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Managing the Transition: How Türkiye Aligns Energy Policy, Markets, and Industry

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Table of Contents

Executive summary

Türkiye's energy transition unfolds at the crossroads of geography, industry, and policy. Positioned between major producers and consumers, the country has turned its geography into an energy platform – linking Caspian gas, Russian flows, LNG routes, and emerging "green corridors" toward Europe. Yet this advantage comes with high import dependence: over 70% of energy supply is imported, and fossil fuels still provide more than half of power generation. Balancing energy security, decarbonization, and affordability has therefore become the defining test of Türkiye's transition.

The government's strategy combines long-term climate neutrality by 2053 with medium-term milestones through 2035. The National Energy Plan envisions 120 GW of renewables, 7 GW of nuclear, and 7,5 GW of storage, while new rules for ETS, GoO, and YEKA auctions aim to synchronize carbon policy with market instruments. Grids and flexibility have emerged as central: network investments, hybrid plants, and demand response convert installed capacity into available power, reducing curtailment and systemic costs. Meanwhile, the ETS and CBAM alignment link industrial decarbonization with export competitiveness, turning carbon regulation from an external constraint into a domestic investment driver.

Three plausible scenarios outline the future: a baseline of steady implementation, an accelerated path focused on grids and carbon pricing, and a corridor-plus-industry model emphasizing localization and green exports. Across all, the trade-offs remain constant—speed versus stability, ambition versus affordability. Managing them depends on synchronizing four levers: grids and system services, the carbon price signal, gas flexibility, and industrial policy that lowers capital costs without slowing deployment.

The logic that opened Türkiye's energy story – "geography as destiny" – now closes it on new terms. Geography still matters, but no longer defines outcomes. What will define Türkiye's success is institutional design: the ability to turn networks, markets, and carbon rules into a coherent system that delivers cleaner energy, resilient prices, and sustained industrial competitiveness.

1. Introduction

The global energy revolution is driving profound transformations not only in the energy sector but also across the economy, society, and geopolitics. In today's multi-crisis environment, energy has become the core of national policy choices: governments must constantly balance the trilemma of security, equity, and environmental sustainability. These trade-offs are shaping the future architecture of economies – from industry and housing to infrastructure and social systems – and will largely determine national competitiveness for decades ahead.

The energy transition has become an objective reality, driven by technological progress, cost reduction of new solutions, and growing environmental and climate concerns. Unlike earlier modernization cycles, it does not automatically lead to cheaper energy. On the contrary, the current transformation is based on a conscious prioritization of cleaner and more sustainable sources, even at a higher cost. This shift changes the very architecture of energy systems: they are becoming more distributed, digital, and flexible. It also redefines market roles, business models, and risk structures, placing consumers at the center of the system.

There is no universal recipe for navigating this transformation. Each country designs its own balance among the trilemma dimensions – security, equity, and sustainability – depending on its resource base, economic structure, and institutional capacity. The effectiveness of the energy transition depends on how flexibly a state can adapt its policy instruments to fast-changing global and domestic conditions.

Türkiye's position makes its experience particularly illustrative. Located between Europe and Asia, facing growing domestic demand and persistent dependence on imported fuels, the country must combine the goals of energy security with those of modernization and climate responsibility. Its energy transition policies influence not only the domestic market but also regional energy flows, transit routes, and investment strategies.

In this paper, the terms *energy transition* and *decarbonization* are sometimes used interchangeably, though their meanings differ. Decarbonization refers to the goal – the reduction of greenhouse gas emissions – while the energy transition represents the broader process that includes technological, structural, and behavioral changes. The flexible use of these terms reflects the fact that in Türkiye's case, decarbonization is both a defining feature and a central objective of the ongoing energy transition.

This essay examines the dynamics of Türkiye's energy transition, reviews existing policies and measures, identifies key challenges and drivers, and assesses opportunities for enhancing their overall effectiveness in the context of regional and global developments.

2. External Context

Since antiquity, Anatolia drew on the same basic energy palette as Europe, the Middle East, Russia, and Central Asia: water and wind mills, wood, geothermal uses, and animal power. The region's economy was agrarian, with limited mining and weaker infrastructure than industrializing Western Europe. In Russia and Central Asia, the pre-industrial mix remained even more rudimentary.

The European industrial revolution in the 18th – 19th centuries radically lifted energy demand and put coal at the core of factories and transport, binding energy, industry, and capital. The Ottoman Empire – and after 1923, the Türkiye's Republic – felt these forces with a lag: coal and small hydro expanded, but at a smaller scale than in Europe, while neighboring Middle Eastern economies stayed largely agrarian.

Early-20th-century oil discoveries in Iran, Saudi Arabia, Iraq, and the Gulf turned the Middle East into a global energy exporter, reshaping domestic economies and foreign policy. Through the mid-20th century, Türkiye's own fossil output remained modest and infrastructure developed slowly. By contrast, the USSR scaled coal and oil and later became a major supplier of oil and especially gas – a foundation of its external influence. Türkiye's geography between producers and European markets already pointed to a future transit role.

After World War II, Europe accelerated electrification, large hydro, nuclear build-out, and national grids, with rising living standards and energy demand. In the USSR and Central Asia, energy policy prioritized raw-material exports and heavy industrialization, creating assets that now need transformation. Türkiye strengthened state involvement, built hydro plants and state enterprises, and grew increasingly dependent on imported fuels – particularly natural gas.

With the Soviet breakup and market globalization, energy became a sharper geopolitical lever. Europe integrated markets, improved efficiency, and tightened environmental rules. Russia doubled down on exports to Europe; Central Asian states pursued modernization and diversification. From the 2000s, Türkiye liberalized power and gas markets, moved to privatization, and advanced its ambition to act as a regional energy hub linking the Middle East, the Caspian, and Europe.

Today Türkiye sits at the crossroads: a high-import-dependence system seeking to expand renewables and align with sustainability principles while leveraging transit advantages. The EU, intensifying decarbonization and erecting new standards amid sanctions-driven disengagement from Russian fuels, faces criticism from the Middle East and the United States; nonetheless, European policymakers frame renewables and the energy transition as the central risk-management response. For Türkiye, this external vector, combined with domestic market reform and resource constraints, sets the stage for its next strategic choices.

Türkiye holds a unique position in energy and geopolitics not only because of its geography, but also due to its energy capabilities, established ties and partnerships, built infrastructure, and regulatory framework.

The global energy order is being reconfigured under pressure from the energy-security crisis, the rise of new industrial policy across many countries, and the continued decline in the cost of clean technologies. Trade routes are being reshaped worldwide, and the composition and influence of alliances are shifting. New approaches to risk assessment are emerging, and they can differ markedly across regions.

Russia

Russia frames reliability as access to relatively cheap, traditional fuels supported by existing infrastructure, and promotes this narrative to developing markets. It remains a major supplier to Türkiye, but deliveries are shifting from long-term contracts to a more portfolio-style structure. In 2024 – 2025, volumes via Blue Stream and TurkStream stayed significant; expiring contracts and geopolitics create room for renegotiation. TurkStream gives Türkiye leverage as a conduit to Southeast Europe, yet also adds risk if the EU presses for a full exit from Russian gas. As a notable buyer and processor of Russian crude, Türkiye gains flexibility and short-term margins but increases exposure to sanctions and commercial constraints.

Economic ties are deepening beyond trade into technology, finance, and joint projects. The Akkuyu nuclear plant, built by Rosatom, will lower gas burn and partly reduce power-sector risk, while raising long-term dependence on Russian nuclear technology.

Cheap gas and Russian capital compress near-term costs and help fund infrastructure (including Akkuyu). However, a large Russian share narrows geopolitical room to maneuver, may hinder access

to European finance and technologies under tightening sanctions, and locks in long-term technical and political obligations to a single nuclear supplier.

Europe

The EU assesses risk differently, treating renewables as a core tool for resilience after the sharp drop in Russian pipeline gas. This drives a durable preference for flexibility (LNG, storage, agile dispatch, demand-side management, and battery storage) over fixed volumes and reshapes market structures. Policy is reinforced by CBAM and a strengthened ETS, while industrial policy and subsidies – including pragmatic localization–reconfigure clean-tech supply chains. As a result, LNG and renewables gain weight; grid integration needs rise (interconnectors, market coupling, storage), and market design continues to evolve (intraday, balancing, capacity mechanisms). Political and social constraints (energy poverty, tariff acceptance) still cap reform speed.

For Türkiye, Europe as a neighbor and partner is less reliant on fixed pipeline volumes and more exposed to spot-price swings, yet new avenues open for export cooperation and component localization – conditional on regulatory and trade compatibility (CBAM/ETS) and competitive offerings in flexibility and power transmission. For Türkiye's exporters, CBAM compliance and emissions control are competitiveness variables; for Türkiye's developers, global equipment oversupply lowers capex even as it strains local manufacturing.

Middle East

Middle Eastern states are investing heavily in renewables while remaining core hydrocarbon exporters. The durability of oil and gas export flows is a global security issue, yet route risks are rising in the Strait of Hormuz, the Suez Canal, and the Red Sea. Reducing exposure raises costs – longer voyages, higher logistics and insurance premiums, and shifting partners. Export strategies are therefore hybrid: oil stays central, but investment is growing in gas, LNG, hydrogen, and logistics. The region now competes not only with other oil sources, but also with clean fuels and emerging value chains. Oil and gas prices remain highly sensitive to regional events, increasing volatility and complicating long-term planning, including for Türkiye.

Since late 2023, rerouting around the Cape of Good Hope has lengthened voyages and lifted insurance costs, reshaping shipping economics for oil, products, and LNG. Türkiye's Mediterranean hubs (Ceyhan and the Marmara Sea) are increasingly viewed as alternatives and as a bridge between Atlantic and intra-Mediterranean trade.

Regional gas dynamics underscore fragility: East Mediterranean volumes are politically exposed – temporary shutdowns at Israel's Tamar and Leviathan, export disruptions to Egypt, Cairo's shift from LNG exporter to importer in 2024 – 2025, and persistent infrastructure risks amid conflict. This supports diversification of supply, flexible contracts, and treating East Med flows as opportunistic supplements rather than guaranteed baseload. For Türkiye, the opportunity set spans import logistics for clean molecules, feedstocks for industrial decarbonization (e.g., ammonia for steel and chemicals), and transit roles – subject to standards compliance, CBAM treatment, and viable transport economics.

United States

U.S. energy and industrial policy sets global investment signals and trade rules that materially shape Türkiye's transition. The Inflation Reduction Act redirects capital into clean technologies, tying subsidies to local-content rules and tax credits. Trade disputes and export controls – tariffs on selected Chinese "green" goods and restrictions on strategic materials and microelectronics – are restructuring supply chains and raising the premium on friend-shoring.

Europe's pivot from Russian pipeline gas to flexible U.S. LNG influences European pricing and seasonal supply optionality for Türkiye. Project bankability is further conditioned by commercial and blended public – private finance linked to these flows.

NATO and bilateral ties with the United States also matter through access to advanced nuclear, grid, and defense-adjacent technologies. At the same time, U.S. sanctions policy remains a non-trivial risk factor.

China

China's excess manufacturing capacity in clean technologies is simultaneously accelerating global renewables deployment and testing producers: module and material prices are falling, lowering LCOE and speeding electrification, while compressing margins and provoking trade responses. The Belt and Road Initiative remains the primary channel for China's outward expansion, with rising investment in renewable infrastructure and active Chinese EPC participation.

A deeper China – Russia alignment is reshaping hydrocarbon markets. Power of Siberia and the prospective "PoS-2" redirect significant Russian gas volumes eastward, with long-term implications for pricing and transit dynamics across Europe – Caucasus – Türkiye corridors.

U.S. – China tensions – tariffs, export controls on strategic materials – and China's counter-measures on rare earths and critical components turn supply chains into a geopolitical arena. The premium on friend-shoring is rising, making standards compatibility and component access pivotal for intermediary countries, including Türkiye. In Europe – China relations, trade barriers, CBAM, and anti-dumping probes add another filter to Chinese exports, pushing European buyers toward localized suppliers and assembly partners. This creates an opening for Türkiye – assembly and exports to the EU conditional on standards alignment – while intensifying price competition with Chinese imports and policy pressure.

Central Asia

Central Asian energy profiles are heterogeneous – coal in Kazakhstan, hydropower in Kyrgyzstan and Tajikistan, and gas in Turkmenistan and Uzbekistan – combined with aging infrastructure and seasonal stress. This mix creates both risk and cooperation opportunities. Governments aim to strengthen intra-regional connectivity and pursue external integration via a Trans-Caspian corridor to export green electricity and hydrogen.

For Türkiye, a "corridor-plus" option exists: leverage TANAP/TAP infrastructure and commercial arrangements to participate in these flows. Maintaining a diversified set of sources, routes, and partnerships – while using seasonal swap contracts where practical – and closely monitoring project progress in Central Asia can enhance flexibility and capture upside.

Azerbaijan

Türkiye – Azerbaijan cooperation has moved beyond transit into an integrated "corridor-plus" platform aligning infrastructure, industry, and commercial ties. The Southern Gas Corridor and the BTC oil pipeline form the backbone, while SOCAR's Türkiye's assets (refining, petrochemicals, terminals) shift value-added to Anatolia, deepening interdependence and delivering industrial benefits – jobs, processing capacity, and export chains.

Strategically, the Baku – Ankara axis acts as a stabilizer for Southeast Europe and a tool of Türkiye's energy diplomacy. Institutional agreements and strategic declarations facilitate capacity expansions and seasonal swap operations. Its effectiveness, however, hinges on long-term offtake commitments,

financing to relieve bottlenecks, and a shared "green" agenda (hydrogen/ammonia pilots, RES exchanges). For Türkiye, this strengthens hub credentials while adding responsibility for the corridor's commercial and political resilience.

Alliances

Producer and political groupings – OPEC+, GECF, and an expanded BRICS – shape price dynamics and enable more multi-vector energy management. OPEC+ supply policy in 2024 – 2025 cushioned oil prices amid soft demand and rising non-OPEC output; GECF remains a signaling venue for gas exporters; BRICS enlargement has shifted forums for finance and trade settlement. For Türkiye, these trends inform hedging strategies for oil and gas exposure and broaden potential financial channels.

In this global puzzle, each actor's energy interests are distinct and tied not only to trade balances, but also to budgets, industrial policy, living standards, long-term strategy, and geopolitics.

Taken together, the evidence indicates:

- **Security shocks – flexibility premium.** Military and maritime disruptions cut the value of fixed pipeline volumes and lift the premium for LNG, storage, and seasonal swaps.
- **Industrial policy as a locator.** IRA, EU subsidies, and CBAM/ETS redirect capital and make local content and regulatory alignment decisive for clean-tech siting.
- **Trade remedies filter supply chains.** Anti-dumping, tariffs, and export controls screen low-cost imports and reset procurement and localization choices.
- **Producer/bloc coordination.** OPEC+, GECF, and expanded BRICS reinforce managed-supply narratives and raise the political share of resource rents.
- **Pipeline re-geometry.** Eurasian rerouting concentrates remaining western corridors (Black Sea/TurkStream) and shifts where transit rents accrue.
- **"Corridor-plus" industrialization.** Pairing transit with downstream processing (refining, petrochemicals, H_2/ammonia) converts fees into higher local value-add.
- **Chinese clean-tech deflation.** Cheaper modules and batteries speed deployment and lower LCOE, while squeezing margins and triggering protectionism.
- **Central Asian heterogeneity & green-corridor scope.** Mixed fuel bases, aging assets, and early variable renewable energy / H2 plans create conditional export options needing major grid and commercial integration.
- **Nuclear/base-load reset.** New nuclear lowers short-term gas exposure but deepens long-term tech and supplier dependence.
- **Maritime chokepoints → logistics premium.** Risks in Hormuz, the Red Sea, and Suez raise freight/insurance costs and increase the value of alternative hubs, including Türkiye's nodes.

Türkiye's comparative edge is option-rich and institutional, not merely geographic. To make it durable, the country should advance in parallel:

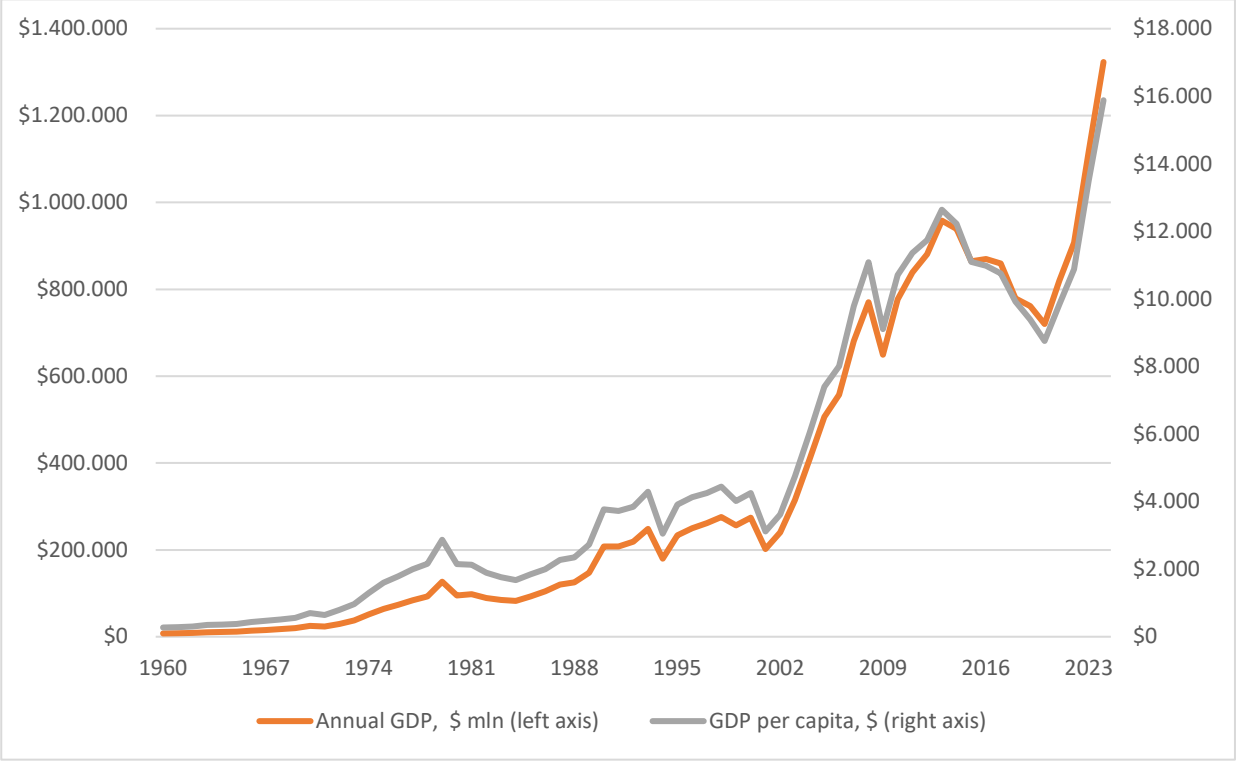
(a) **operational resilience** (storage, diversified LNG and seasonal swaps, port/terminal readiness);
(b) (b) **institutional alignment** (credible ETS, CBAM compatibility, standardized offtake with corridor partners);
(c) (c) **industrial capture** (leveraging SOCAR/TANAP/TAP to localize higher value-add, P2G pilots, export-oriented manufacturing).

Lack of coordination would leave Türkiye exposed to politicized suppliers and logistics shocks; successful integration would position Ankara as a negotiated center of Eurasian energy flows rather than a simple conduit.

3. Internal Context

Macroeconomy

Fig. 1 Türkiye GDP Dynamics



Source of data: Türkiye GDP - Gross Domestic Product [3]

In 2025, Türkiye's economy shows signs of stabilization after a period of high inflation and turbulence. According to World Bank data, the country's GDP amounts to about 1,32 trillion USD, making Türkiye the 17th largest economy in the world. Between 2002 and 2022, GDP grew by an average of 5,4% per year; growth reached about 4,5% in 2023 and 3.2% in 2024. This growth rally allowed real income per capita to double, while the poverty rate fell from more than 20% in 2007 to 7.6% in 2021 [4, 5].

In 2025, the growth rate is expected to slow slightly to around 3,1 – 3,3%, while poverty indicators have begun to worsen again.

The main macroeconomic challenge remains high inflation. During 2024, inflation reached record levels – over 75% in June 2024 – before declining to about 33 – 35% in June – October 2025, indicating noticeable but still incomplete easing of price pressure. The high price level complicates the social and economic situation, especially given the rising cost of living and consumer prices.

Amid these challenges and the government's efforts to stabilize the macroeconomic environment, Türkiye's economy continues to rely on a strong services sector and exports of industrial goods,

especially machinery and tourism. However, declining investment activity and cooling of the economy due to expensive credit have slowed growth.

Economic Structure

Türkiye's economy is characterized by a diversified structure dominated by services, industry, and agriculture. In terms of GDP composition in 2025, industry accounts for about 22 – 33%, while services reach up to 60%. The main industrial sectors include automotive, machinery, construction, metallurgy, chemical and food industries, and textiles.

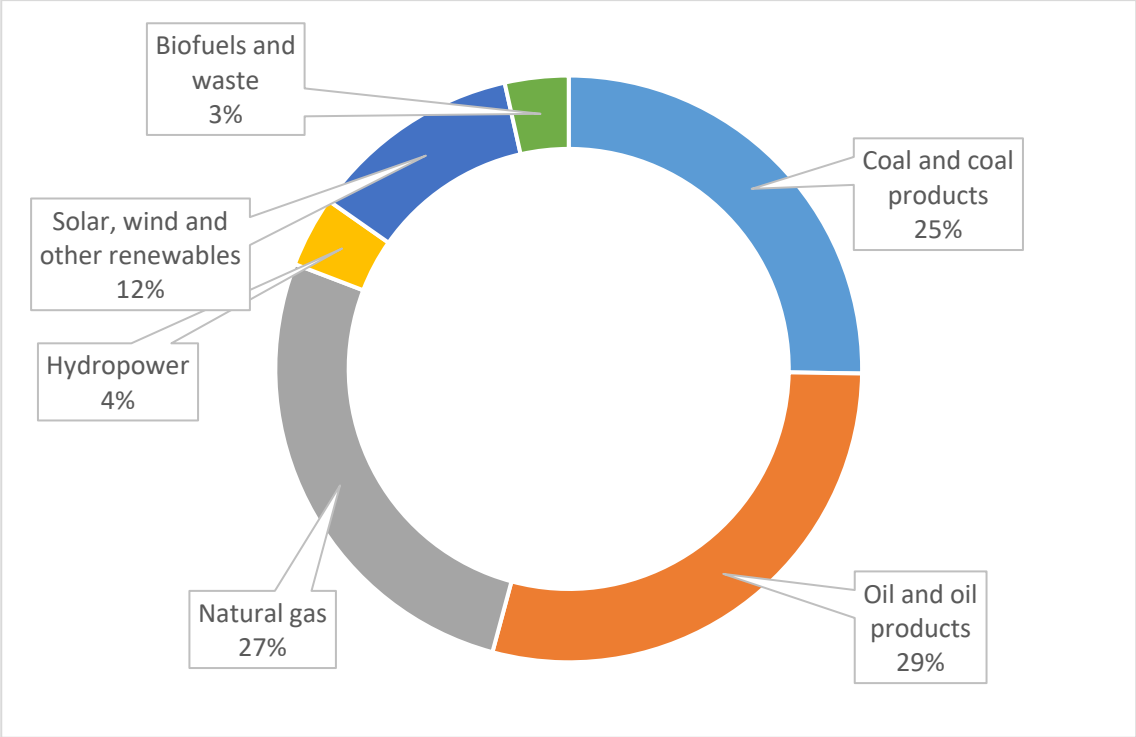
Heavy and medium-technology industries consume large amounts of energy and are highly sensitive to electricity and gas tariffs; major enterprises are the key buyers of industrial power and natural gas.

Export-oriented sectors include textiles and light industry, which together make up to 42% of total exports, as well as the automotive and food industries. The main imports are raw materials and energy carriers, including oil and gas, as well as chemical products and machinery.

Energy Mix

Türkiye's energy sector is actively developing – the country aims to reduce import dependence through investment in renewable energy, particularly solar and wind, although these challenges remain. In total energy supply (domestic production plus imports minus exports), oil and petroleum products, natural gas, and coal continue to dominate [6].

Fig. 2. Türkiye Energy Supply 2024



Data source: IEA – Türkiye country profile [7]

In 2024, imports accounted for more than 70% of total energy supply, and the situation is worsening: energy imports have grown steadily since 2000, reaching an increase of 146% by 2024 – meaning imports have risen 2,5 times. Energy import dependence remains a key structural risk.

Türkiye faces a strong import burden:

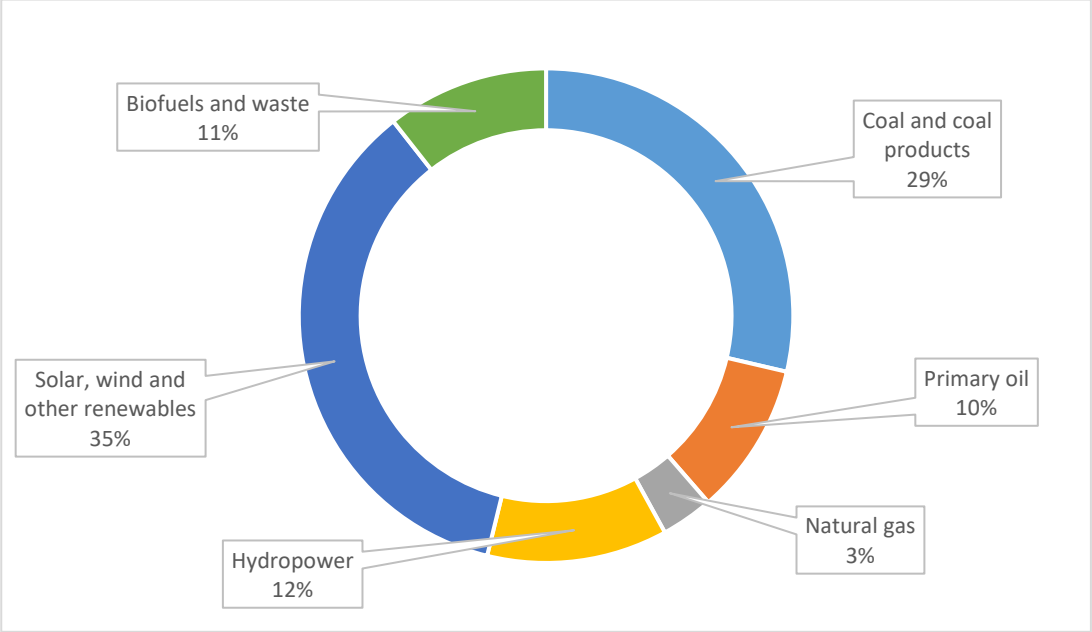
- for coal (≈1 070 PJ, Türkiye is the largest coal importer in Europe);
- for gas (≈1 740 356 TJ in 2023), with domestic production covering only 4,2%;
- for oil: net crude oil imports in 2024 accounted for 85,5% of total crude supply, while imports of petroleum products rose by 199% between 2000 and 2024.

Dependence on imported hydrocarbons is structural. Fluctuations in global prices and logistics represent a major risk and vulnerability for Türkiye's energy system and macroeconomic stability.

Domestic Energy Production and Consumption

Domestic energy production in Türkiye is concentrated in renewables and coal: as of 2024, renewables accounted for 35,6% of domestic production and coal for 28,6%, while domestic oil and gas resources represented much smaller shares – 10% and 3,4%, respectively. Solar, wind, and other renewable sources together formed the largest share at 35%, exceeding coal-based generation.

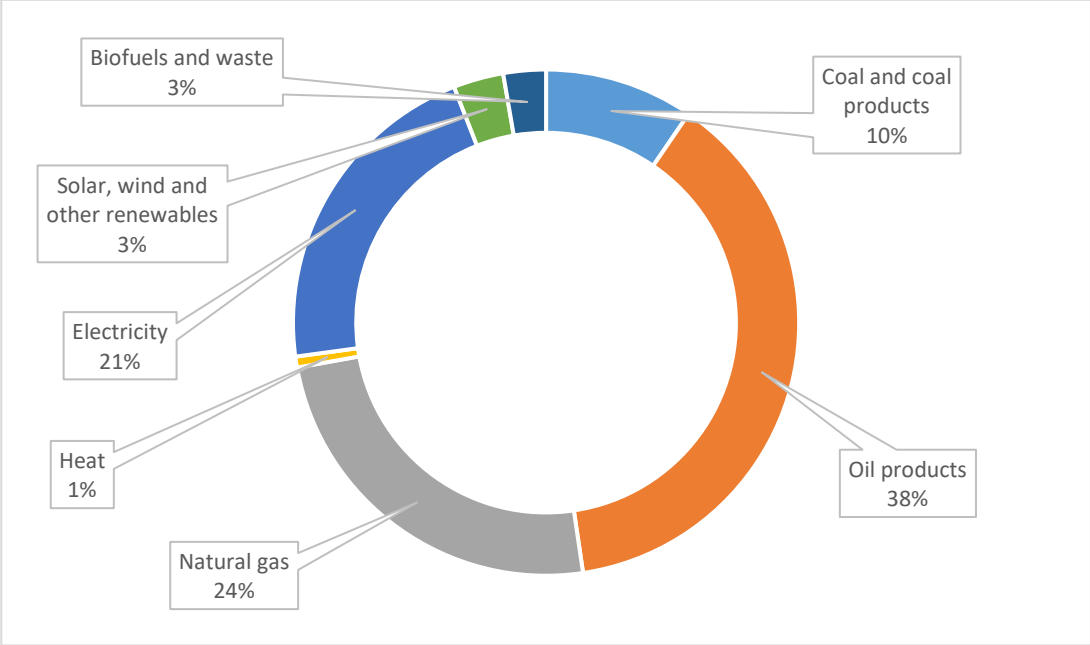
Fig. 3. Türkiye domestic energy production, 2024



Data source: IEA – Türkiye country profile [7]

In final energy consumption, petroleum products dominate (38% in 2023), followed by natural gas (24%), electricity (21%), and coal and its products (10%).

Fig. 4. Türkiye final energy consumption, 2023



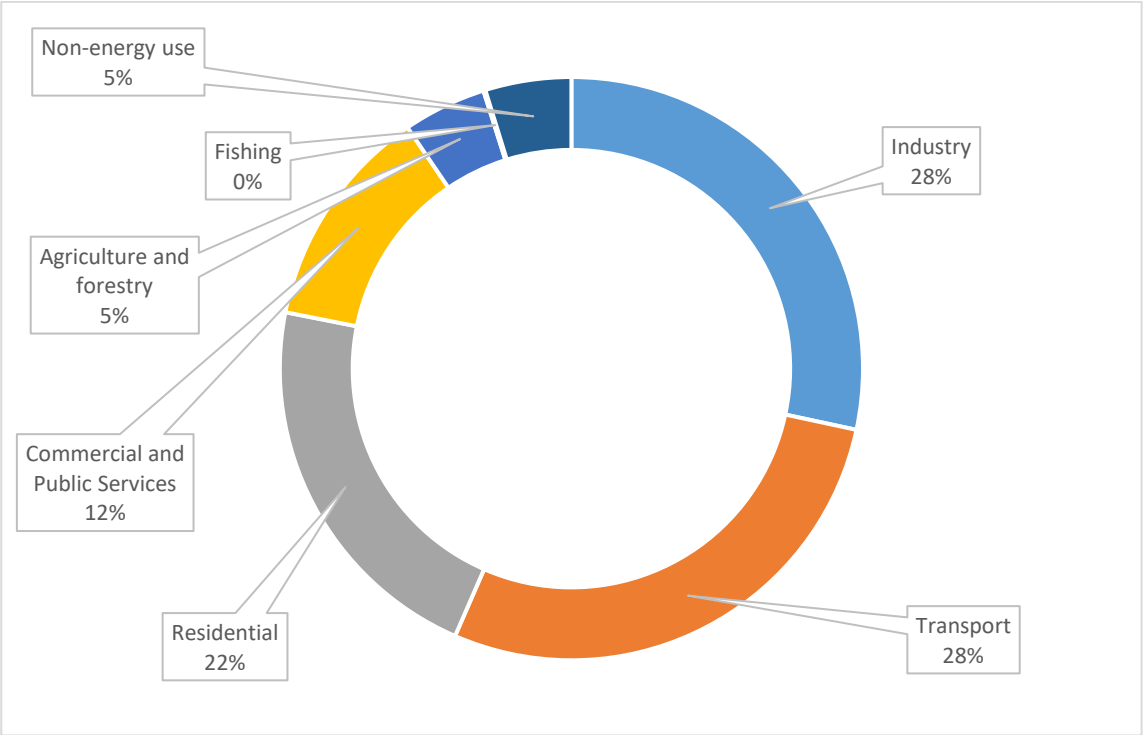
Data source: IEA – Türkiye country profile [7]

Oil remains a major component of demand – about 29% of total energy supply in 2024 and 38% of oil and products in final energy consumption in 2023 – which makes oil-dependent sectors (primarily transport) critical for the national energy balance. Any effort to reduce oil consumption would therefore significantly affect overall energy demand and emissions.

Energy efficiency is improving. Total energy supply per unit of GDP, adjusted for purchasing power parity, was 2 260,9 MJ per 2015 USD in 2024, showing a 31% decline between 2000 and 2024. Manufacturing energy intensity in Türkiye was 2,64 MJ per 2020 USD PPP in 2023, having dropped 50% since 2000. However, over the same period, energy intensity in the services sector increased by 90% in 2023 compared to 2000.

The main final consumers of energy are industry (28%), transport (28%), and the residential sector (22%). In industry, 33% of consumption comes from electricity and 27% from natural gas. In transport, 98% of energy use is oil products, while in the residential sector 56% is supplied by natural gas.

Fig. 5. Türkiye energy consumption by sector, 2023



Data source: IEA – Türkiye country profile [7]

Sector outlook and policy

Oil

There is a steady rise in oil supply and imports – total oil supply increased by 57% from 2000 to 2024. Rising demand requires systemic measures to reduce oil consumption.

Oil use is concentrated in the transport sector (73% of final oil product consumption), mainly as liquid fuels (about 58% is diesel/gas). Oil is almost absent in power generation. Its share in electricity generation is 0,3% (2024), so the potential to cut oil demand by switching mazut/diesel power to other sources is very limited. This confirms that decarbonization on the oil side depends on transforming transport.

Türkiye has large **refining volumes** (1 700 118 TJ in 2023). In 2024, 92% of imported crude was refined. Refining is an important element of industrial policy and employment, which complicates a rapid decline in product demand. The sector also makes a significant contribution to CO2 emissions: in 2023 it accounted for 32% of all emissions from fuel combustion, up 58% since 2000. This makes the oil sector central to the climate agenda: reducing oil product use directly lowers national emissions.

Coal

As noted earlier, coal is also marked by a heavy import burden, along with significant domestic lignite production despite its environmental drawbacks and low calorific value (only 0,84% exceeds 4 000 kcal/kg). Coal accounted for more than one quarter of total energy supply in 2024 – 25,3%, and for more than one third of electricity generation – 34,5%. It remains the main carbon-intensive power source, with 70% of final coal consumption coming from industry.

Coal is the largest source of CO2 emissions in the energy sector – 42%. The substantial volume of imported coal highlights Türkiye's vulnerability to maritime routes, freight costs, and global market fluctuations.

Gas

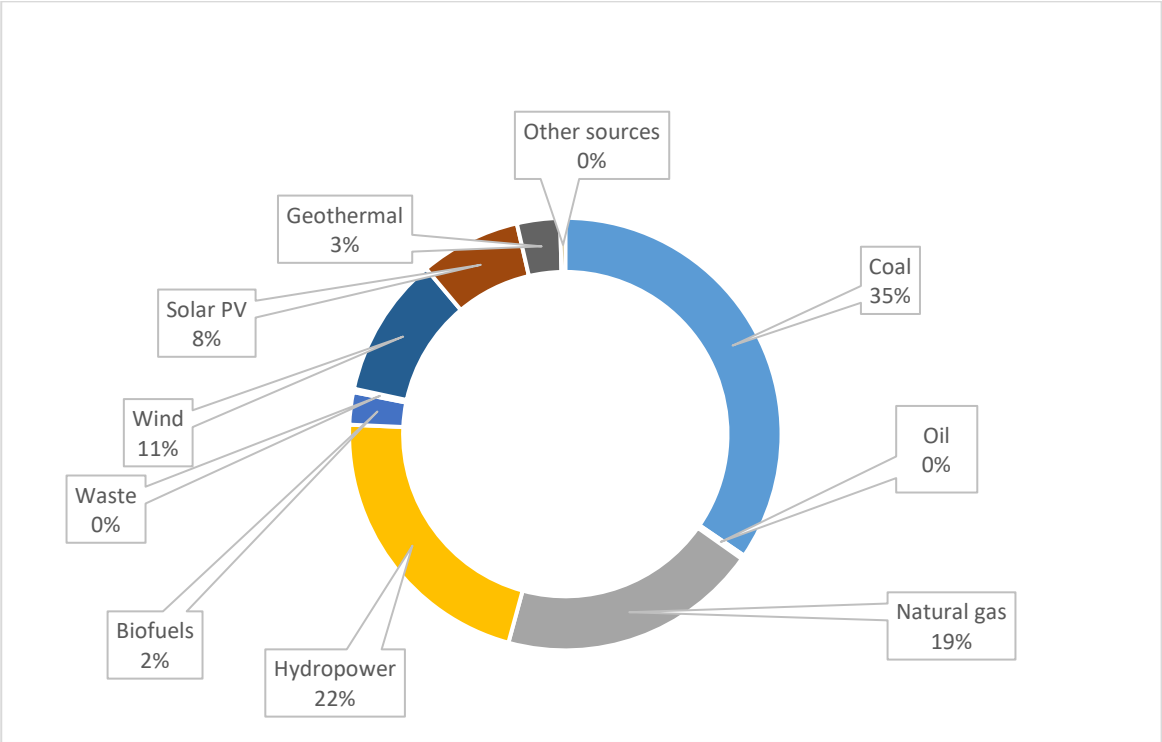
About 68% of natural gas is used for final consumption, of which the residential sector accounts for 49% and industry for 31%. This makes the energy balance sensitive to heating policy and social tariffs, while external gas supplies remain a decisive element of energy security, and industrial decarbonization forms part of the gas strategy.

Gas represents 19,4% of electricity generation (≈69 453 GWh), serving as an important source of flexibility and demand coverage, though it is not a dominant baseload resource. Gas also has a significant impact on national emissions – 23% of CO2 from fuel combustion (≈92,07 MtCO2) – therefore, emission reduction measures must include the gas segment as an integral component.

Electric Power Sector

The total increase of electricity generation by 179% between 2000 and 2024 indicates rapid growth in both consumption and production. Türkiye's power system remains centered on coal and hydropower while rapidly expanding its renewable base. Coal is the largest source of generation (35%), followed by hydro (21,5%) and a significant share of gas (19,4%), while renewables (wind, solar, geothermal energy, and biomass) already make a visible contribution to total generation. Between 2000 and 2022, the share of modern renewables (excludes traditional uses of biomass, such as burning collected wood, agricultural byproducts or dung for cooking or heating) in Türkiye's electricity production increased 1,7 times.

Fig. 6. Türkiye electricity generation, 2024



Data source: IEA – Türkiye country profile [7]

The latest data show [8] that in 2024 the combined share of wind and solar in Türkiye's electricity generation exceeded 18%. Coal accounted for 35,6% of the mix, while the overall share of fossil fuels fell to 55% – the lowest level since 1993.

Wind and solar generation reached 62 TWh in 2024, surpassing domestic coal output (47 TWh) for the second consecutive year. For the first time, renewables also exceeded the historic peak of domestic coal generation (53 TWh in 2019). According to Ember analysts, domestic coal generation is unlikely to overtake wind and solar again in the future.

However, electricity demand continues to grow faster than renewable capacity additions: over the past five years, demand has risen by 42 TWh, while wind and solar output expanded by 31 TWh. Under these conditions, the government faces a key challenge – accelerating the grid integration of clean generation capacity at the pace required by demand growth.

Türkiye's newly announced 2035 targets, unveiled during COP29, aim to quadruple current wind and solar capacity. If achieved, the share of fossil-based power could fall below 20% by 2035, while wind and solar together could reach around 49%.

Industry is the main electricity consumer (44%), making the efficiency and decarbonization of industrial demand a central element of the transition. Energy dependence on imported electricity is low, but cross-border interactions exist. Imports of 6 094 GWh in 2023 represent a small flow relative to domestic generation, yet they demonstrate the existence of interconnections and potential for regional balancing.

The power sector is a key source of emissions. The "electricity and heat" segment accounts for 35% of energy-related CO2 emissions, meaning that action within the power sector offers one of the most effective pathways for emission reduction.

Renewable Energy

Türkiye ranks 5th in Europe and 11th in the world [9] in renewable energy. Renewables are already a visible part of the national energy balance, although their share in final energy consumption remains moderate. Modern renewables account for 13,81% of total final consumption (TFC) in 2022, showing clear progress but also significant room for growth.

In 2024, solar power in Türkiye increased by a record 39% year-on-year [8]. This pushed solar share of electricity generation to 7,5%, up from 5,7% in 2023. As a result, the total share of wind and solar in electricity generation surpassed 18%.

The power segment of renewables is stronger than heat or transport: about 42% of electricity generation came from renewables in 2022, with hydropower making up half of this renewable output. This means the electricity sector is already more "green" than heat or transport applications. Hydropower remains the anchor of renewable generation, while other sources – wind, solar, biomass, and geothermal – complement the profile; hydro accounts for about 50% of non-combustible renewables.

Geothermal resources include around 200 identified sites, 95% of which are suitable for heating.

However, contradictions persist – the construction of hydro and wind power plants in protected areas undermines ecosystems. About 70% of hydropower potential is already utilized, and many projects disrupt ecosystems and watershed regimes. WWF warns of potential water shortages by 2030. Biomass remains limited in potential and costly, while marine and hydrogen energy are still at the experimental stage.

Energy Intensity

Türkiye's economy remains relatively energy-intensive, even compared with other countries in the region. Per capita energy consumption – 3,581 MWh/person in 2023 – places the country in the mid-range among European economies in terms of electricity use intensity. Per capita energy availability has more than doubled between 1980 and 2021 [10], reflecting the country's rapid development and improved living standards.

Given this situation, energy policy must give equal attention to energy consumption in both industry, where remains room for electrifying certain processes where technically feasible, as well as significant potential for further efficiency gains, and transport with its 98% dependence on oil and petroleum products which highlights enormous decarbonization potential. Measures in the residential sector should focus on reducing heating demand and improving efficiency, since 56% of the sector's energy use comes from natural gas.

Emissions

Total CO2 emissions almost doubled between 2000 and 2023, while per capita emissions increased by 47%. Coal accounts for 42% of energy sector emissions, oil for 32%, and natural gas for 23,5% (2023). Electricity and heat generation represent 35,5% of energy-related CO2 emissions, transport 24,8%, industry 18,9%, and the residential sector 9,7%.

The dominance of coal in energy-sector emissions (≈165 MtCO2 in 2023) highlights the main potential in reducing coal-based generation. Overall, measures in the power sector can deliver the largest short-term emission reductions. Transport, as the second most energy-intensive sector (≈24,8% or about 97 MTCO2), also requires heightened attention.

The persistent and systemic rise in emissions over recent decades is concerning. Since it is also visible in per capita terms, it cannot be explained by population growth alone; it indicates growing carbon intensity of the economy. Decarbonization will require a comprehensive set of coordinated cross-sectoral measures.

Rapid economic and population growth over the past two decades has led not only to a sharp increase in energy demand but also to a corresponding rise in import dependence. Since final energy consumption is split almost equally between industry and transport – where transport relies almost entirely on oil products, industry on electricity and gas, and the residential sector on natural gas for heating – there are three key pillars of decarbonization: transport, building heat, and energy-intensive industrial processes.

The main vulnerability remains the import-oriented energy balance. More than 70% of total energy supply is covered by imports; dependence on oil, gas, and coal is high, while domestic production is concentrated in renewables and lignite. Any price or logistics shock quickly translates into inflation and higher energy bills.

The oil segment represents a large share of emissions and a long-term challenge. Oil contributes significantly to final demand and emissions but is almost absent from power generation. Therefore, reducing oil dependence is primarily a task for the transport sector – through electrification, efficiency, and alternative fuels – rather than for power generation.

The high share of coal in both generation and emissions makes coal phase-down or modernization the most effective short-term measure for reducing national emissions. Coal is the main source of energy-sector CO2 and the fastest point of reduction.

Gas plays a critical role in balancing the system and meeting household needs. Any measures to reduce gas dependence must combine modernization of heating (insulation, heat pumps, targeted tariffs) with reliability and price stability. For Türkiye, gas remains a flexibility resource with strong social importance.

The power sector is already changing rapidly, but its bottlenecks lie in grids and flexibility. Generation has expanded sharply over two decades; shares of wind, solar, and hydro are significant. Yet connection capacity, transmission, storage, and balancing remain constraints. Without greater investment in flexibility, the share of renewables in final consumption will rise more slowly than in generation.

Oil and gas refining are not only industrial assets but also political-economy factors. Large domestic refining capacity and the strong position of local refineries in the market provide employment and added value but complicate a quick decline in oil product demand. A strategy for gradual refinery adaptation is needed – adjusting output structure, shifting toward chemical feedstocks, and producing lower-carbon products.

Energy efficiency remains a proven source of low-cost demand reduction. The decline in GDP and industrial energy intensity between 2000 and 2024 demonstrates the potential of demand-side management. At the same time, the growing energy intensity of the services sector calls for targeted policy interventions – focused on buildings, cooling, and digital load.

Emissions are rising systemically, including per capita, which means that coordinated sectoral packages are required for the power sector, transport, industry, and buildings.

4. Current Energy Policy

Türkiye is undergoing a large-scale transformation of its energy system, building on the laws and institutional reforms introduced in the early 2000s. The country aims to reduce import dependence, expand the share of renewables (to reach an installed renewable capacity of 120 000 MW by 2035), introduce nuclear power into the energy mix, and strengthen Türkiye's position as an energy hub in Eurasia [10, 11, 12, 13, 14].

Türkiye defines its energy transition as a combination of a long-term climate goal – greenhouse gas neutrality by 2053 – and a set of medium-term milestones for 2030 – 2035 [15], distributed across the power sector, energy demand sectors (industry, buildings, transport), and infrastructure (grids, storage, gas and oil refining). Electricity demand is expected to triple over the next 30 years.

The logic of these measures can be structured into several main blocks.

1. Key Documents

The **National Energy Plan (2022)** sets the supply and demand trajectory through 2035 and defines key capacity targets: accelerated renewables deployment (≈120 GW), energy storage (≈7,5 GW), the introduction of nuclear generation (≈7 GW), and prioritization of grid modernization and flexibility. The document is aligned with the 2053 climate neutrality target and includes hydrogen pilot projects and its gradual integration into the gas network [16].

The **Electricity Market Law No. 6446** established the legal foundation for wholesale and retail power markets, licensing, and the roles of market participants [17].

The **Renewable Energy Law No. 5346** provides the framework for renewable energy promotion– resource zones, certification, and support mechanisms [18].

The **Green Deal Action Plan (Presidential Circular 2021/15)** aligns national policy with the European agenda, ensuring compatibility with CBAM, ETS, and "green" supply chains [19].

The **National Hydrogen Strategy (MENR, 2023)** sets priorities for hydrogen and its blends with natural gas and defines the framework for sectoral pilot projects [20].

The **YEK-G Market Regulation / EPİAŞ** establishes the rules for the organized market of guarantees of origin [21]. YEK-G is the national system of guarantees of origin, administered by EPİAŞ: for every 1 MWh of renewable electricity, a digital certificate is issued and traded on the organized market. This mechanism links the physical supply with its "green" attribute for PPA and export compatibility under CBAM and ETS.

2. Markets and the Attribution of the "Green" Kilowatt-Hour

The network segment, managed by TEİAŞ, has shifted its focus from simply "connecting more" to "connecting reliably." Targeted investments in transmission lines, substations, interconnections, and digital dispatching are now linked to grid connection queues and areas of generation congestion. A regulatory framework has been established for energy storage systems, hybrid plants, and demand response participation in system services. This approach converts installed capacity into actual generation, reduces curtailment volumes, and enhances overall system flexibility.

The Energy Exchange (EPİAŞ/EXIST) has evolved from a day-ahead platform into a full-scale wholesale trading infrastructure. Intraday markets have been introduced, balancing segments are now established, and the service component for long-term contracts continues to expand. The registry of guarantees of origin complements this structure, ensuring traceability of "green" supply attributes. It links physical electricity deliveries with their renewable origin, which is critical for corporate procurement and export compatibility.

Renewable Energy Zones (YEKA, operating since 2017) auctions have institutionalized competitive large-scale project deployment, including hybrid projects with storage, under unified grid connection rules and the option to set technological and localization requirements. Starting in 2025, annual tenders for 2 GW of new capacity are scheduled.

3. Emergence of New Asset Classes and Markets

The regulatory framework for storage systems – target capacity 7,5 GW – and hybrid power plants has recognized energy storage as both an independent market participant and an integral part of generation projects. This has enabled the co-location of batteries with solar and wind power plants and their participation in ancillary service markets. For a country with a rapidly growing share of renewables, this is a key tool to reduce curtailed generation and system costs. By 2035, total investments are expected to reach 108 billion USD (public and private), of which 28 billion USD will be directed to grid and transformer modernization [13].

4. Redistribution of Regulatory Functions

The institutional roles of energy governance bodies have been clarified and strengthened.

- The **Energy Market Regulatory Authority (EPDK)** expanded regulation to cover new asset classes (storage, hybrids), updated the rules for renewable connection and licensing, and approved procedures for corporate power purchase agreements and the inclusion of guarantees of origin in compliance mechanisms.

- The **transmission system operator (TEİAŞ)** now synchronizes investment programs with grid bottlenecks and connection queues, improving transparency on curtailment and balancing data.
- The **Ministry of Environment, Urbanization and Climate Change (MoEUCC)** consolidated climate governance functions – monitoring, reporting, and verification of emissions, preparation of the national carbon trading system, and alignment with European regulation.
- The **Ministry of Energy and Natural Resources (MENR)** institutionalized the auction-based model for Renewable Energy Zones (YEKA) and linked it with industrial policy – localization and export incentives – acting as an aggregator of demand for capacity and renewable components.
- The **Nuclear Regulatory Authority (NDK)** was established as an independent body responsible for nuclear licensing and safety oversight, enhancing confidence in regulatory procedures.
- The state-owned company **BOTAŞ** and associated natural gas trading platforms gained more formal mechanisms for trading and hedging, including reliance on LNG and underground storage, which improve contractual flexibility and seasonal balancing.

5. Energy Sources

Coal. Policy in the coal generation sector has shifted toward regulated carbon-intensity reduction while maintaining system reliability. Environmental standards and requirements for dust and gas cleaning modernization have been strengthened. For some units, phase-out or conservation trajectories are being developed and linked to the commissioning of alternative capacity and grid readiness. In regions with high employment in coal mining and thermal generation, elements of a "just transition" are applied – retraining programs, local industrial substitution projects, and targeted fiscal support for municipal budgets. Selective modernization of the most efficient units is allowed if it reduces specific emissions and improves system flexibility during the expansion of renewables.

Gas. Reforms in the gas segment are centered on the diversification of sources and contractual indices, as well as on expanding seasonal flexibility. LNG receiving terminals and underground storage facilities are being developed, while import contracts are being updated to include a greater share of flexible conditions (spot indices, seasonal profiles, re-routing options). A functional wholesale trading platform is being established to enhance price transparency and enable hedging. In the power sector, gas generation is consolidated as a balancing resource: participation rules for capacity and ancillary service markets are being refined to compensate for the increased variability of wind and solar. The state company BOTAŞ and related platforms have received more formal trading and hedging mechanisms. Combined with the expansion of LNG capacity and underground storage, this has improved seasonal resilience and reduced exposure to price shocks. For the electricity system, this ensures more reliable balancing options as renewables continue to grow.

Nuclear Power. Law No. 5710 (2007) launched the Akkuyu (4 800 MW) and Sinop (22 billion USD) projects. Once operational, both plants are expected to supply around 10% of the country's electricity. Small modular reactors (SMRs) are also being considered as part of the future energy mix. By 2035, Türkiye plans to commission 7 GW of nuclear capacity, and if SMRs are added, total nuclear capacity could reach 20 GW by 2050 [22].

Projects are implemented through long-term concession and service models that clearly delineate responsibilities among the project company, the regulator, and the system operator. The regulator ensures independent licensing, safety oversight, and integration of reactor operations into market rules, including dispatching, imbalance responsibility, and participation in ancillary services according to defined profiles. The commissioning of new units is planned to be synchronized with

grid reinforcements and the coal phase-out schedule to mitigate price spikes and maintain frequency stability. The expected outcome is an increase in zero-carbon baseload generation, a reduction in the overall carbon intensity of electricity, and greater price predictability. However, experts point to high tariffs (up to 15,3 cents/kWh) and weak mechanisms for waste management.

6. Emissions Trading System (ETS)

The national emissions trading system is being introduced in stages: a pilot phase is scheduled for 2026, followed by full implementation in 2027. The integration of monitoring, reporting, and verification with the market circulation of allowances creates an internal carbon price signal aligned with external requirements. This mechanism redirects investment toward energy efficiency, low-carbon generation, and process modernization in industry.

7. Demand-Side Measures

Since 2016, **industrial policy** has evolved to link energy instruments with localization and exports. Local-content requirements in auctions, financial incentives, and export measures help create predictable domestic demand for equipment and services, reducing capital and financing costs through scale and stability, while simultaneously building export-ready clusters for components and engineering. The potential for reducing energy consumption is estimated at 15 – 20% through the deployment of modern technologies [14]. National industrial policy establishes a strong link between energy efficiency, carbon pricing, and export competitiveness.

In practice, this approach is reflected in several key measures:

- obligations and incentives to improve energy efficiency (energy audits, action plans, prioritization of short-payback measures, and access to concessional financing for equipment modernization);
- support for the electrification of process heat where technically and economically justified (replacement of steam/gas systems with electric-thermal processes, integration with demand management and tariff incentives);
- pilot projects on hydrogen and carbon capture/ compression/ and storage in selected high-temperature or concentrated emission applications, focused on demonstration and cost assessment;
- alignment with the national ETS and the EU's carbon border adjustment mechanism (CBAM): readiness for monitoring – reporting – verification, use of guarantees of origin to "green" purchased electricity, and long-term green power contracts for export-oriented industries.

Regulation and support programs in the **sector of buildings** are aimed at reducing heat and gas demand in residential and commercial use [23]:

- updating and enforcing building energy efficiency standards (for new construction and major renovation), prioritizing building envelopes, ventilation, and automation;
- scaling up thermal modernization of the existing stock (standard retrofit "packages," quality control, and integration with measurable energy savings);
- targeted support for heat pump deployment (direct subsidies or concessional loans, grid connection conditions, and tariff regulation for load management);
- social protection mechanisms for vulnerable households (targeted assistance or tariff instruments) to ensure that the shift to more efficient solutions does not reduce energy accessibility.

Buildings account for around 30% of total energy use in Türkiye and a significant share of CO2 emissions; therefore, reducing the energy intensity of the economy is directly linked to modernizing this sector. With a total saving potential of 15 – 20% through advanced technologies, the key policy goal is the transition to nearly zero-energy buildings (nZEB). In 2019, the nZEB target was incorporated into national legislation in line with EU directives (EPBD). The updated Building Energy Efficiency Code (2008) and the mandatory Energy Performance Certificate (EPC) system form the regulatory foundation: starting in 2025, nZEB will be required for all new public buildings, and from 2030 – for all new buildings.

By the end of 2023, over 1 million EPCs had been registered, but most buildings remain in energy efficiency classes C – D. Actual nZEB construction is limited mainly to pilot projects (universities and residential districts). The technical potential, however, is substantial: transitioning to nZEB could reduce building energy consumption by 50 – 70%, with additional capital costs typically paid back within 8 – 10 years. Support comes through state funds and international programs (EBRD, World Bank), though their scale remains insufficient for a market-wide shift.

Key barriers include the high cost of energy-efficient and renewable technologies at the construction stage, high interest rates, a shortage of qualified architects, engineers, and builders, low public and developer awareness, and limited local production capacity (solar panels, insulation, smart systems). These factors create a gap between policy targets and implementation. Closing this gap will require targeted investment incentives (tax benefits and subsidies for nZEB), systematic training programs, and scaling up pilot projects into standard construction practice. With continued regulatory alignment with the EU and expanded financing, the building sector could become a major source of rapid and measurable reductions in energy use and import dependence.

Transport policy focuses on building infrastructure and regulatory conditions to reduce oil dependence and local emissions:

- expanding charging infrastructure for electric vehicles (requirements for connection points, access and billing rules, support in cities and along highways), with integration into demand management systems;
- improving the fuel efficiency of the vehicle fleet and upgrading public transport (standards and incentives, prioritizing urban and corporate segments);
- framework support for alternative fuels in niche sectors (aviation, maritime transport) through standards, demonstration projects, and coordination with international requirements, without forcing fuel switches where mature technologies are not yet available.

8. Coordination and Data

For standard project types, documentation packages have been standardized, permitting cycles shortened, and connection queues made more transparent. Interagency roadmaps between the Ministry of Energy, the Ministry of Environment, the market regulator, and the grid operator are used to verify policy coherence. Before launching auctions, grid readiness and balancing rules are assessed; before starting carbon trading, emission benchmarks are cross-checked against industrial trajectories and export exposure. Regular publications on grid loading, curtailments, and ancillary service prices have been expanded, reducing investor uncertainty and the cost of capital.

Türkiye’s ongoing energy policy, together with adjacent regulatory areas, can be summarized through an integrated coordination matrix.

At the same time, there remains a strong dependence on foreign capital (EDF, ENGIE, E.ON, RWE, CEZ, PSP, and others): total international energy loans between 2007 and 2022 amounted to approximately 26,2 billion USD. Since the 2000s, the number of patents has grown, but research and development remain largely controlled by foreign companies. Türkiye's energy firms have lower liquidity and financial resilience compared to their European peers and rely mainly on short-term credit. The energy sector in Türkiye creates few direct jobs; employment is low-paid, and labor productivity remains below developed-country levels, limiting the sector's overall competitiveness.

As a result, auctions and distributed projects are designed to create a steady pipeline of applications, while grids and storage are assumed to convert installed capacity into available electricity with lower curtailment losses. At the same time, gas infrastructure and trading mechanisms are to shift the role of gas from "structural dependence" to "managed flexibility," reducing price risks and supporting renewable integration. Finally, the climate framework is no longer an external constraint but is to become an internal pricing rule that translates corporate and export requirements into domestic investment decisions.

This institutional restructuring is meant to synchronize sectoral measures on the supply side: the phase-out or modernization of coal assets should align with grid reinforcement schedules and the commissioning of zero-carbon capacity; nuclear units should be integrated into dispatching with clear imbalance obligations; wind and solar capacity should be planned together with storage and demand response participation; and gas-fired generation should, under defined roles, contribute to system services.

Table 1. **Türkiye's Current Energy Policy Overview**

Policy area	Metric	Possible stages	instruments	Potential stakeholders
Climate / CO2	Trajectory toward "net-zero 2053"; reduction of CO2 (Mt) in power and industry Траектория к «net-zero 2053»; снижение CO_2 (Mt) в электроэнергетике и индустрии	Stable downward trend in CO2 in the power sector (renewable deployment, coal phase-out) Significant CO2 reduction from the baseline; launch of ETS with actual coverage of major emitters Tightening of ETS / reduction of free allowances; sectoral benchmarks	ETS (law + by-laws), MRV, carbon benchmarks	MoEUCC, MENR, EPDK
Power generation	Share of renewables in generation; reduction of coal share; role of nuclear baseload	Commissioning of new renewable capacity outpaces demand growth; plan for retirement or modernization of some coal units Steady growth of renewables share; first nuclear plant affects baseload Consolidation of "renewables + nuclear" as the foundation; coal share declines significantly	YEKA auctions, hybrids (renewables + storage), dispatch rules	MENR, TEİAŞ, EPDK
Grids and flexibility	Transmission capacity; renewable grid connection; storage power/energy;	Reduction of grid connection queues; pilot BESS/DR projects on the market Scaling up BESS/DR; reduced curtailment Interconnections and storage cover renewable peaks	TEİAŞ investment programs, storage and balancing regulations	TEİAŞ, EPDK, EPİAŞ

Policy area	Metric	Possible stages	instruments	Potential stakeholders
	demand response (DR)			
Gas – security and transition role	Import diversification; LNG volume/flexibility; underground gas storage (UGS); role of gas in balancing	Available flexibility (LNG/UGS) covers winter peaks Contract structure includes seasonal and price flexibility Gas serves as "reserve/transition flexibility" without increasing dependence	LNG infrastructure, UGS, market rules, hub model	BOTAŞ, EPDK
Coal/ legacy assets	Decommissioning /retrofit of capacities; social measures in regions	Social adaptation packages and employment programs Managed retirement of some capacities without reliability risks Significant reduction of coal generation	Environmental standards, Just Transition programs, market signals	MENR, MoEUCC, regions
Nuclear	Commissioning of units; share in baseload; workforce	Personnel and service base preparation; pre-integration testing Sequential commissioning of units according to schedule Stable baseload capacity; market integration	Long-term EPC/O&M contracts, regulatory permits	MENR, NDK
Renewables – scale and localization	Commissioning of capacities (solar/ wind/ geo/ hydro); share of distributed generation; local content	Regular YEKA rounds; growth of rooftop and agro-PV Stable commissioning pace; component localization Export capability of value chains; service cluster	YEKA design, localization, green finance	MENR, EPDK, MoIT

Policy area	Metric	Possible stages	instruments	Potential stakeholders
Storage	Installed BESS capacity/energy; participation in system services	Regulatory framework and first hundreds of MW GW-scale deployment and participation in balancing/FRR Integration into the flexibility market	"Generation + storage" rules, payment for system services	EPDK, TEİAŞ, EPİAŞ
Industry	Energy intensity; share of electric processes; H2/CCUS pilots (niche)	Energy efficiency obligations, audits; initial electrification projects Scaling up to key industries; alignment with ETS Reduced energy and carbon intensity of exports	ETS, energy efficiency standards, concessional financing	MoIT, MENR, MoTF
Buildings / Heat	Thermal modernization; heat pumps; targeting	Launch of programs for vulnerable groups, pilot heat pump projects Mass rollout: heat pumps, thermal insulation; standards for new buildings Significant reduction of gas dependence in heating	Building standards, subsidies, targeted tariffs	MoEUCC, municipalities
Transport	Share of electric vehicles in fleet; charging infrastructure; fuel efficiency	Basic charging network; efficiency measures Mass electrification of urban and corporate fleets Significant reduction of transport oil dependence	Standards, incentives, municipal procurement	MoTI, MoTF, municipalities
Finance / Cost of capital	WACC by technology; share of "green" instruments	Pilot issuances of green bonds/guarantees Lower WACC for renewables and storage Stable capital cost and project closure timelines	Sovereign/ banking guarantees, blended finance	MoTF, multilateral finance institutions

Policy area	Metric	Possible stages	instruments	Potential stakeholders
Export/ CBAM/ guarantee of origin (GoO)	Share of exports compatible with CBAM/ EU ETS; GoO turnover	Adjustment of GoO system and pilot contracts Systematic use of GoO; reduced CBAM exposure Stable “green” export portfolio	ETS linkage, GoO registry, energy contracts	MoEUCC, MENR, MoT

Explanation of the abbreviations used in the table:

- BOTAŞ – Boru Hatları ile Petrol Taşıma A.Ş., state pipeline and natural gas company
- EPDK – Enerji Piyasası Düzenleme Kurumu, energy market regulatory authority
- EPİAŞ – Enerji Piyasaları İşletme A.Ş., energy exchange operator
- ETS – Emissions Trading System
- MENR – Ministry of Energy and Natural Resources (ETKB)
- MoEUCC – Ministry of Environment, Urbanization and Climate Change (ÇŞİDB)
- MoIT – Ministry of Industry and Technology
- MoT – Ministry of Trade
- MoTF – Ministry of Treasury and Finance
- MoTI – Ministry of Transport and Infrastructure
- NDK – Nükleer Düzenleme Kurumu, Nuclear regulatory authority
- TEİAŞ – Türkiye Elektrik İletim A.Ş., national transmission system operator
- YEKA – Yenilenebilir Enerji Kaynak Alanları, utility-scale renewable zones & auctions scheme
- MRV – Monitoring, Reporting and Verification
- BESS – battery energy storage system
- DR – demand response / demand-side management

- FRR – Frequency Restoration Reserve
- HVDC –High-Voltage Direct Current
- EPC – Engineering, Procurement, Construction
- O&M – Operations and Maintenance

5. Energy Connectivity and Corridors

Türkiye is systematically strengthening its "corridor" resilience – from Caspian gas and Russian flows to LNG logistics, underground storage, and electricity interconnections with the EU – so that geography becomes a managed option in terms of price, route, and delivery timing.

Gas Corridors

The Southern Gas Corridor (SCP – TANAP – TAP) remains the key "non-Russian" axis. The expanded South Caucasus Pipeline (SCPX) has been operational since 2018. TANAP, with a shareholder structure including SGC, BOTAŞ, BP, and SOCAR Türkiye, carries gas across Anatolia. TAP operates with a throughput of 10 bcm per year and is technically prepared for phased expansion up to 20 bcm per year (the first increase – about 1,2 bcm per year – from 2026). These parameters create a predictable baseline and a potential for expanding transit through Türkiye to Southeast Europe.

In parallel, TurkStream operates two offshore lines with a total capacity of 31,5 bcm per year, landing in Kıyıköy and continuing toward Bulgaria and the Balkans, providing an additional supply vector and redistributing transit flows in Southeast Europe.

To reduce route and price risks, Türkiye is expanding its LNG infrastructure: the state-owned FSRU Ertuğrul Gazi in Dörtyol (≈170 000 m³ storage; regasification up to 28 million m³/day), along with public and private terminals in Aliağa (Egegaz) and Marmara Ereğlisi. This enables spot gas purchases and coverage of seasonal demand peaks.

Seasonal flexibility is further supported by underground gas storage. The Silivri facility has reached ≈4,6 bcm capacity with significantly increased daily withdrawal rates, while the Tuz Gölü expansion project targets around 5,4 bcm with new caverns to be commissioned gradually starting in 2025. These measures strengthen resilience against winter peaks and disruptions in maritime routes.

Electric Connectivity with the EU and Neighbors

Türkiye's power system is synchronized with ENTSO-E through interconnections with Bulgaria and Greece. The existing net transfer capacity (NTC) limits on these lines serve as a benchmark for power exchange and frequency stability. Planned interconnector expansions are expected to further increase commercial electricity flows.

Caspian–Mediterranean Oil Corridor

The Baku – Tbilisi – Ceyhan (BTC) oil pipeline, with its terminal in Ceyhan, provides a major export route for Caspian crude to global markets and complements gas transport corridors, strengthening the role of Türkiye's ports and logistics.

"Green" Corridors: Electricity and Molecules

In the western direction, the Green Energy Corridor linking Central Asia – Azerbaijan – Georgia – Romania – Hungary (via a submarine cable across the Black Sea) is being advanced, creating an alternative channel for exporting renewable electricity to the EU in parallel with gas routes. Its implementation diversifies regional power flows and enhances the role of the Black Sea basin in the energy transition. Domestically, Türkiye has launched a registry of guarantees of origin operated by EPİAŞ, linking the national electricity market with exporters' demand for "green" attributes.

These transit opportunities support Türkiye's broader energy policy objectives:

- **Price stability**. LNG terminals and FSRUs enable rapid switching to spot deliveries and peak coverage, smoothing volatility and reducing dependence on fixed pipeline volumes. Underground gas storage facilities (Silivri, Tuz Gölü) provide temporal flexibility – gas injection in summer and withdrawal in winter.

- **Reliability and operational flexibility**. The combination of SGC, TurkStream, LNG, and interconnectors forms a multi-route architecture where disruptions in one direction can be compensated by alternatives; synchronization with ENTSO-E improves frequency stability and enables targeted import/export balancing during renewable surpluses or deficits.
- **Compliance with ETS/CBAM and export competitiveness**. The guarantees of origin registry facilitates verification of low-carbon electricity for corporate contracts, while the EU's CBAM mechanism redirects industrial supply chains toward lower-carbon energy inputs – a shift that Türkiye's corridors and market instruments are well positioned to support.

6. Core Scenarios for The Energy Transition

The possible future can be divided into three potential scenarios for Türkiye's energy transition [12, 14, 24].

Scenario 1. Baseline

Reliance on the inertial implementation of already announced plans and measures. Renewable deployment proceeds in line with the National Energy Plan to 2035; YEKA auctions continue with the current frequency and design; exchange segments and the guarantees of origin market operate under existing rules; storage and hybrid plants are commissioned within current regulations without acceleration. The ETS goes through a pilot phase, with the move to full implementation following the announced calendar; companies adapt to reporting, but the carbon price signal remains moderate. The EU's CBAM becomes an external price tag on carbon-intensive exports, reinforcing demand for green electricity across sectors. In the power market, YEK-G certificates and corporate PPAs gain importance without a radical market reconfiguration.

Expected profile by 2030/2035: gradual growth of the renewables share in generation in line with the plan; slow but steady coal decline; storage scale remains project-based and niche; ETS coverage reaches the pilot and first stage; grid capex stays on planned tracks; industrial energy intensity decreases through standard efficiency measures; export sensitivity to CBAM remains moderate but persistent.

Scenario 2. Accelerated

Priority is given to grids and flexibility, combined with a full-scale carbon price signal. The state accelerates grid CAPEX (linked to connection queues and congestion points), expands storage access to ancillary service and intraday balancing markets, and strengthens participation of demand response. This reduces curtailment and converts installed renewable capacity into actual generation. At the same time, the ETS moves more rapidly from the pilot to full implementation, with a tangible carbon price and benchmarking for energy-intensive sectors. YEK-G and corporate PPAs are actively used as decarbonization tools for value chains, while the external CBAM framework reinforces the incentive to lower specific emissions.

Expected profile by 2030/2035: higher share of renewables in actual generation (enabled by grid and flexibility improvements); accelerated coal phase-out; significantly larger deployment of storage and demand response; broader ETS coverage and higher carbon prices; grid CAPEX exceeding baseline levels; faster reduction of industrial energy intensity; export sensitivity to CBAM decreases due to a cleaner energy mix and wider use of GoO contracts.

Scenario 3. Corridor-plus-industry

The focus is on "corridors + industry": component localization, export of green attributes, and interconnectors, with a moderate ETS trajectory. YEKA and distributed energy deployment continue to scale up with localization requirements; cross-border power flows and exchange mechanisms for green electricity (YEK-G) expand, supported by corporate demand; the use of exchange instruments and PPAs accelerates for export-oriented industries affected by CBAM. Gas infrastructure and storage are used as a "spring" for price and seasonal stability, maintaining system balance as renewables grow. The ETS develops according to plan but with a milder price gradient, while the external CBAM discipline keeps the economy on a decarbonization path through cleaner electricity procurement and localization.

Expected profile by 2030/2035: renewables share in generation higher than in the baseline scenario due to interconnectors and green contracts; coal declines gradually; storage deployment is selective, concentrated around industrial clusters and grid bottlenecks; ETS coverage remains on schedule with moderate prices; grid CAPEX exceeds baseline along export flow corridors; industrial energy intensity decreases through efficiency and "greening" of electricity; export sensitivity to CBAM diminishes thanks to GoO and contract-based decarbonization.

Risks and trade-offs

The energy transition in Türkiye is progressing amid high external volatility and internal bottlenecks. The main cross-cutting risks and possible compromises across all scenarios are as follows.

Regulatory predictability and rollout pace. Risk: a gap between adopting norms (ETS, storage/DR, GoO) and by-law detail/ IT implementation reduces investment readiness. Trade-off: speed vs quality - accelerating launch can lead to rule revisions and the risk of retrospective changes.

Grid bottlenecks and actual renewables output. Risk: adding capacity without synchronous grid/ system-services CAPEX raises curtailment and breaks project economics. Trade-off: connect faster vs connect reliably – accelerating connections without flexibility increases system costs.

Carbon price and industrial competitiveness. Risk: a too-soft ETS does not change behavior; a too-strict one accelerates carbon-intensive production leakage. Trade-off: environmental ambition vs industrial profitability, mitigated by targeted support for electrification and energy efficiency.

CBAM and export compatibility. Risk: delayed greening of electricity and limited access to GoO/PPA for large exporters raise fiscal burdens at EU entry. Trade-off: broad coverage vs targeted priority - choosing between mass access to green attributes and prioritizing export-intensive sectors.

Gas: **price and balancing role**. Risk: LNG/spot volatility and transit disruptions can raise the cost of flexibility at peak times. Trade-off: depth of UGS/FSRU vs budget CAPEX limits, and contractual flexibility vs baseline price under LTAs.

Coal: capacity phase-down and just transition. Risk: a rapid phase-down without compensating baseload/grids creates reliability risks and social costs in mono-industry regions. Trade-off: decarbonization speed vs social stability, mitigated by proactive employment programs and targeted modernization of the "cleanest" units for a transition period.

Nuclear power: schedule and integration. Risk: EPC/licensing delays, cost of capital, and market integration issues (dispatch regime, imbalances). Trade-off: zero-carbon baseload vs debt and tariff risk - need for long-term anchor demand and pricing rules.

Storage and demand response. Risk: lagging rules for BESS/DR participation in system services undermine bankability; overcorrections distort revenues. Trade-off: rapid scale-up vs market neutrality - tuning tariffs, service auctions, and measurability-verifiability standards.

Industrial localization and project cost. Risk: strict local-content requirements in a narrow component market increase CAPEX and timelines. Trade-off: localization vs LCOE/WACC - balance via a predictable auction pipeline, export incentives, and flexible localization pathways.

Financial conditions and FX risks. Risk: higher rates and FX volatility lift WACC, especially for capex-heavy assets (grids, nuclear, renewables + storage). Trade-off: deployment speed vs debt sustainability - need for guarantee/blended mechanisms and FX hedging.

Corridor geopolitics. Risk: incidents in the Black Sea/Mediterranean, Red Sea/Suez, and regional conflicts change risk premia and route availability. Trade-off: excess connectivity vs reserve cost - holding spare routes/UGS/FSRU is pricier, but it insures against shocks.

Data and execution. Risk: incomplete or delayed publication of grid and market data raises the uncertainty premium. Trade-off: reform speed vs MRV/IT quality - without mature accounting and verification, it is hard to capitalize on ETS, DR, and GoO effects.

System-wide tension. The core trade-off lies between the speed of decarbonization and price/reliability stability. It is manageable if four levers are synchronized: grids and system services; the carbon signal (ETS) and CBAM compatibility; contractual gas flexibility (UGS/FSRU) as a spring for renewables integration; and industrial policy that lowers CAPEX/WACC without over-inflating project costs.

7. Conclusions

The main lever is reducing the transport sector's oil dependence. Oil products account for 38% of final consumption, and 73% of their demand is concentrated in transport. Fast and large reductions can be achieved through three measures: electrifying the vehicle fleet, fuel efficiency standards, and deploying alternative fuels. This directly lowers both import vulnerability and oil-related emissions.

The largest CO2 effect comes from a managed coal phase-down in power generation. With coal at about 35% of generation and about 42% of national emissions, the priority is replacing or retiring old units and selective retrofit/ccs where economically justified. To make replacement work without losing reliability, a "grid cushion" is required: storage, dispatchable flexibility, targeted investments in bottlenecks and interconnectors. This converts wind and solar growth (hydro about 21% as an anchor) into actual output, reducing peak starts of coal and gas.

Gas is no longer a long-term pillar but a flexibility tool. High import dependence requires diversification of sources and price indices, development of LNG and strategic reserves. In parallel, gas demand should fall where rational: efficiency improvements and partial electrification of industrial processes, thermal modernization and heat pump deployment in the residential sector. This lowers gas-related emissions and frees gas-fired generation to balance RENEWABLES.

Industry and hydrocarbon refining need synchronization with decarbonization. Large domestic refining volumes (1 700 118 TJ) with a high "domestic" share (92%) require an advance plan to adapt refineries and chemicals to declining oil demand: shifting toward higher value-added products and retooling for low-carbon value chains. In industry (as in transport – each at 28% of TFC), the key mix is energy efficiency, electric heat, and long-term green power contracts.

For renewables, the emphasis must shift into final heat and process use. With 13,8% modern renewables in TFC (2022), further progress depends not only on new capacity, but also on green heat: building retrofits, heat pumps, biogas, and maintaining hydro while scaling variable renewables and flexibility.

Electricity requires targeted integration and regional balancing. Small import volumes (6 094 GWh) open a window for mutual balancing as renewables grow without critical external vulnerability, provided institutional agreements and stronger interconnections are in place. The priority is converting

installed capacity into available energy (storage/DR/market design), while on the demand side electrifying high-electric-intensity segments (industry, services) alongside savings.

Import risks can be contained through route and contract diversification, system flexibility, strategic reserves, and development of refining/storage. Structural demand changes are also needed in transport, buildings, and industry.

Support from clear measurability is necessary to manage the transition. Emissions progress against the baseline should be tracked with sectoral KPIs: reductions from coal in power, from transport, and from industry. In parallel, GDP energy intensity and sectoral intensities should decline. Where data are incomplete, priority should be strengthening monitoring; otherwise, policy design risks inaccuracy.

Fast and visible reductions come from transport and coal power; medium-term resilience from grids, storage, and flexibility; strategic independence from gas diversification, refinery/chemicals adaptation, and shifting renewables into final consumption. This combination can reduce import vulnerability, stabilize prices, and deliver verifiable emission cuts at the same time.

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