, as a consequence of population and GDP growth; (2) domestic shortages of energy sources and the resulting dependence on energy imports; and (3) the geographical proximity to both energy-rich and high-consumption countries. Therefore, the country's primary and most urgent objectives include (1) boosting domestic energy supply security, especially by diversifying its energy supply sources, which is directly related to the goal of (2) gaining more energetic independence, but also (3) exploiting its strategic geographical location at the intersection of two continents to gain international and regional relevance as a vital energy hub. In light of this, the long-term goal of decisively decarbonising its energy sector and increasing employment of renewable sources, in compliance with its international-level responsibilities, is a cross-cutting objective that applies to all the other objectives listed above. Although it achieved universal electricity access only in 2010, Türkiye is an ambitious emerging power characterised by rapid industrial, economic, and population growth. Between now and 2035, energy consumption in the country is expected to increase by another 50% (Gulaydin & Mourshed, 2025), underscoring the need for and the urgency of adopting strong measures and policies to meet future energy demands and sustain the nation's steadfast growth.

2. The current state of Türkiye's energy resources and the *corridor role*

Türkiye's structural energy deficit is the central constraint shaping its energy strategy. Because of the substantial energy supply shortfall on its territory, the country relies heavily on external sources to meet its domestic energy demand, creating a significant degree of foreign dependence. According to the International Energy Agency (IEA), around 70.6% of Türkiye's overall energy supply in 2024 came from imports of natural gas, oil, and coal. Looking at the past couple of decades, the country's energy import trend has steadily increased by 146% since the beginning of the new millennium, mainly to keep up with rapidly growing energy demand, which is projected to continue rising in the years and decades to come (IEA, 2026). In fact, not only does Türkiye have very few energy sources within its territory, but it also has one of the fastest-growing energy demands and ranks

among the top twenty energy consumers worldwide as a consequence of both population and GDP growth (Siccardi, 2024).

Electricity for lighting purposes first emerged in the Ottoman Empire during the reign of Sultan Abdul Hamid II, between 1876 and 1908. Istanbul, along with other major cities of the Empire such as Izmir, Beirut, and Damascus, was among the first settlements to adopt electricity. The first attempts to produce electricity directly in the Empire occurred in 1902 in the Tarsus district of Mersin, on the southern shore of modern-day Türkiye. The real importance of energy production, however, became a prominent issue in Türkiye after the birth of the Turkish Republic in 1923, when electricity production became a vital element to economic and social development (Yurtoğlu, 2018).

Throughout Türkiye's Republican history, and especially over the past twenty-five years, Turkish policymakers have made significant efforts through reforms, investments, and diversification strategies to address the country's inherent shortages and, as much as possible, limit its vulnerability and exposure to external shocks, especially given the frequency of crises unfolding in the neighbouring resource-rich countries. Despite these attempts, the Turkish energy sector landscape remains characterised by heavy reliance on external actors and limited domestic supply capacity. Adding another layer of complexity to Türkiye's situation is the country's particular vulnerability to the consequences of climate change. According to the United Nations Development Programme (UNDP), Türkiye ranks among the *highly vulnerable* countries to climate change (UNDP, 2026). Increasing temperatures, changing precipitation patterns, and exposure to natural disasters such as earthquakes, floods, and water stress paint a picture of a country that has much to lose from worsening global climatic instability, making the road to net-zero greenhouse gas emissions an even more pressing issue for Ankara.

Despite its limited energy resources, Türkiye's strategic location between Southern Europe, Russia, the Caucasus, and the Middle East has enabled Ankara to carve out a role as a crucial transit partner for these supplies. Precisely because of its position between very energy-rich and energy-needy countries (and between energy-producing and energy-consuming countries), Türkiye has built much of its strategy on energy transit, trade, and diplomacy. The numerous pipeline projects implemented by the country (or *through* the country) precisely reflect this approach. Among these, the TurkStream Pipeline, which directly connects Russia to Türkiye through the Black Sea and extends to Southern Europe, and the Trans-Anatolian Pipeline, generally known as TANAP, linking Azerbaijan to the Greek border, also extending all the way to Southern Europe, are among the most important natural gas infrastructures determining the energy supply of the whole region. To provide a more specific example demonstrating the significance of the Turkish geostrategic position, during the joint attack by the United States and Israel on Iran in February 2026, and the subsequent retaliation from Tehran which led to the blockage of the Strait of Hormuz, through which around 20% of the world's energy supplies pass, the importance of the Iraq-Türkiye Pipeline (ITP) connecting and moving crude oil from the Iraqi town of Kirkuk to the Turkish maritime town of Ceyhan quickly resurfaced. This serves as yet another testament to the significance of these energy infrastructures passing through Turkish territory (Saeed, 2026) *(Figure 1)*.

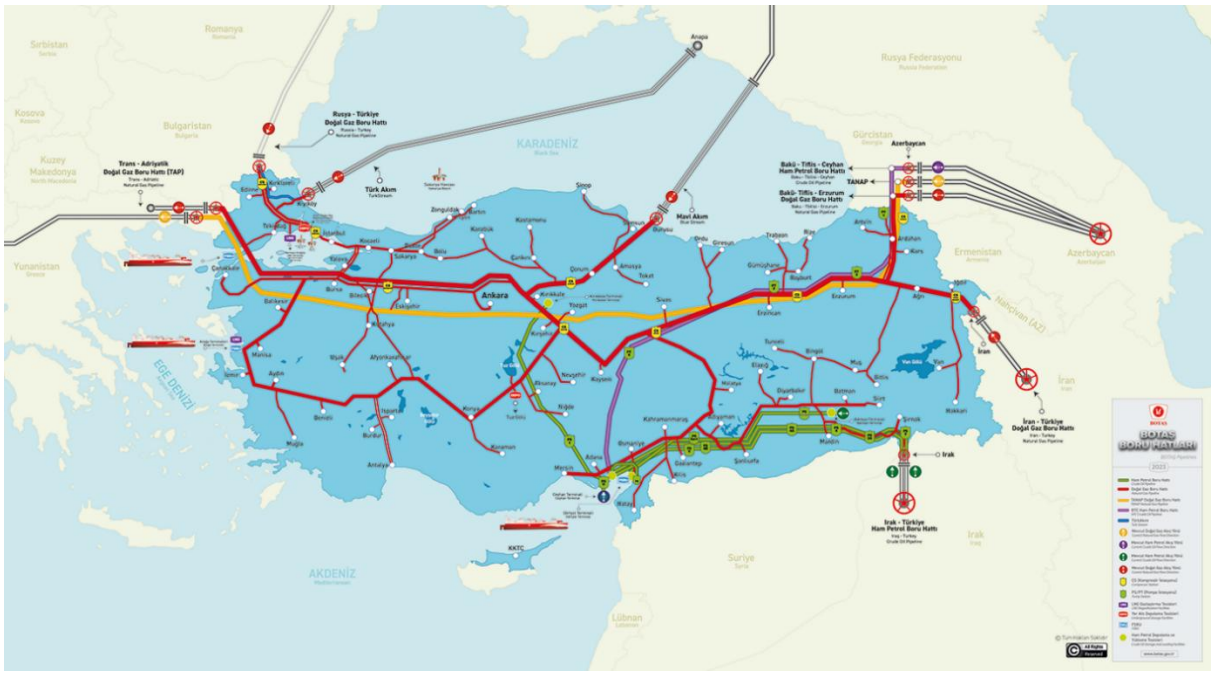


Figure 1 – "Map of Natural Gas and Oil Pipelines" (Turkish Ministry of Energy and Natural Resources, 2022).

Türkiye's energy policies and the *corridor role* exemplified by these examples also reflect the broader strategic ambiguity characterising Ankara's international stance. The country's ability (and, to a certain extent, necessity) to simultaneously engage with different actors, sometimes walking a tightrope between its partners' frictions and animosities, is also well reflected in its energy policies, with Türkiye implementing projects and signing agreements with European Union countries, Russia, Caucasian and Middle Eastern countries. The implementation of these pipeline diplomacy projects is just one facet of a broader energy strategy aiming at increasing domestic energy production and renewable capacity to decrease Türkiye's dependence on import reliance, an urgent issue that, despite the significant results achieved, continues to be an important constraint on the country's freedom of manoeuvre (İvgin & Demirel, 2025).

For many years, the country has heavily depended on Russia and Iran for its energy supplies. To this day, the energy sector remains a crucial element in the relationship between Ankara and Moscow. This shared interest has enabled the two countries to often go beyond their diverging foreign policy visions and goals. At the same time, given Iran's importance to Türkiye's natural gas supply, Ankara has always adopted a more cautious stance toward sanctions against Tehran, even though its neighbour's alleged military nuclear ambitions are a source of concern for the Turkish government. Increased energy ties with other European, Central Asian, and Middle Eastern countries aim to diversify and secure a more stable energy flow, less vulnerable to shocks affecting partners. In this context, the enhanced partnership with Azerbaijan warrants further exploration. Through the TANAP, mentioned above, which has been fully operational since 2019, an ambitious natural gas corridor connecting Azerbaijan to Greece, Albania, and Italy via Türkiye, Ankara has taken another step toward diversifying its energy partnerships, officially becoming an energy hub able to influence foreign markets (Demir & Barış, 2025).

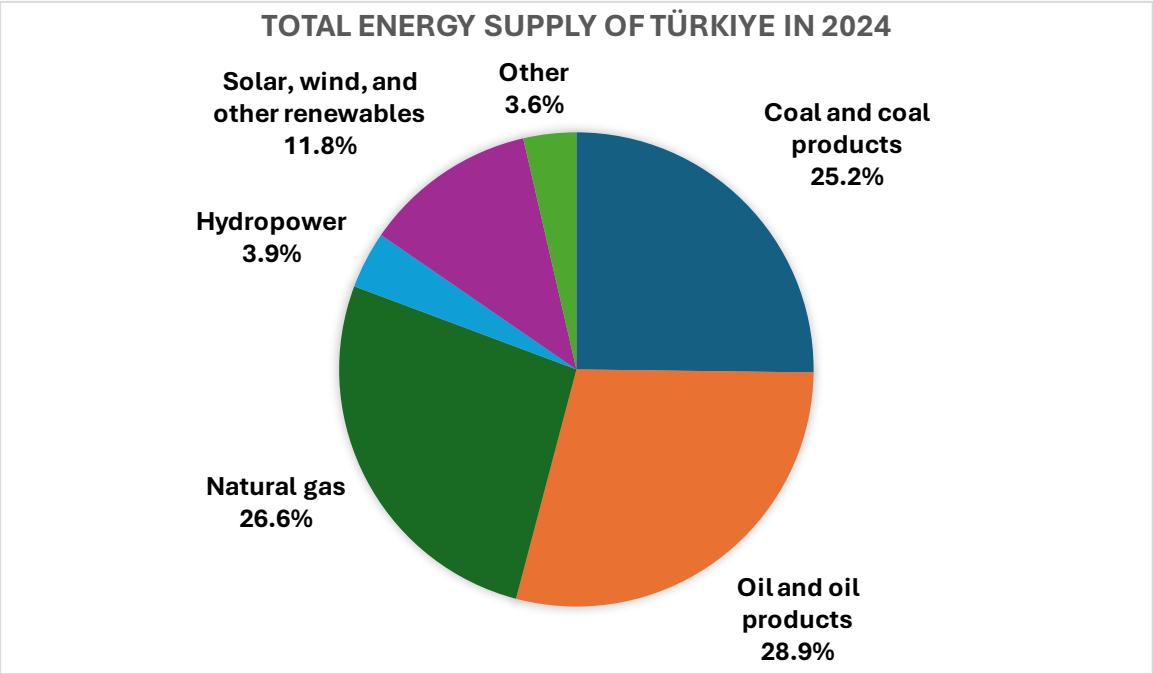
Presumably, also due to the significant opportunity for Türkiye to serve as a strategic energy corridor between continents, efforts to deploy sustainable and innovative energy sources have to date yielded limited results and have not been sufficient to bolster the country's energy self-sufficiency decisively. Although noteworthy

advances are recorded, detailed further below, the unstable character of Türkiye's investments in this field, as well as the slow and rather complicated transition toward renewable sources and away from fossil fuels, has contributed to an energy structure that continues to reinforce and replicate external dependency (Demir & Barış, 2025), but also to maintain Türkiye's energy supply tightly tied to non-renewable sources. In 2024, approximately 80% of Türkiye's total energy supply was derived from fossil fuels, specifically oil (28.9%), natural gas (26.6%), and coal (25.2%) (IEA, 2026). While intentions to reduce fossil fuel reliance exist, as evidenced by Ankara's announcement of the Net Zero 2053 Target in 2021 after ratifying the Paris Agreement that same year, achieving a considerable shift to renewable energy sources, with the associated economic, infrastructural, and cultural implications, remains a far-off goal.

3. Oil, coal, and natural gas

Türkiye's territory is not completely devoid of energy sources. In 2024, abundant natural gas reserves were discovered in the Thrace region, in the Northwest of the country, estimated at around 300 million cubic metres and valued at $91.94 million (Daily Sabah, 2024), Türkiye's largest natural gas reserve to date. On the other side of the country, in Southeastern Anatolia, especially in the Adıyaman, Diyarbakır, and Batman regions, lies Türkiye's most prominent oilfield area, which in 2019 could produce as much as 34.917 barrels per day (Özdemir, 2019). Furthermore, the discovery in 2021 of massive crude oil reserves in the mountainous Gabar region, also located in Southeastern Anatolia, has boosted Türkiye's expected total oil reserves, with this single extraction site allegedly accounting for up to 8% of the country's daily oil demand (Daily Sabah, 2025a). Despite these extraction sites and recent discoveries, natural gas and oil appear to be very limited in Turkish territory.

Among fossil fuels, coal remains a significant contributor to Türkiye's domestic energy production. Coal emerged as a key source of energy between the sixteenth and seventeenth centuries, especially in countries that first industrialised and expanded their economies, replacing burned wood, dried manure, and water mills for household heating and grain grinding. As new energy sources emerged over the centuries, particularly oil and gas, coal gradually lost relevance in certain markets such as household heating and transportation (Bhutada, 2022). However, coal remains a widely used source of electricity generation, reaching a record high in 2024 and accounting for over one-third of global electricity production today. Substantial energy demand and extreme heatwaves, particularly in highly populated countries such as China and India, have driven a peak in absolute terms of coal-generated power, which now accounts for two-thirds of global power emissions (Schumer et al., 2025). In Türkiye, too, coal-based production has steadily increased over the past two decades, primarily to provide immediate supply relief to a domestic energy market unable to meet demand, and as a response to high inflation rates that encourage power producers to use cheaper coal rather than more expensive natural gas for electricity generation (Maguire, 2024). In 2024, coal and coal products accounted for 29% of the country's overall domestic energy production (IEA, 2026). Despite the presence of these sources on its territory, energy import data indicate that they are insufficient to meet Türkiye's energy needs. Only in 2022 (before the discovery of the Thrace reserves) did almost 100% of the country's natural gas supply, 91% of its oil products supply, and 77% of its coal supply come from imports (Siccardi, 2024).



Source: International Energy Agency (2024).

4. The shift toward renewable energy sources

Türkiye has on several occasions declared and institutionalised its commitment to renewable energy transition. In 2021, the government of Ankara ratified the 2016 Paris Agreement, thus aligning with the United Nations Framework Convention on Climate Change (UNFCCC). The same year, it announced the country's intention to achieve a net-zero carbon target by 2053. This long-term commitment involves legislative, institutional, and technological advancements to achieve a decisive transition to renewable energy sources. Moreover, to align its economic, industrial, and trade standards with the European Union's European Green Deal and Carbon Border Adjustment Mechanism (CBAM), also proclaimed in 2021, Türkiye announced the Green Deal Action Plan, a broad policy initiative composed of 32 goals and 81 actions to involve different sectors (such as agriculture, transportation, finance, circular economy, and construction) in the effort toward greater sustainability (Republic of Türkiye's Ministry of Trade, 2022).

Since 2010, Türkiye has considerably expanded and diversified its installed renewable capacity, achieving significant results, also thanks to the country's generally favourable climatic circumstances. The solar radiation levels and wind corridors in both the Aegean and Marmara regions are important examples of these favourable weather conditions (Gözkün & Orhangazi, 2025). In addition to hydropower, which has been the dominant renewable power source in Türkiye for decades, energy generated from wind, solar, geothermal, and biomass sources has steadily increased. In 2024, domestic energy production from these sources accounted for 47.4% of total energy production (11.8% from hydropower and 35.6% from solar, wind, geothermal, biomass, and other renewables) (IEA, 2026).

Today, the hydropower sector in Türkiye looks particularly solid. About 764 facilities, including river- and dam-based facilities, accounted for an overall power capacity of 32.2 GW. Simultaneously, wind power plants have reached 369, with a combined installed capacity of around 12.6 GW. Moreover, solar energy supply can count on 31.224 power plants scattered across the country, with a total capacity of 19.6 GW (Gulaydin &

Mourshed, 2025). Overall, renewable installed capacity has increased from 33% of 2005 to 59% in 2024, a testament to the country's commitment in this direction. According to the International Energy Agency, 54% of the electricity generated in Türkiye in 2024 came from renewable sources. As a result, Türkiye now ranks 5th in Europe and 12th in the world by installed renewable energy capacity (Demir & Barış, 2025). A significant outcome that testifies to Ankara's commitment to implementing sustainable energy solutions, reducing its dependence on external suppliers, and diversifying its domestic energy sources. While these developments have certainly improved the country's position, much work remains to achieve the announced long-term goals fully. However, it should be kept in mind that investments in sustainability and renewable energy are inevitably affected by security issues and vulnerabilities stemming from Türkiye's delicate position, and especially the exposures to international crises, diplomatic frictions, and external actors' supplies, all factors that can slow down and limit the country's pace toward its long-term goals.

To further raise awareness of the importance of renewable energy sources and attract more investors, the Turkish government has introduced the Renewable Energy Resource Zone (YEKA) auction model since 2016. This system is based on the identification of government-designated zones for large-scale wind and solar projects, awarded to investors through competitive auctions, resulting in long-term 15-year purchase guarantees. These tenders focus on areas with high generation potential to contribute to the country's 2035 sustainability goals (Daily Sabah, 2025b). Moreover, financial incentives for companies and investors in the energy sector, and the establishment of direct collaborations among universities, research institutes, and private enterprises, both within the country and with foreign partners, all aim to boost Türkiye's competitiveness and technological self-sufficiency in the renewable energy sector.

For instance, another crucial initiative that any country should embrace in the struggle toward long-term environmental goals is adopting new, more advanced technologies to reduce CO^2 emissions from fossil fuel extraction as much as possible. These tools, known as Carbon Capture and Storage technologies (CCS), are intended to capture CO^2 emissions from fossil fuel extraction immediately, either by storing them underground or using them in alternative ways, thus avoiding their dispersion in the atmosphere. The adoption of these technologies has recently been discussed and carefully studied in the Turkish context to enable the continued use of domestic non-renewable sources while significantly reducing power-sector emissions. Still, their large-scale adoption in the country has not yet occurred (İvgin & Demirel, 2025).

Given the country's inherent constraints, increased investment in the green energy sector is a crucial way to address several issues affecting Türkiye simultaneously. Beyond constituting a crucial step toward the country's ambitious long-term goals of achieving net-zero emissions and enhancing the sustainability of energy production, these investments would also reduce dependence on external fossil fuel supplies, thereby contributing to energy security, sustained economic development, and geopolitical prominence. Besides improving the commercial balance of the energy sector *per se*, investments in this direction would translate into several other benefits for other sectors and industries, also by creating new jobs and career opportunities in the sustainability sector that would overcome the projected job losses arising from the gradual shutdown of the fossil fuels extraction sector (Gözkün & Orhangazi, 2025). Although some of these initiatives certainly aim to align Türkiye with the European Union's green agenda, as the EU represents a crucial market for Turkish exports, Türkiye has much to gain from the long-term implementation of these policies, including greater independence from external oscillations, reduced vulnerability, and improved sustainability.

Directly funded by the European Union, the BEST For Energy (Boosting Effective and Sustainable Transformation for Energy) project, running between 2020 and 2023, is a prominent example of an EU-funded initiative in Türkiye, specifically in Izmir and its surroundings in the Aegean region. The goal of this specific initiative was to sustain and advance the country's renewable energy transition by focusing on a cluster of technological advancements in wind, solar, and geothermal energy in this area, which has significant economic potential, and enhance its competitiveness in the clean energy domain (Delegation of the European Union to Türkiye, n.d.).

Reforms in the green finance sector are also fundamental to decisively improve the financial sustainability of Türkiye's energy and climate policies. In the first half of the 2020s, green financing in Türkiye relied heavily on short-term loans. At the same time, the share of institutional investors remained below the Organisation for Economic Co-operation and Development's (OECD) average, and private-sector investments were still perceived as risky due to unpredictable exchange rate fluctuations, which discouraged long-term investment. In this context, green taxonomy (i.e. a scientific method to classify and determine the environmentally sustainable economic activities) and improved transparency standards are crucial examples of reform areas that could decisively enhance the financial sustainability of the country's energy and climate policies (Demir & Barış, 2025; World Bank Group, 2022).

5. Conclusion: The future of Türkiye's energy sector and nuclear power implementation

Several indicators show that nuclear energy is also an appealing option that the Turkish government is closely considering and, to a certain extent, implementing to improve energy independence and efficiency, specifically through its intention to introduce three nuclear power plants into its energy mix, thereby simultaneously decreasing energy dependence, maximising the use of domestic resources, and addressing climate change-related consequences (Özgül et al., 2020). According to the World Nuclear Association (2025), as of 2026, three nuclear power plants and one small uranium mining site are currently under construction in Türkiye. The most prominent of these, envisioned since 2010 and expected to begin operations in 2026, is the four-unit Akkuyu nuclear power plant, financed and built by Russia on the southern coast of Türkiye, in the Mersin province. Expected to begin operations in 2023, but delayed mainly by United States sanctions on Russia, its launch should have a very positive impact on Türkiye's energy sector. Besides further diversifying the country's power supply, the nuclear plant is expected to provide up to 10% of Türkiye's annual electricity demand (Michalski, 2025). Two other nuclear power plants are currently being discussed: the Sinop nuclear power plant, by the Black Sea, to be realised with the participation of a Franco-Japanese consortium, and a third power plant financed and built by China in the Kirklareli region of Eastern Thrace, close to the borders with Bulgaria and Greece (World Nuclear Association, 2025). Although these nuclear power generation partnerships risk putting the Turkish energy sector in a subordinate position to the countries implementing them, their undertaking could decisively change the structure of the country's entire energy sector.

In light of the systemic and inherent issues affecting Türkiye's energy sector as a whole, accelerating efforts toward more sustainable investments and new renewable energy policies would help address several of the issues cited at the beginning of the text simultaneously. First of all, a major share of renewable energy production on Turkish soil would automatically entail a reduced dependence on external actors for non-renewable energy sources and a reduced vulnerability to regional and international fluctuations. Secondly, it would decisively help

address concerns about climate change-related consequences in the country through long-term sustainable choices, an issue Türkiye should continue to address in line with the international commitments and agreements it has undertaken. Thirdly, given the enormous potential the Turkish territory displays in terms of renewable sources application, and the growing international influence enjoyed by the country in all the areas around its territory, especially those sharing a common historical past with Ankara, Türkiye has the potential to become a role model and a leading international player in the field of renewable energy production. The introduction of nuclear power plants into the country's energy scheme will certainly impact the current energy strategy for years and decades to come; given the prominence of external actors' involvement in implementing these projects, however, it is not certain that external influence over Türkiye's energy sector will cease.

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