International Area Studies Review
2026, Vol. 29(2) 113–134

https://doi.org/10.69473/iasr.2026.29.2.113

Article

Why Fossil Fuels Endure: Structural Constraints on Türkiye's Green Energy Transition

Göktuğ Kıprızlı*
Assistant Professor, Department of International Relations, Karadeniz Technical University, Trabzon, Türkiye and Visiting Researcher, Institute of European Studies and International Relations, Comenius University in Bratislava, Bratislava, Slovakia

Abstract

This article examines the institutional obstacles to the green shift in Türkiye. Based on the theoretical approach that combines state capitalism, path dependency, national innovation systems, and policy-feedback mechanisms, it explains how the tax revenues, education-labour market misalignments, and pre-leading status of the defence sector strengthen a crowding-out process that undermines green innovation and human-capital investments. The article not only provides the concept of fiscal lock-in as an insufficiently discussed and a vital aspect of fossil path dependency, but it also highlights indirect carbon rents in non-rentier states as a key process of policy inertia. It synthesises political economy and innovation system views, which adds to the literature on fossil lock-ins and energy transition governance. It also calls for a broader understanding of policy priorities beyond techno-fixes and insists on the need to capture structural aspects of a rapid energy transition, like fiscal policy, human capital trends, and innovation systems, to understand the inertia affecting a rapid transition of the energy mix.

Keywords

Energy transition, State capitalism, Fossil lock-in, Policy feedback, Innovation systems

Introduction

Although there is a vast amount of renewable materials, Türkiye is very much dependent on fossil fuels. This issue between the green potential and the carbon reality requires research into the structural forces blocking transition. In order to determine the wind power potential in Türkiye, the government created the Wind Energy Potential Atlas that estimates the onshore wind energy potential at about 57,786 MW and the offshore potential at 20,788 MW (Minister of Energy and Natural Resources [MENR], 2024a). The Solar Energy Potential Atlas was also launched to assess the solar potential in the country. The solar energy potential in Türkiye is estimated to

Corresponding author:
* Email: goktugkiprizli@ktu.edu.tr

at least "380 billion kWh", with the gross technical solar potential at "87.5 million tons of oil equivalent" with an average annual solar irradiation of 2,741 hours (MENR, n.d.). Moreover, Türkiye leads in Europe and fourth in the world in terms of potential to generate geothermal energy (MENR, 2024b).

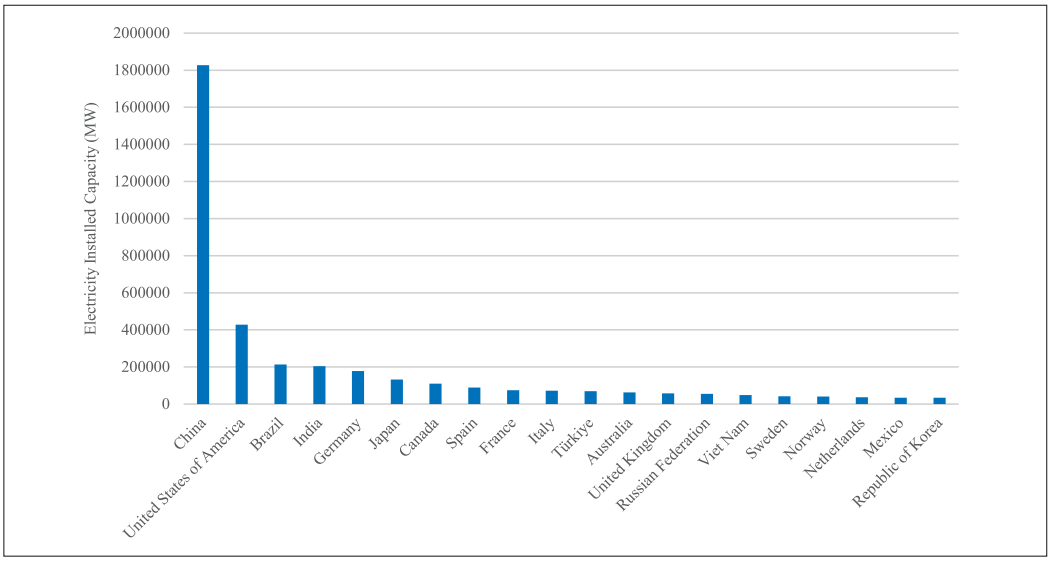

Figure 1. Top 20 countries in total renewable capacity, 2024
Source: International Renewable Energy Agency (IRENA), 2025.

Regardless of the massive renewable energy potential and official intentions to become green, Türkiye has problems with converting its potential into practice, as it is shown in Figure 1. In 2022, oil, natural gas, and coal comprised 81.6 per cent of the total energy supply of the country, as demonstrated in Figure 2 (International Energy Agency [IEA], 2024). This paradox brings out the fact that Türkiye is still trapped in the fossil fuel paradigm. As a result, the main question of this article is why Türkiye continues to rely on fossil fuels and is not able to translate its potential for producing renewable energy into an energy transition. Current explanations are either regulatory inefficiency (Brand, 2012) or financing deficits (Volz et al., 2015) and do not reflect the underlying structural constraints that limit the transition of the country. This article provides a structural and political-economy-based explanation that prefigures the way fiscal biases, inadequacies in the growth of the human-capital, and failures in national innovation systems (NIS) come together to bar a real post-carbon pathway.

This article holds the argument that three mutually reinforcing structural mechanisms perpetuate an existing state of fossil-fuelled dependence and a sluggish pace of a quick green energy transition in Türkiye. To begin with, the fiscal reliance of the Turkish state on carbon-based revenues to a large extent, especially the consumption tax system, including the Special Consumption Tax (SCT), generates strong budgetary incentives against relinquishing fossil fuels. Second, insufficient investment in green human capital and the fragmented and supply-based system of innovations hinder the structural autonomy of renewable-energy technologies and skills in Türkiye. This situation recreates structural reliance on the imported technologies. Third, the securitised orientation of the industrial policy, especially by the emphasis on defence and fossil-

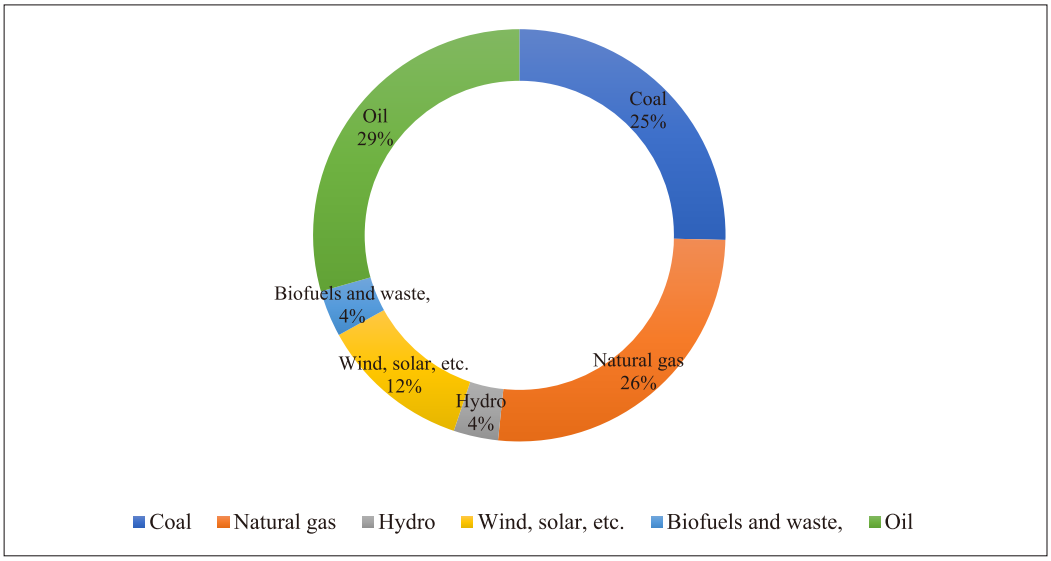

Figure 2. Total energy supply in Türkiye, 2023
Source: IEA, 2024.

based mega-projects, redistributes state resources and institutional capacity out of the focus of ecological transition-technology investments. In this respect, renewable underdevelopment in Türkiye is not an issue of resource supply or policy intention, but rather a structurally determined constraint due to the interaction of fiscal incentives, labour-market capacity, and national research and innovation ecosystem. Such constraints are not second wave friction but are the primary conditions that form the pace and depth of the energy transition.

There are three main contributions that this article brings in literature of green transitions, state capitalism, and political economy of energy transformation. First, it offers a structural political-economic account of Türkiye remaining stuck in a stage of fossil-based reliance. Here, the article shifts the focus away from policy design, technological adoption, or international climate obligations. It throws into the limelight the endogenous obstacles to decarbonisation by emphasising domestic fiscal frameworks, industrial priorities, and failures in innovation that are institutionally rooted in the state-capitalist development model in Türkiye.

Second, the article serves as a contribution to the theoretical dialogue between state capitalism and path dependency by empirically proving how carbon lock-in is replicated not just through material infrastructures but also through fiscality (excise-tax regimes), labour-market failures, and securitised resource-allocation policies. Although most of the fossil lock-in literature is based on the infrastructural/technological lock-in, this article points to the fact that another facet of the lock-in. The role of fiscal lock-in is largely ignored but this article points out that the state-revenue systems themselves are becoming structurally dependent on the use of fossil fuels. Based on this, it is considered the fundamental process for strengthening the pathways of carbon intensity.

Third, the article expands the green-transition perspective of the Global South by showing that fossil reliance may be strongly institutionalised even when direct fossil rents (e.g. oil exports) are not present. Accordingly, the article uncovers the indirect form of carbon rent, policy bias, and state-led investment programmes. This analysis thus broadens the notion of rentier processes

outside of the classical petro-states with an emphasis on indirect carbon rents, such as value-added and consumption taxes on fossil fuels, to demonstrate the possibility of non-rentier economies becoming carbon-based.

By doing so, the article not only fills the gap between international relations, political economy, and environmental studies but also provides a multidimensional explanation of why Türkiye, despite its potential to renew, is still structurally trapped in the carbon-intensive development. It is necessary to mention that the article is not intended to give detailed technical explanation of renewable-energy capacity, the infrastructure implementation, and the outcome of particular projects. Neither does it provide a prospective model or a blueprint for a successful green transition. Rather, it attempts to offer a political-economy explanation of fossil lock-in inertia, tracked institutional path dependencies, fiscal frameworks, and state-capitalist governance approaches.

The article is divided into five sections. After this introduction, the second section contextualises the article within the body of literature on green transitions, fossil-fuel persistence, and state capitalism, and defines the conceptual and empirical gaps the article aims to fill. The third section introduces the theoretical framework, which is a synthesis of state capitalism, path dependency, and fossil lock-in, to create an analytical lens. The fourth section is the domestic policy backdrop and demystifies the structural obstacles posing a challenge to the energy transition in Türkiye. It looks at dependency on carbon revenues, securitisation of industrial policy, institutional under-investment in green human capital, and infrastructural decisions leading to path dependency. The conclusion then wraps up the results, reflects on the consequences of the results on the energy future of Türkiye, and provides avenues in which more research on the subject of fossil persistence in middle-income, state-capitalist societies could be conducted.

Outlining the Terrain of Structural Constraints in Energy Transitions

The field of energy transitions has grown significantly over the last 20 years, providing a vast range of theoretical instruments and empirical evidence on the structural and political circumstances that steer decarbonisation trajectories. This article spans five overlapping strands, namely, the political economy of energy transitions, state capitalism and fossil lock-in, path dependency in energy governance, national innovation systems and green capacity-building, and policy-feedback mechanisms and fiscal entrenchment. By so doing, it develops a multi-dimensional base upon which the reasons why countries with renewable potentials, like Türkiye, continue to stick to fossil intensive paths, are evaluated. This group of theoretical approaches sheds light on different, but overlapping, forces of energy inertia and gives a conceptualisation.

Those who analyse change in the field of political economy have anticipated the internalisation of energy transitions in larger patterns of state-market relationships, industrial policy, and power relations. Research outcomes highlight transitions are not simply a technological change but can be results of geographically constituted (Bridge et al., 2013), politically disputed (Breetz et al., 2018) and justice-related (Newell & Mulvaney, 2013) processes. The roles of comprehending the interplay of institutionalised structures (Newell, 2021), political alliances (Grasso & Delatin Rodrigues, 2025), and economic imperatives (Christophers, 2022; Kim & Paik, 2025) as determinants of transition paths within a more structural framework, it tends to underline the large-scale global processes at the expense of the national institutional and structural differences, which this article seeks to anticipate in the case of Türkiye.

State capitalism is an effective paradigm that can be employed to analyse how the use of state-owned enterprises, financial instruments, and strategic policy tools are mobilised by governments

to regulate sensitive industries, covering the topic of energy (Lo & Mah, 2024). As opposed to the liberal model of market, state-capitalist systems are characterised by the intentional state control of investment and industrial orientation, which are often emphasised towards energy security, geopolitical positioning (Babić & Mertens, 2025), and infrastructural control over environmental sustainability (Helmrich et al., 2023). The literature is capable of explaining the high position of the state agencies and their related firms in the fossil-energy sector, specifically the natural-gas and coal infrastructure. However, the state-capitalism view is to be complemented to comprehend the full extent of such structural dispositions into fiscal dependency, sectoral crowding-out, and institutional inertia. Thus, this article highlights the importance of the fiscal lock-in of states becoming financially dependent on carbon-based revenues, which creates a self-reinforcing obstacle to the quick transition. This is the phenomenon that has not been studied in depth in the fossil lock-in literature.

Path-dependency theory provides a historical-institutionalist perspective on how past policy choices, infrastructural investments, and institutional norms produce self-reinforcing feedback loops that limit present and future policy implementations. The governance of energy entails early investments in fossil-based infrastructure (Unruh, 2000) and policy designs (Seto et al., 2016), which produce increasing returns that make other options more expensive and politically disputed. The path-dependency lens comes in handy, especially in the Turkish scenario, whereby the seemingly rational decisions trap Türkiye in an energy model that is not easily altered. However, the framework is more of a retrospective one. This stance needs more mechanisms to provide the active reproduction of this inertia by modern political incentives and fiscal structures, which supports the relevance of national innovation systems and mechanisms of policy-feedback.

The literature of NIS is concerned with the way in which nations are forming, spreading, and maintaining technological innovation via coordinated investments in research and development (R&D), education, industrial policy, and institutional support. The NIS approach focuses on systemic interdependencies of actors that affect the ability of a country to modernise its technology (Li et al., 2023). It has been used in the energy-transition scenario to understand why certain states are ahead of the rest in renewable innovation and why some are behind (Santana et al., 2015; Walz & Eichhammer, 2012). This framework in the context of Türkiye may shed light on how limited investment in green technology, fragmented R&D infrastructure, and the effect of strategic fiscal prioritisation, especially defence and fossil infrastructure, in the country can limit longer-term innovation capacity in this sector. Nevertheless, as much as this literature predicts capability deficits, it tends to ignore the influence of political priorities and budgetary decisions on the processes of defining and limiting innovation ecosystems.

The policy-feedback theory bases its reasoning on historical studies of institutionalism and the study of public policy by examining the influence of current policies on political behaviour in the future, routines in an administrative setting, and the formation of interest groups. Recent scholarship has investigated the ways in which fiscal instruments that have carbon intensive elements, including fuel taxes, fossil subsidies, and state revenues on hydrocarbons create lock-in impacts in energy transitions (Lockwood, 2022; Szabo, 2021). This framework increases explanatory power as it helps to shed light on clarifying the role of political and fiscal interests, not as passive generators, but as active factors in path dependencies. Notably, it emphasises the contribution of the indirect carbon rents i.e. income gained by domestic taxes and consumption of fossil fuel instead of fossil fuel exports. With this focus, the article illustrates how even that non-rentier in characteristic can develop into structurally dependent on carbon-based revenue. That is why, despite the technical and geographical feasibility of renewable energy, a consistent tendency to rely on fossil fuels persists in Türkiye's policies.

Theoretical Anchors of Fossil Lock-In and Transition Failure

This article builds on a multi-layered theoretical framework, integrating state capitalism, path dependency, the NIS approach, and policy-feedback mechanisms. This approach enables to discuss why a country remains dependent on fossil fuels and why a comprehensive and rapid transition to green is thwarted by structural factors. All these factors throw light on the political, institutional, and fiscal dynamics, supporting the carbon-intensive path that Türkiye is on. The focus of the analysis is state capitalism, which puts a strong focus on the way in which the state is preference promoting fossil-fuelled development through the strategic control it holds in the energy infrastructure, investment flows, and fiscal priorities. Moreover, the notion of path dependency shows how previous decisions have created institutional and infrastructural lock-ins that restrict the policy alternatives in the future. The political economy of policy feedback explains the reinforcement of the current energy model and the discouragement of reform by financial reliance on carbon revenues especially in the SCT and the encouragement of growth based on fossil fuel by the political incentives. Lastly, the NIS approach points out the historical underinvestment in human capital and R&D of renewable energy by Türkiye, aggravated by the crowd-out effect of strategic investment in securitised sectors of the economy like defence.

The idea of state capitalism emphasises the key role of the state in defining the pattern of the long-term development of a country and setting economic and sub-sectoral policy agendas (Alami et al., 2024). State capitalism is a referent to a co-dependent relationship of mutually reification between the state apparatus and liberal market economy. This view requires that the capital accumulation is taken into account because state-capitalist relations frequently provide a lot of revenue to the national savings. However, modern problems force states to reform their economic systems and modes of production. Moving beyond the firm-based readings of the state intervention in the capitalistic development, it is essential to look at the active state participation in the transition process in the energy sector. This need has led to the development of efforts to realise a green transition. As a result, since these interventions are mostly aimed at increasing economic power and profit maximisation through capitalistic processes, state interventions have gained a new dimension in the wake of the rising green issues.

The article extends this approach by adding the aspect of path dependence to recognise and explain country-specific features and historical moves based on the present-day economic and political environment (Musacchio & Lazzarini, 2012). The path dependency theory assumes that once certain institutional choices have been accepted, they become self-reinforcing through such mechanisms as increasing returns, coordination effects, and institutional lock-ins (Arthur, 1994; Pierson, 2000). In this case, the theory allows the contextualised examination of the role that institutionalised fossil based fiscal structures. It also facilitates exploring long-term strategic and policy orientations, influencing the energy policy in Türkiye. Path dependence in the context of green transition is that it entails the existence of reinforcing feedback loops that lock in a fossil-fuel system. It makes a fast policy change to renewable energy, harder even in cases where technical potential exists. In the context of the innovation policy, initial funding in specific sectors, technological paradigms, or an institutional arrangement may create feedback mechanisms that make movement economically expensive and politically limiting.

A combination of theoretical stances that embraces historical limitations and institutional dynamics is needed to understand the disparate variation of R&D investments and technological growth. It is possible to integrate the perspectives of path-dependency theory and the NIS to examine the impact of the past policy decisions, institutional arrangements, and developmental tactics on the present innovation capabilities. The NIS framework, which was developed by scholars like Lundvall (2007) and Nelson (1993), holds that innovation is the result of dynamic

interactions between an enormous number of actors, businesses, academic institutions, research institutes, governmental organisations, and financial institutions. In this network, a competent workforce co-evolves with investment in R&D and technology development. Nevertheless, failure in the interaction among key subsystems (including education, finance, or industrial policy) leads to the outcome that Weber and Rohracher (2012) call innovation-system failures. These deficiencies create problems for systemic coordination and ensure the continuation of deep-seated patterns of power relations, knowledge hierarchies, and technological pathways. By extension, there will be a mismatch with the demands of a low-carbon, innovation-based economy.

At the meso-level, the NIS approach illuminates the fact that Türkiye has a small potential to establish and implement the use of green energy technologies. It focuses the attention on the crowd-out effects of the strategic expenditures on the defence sector. This view shows that the dynamics of the innovation environment are mirrors of the larger political economy, where the strategies of state-led industrial policies are biased to favour incumbent industries. This, therefore, suffocates the growth of green technology.

Lastly, in the micro-analytical level, there is the policy-feedback mechanism that was based on the literature of the public policy and historical-institutionalism which provides information on how the fiscal tool and political incentives can support the current model of energy. Policies in this approach do not simply emerge as the product of political processes. They rather reconfigure the political terrain that spawns material resources, social expectations, and institutional routines that ultimately become the input to subsequent policymaking. Specifically, the reliance of Türkiye on the carbon revenues, including those brought about by the SCT, would impose institutional and political incentives against ambitious decarbonisation. The tax regime creates a vicious cycle: the higher the dependence of the state on fossil resources, the stronger the need to conserve or increase fossil usage and thus restrict the decarbonisation targets in the long term.

Although each of the theoretical frameworks illuminate a different aspect of the energy transition challenges in Türkiye, the persistence of fossil fuel dependency cannot be explained by any single mechanism in isolation. Rather, fiscal dependency, human capital deficits, and innovation misallocation are corresponding to a specific structural barrier. Fiscal reliance on the revenues of carbon consumption, and especially through the SCT, paves a way for a rentier-fiscal trap, which structurally disincentivises decarbonisation. The human capital theory explains the reason behind the current inabilities to scale renewable energy systems on the basis of deficits in green skills. The national innovation systems approach, in turn, reveals how the prioritisation of securitised sectors diverts attention away from renewables, limiting future innovation trajectories.

The three mechanisms do not add up but rather they are reinforcing each other. Fiscal dependency shapes state incentives. Lack of human capital limit capacity for implementation. Last but not least, innovation preferences constrain technological advancement in terms of specific sectors. Altogether, they reproduce carbon lock-in across fiscal, labour, and innovation domains simultaneously. This multi-layered interaction is further structured by path-dependent processes. On the one hand, fiscal and industrial choices constrain present policy options. The revenue dependence, skill shortages, and innovation bias, on the other hand, suggest self-reinforcing dynamics which imply a feedback loop. These processes are operating within a state capitalist system in which the state is a key agent in terms of coordinating resource allocation, setting industrial priorities, ensuring economic stability, and managing structural transformation.

The methodology of the research is the qualitative case study design with a particular focus on Türkiye. The article is supported by descriptive, longitudinal data analysis and takes the advantage of multi-year data to trace the structural evolution of energy production, fiscal revenues, human capital formation, and the allocation of innovation. In the empirical part, this

article relies on the statistics on sectoral R&D expenditures provided by Turkish Statistical Institute (Türkiye İstatistik Kurumu-TÜİK) and the Scientific and Technological Research Council of Türkiye (Türkiye Bilimsel ve Teknolojik Araştırma Kurumu-TÜBİTAK). The statistics on energy production and consumption are drawn from the IRENA and the IEA. The data on carbon related tax revenues are borrowed from the Republic of Türkiye Ministry of Treasury and Finance. Human capital indicators are collected from various institutions which include the Council of Higher Education, Türkiye, IRENA, Organisation for Economic Co-operation and Development (OECD), and World Bank. These data are descriptively analysed to identify patterns and underlying relationships across time.

Carbon Revenues and Fiscal Lock-In: Türkiye's SCT in the Political Economy of Path Dependency

A structurally major yet mostly neglected obstacle in the path to the green transition of Türkiye is the deep-seated fiscal reliance on fossil fuel-based sources of income, particularly the SCT on motor vehicles, petroleum products, and natural gas. Although the SCT offers the most apparent and measurable indicator of fiscal dependence, the article does not consider it as a discrete causal explanation. Rather, SCT is an empirical point of entry into a larger structural design of fiscal dependency which shapes state incentives and policy priorities. The fiscal dependence on the carbon-based revenues in this framework not only creates path- dependent bottlenecks to decarbonisation but also interacts with other structural domains.

Despite the fact that Türkiye has introduced facilitating mechanisms, such as the Renewable Energy Resources Support Mechanism (Yenilenebilir Enerji Kaynaklarını Destekleme Mekanizması-YEKDEM), Renewable Energy Resource Zone (Yenilenebilir Enerji Kaynak Alanı-YEKA) schemes, investment incentives, and feed-in tariffs to promote the consumption of solar, wind, and geothermal energy, these tools work within a larger fiscal framework that structurally favours the fossil fuel consumption. While these policies are geared towards achieving a higher share of renewable capacity, their effectiveness has been limited since they do not alter the state's underlying dependence on carbon-based revenues. As a result, renewable support mechanisms function as complementary rather than transformative instruments and will not be in a position to override the underlying fiscal logic that sustain fossil fuel dominance.

Originally presented in the aftermath of the 1999 Marmara Earthquake as a temporary funding source to finance post-disaster recovery, this tax mechanism has since been turned into a permanent and significant source of general budget revenue,[1] and way beyond its original scope and purpose. It, therefore, provides an example of how fiscal instruments become institutionalised and create powerful path dependency.

In order to maintain political legitimacy and macroeconomic stability, the state uses fiscal instruments in a proactive manner, which were initially developed in response to acute crises. This is the wider reasoning of state capitalism. With time, however, these tools become established in the fiscal apparatus, which create path-dependent lock-ins that limit the flexibility of policy and negate the objectives of sustainable development and swift energy decarbonisation. Within the Turkish situation, the SCT strengthens a carbon-intensive model of growth and transforms the temporary indicator of revenue into a structural foundation of the budget policy of the state. The most appropriate framework to analyse this evolution is the use of the policy-feedback mechanisms which record the long-term institutional and political impacts of previously transitory fiscal policies. The SCT institutionalises the fiscal expectations through a positive feedback mechanism, not only the behaviour of the states but also the preferences and

expectations of the people in reference to the finance. These policies ultimately become sticky and politically and administratively desirable to sustain.

The SCT on energy-related consumption is a revenue-increasing device, as well as a regressive fiscal measure that affects the middle- and lower-income households disproportionately. It also provides fewer incentives to change the behavioural or infrastructural patterns at a systemic level. Though the high fuel taxes theoretically would be beneficial to the environment, as they would reduce the consumption of fossil-fuels and fund alternative, sustainable infrastructure, clean-energy research and development, energy-saving programmes, and sustainable mobility networks, the revenues collected in Türkiye are channelled to the central budget to offset fiscal deficits, support social spending amid the inflationary pressures, and macro-fiscal stability in an unstable political-economic environment (Telatar & Birinci, 2022). In this regard, the policy-feedback loops work because of institutional inertia, and the regressive character of the SCT does not encourage the implementation of the green fiscal options. In turn, the SCT not only constitutes the material structure of the state revenue but also replicates the weak reform, which further strengthens a loop of inaction.

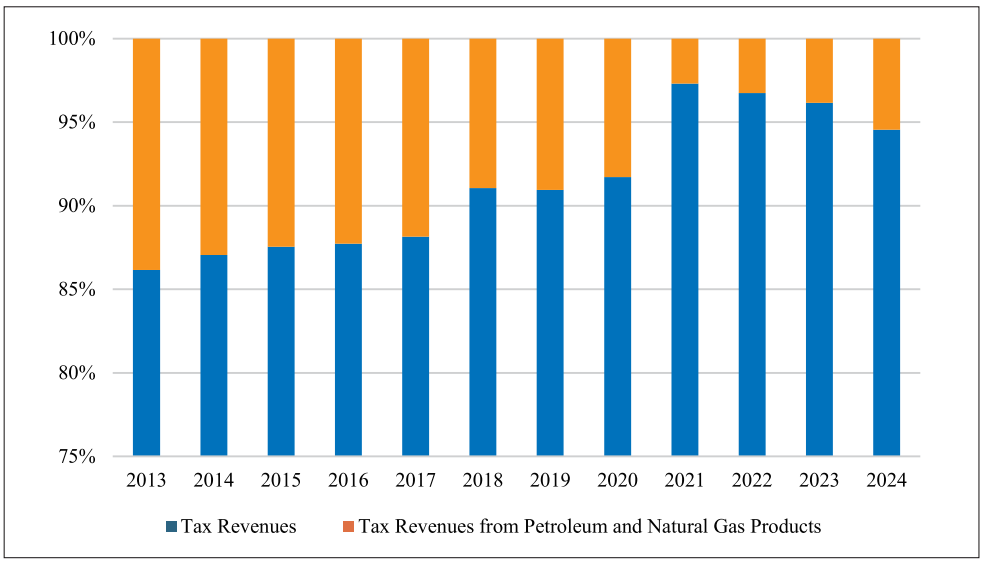

Figure 3. The share of tax revenues generated from petroleum and natural gas products in Türkiye between 2013 and 2024
Source: Ministry of Treasury and Finance (MTF), 2025.

Even though Figure 3 shows that the amount of tax money recorded in petroleum and natural-gas products declined over several years, the situation changed in 2022, and the portion began to grow slowly. The first fall may be explained by high inflationary situation in Türkiye which undermined the real value of the tax income. The Turkish government reacted by raising the fixed amount of the SCT on such goods by implementing the fiscal policy to offset the loss in the state budget caused by inflation and stabilise the situation (MTF, 2023). The 2022 turnaround discloses the fiscal reflex actions of the state during economic turmoil, which is politically unstable, which rejuvenates fossil revenues as a trusted, politically safe budgetary stabiliser.

This financial model puts a two-sided bind. On the one hand, it embeds fossil-fuel consumption

in the very fabric of the state revenue, which makes it both politically and economically expensive to actively cut the use of fossil fuels. On the other hand, it creates a disincentive to the government to transition to a more ambitious green transition strategy that will erode its tax base and destabilise its most reliable sources of revenue. This trend is typical of a state-capitalist trap where the state is so reliant on extractive fiscal tools in the short term that it cannot redirect itself to long-term structural change. The role of state capitalism in this instance is seen as a form of entrenchment as opposed to change. In this respect, this dependency also ensures the fiscal policy that is lodged within revenue streams relying on unsustainable consumption trends. The continued existence of such fiscal policies is an indication of resistance to structural change more generally, and short-term budgetary stability prevails rather than long-term ecological resilience. In short, this is a typical feature of a greater political-economic inertia.

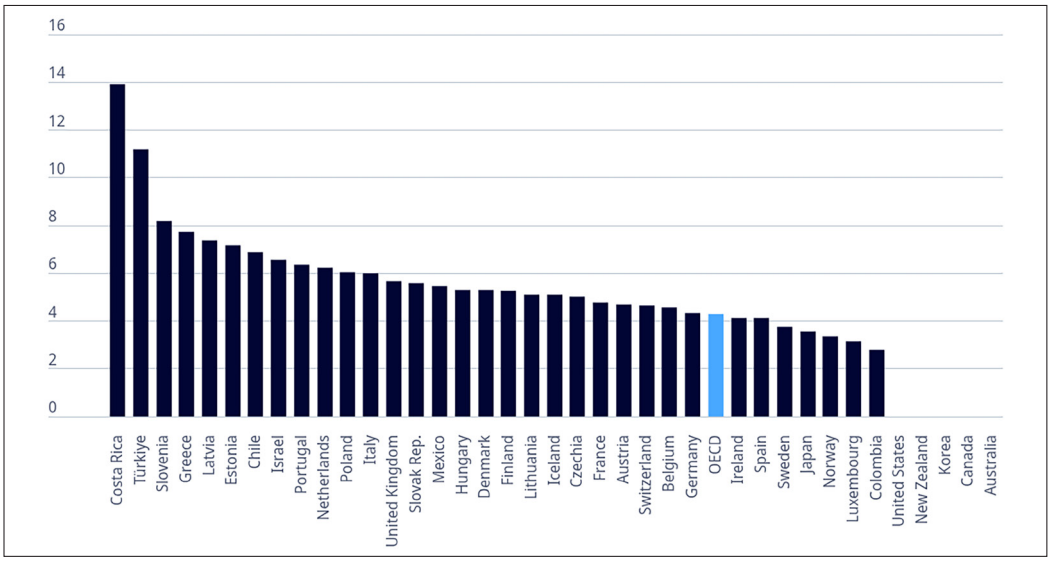

Figure 4. The share of environmental tax revenues of OECD countries, 2023
Source: OECD, 2026.

Additionally, the costs for Türkiye to abandon the dependence on tax revenue founded on fossil fuels have exacerbated with time, as the institutional practises, administrative forms, and political discourses are rooted in the existing fiscal regime. Any move towards a green fiscal policy, including reorganising subsidies or replacing the tax on the consumption of fossil fuel with carbon pricing, encounters significant institutional, ideological, and financial difficulties. This structural imbalance becomes clearer with reference to the scale and reliability of the tax revenues that are generated by fossil consumption. Türkiye's reliance on consumption-based taxation, in particular with the SCT as its main source, is not an undeliberate implementation but rather a part of the planned fiscal strategy, as noted by OECD (2010). Figure 4 demonstrates that in 2023, Türkiye was the second out of the OECD countries in terms of the portion of the environmental tax revenues in the total tax in the total tax income (OECD, 2026). This ranking indicates the key importance of fiscal flows related to carbon revenues for Türkiye. As compared to renewable incentives, SCT revenues provide immediate, predictable, and administratively efficient returns without the need for long-term public investments. They are more appealing

due to their simplicity. Increasing returns, sunk costs in the political realm, and interests in the administrative and economic spheres are factors that contribute to the long-term path dependency of these fiscal patterns.

Feedback mechanisms in the areas of policymaking and coalition building make fiscal fossilisation even more persistent. It is important to note that such asymmetry constructs this structural disincentive to take bold actions for decarbonisation. Indirect taxation on energy consumption is more useful to prevent evasion and more reliable compared to the taxation on personal income (Heine et al., 2012). This directness further deepens the dependence on these sources of revenue. In this context, renewable support policies do not fail due to design deficiencies, but because the SCT systematically rewards the continuous consumption of fossil fuels. Due to its recurrent and politically stable flow of revenue, the SCT maintains the development of political coalitions and bureaucracy aimed at keeping the status quo. Fiscal policy is both a tool and a product of a feedback process that insulates the ideas of a reform. This state of affairs inhibits the policy imagination of green alternatives in that dependency and state-capitalist logics, together with policy feedback mechanisms, deepen fiscal embeddedness in and dependence on the revenues of the fossil fuels.

Human Capital, State Capitalism, and Innovation System Failure in Türkiye

Conventional approaches to the green transition have paid too much attention to financial investment and technology diffusion, but the availability and development of human capital, including engineers, technicians, energy planners, and system integrators, cannot be overlooked in terms of innovation maintenance, system functioning, and localisation of clean-energy solutions. Green transition is not a technological change, but it is a systemic change and requires professional staff at all levels of the value chain. However, a lesser, unspoken structural challenge in Türkiye is the lack of qualified and specialised labour force in renewable energy technologies and related green industries. This deficit does not only limit the ability of Türkiye to be able to fulfil its renewable potential but also undermines the capability of the country to devote both the institutional and financial capital to a long-term and innovation-based transition.

The more profound structural dynamic, which arises out of the particular state-capitalist structure of Türkiye, is manifested in the skills shortage. The institutional implication of a path-dependent NIS that has developed with fossil fuel-based and militarised industrial interests is the fact that the skills gap is no longer just a labour-market problem. Instead of investing in fundamental changes like the development of a clean-energy workforce, the state actively rearranges the capacity of its industries on a regular basis to reap the greatest short-term political or geopolitical benefits. Hence, the course of the workforce development is still influenced by the past policy decisions that imply the prevalence of the dominant industries over developing the capabilities oriented to the future. Other areas of the economy, including construction and defence, which can generate more rapid financial payoffs or enjoy more political popularity receive priority. This has led to a systematic under investment in the development of green human capital. Even though Türkiye is rushing to grow its renewable energy interests on paper, investments in green industries requiring knowledge-based advancement are secondary and falls short in meeting the needs for achieving energy transition.

This is a cycle of self-reinforcement. To start with, the national educational and vocational system in Türkiye has been underperforming in terms of generating an adequate number of graduates that could be absorbed in the green-economy sector of the labour market. This is a weakness that prevents the construction of competitive, self-reliant, green industrial base

and postpones the implementation of clean-energy infrastructure. There is also a shortage of trained labour, which reduces the need to invest in a specialised training programme. Therefore, disincentivising the further development of green education. This vicious circle of institutions creates institutional inertia that is typical of the fossil-era.

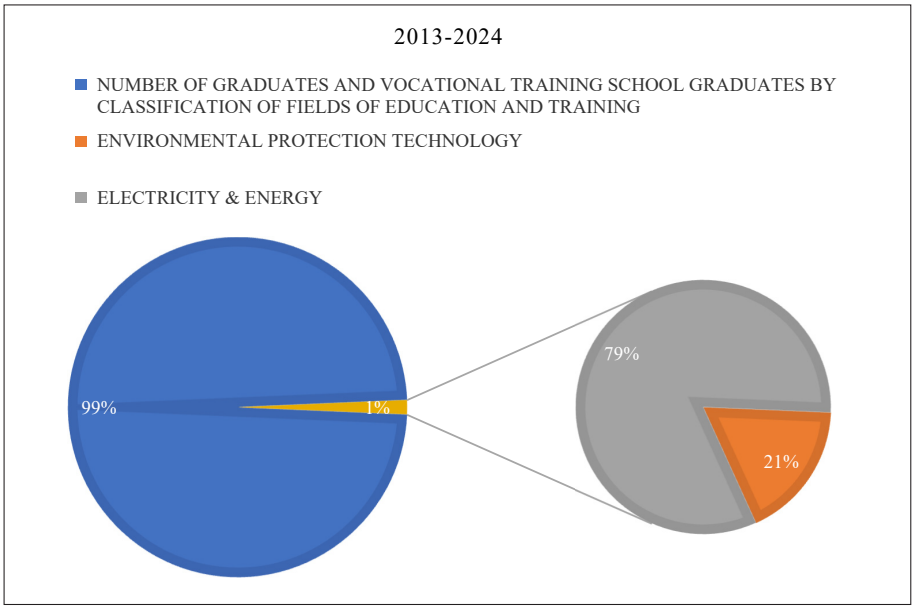

Figure 5. Number of bachelor's degree and vocational training school graduates in Türkiye between 2013 and 2024
Source: Council of Higher Education (CHE), 2025.

Second, the human-capital bottleneck contributes to the overall failure of the innovation-system in Türkiye. Specifically, education, R&D, employment, and strategic planning have not been integrated in the NIS to develop long-term abilities in clean-energy technologies. In the absence of this coordination, resources that can foster domestic green innovation systems are either not used fully or they are diverted to the conventional sectors. This institutional disintegration hinders the ability of the innovation system in the country to realign itself to sustainability objectives.

There are also empirical signs that highlight this misalignment of the structure. A total of 9,632,286 graduates were produced in the period between 2013 and 2024 in Türkiye. According to Figure 5, only a 1 percent of these graduates took programmes that were directly related to the occupations in the green workforce. This percentage may not necessarily seem to be small given the diversity of university disciplines, but its insignificance becomes more obvious when weighed against the scale and the technical needs of a structural energy transition. A constant growing space for renewable energy systems, grid modernisation, and low-carbon industrial processes requires a continuing and expanding pool of specialised engineers, technicians, and system operators.

However, the problem with it does not lie in its absolute size of the share but rather in respect of the anticipated demand of labour in a transitioning energy system. This weakness is more

visible, so when it is combined with the current ratio of renewable employment. The ability to increase the use of renewable energy sources, keep the infrastructure up, and continue to innovate is structurally limited unless it has a much larger pool of specialised graduates. This dimension indicates a lack of equilibrium between the supply of higher education and strategic needs of the sector. The lack of alignment between supply and demand of labour-market qualifications is an example of what the conceptualisation of the human capital theory envisages as skills misallocation. This imbalance signals the overall shortcoming to facilitate the mass transition.

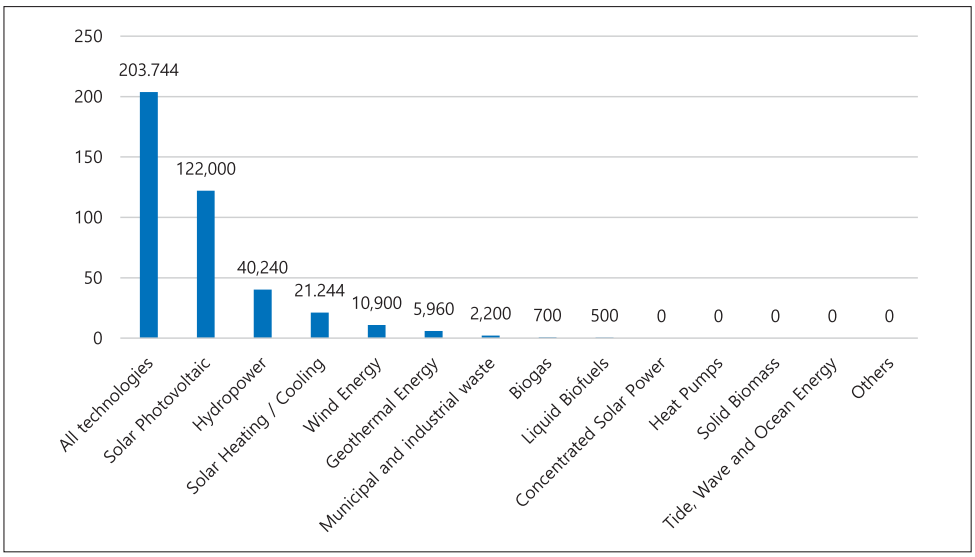

Figure 6. Renewable energy employment in Türkiye by technology, 2023
Source: IRENA, 2026.

It can be also observed in Figure 6 that as of 2024, the renewable energy sector in Türkiye employed some 203,744 people (IRENA, 2026) which can be equated to only 0.56 percent of total 36,409,307 employment (World Bank, 2026). Although this number might look high in the absolute terms, its structural significance becomes clearer when the number is placed in the international context. The percentage of the employment in the renewable energy is 0.54% of the total workforce in the OECD countries (IRENA, 2026; World Bank, 2026). Though the relative share of Türkiye is widely comparable, it does not mean that there is no underlying structural issue. Within this framework, the renewable employment level remains disproportionately low in relation to the significant renewable energy potential and installed capacity where Türkiye ranked 11th in the world as illustrated by Figure 1. The nations placed above Türkiye in the same Graph performs better in terms of the overlap between capacity, renewable expansion, and labour market transformation. For example, the portion of workforce employed in renewable sectors is 0.95% in China, 1.28% in Brazil, 0.65% in the United States, 0.75% in Germany, 0.57% in Spain, and 0.65% in Italy (IRENA, 2026; World Bank, 2026). This divergence between Türkiye and other OECD countries supports the main point of the article. Accordingly, the structure experiencing deficits in green human capital would allow a limited share of renewable employment. These barriers would pose system-wide challenges for the development of a labour intensive, self-sustaining energy transition. Also, the shortage of sufficient number of trained manpower can

be translated into tangible bottlenecks that will prevent the spread of low-carbon technologies even in the context of the adequate financial resources and the presence of the supportive policy frameworks.

The underdevelopment of structurally well-grounded green labour force is both a cause and an effect of the prevalence of the fossil-dominated techno-industrial paradigms in Türkiye. The current patterns of skill distributions, training systems, and labour market expectations in the areas of legacy sectors reinforced path dependency of employment structures. The relatively smaller size of the labour force in the field of renewables, in turn, appears as a bottleneck constraining the capacity of the sector to expand. Without a vital mass of skilled labour, the renewable energy sectors cannot scale up with or without investment or policy support. Consequently, the renewable employment of Türkiye is not only below global benchmarks, but it also structurally reinforces the concept of the carbon lock-in and limits the possibility of the realignment of the labour market of the country to the needs of the green transition.

In the past, industrial policies developed by states have favoured construction and military industries, which have quick returns and strengthen political economy of state capitalism. Such short-term interests preserve long-term flexibility and restrict institutional sight to place human-capital development in line with the need to decarbonise. In this setup, the state capacity has been channelled to maintain political and economic stability, instead of creating an ecosystem that may foster the green innovation. In particular, the human-capital bottlenecks in Türkiye also demonstrate that it is not only a technical or educational deficiency, but a structural failure of the NIS. Lack of cross-sectoral alignment, the inertia of policy preferences towards path-dependencies, and the strategic prioritisations of sectors that are fossil intensive and military industries hamper building a green workforce. The green transition is not yet a truly transformative process. The innovation-system failure that is caused by sectoral lock-ins and short-term political preferences impedes the green transition. Thus, this sluggishness constrains technological development as well as the social foundations which are essential for having a sustainable future in energy mix.

Securitised State Capitalism and the Skewed Innovation System: Structural Barriers to Türkiye's Green Transition

There is no way that the poor performance of Türkiye in achieving a wholesome green transition can ever be fully understood without subjecting the strategic biases within the industrial policy regime, especially the securitisation of the defence industry. One of the main structural limitations regarding the green transition in Türkiye is the strategic investment priorities of the state, which is, in particular, the tendency of the political elites to channel the resources and institutional focus on the defence and security-industrial complex at the cost of systematic investments in the development of green technologies and renewable energy sources. In this respect, President Erdoğan has constantly stressed the point that the defence sector is the leading export-generating industry in Türkiye, thus enhancing the country image at the regional and international levels (Presidency of the Republic of Türkiye, 2023a, 2025). The support of budgetary resources to research and development is also emphasised by Erdoğan as the means to maintain the dynamism in this branch (Presidency of the Republic of Türkiye, 2023b, 2024a). In the Turkish instance, the large-scale state investment in defence companies is frequently directed by way of public-corporate joint venture and acquisition schemes. As a result, climate-based areas like renewable energy, environmentally friendly mobility, and green R&D are under-funded and institutionally marginalised. This is an act of state intervention where economic and technological investments

are directed with the perceived national security needs. This policy is an example of securitised state capitalism, in which the government subsidises strategic sectors, most of which are related to national security and geopolitical ambition.

In addition, Erdoğan appeals to the principle of the dual use, and states that the products and expertise of the defence sector, as well as its technological advances, are spilled over to the civilian sector, which further contributes to the strategic primacy of this sector (Directorate General for Strategic Research and Productivity, 2025; Presidency of the Republic of Türkiye, 2024b). This trend is illustrative of such logic of state capitalism where the state plays an active role in forming industrial paths through resource distributions, guiding strategic industries, and creating alliances between the state and businesses. The Turkish case is not a market-based investment decision but rather one informed by the interests of the regime and geopolitical calculations, favouring the investment options to enhance the sovereignty and national pride. In this context, the NIS is biassed to a very small mission orientation in which the public R&D ecosystems, universities, and industrial capabilities are directed towards the support of militarised technological developments as opposed to a universal, sustainability-focused innovation. Such a sectoral imbalance hints at an institutional failure of the NIS to organise learning, innovation, and diffusion of climate-aligned technologies.

The securitisation of industrial policy indicates the external perception of a threat as well as internal incentive of the regime in terms of developing national pride, electoral popularity, and bargaining power in international arena. According to Erdoğan (The Republic of Turkey Directorate of Communications, 2024), the strength of the defence industry is tightly connected with the increasing reputation and effectiveness of the foreign policy. He also points out the fact that the nation has emerged as an essential regional force and a global power due to strategic breakthroughs in this sector (Presidency of the Republic of Türkiye, 2024c, 2025).

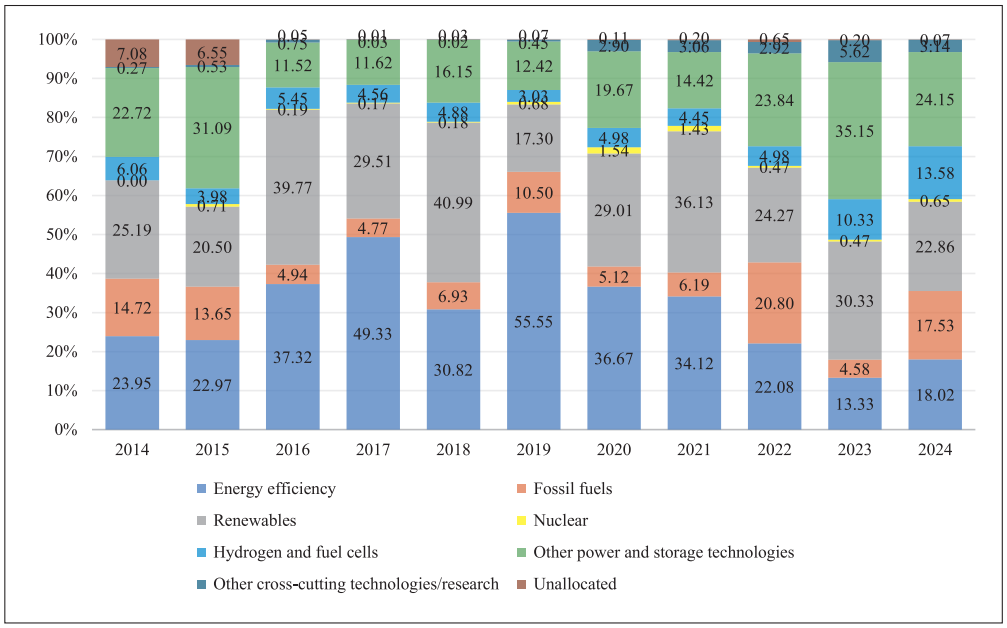

Figure 7. Public research, development, and demonstration (RD&D) spending in million, Türkiye
Source: IEA, 2025.

Nevertheless, this policy-making-focus is an expansion of state-capitalist modes and has generated adverse externalities in climate-friendly industries. The budgetary allocations are skewed towards defence related areas that marginalise the green innovation in both an institutional and monetary context. Although Türkiye spends an average of 28.44 percentage of its energy RD&D budget to renewables as revealed by Figure 7, this expenditure is negligible when compared to the disproportionate amount given to defence technology R&D as Table 1 shows.

Table 1. Central government budget appropriations and outlays on R&D by socio-economic objectives (2008-2024)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Exploration and exploitation of the Earth (%)	3,3	1,4	2,6	2,4	2,6	1,8	2,3	2,5	1,5	1,9	1,8	1,8	1	0,2	0,1	0,2	0,1
Environment (%)	1,5	1,2	1,2	1,7	1,2	0,8	0,9	1,8	1,1	0,8	0,7	0,6	0,6	0,3	0,1	0,2	0,1
Energy (%)	1,8	1,5	1,9	1,7	1,5	1	0,6	2,1	1,4	1,3	1,1	1,1	0,9	0,6	0,8	1,1	0,3
Defence (%)	17,2	22,8	20	18	14,1	25,6	11,4	10,1	11,1	14	15,8	14,4	9,4	11,5	10,9	4,5	4,9
General advancement of knowledge: R&D financed from General University Funds (GUF) (%)	49,4	47	49,4	53,2	56,4	47,5	54,6	56	58,6	58,1	57,2	56,6	64,1	61,6	63,3	70,7	73,2
Other	26,8	26,1	24,9	23	24,2	23,3	30,2	27,5	26,3	23,9	23,4	25,5	24	25,8	24,8	23,3	21,4

Source: Turkish Statistical Institute (TÜİK), 2025.

Over the last few years, Türkiye has seen a phenomenal rise in its expenditure on defence-oriented R&D due to the national security needs, the desire to decrease its reliance on imported technologies and products, and the political relevance of self-sufficiency discourses. These investments have been spearheaded by large state-owned enterprises and public institutions with the participation and support of politically related conglomerates. Low-carbon innovation has not been getting the same degree of strategic vision and institutional attention. Such a securitised orientation pales the development of green innovation systems not through generalised underinvestment alone, but through a differentiated allocation of institutional attention, financing structures, and innovation incentives. Industries that are related to defence and security enjoy the benefits of mission-oriented innovation frameworks that are characterised by multi-year funding commitments. Shielded budgetary allocations and high level of alignment with the national security priorities guarantee their central place. By extension, these conditions ensure the stable cycles of R&D, predictable investment trajectories, and a high level of coordination with respect to state–industry collaboration. These conditions are directly linked to the reality of whether a sector would become a mature innovation system. In comparison, renewable energy initiatives emerge on a fragmented structure. In this respect, investments are mediated by regulatory

interests, market sensitivities in addition to short to medium term fiscal planning processes. This situation is a manifestation of structural asymmetry which constitutes a partial institutional support. While such an imbalance has a crowding-out effect, it leads to the net decline in the level of innovation resources and results in the redistribution of the most stable and strategic types of state support not to renewable technologies but to securitised domains. This evaluation is supported by the 2030 Industry and Technology Strategy document. Here, the document states that defence industry already occupies a remarkable portion of the national R&D spending (Directorate General for Strategic Research and Productivity, 2025).

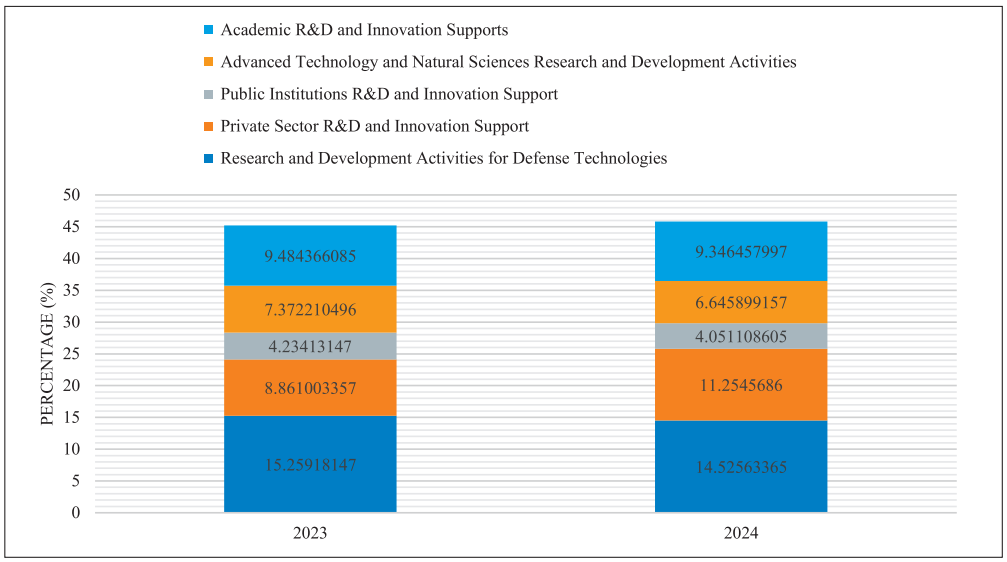

Figure 8. Classification of budget expenditures by activity (2023-2024)
Source: The Scientific and Technological Research Council of Türkiye (TÜBİTAK), 2025.

Nonetheless, such state capitalism, bureaucratic capacity, and policy of innovation strategies in the field of defence have displaced the focus and investment in clean technologies, grid modernisation, and climate-consistent R&D. In line with Figure 8, this institutional bias in the distribution of R&D expenditure is evident in the analysis of the biggest part in the R&D expenditure by the central government. Within the framework of the general advancement of knowledge, which is funded by the General University Fund, a substantial share of this expenditure, about 15 per cent, goes to defence technologies R&D. This once again reflects their pre-eminent role in the overall research agenda of Türkiye. This also implies that universities are not positioned as the core drivers of green transition.

This has led to an underdeveloped and fragmented green technology environment in Türkiye. Climate-related research, clusters of sustainability-related technology innovation, or university-industry connections in the field of renewables receive less financial support than in OECD standards. Although the country has a significant potential in solar and wind energy, the technological base is largely dependent on foreign technologies and does not have an internationally competitive power in such basic areas as battery storage, smart grid systems, and green hydrogen. Such technical reliance negatively impacts the place of Türkiye in the global

low-carbon value chain and limits the sovereignty of green energy.

The decisions of the Turkish industrial policy, being motivated by both techno-nationalist goals and national security concerns, have endorsed such a path-dependent innovation structure that gives a priority to the defence sector. This securitised model consumes the resources, institutional focus, and strategic capacity of climate-related innovation, so it solidifies the gap in green R&D and inter-sectoral coordination. The more sunk costs, vested interests, and political preferences make the chance to achieve ecological modernisation, complete decarbonisation, and fair green transition narrower.

Conclusion

The article discusses the reasons why Türkiye, with its huge potential in terms of renewable energy, still remains structurally oriented towards fossil fuels. Going beyond the well-investigated factors such as infrastructure gaps or policy design, the analysis shows that the existence of a fossil-intensive developmental path is entrenched in deep-rooted fiscal dependence, human capital deficiencies, and lack of sector-based innovation system. The study predicts that the trend of institutional inertia, path-dependent policy decisions, and securitised economic priorities systematically marginalise renewable energy options.

The empirical findings shows that the fossil path dependency of Türkiye is aggravated by fiscal dependency on carbon-intensive revenues as well as distorted policy environment where the defence-oriented development of industrial policies shuns out the green innovation. The discussion also highlights the fact that the green human capital remains underdeveloped and that the educational connection and labour-market coordination is not in line with the demands of renewable-sector thus exacerbating the problem of capability traps that hinder strategic change. All these forces are combined to create a trap that prevents a radical energy transition in Türkiye because they anchor the past with fiscal lock-in and restrict the present ability to implement changes due to labour-market mismatches and distorted innovation priorities. When it comes to the renewable industries, e.g. solar and wind, this aspect takes a form of an interrelated mechanism. First, fiscal dependency undermines the willingness of the state to take forceful policies that would greatly displace the consumption of fossil fuels thus limiting the magnitude and pace of renewable deployment. Second, lack of sufficient numbers of engineers, technicians, and system operators trained to work with renewable technologies introduces bottlenecks, so the expansion of the functioning of solar and wind capacity slows down. Third, a long-term investment in renewable energy systems is diverted by the prioritisation of defence-oriented R&D.

The article conjectures a multidimensional framework of understanding how structural, institutional, and fiscal logics come together in a vicious cycle to sustain fossil lock-in. It synthesises the insights of five related literatures, namely political economy, state capitalism, path dependency, the NIS, and policy feedback. Consequently, it gives three major contributions. It adds to the body of literature about state-capitalism by first analysing how the strategic orientation of state-based growth models can accommodate unsustainable energy regimes. Second, it presents the concept of fiscal lock-in as a crucial but least studied process in the fossil path dependency. Third, it brings forward the part of indirect carbon rents and policy bias of the sector in a non-rentier setting, expanding the geographic and institutional focus of the study of energy-transition.

The implications of the findings are important to both the scholarly discourse and policy agenda. Here, it is disclosed that an engagement with energy transition is not limited with

the concepts of technology diffusion or political will. Such an engagement provides insights, once structural forms of economic governance, institutional designs, and the long-term policy feedback become parts of the analysis. To Türkiye (and other nations with similar state-capitalist institutions), a fair and successful green shift will need not just infrastructural and financial repositioning but also a radical reassessment of strategic priorities in the education, innovation, and industrial-policy arenas. It is critical to value such dynamics in order to make transition strategies that are viable and fair in structurally constrained environments.

Other than its empirical contribution, this study provides a number of opportunities for future research. To start with, more comparative research might be carried out to determine whether other forms of internalised rentierism exist in different countries belonging to the category of middle-income country. Second, the political feasibility of green fiscal reform, which would allow states to move off carbon-dependent revenue models without sacrificing macroeconomic stability, could be studied in the future. Lastly, this macro-structural analysis could be complemented by micro-level studies. Such studies can examine the behaviour of firms and the implementation of regional policies that could be used to understand bottlenecks in transition efforts.

AI Acknowledgment

Generative AI or AI-assisted technologies were not used in any way to prepare, write, or complete essential authoring tasks in this manuscript.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Notes

1. The Central Administration budget revenues in Türkiye are comprised of collections of the general budget, special budget administration, and regulatory and supervisory authority. The general budget revenues include taxes, income from the state-owned enterprises and assets, interests, profit shares, fines, capital repayment, dept recovery, and special revenues, including donations and grants. Among the tax categories that exist in number (seven categories in total), the special tax revenues are mostly collected by tax on goods and services.

References

Alami, I., Taggart, J., Whiteside, H., Gonzalez-Vicente, R., Liu, I. T., & Rolf, S. (2024). Quo vadis neoliberalism in an age of resurgent state capitalism? *Finance and Space*, *1*(1), 340–367. https://doi.org/10.1080/2833115X.2024.2392736

Arthur, W. B. (1994). *Increasing returns and path dependence in the economy*. University of Michigan Press.

Babić, M., & Mertens, D. (2025). Decarbonization under geoeconomic distress? Energy shocks, carbon lock-ins, and Germany's pathway toward net zero. *Regulation & Governance*, *19*(2), 448–468. https://doi.org/10.1111/rego.12634

Brand, U. (2012). Green economy–The next oxymoron? No lessons learned from failures of implementing sustainable development. *GAIA-Ecological Perspectives for Science and Society*, *21*(1), 28–32. https://doi.org/10.14512/gaia.21.1.9

Breetz, H., Mildenberger, M., & Stokes, L. (2018). The political logics of clean energy transitions. *Business and Politics*, *20*(4), 492–522. https://doi.org/10.1017/bap.2018.14

Bridge, G., Bouzarovski, S., Bradshaw, M., & Eyre, N. (2013). Geographies of energy transition: Space, place and the low-carbon economy. *Energy Policy*, *53*, 331-340. https://doi.org/10.1016/j.enpol.2012.10.066

Christophers, B. (2022). Fossilised capital: Price and profit in the energy transition. *New Political Economy*, *27*(1), 146-159. https://doi.org/10.1080/13563467.2021.1926957

Council of Higher Education. (2025). *Student Statistics*. Yükseköğretim Bilgi Yönetim Sistemi. https://istatistik.yok.gov.tr/

Directorate General for Strategic Research and Productivity. (2025). 2030 Sanayi ve Teknoloji Stratejisi, Ministry of Industry and Technology of the Republic of Türkiye. *T.C. Sanayi ve Teknoloji Bakanlığı*. https://www.sanayi.gov.tr/plan-program-raporlar-ve-yayinlar/strateji-belgeleri

Grasso, M., & Delatin Rodrigues, D. (2025). Sustainability transitions through fossil infrastructure deactivation. *Sustainability*, *17*(14), 6465. https://doi.org/10.3390/su17146465

Heine, D. Norregaard, J., & Parry, I. W. H. (2012). *Environmental tax reform: Principles from theory and practice to dat*e. IMF Working Paper, WP/12/180. International Monetary Fund.

Helmrich, A., Chester, M., Miller, T. R., & Allenby, B. (2023). Lock-in: origination and significance within infrastructure systems. *Environmental Research: Infrastructure and Sustainability*, *3*(3). https://doi.org/10.1088/2634-4505/acf7e6

International Energy Agency. (2024). *International Energy Agency (CC BY 4.0.)* [Dataset]. International Energy Agency. https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser?country=TURKEY&fuel=Energy%20supply&indicator=TESbySource

International Energy Agency. (2025). *IEA energy technology RD&D budgets* [Dataset]. International Energy Agency. https://www.iea.org/data-and-statistics/data-product/energy-technology-rd-and-d-budget-database-2#energy-technology-rdd-budgets

International Renewable Energy Agency. (2025). *Renewable capacity statistics 2025* [Dataset]. International Renewable Energy Agency. https://irena.sharepoint.com/:x:/s/statistics-public/EZir9y4VamRNvPDFCpuxSIUB62N4Uf_RyalVGYbcUS-9kw?rtime=fUxf7Fif3Ug

International Renewable Energy Agency. (2026). *Renewable energy employment by country* [Dataset]. International Renewable Energy Agency. https://www.irena.org/Data/View-data-by-topic/Benefits/Renewable-Energy-Employment-by-Country

Kim, H., & Paik, S. (2025). Dynamic analysis of Korea's crude oil import demand: The impact of economic growth, oil prices, and major economic disruptions (1980–2023). *International Area Studies Review, 28*(3), 263–276. https://doi.org/10.69473/iasr.2025.28.3.263

Li, X., Wu, T., Zhang, H. J., & Yang, D. Y. (2023). National innovation systems and the achievement of sustainable development goals: Effect of knowledge-based dynamic capability. *Journal of Innovation & Knowledge*, *8*(1). https://doi.org/10.1016/j.jik.2023.100310

Lo, K., & Mah, D. N. Y. (2024). State capitalism, fragmented authoritarianism, and the politics of energy policymaking: Policy networks and electricity market liberalization in Guangdong, China. *Energy Research & Social Science*, *107*. https://doi.org/10.1016/j.erss.2023.103348

Lockwood, M. (2022). Policy feedback and institutional context in energy transitions. *Policy Sciences*, *55*(3), 487–507. https://doi.org/10.1007/s11077-022-09467-1

Lundvall, B. Å. (2007). National innovation systems—Analytical concept and development tool. *Industry and Innovation*, *14*(1), 95–119. https://doi.org/10.1080/13662710601130863

Minister of Energy and Natural Resources. (2024a). *Energy: Rüzgar*. Minister of Energy and Natural Resources, Republic of Türkiye. https://enerji.gov.tr/bilgi-merkezi-enerji-ruzgar

Minister of Energy and Natural Resources. (2024b). *Energy: Jeotermal*. Minister of Energy and Natural Resources, Republic of Türkiye. https://enerji.gov.tr/bilgi-merkezi-enerji-jeotermal

Minister of Energy and Natural Resources. (n.d.). *Resources: Wind*. Minister of Energy and Natural Resources, Republic of Türkiye. https://enerji.gov.tr/eigm-resources-en

Ministry of Treasury and Finance. (2023, June 16). *Press release* [Press Release]. Ministry of Treasury and Finance, Republic of Türkiye. https://www.hmb.gov.tr/haberler/basn-acklamas-16-temmuz-2023

Ministry of Treasury and Finance. (2025). *Statistics of the central administration budget*. Ministry of Treasury

and Finance, Republic of Türkiye. https://muhasebat.hmb.gov.tr/merkezi-yonetim-butce-istatistikleri

Musacchio, A., & Lazzarini, S. G. (2012). *Leviathan in business: Varieties of state capitalism and their implications for economic performance*. http://dx.doi.org/10.2139/ssrn.2070942

Nelson, R. R. (1993). *National innovation systems: A comparative analysis*. Oxford University Press.

Newell, P. (2021). *Power shift: The global political economy of energy transitions*. Cambridge University Press.

Newell, P., & Mulvaney, D. (2013). The political economy of the 'just transition'. *The Geographical Journal*, *179*(2), 132–140. https://doi.org/10.1111/geoj.12008

Organisation for Economic Co-operation and Development. (2010). *Taxation, innovation and the environment*. OECD Publishing. https://www.oecd.org/content/dam/oecd/en/publications/reports/2010/10/taxation-innovation-and-the-environment_g1g1044d/9789264087637-en.pdf

Organisation for Economic Co-operation and Development. (2026). *Environmental tax* [Dataset]. Organisation for Economic Co-operation and Development. https://www.oecd.org/en/data/indicators/environmental-tax.html

Pierson, P. (2000). Increasing returns, path dependence, and the study of politics. *American Political Science Review*, *94*(2), 251-267. https://doi.org/10.2307/2586011

Presidency of the Republic of Türkiye. (2023a, September 29). *Türkiye'yi savunma sanayii başta olmak üzere, her alanda başarıdan başarıya koşturduk*. T.C. Cumhurbaşkanlığı. https://www.tccb.gov.tr/haberler/410/149692/-turkiye-yi-savunma-sanayii-basta-olmak-uzere-her-alanda-basaridan-basariya-kosturduk-

Presidency of the Republic of Türkiye. (2023b, April 10). *TCG Anadolu Gemisi Teslim Töreni ve Yeni MİLGEM Fırkateynleri Sac Kesme Töreni'nde Yaptıkları Konuşma*. T.C. Cumhurbaşkanlığı. https://www.tccb.gov.tr/haberler/410/145635/-tcg-anadolu-yu-dunyada-soz-sahibi-ulke-konumumuzu-percinleyecek-bir-sembol-olarak-goruyoruz-

Presidency of the Republic of Türkiye. (2024a, January 19). *Mavi Vatana Güç: Yeni Deniz Platformları Teslimat Töreni'nde Yaptıkları Konuşma*. T.C. Cumhurbaşkanlığı. https://www.tccb.gov.tr/konusmalar/353/150804/mavi-vatana-guc-yeni-deniz-platformlari-teslimat-toreni-nde-yaptiklari-konusma

Presidency of the Republic of Türkiye. (2024b, July 26). *Yüksek Teknoloji Teşvik Programı Tanıtım Toplantısı'nda Yaptıkları Konuşma*. T.C. Cumhurbaşkanlığı. https://www.tccb.gov.tr/konusmalar/353/153163/yuksek-teknoloji-tesvik-programi-tanitim-toplantisi-nda-yaptiklari-konusma

Presidency of the Republic of Türkiye. (2024c, May 30). *Türkiye, savunma sanayinde gerçekleştirdiği atılım sayesinde bölgesinde vazgeçilmez oyunculardan biri hâline geldi*. T.C. Cumhurbaşkanlığı. https://www.tccb.gov.tr/haberler/410/152560/-turkiye-savunma-sanayinde-gerceklestirdigi-atilim-sayesinde-bolgesinde-vazgecilmez-oyunculardan-biri-h-line-geldi-

Presidency of the Republic of Türkiye. (2025, March 27). *2030 Sanayi ve Teknoloji Stratejisi Tanıtım Toplantısı'nda Yaptıkları Konuşma*. T.C. Cumhurbaşkanlığı. https://www.tccb.gov.tr/konusmalar/353/158213/2030-sanayi-ve-teknoloji-stratejisi-tanitim-toplantisi-nda-yaptiklari-konusma

Santana, N. B., Mariano, E. B., Camioto, F. D. C., & Rebelatto, D. A. D. N. (2015). National innovative capacity as determinant in sustainable development: A comparison between the BRICS and G7 countries. *International Journal of Innovation and Sustainable Development*, *9*(3-4), 384–405. https://doi.org/10.1504/IJISD.2015.071860

Seto, K. C., Davis, S. J., Mitchell, R. B., Stokes, E. C., Unruh, G., & Ürge-Vorsatz, D. (2016). Carbon lock-in: Types, causes, and policy implications. *Annual Review of Environment and Resources*, *41*(1), 425–452. https://doi.org/10.1146/annurev-environ-110615-085934

Szabo, J. (2021). Fossil capitalism's lock-ins: The natural gas-hydrogen nexus. *Capitalism Nature Socialism*, *32*(4), 91–110. https://doi.org/10.1080/10455752.2020.1843186

Telatar, O. M., & Birinci, N. (2022). The effects of environmental tax on ecological footprint and carbon dioxide emissions: A nonlinear cointegration analysis on Turkey. *Environmental Science and Pollution Research*, *29*(29), 44335–44347. https://doi.org/10.1007/s11356-022-18740-y

The Republic of Türkiye Directorate of Communications. (2024, February 25). *Cumhurbaşkanı Erdoğan: "Türkiye sadece bölgesel bir güç olmaktan çıkıp küresel bir güç olma yolunda emin adımlarla ilerliyor"*. T.C. İletişim Başkanlığı. https://www.iletisim.gov.tr/turkce/haberler/detay/cumhurbaskani-erdogan-turkiye-sadece-bolgesel-bir-guc-olmaktan-cikip-kuresel-bir-guc-olma-yolunda-emin-adimlarla-ilerliyor

The Scientific and Technological Research Council of Türkiye. (2025). *Classification of budget expenditures by activity (2023-2024)*. Türkiye Bilimsel ve Teknolojik Araştırma Kurumu. https://tubitak.gov.tr/tr/kurumsal/hakkimizda/mali-tablolar

Turkish Statistical Institute. (2025). *Central government budget appropriations and outlays on R&D by socio-economic objectives, 2013-2024* [Dataset]. Türkiye İstatistik Kurumu. https://data.tuik.gov.tr/Bulten/Index?p=Merkezi-Yonetim-Butcesinden-AR-GE-Faaliyetleri-Icin-Ayrilan-Odenek-ve-Harcamalar-2023-49573

Unruh, G. C. (2000). Understanding carbon lock-in. *Energy Policy*, *28*(12), 817–830. https://doi.org/10.1016/S0301-4215(00)00070-7

Volz, U., Böhnke, J., Eidt, V., Knierim, L., Richert, K., & Roeber, G. M. (2015). Financing the green transformation—Market failures, government failures and the role of the state. In U. Volz, J. Böhnke, V. Eidt, L. Knierim, K. Richert, & G. M. Roeber (Eds.), *Financing the green transformation: How to make green finance work in Indonesia* (pp. 7–21), Palgrave Macmillan London. https://doi.org/10.1057/9781137486127_2

Walz, R., & Eichhammer, W. (2012). Benchmarking green innovation. *Mineral Economics*, *24*(2), 79–101. https://doi.org/10.1007/s13563-012-0016-y

Weber, K. M., & Rohracher, H. (2012). Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures' framework. *Research Policy*, *41*(6), 1037–1047. https://doi.org/10.1016/j.respol.2011.10.015

World Bank. (2026). *Labor force, total* [Dataset]. UN Population Division. https://data.worldbank.org/indicator/SL.TLF.TOTL.IN