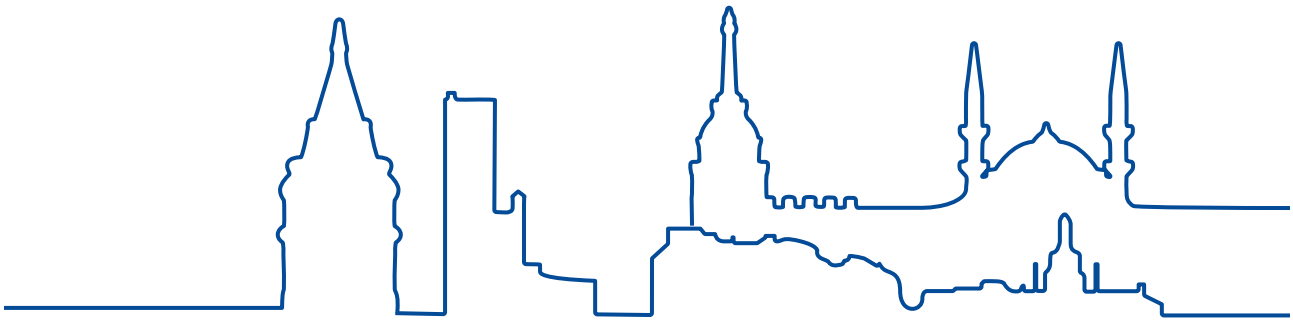


IPC–MERCATOR POLICY BRIEF December 2022

GREEN ENERGY & REGIONAL DEVELOPMENT II: POLICY & MARKET DESIGN CONSTRAINTS FOR THE TURKISH ENERGY SYSTEM

Theocharis N. Grigoriadis

Executive Summary

In this IPC Policy Brief, I discuss the policy and market design framework of energy transitions in Turkey in light of domestic and international uncertainties that maintain natural gas as an option value resource for the Turkish energy system. While the share of renewable energies such as wind and solar power is rising globally, its effect on economic performance remains contested, and the role of traditional fossil fuels remains crucial for the provision of public goods and industrial output. This observed paradox is due to a series of policy and market design choices that reduce the efficiency of financing for green projects and render green transitions dependent on central governments and major energy companies that find themselves in a principal-agent relationship. I model the government's optimization problem by reporting the baseline constraints that slow down the green transition path: 1. A political economy constraint related to the provision of public goods and therefore the reelection probability of the incumbent government; 2. A financial constraint that implies an exclusive dependence on government-provided liquidity without any active role for state banks and, therefore, the provision of subnational finance to local initiatives under conditions of corporate decentralization. In light of the model proposed, I provide policy and market design recommendations for the Turkish energy system including the reform of the Renewable Energy Resource Areas (YEKA) regulatory framework and the introduction of a partial bottom-up financing approach that may speed up green transitions in emerging markets.

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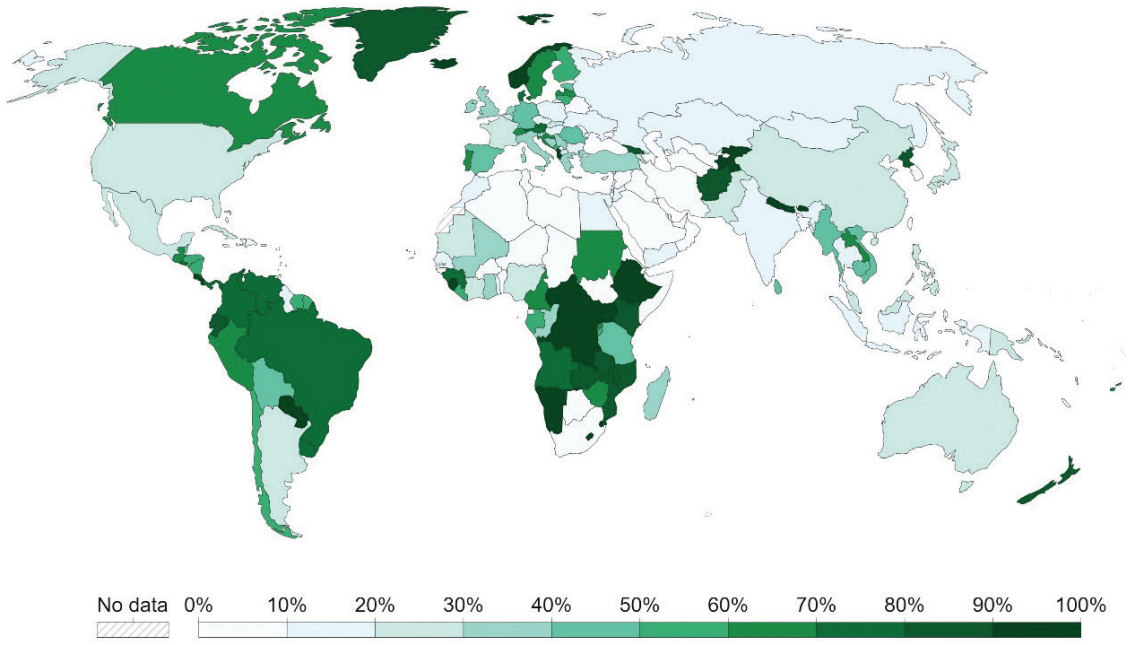
I. Introduction

The expansion of green energy as part of global electricity production has transformed the world economy and has offered new opportunities for profit and development to businesses, governments, and civil society. While the share of renewables in electricity production appears to be increasing much more significantly in advanced rather than in emerging economies (see Figure 1), the role of natural gas still appears to be an important option value for the economic performance of both rich and poor countries—meaning that countries are willing to pay in order to have this resource as a reserve possibility in case renewable energies are not sufficient to cover industrial and household demand. Security developments in Eastern Europe during 2022 have shown that while renewables have become a strategic component of the European Union's energy mix, there is a long way to go until natural gas and traditional fossil fuels play only a minor role in the overall socio-economic welfare of EU citizens and the political survival of their governments.

It is also important to point out that there is no established causal pattern between the renewables share in electricity production and economic performance. Causality can go either way: richer countries may be more inclined to develop a higher renewables share in electricity production because of the high sunk investment costs, or countries with a higher share of renewables in electricity production are inclined to become richer due to positive externalities related to sustainable development (better living standards, air quality, human development conditions). When it comes to hydrogen-based renewable energy, there is a reversed positive impact observed; as seen in a sample of 35 European countries, economic performance has a positive effect on hydrogen-based renewable energy production.[1]

As seen in Figure 1, examining a combination of advanced and emerging economies with a significant component of renewables in their electricity production (Canada, Scandinavia, and several West European countries as well as sub-Saharan Africa, several Latin American and Asian countries) reveals a major asymmetry in global energy policies, which has strong implications for the Turkish energy system given its key position between the European Union and Eurasia and the Middle East.

Figure 1: Share of Renewables in Electricity Production, 2021



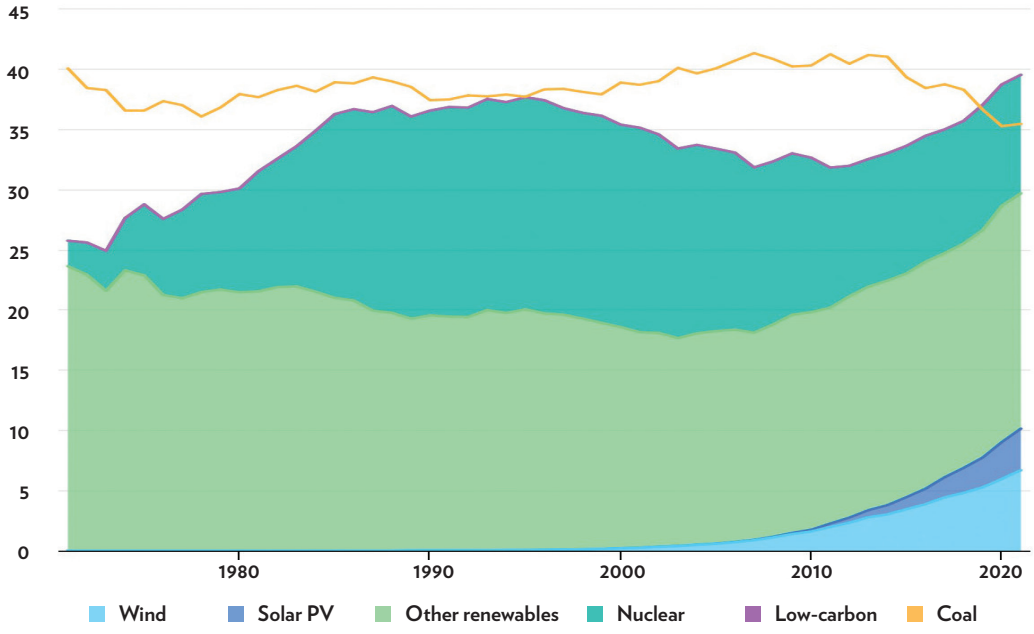
Source: Our World in Data, 2022.[2]

The comparison between the global share of coal in electricity production and the share of low-carbon energy resources underscores the significant role of hydroelectric and geothermal power for emerging markets; the limited share of solar energy, which is primarily focused on agriculture; and the rising share of wind energy in industrial production (see Figure 2). Furthermore, the share of nuclear energy has been drastically reduced since the early 2000s, while shortly before 2020, the overall low-carbon energy share exceeded the share of coal (Figure 2). The green transition path, therefore, appears to be an irreversible process, while decarbonization occurs at a much lower rate.

This phenomenon is particularly relevant for emerging markets, where green transitions are often directed by central government decisions. The introduction of solar energy into the agricultural systems of the Global South has produced Pareto optimal solutions both for crop size and environmental quality. Nevertheless, the situation becomes more complex in areas where hydroelectric power and biofuels as well as nuclear power dominante renewable energy shares (Figure 2). Nuclear power during and in the aftermath of the Cold War has been highly politicized, and it has followed a contractionary course since the 2010s. Hydroelectric power has considerable negative implications for the preservation of ecosystems and human livelihoods as it may affect water quality and the living conditions of the humans and animals attached to it. At the same time, the extensive use of biofuels (bioethanole or biodiesel) often is at odds with food security, and it facilitates the emergence of food conflicts, particularly in emerging markets. The environmental sustainability of biofuels is also contested despite their overall positive impact on the reduction of greenhouse emissions (GHG).[3] Biofuels have had several determental effects on biodiversity as well as patterns of water and energy use.[4]

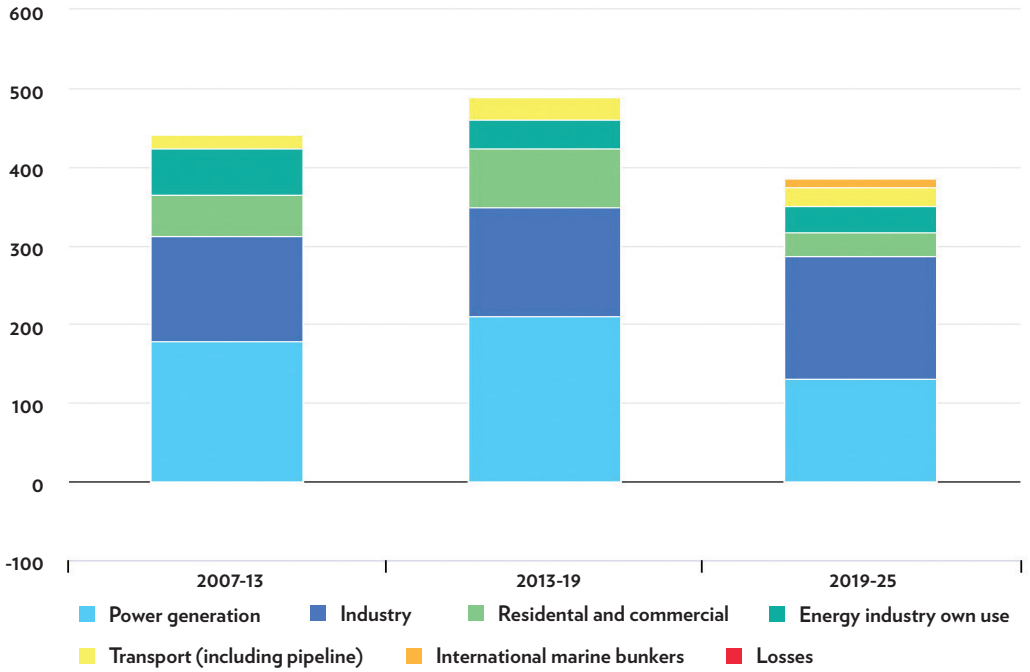
As Figure 3 points out, the role of natural gas has consistently remained indispensable for industrial output and power generation, while its share has decreased significantly for residential and commercial use. Moreover, despite the rise of the share of renewables in electricity production, the share of natural gas in industrial use has increased, as well. This suggests that renewable energies have reduced but not eliminated the global demand for natural gas in power generation, while they have not been able to substitute natural gas in manufac-

Figure 2: IEA, Share of low-carbon sources and coal in world electricity generation, 1971–2021



Source: IEA Global Energy Review, 2021.[5]

Figure 3: IEA, Global natural gas demand per sector, 2007–2025



Source: IEA Gas, 2020.[6]

turing and other industrial applications. This reality reveals the presence of major policy and market design challenges in the development of renewables as an instrument for modernization and human development.

High dependence on natural gas for industrial and business development and the increased participation of renewable energies in electrical power generation constitute the main policy and market dilemmas in both advanced and emerging markets, albeit for different reasons. Advanced markets, on the one hand, have made significant investments in renewables to reduce their dependence on fossil fuels and natural gas in particular, given the political risks associated with it. However, wind-generated electricity does not appear to be sufficient in covering industrial energy demand, which in turn preserves the high option value of natural gas and prevents the full decarbonization of advanced economies in the long run. Emerging economies, on the other hand, are inclined toward higher growth rates to counter pressing income inequalities and maintain a stable rate of private sector development; given harder budget constraints, renewables are less profitable for industrial development compared to natural gas, oil and its related products, and coal. At the same time, renewables may become a driver for enhanced foreign direct investment (FDI) from advanced economies and make efficient use of the diverse climate conditions in the Global South. This is particularly the case for economies such as India, Brazil, Turkey, and Argentina, whose massive populations make the reliance on fossil fuels costly and where the option value of natural gas remains even higher.

The paper is structured as follows. Section 2 explains the market and regulatory characteristics of the Turkish energy system, which is currently undergoing green transitions and improvements in sustainable development. Section 3 proposes and solves a microeconomic model on policy and market design constraints that slow down green transitions and preserve natural gas as an option value for industrial output and redistribution. Section 4 explores sustainable financing instruments as a way to reduce the role of natural gas in emerging markets, while Section 5 discusses the energy perspectives for Turkey and makes related policy recommendations. Section 6 concludes.

II. Turkey's Wind Transformation & the YEKA Auction Model

Though the expansion of renewable energies in Turkey was largely seen in the 2010s, the use of renewable energy began in the 2000s or, for some regions of the country, even earlier. As Figure 4 points out with respect to wind energy, the western and southern provinces of Turkey constitute the main areas of distribution for wind farms. This is due mainly to climatic conditions but also to prior industrialization and environmental degradation. The Aegean provinces of Turkey such as Izmir, Manisa, and Aydin have been home to several domestic and foreign industries, which before the green transition of the Turkish economy produced severe pollution-related externalities for local livelihoods. Southern provinces such as Hatay host a mix of coal-fired power plants and wind farms, which support industrial demand for electric power. While this structure of the regional energy market suggests that electricity production has been moving in a more environmentally friendly direction, the critical implications for the province's fauna and flora remain significant. Furthermore, the cultural and maritime environment in the Hatay region has also been threatened by wind power infrastructure or its planning next to historical religious sites or the Samandağ beachfront.

Wind energy has been a central component for the transformation of Turkey's electrical power sector. This sector has been developed within the regulatory framework of the Renewable Energy Resource Areas (YEKA) auction model.[7] There have been two YEKA tenders on wind energy in Turkey. The first YEKA tender was won by the German-Turkish consortium Siemens-Türkerler-Kalyon, which started Turkey's first massive wind energy transition in the Marmara region and in Central Turkey in 2017. In 2019, the second YEKA tender was won by Enerjisa, a Turkish company of which 50 percent is owned by the German energy leader E.ON, and Enercon, a German company specializing in wind energy infrastructure. The regional focus of the second YEKA tender covers primarily the Aegean as well as Marmara regions of Turkey.

An initial critical evaluation of the YEKA auction model may suggest that its focus lies on the preservation of minimum requirements for the deployment of renewable energy infrastructure while benefitting from complementarities with prior models such as the Extension of Renewable Energy Support Scheme (YEKDEM) auction model and pre-license auctions.[8] The selection of the consortium with the most efficient price bid has been a key priority for the YEKA-based renewable energy spaces; nevertheless, the sustainable financing of renewable projects beyond the horizon of their construction and initial operation is also important and remains a major prerogative for the long-term success of Turkey's green transformation. At the same time, the external financial pressures on the Turkish economy and domestic economic policy decisions may pose significant constraints on the sustainable development of the renewable energy industry. This set of constraints, which will be discussed in the following section of the paper, relate both to the financial solvency and the political feasibility of a full-scale green transformation of an emerging market such as Turkey.

Figure 4: District-level wind farms in Turkey, 2010–2021



Source: Energy Atlas of Turkey, 2022.[9]

III. The Model

The role of policy and market design constraints, as exemplified in the YEKA model, is crucial for the speed and effectiveness of green transitions. The central player is the government, and therefore, this optimization problem is proposed in a micro-economic framework. The main dilemma of a government that is interested in maximizing its income from green transitions is related to the existence of a political economy constraint, which necessitates a minimum flow of taxable revenue for the government budget so that the provision of public goods is possible. Furthermore, there is a financial constraint related to the banking system and its ability to provide liquidity to the company that runs the renewable energy project in any given regional center or district. The central government intends to utilize the green transformation of the economy in order to maximize its probability of reelection, and thus, this becomes the government's own rent-seeking strategy. As Turkey remains the main reference case in this framework, the proposed equilibrium solutions capture both advanced and emerging markets.

Hence, the solvency of the renewable project and its potential to expand the coverage of electricity demand are crucial for the reduction of the option value of natural gas. This is why the provision of financing through state-supported banks and without the creation of bottom-up financing schemes that advance local innovation are inclined to slow down the effects of the green transformation on overall economic performance. It is also important to point out that civil society responses are not always positive toward sustainability projects, as they oftentimes pose significant challenges for local livelihoods, the stability of ecosystems, and regional economic activity. The debate over the installment of wind farms in the Samandağ beachfront, which was cancelled after the reaction of Hatay civil society, is indicative of the discrepancies between central decisions and local priorities in Turkish energy policy.

I assume that the government has the following utility function:

$$U_G(\theta_1,\theta_2)=\alpha\ln\theta_1+\beta\ln\theta_2+\mathrm{H}(g;\theta_1,\theta_2)-C(g;\theta_1,\theta_2)$$

where $\theta_1\in(0,+\infty)$ denotes rents from natural gas, $\theta_2\in(0,+\infty)$ rents from renewable energies, $g\in(0,+\infty)$ the public good, H the political pay-off from the provision of the public good, and C the cost of its provision. Furthermore, $\rho\in(0,1)$ denotes the degree of financial centralization, and $\alpha,\beta\in(0,1)$ are parameters denoting the share of natural gas and renewables in the economy. There is also a political economy constraint that captures the relationship between rents from renewables and natural gas, on the one hand, and the provision of the public good, on the other, such that:

$$\theta_1+\theta_2\geq g$$

When the reservation value of the public good $\underline{g}$ is not satisfied, then the government is removed from office. The financial constraint relates to the liquidity available for the implementation of projects in the areas of renewable energies and natural

$$\theta_1+\theta_2=\tau\rho\left[\frac{\pi^N}{\lambda_1}+\frac{\pi^R}{\lambda_2}\right]$$

where $\tau\in(0,1)$ denotes the tax rate imposed by the government on energy companies, $\pi^N,\pi^R\in(0,+\infty)$ corporate profits from natural gas and renewable energies, respectively, and $\lambda_1,\lambda_2\in(0,+\infty)$ the financial liquidity available for natural gas and renewable energies, respectively.

Therefore, the government's optimization problem can be written as follows:

$$\max_{\theta_1,\theta_2}EU^G=\begin{bmatrix}\frac{\partial EU^G}{\partial\theta_1}\\ \frac{\partial EU^G}{\partial\theta_2}\end{bmatrix}=\begin{bmatrix}\frac{\alpha}{\theta_1}+H_g\frac{\partial g}{\partial\theta_1}-C_g\frac{\partial g}{\partial\theta_1}\\ \frac{\beta}{\theta_2}+H_g\frac{\partial g}{\partial\theta_2}-C_g\frac{\partial g}{\partial\theta_2}\end{bmatrix}=\begin{bmatrix}0\\0\end{bmatrix}\Rightarrow$$

$$\max_{\theta_1,\theta_2}EU^G=\begin{bmatrix}\frac{\partial EU^G}{\partial\theta_1}\\ \frac{\partial EU^G}{\partial\theta_2}\end{bmatrix}=\begin{bmatrix}\frac{\alpha}{\theta_1}+H_g-C_g\\ \frac{\beta}{\theta_2}+H_g-C_g\end{bmatrix}=\begin{bmatrix}0\\0\end{bmatrix}\Rightarrow$$

$$\begin{bmatrix}\frac{\alpha}{\theta_1}\\ \frac{\beta}{\theta_2}\end{bmatrix}=\begin{bmatrix}C_g-H_g\\ C_g-H_g\end{bmatrix}\Rightarrow\frac{\alpha}{\theta_1^*}=\frac{\beta}{\theta_2^*}\Rightarrow\frac{\alpha}{\beta}=\frac{\theta_1^*}{\theta_2^*}$$

Proposition 1

The ratio of optimal rents from natural gas and renewable energies depends on the respective shares of the natural gas and renewable energies sectors in the economy.

1 | *If* $\alpha < \beta$ *, then* $\theta_1^* < \theta_2^*$.

2 | *If* $\alpha \geq \beta$, *then* $\theta_1^* > \theta_2^*$.

If this baseline finding is matched with the empirical predominance of natural gas over renewable energies in industry, it can be inferred that governments that care about their survival are inclined to place a higher value on their rents from the natural gas sector of the economy. This puts renewable energies in a disadvantageous position when it comes to their development and sets significant limitations on the speed of green transitions in both advanced and emerging economies.

Replacing the financial constraint on the objective function of the government, it is possible to rewrite it as follows:

$$U_G(.) = \alpha \ln \tau\rho \frac{\pi^N}{\lambda_1} + \beta \ln \tau\rho \frac{\pi^K}{\lambda_2} + \mathrm{H}(g;.) - C(g;.) \Rightarrow$$

$$U_G(.) = \alpha \ln \tau\rho\pi^N - \alpha \ln \lambda_1 + \beta \ln \tau\rho\pi^R - \beta \ln \lambda_2 + \mathrm{H}(g;.) - C(g;.) \Rightarrow$$

$$\frac{\partial U_G(.)}{\partial \rho} = \frac{\alpha+\beta}{\rho} - \frac{\alpha}{\lambda_1}\frac{\partial \lambda_1}{\partial \rho} - \frac{\beta}{\lambda_2}\frac{\partial \lambda_2}{\partial \rho} + \mathrm{H}_\rho - C_\rho = 0 \Rightarrow$$

$$\Rightarrow \frac{\alpha+\beta}{\rho} - \frac{\alpha}{\lambda_1}\frac{\partial \lambda_1}{\partial \rho} - \frac{\beta}{\lambda_2}\frac{\partial \lambda_2}{\partial \rho} + \mathrm{H}_\rho - C_\rho = 0 \Rightarrow$$

$$\frac{\alpha+\beta}{\rho} = \frac{\alpha}{\lambda_1}\frac{\partial \lambda_1}{\partial \rho} + \frac{\beta}{\lambda_2}\frac{\partial \lambda_2}{\partial \rho} - \mathrm{H}_\rho + C_\rho \Rightarrow \rho^* = \frac{\alpha+\beta}{\frac{\alpha}{\lambda_1}\frac{\partial \lambda_1}{\partial \rho} + \frac{\beta}{\lambda_2}\frac{\partial \lambda_2}{\partial \rho} - \mathrm{H}_\rho + C_\rho}$$

To find the relationship between the optimal level of financial centralization from the government's perspective and the shares of natural gas and renewable energies in the economy, I compute the following two derivatives:

$$\frac{\partial \rho^*}{\partial \alpha} = \frac{\lambda_1\lambda_2\left[\beta\left(\lambda_1\frac{\partial \lambda_2}{\partial \rho} - \lambda_2\frac{\partial \lambda_1}{\partial \rho}\right) + \lambda_1\lambda_2\left(C_\rho - H_\rho\right)\right]}{\left[\lambda_2\alpha\frac{\partial \lambda_1}{\partial \rho} + \beta\lambda_1\frac{\partial \lambda_2}{\partial \rho} + \lambda_1\lambda_2\left(C_\rho - H_\rho\right)\right]^2}$$

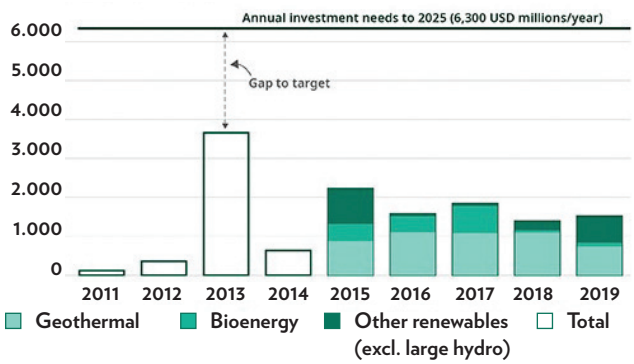
$$\frac{\partial \rho^*}{\partial \beta} = \frac{\lambda_1\lambda_2\left[\alpha\left(\lambda_1\frac{\partial \lambda_2}{\partial \rho} - \lambda_2\frac{\partial \lambda_1}{\partial \rho}\right) + \lambda_1\lambda_2\left(C_\rho - H_\rho\right)\right]}{\left[\lambda_2\alpha\frac{\partial \lambda_1}{\partial \rho} + \lambda_1\beta\frac{\partial \lambda_2}{\partial \rho} + \lambda_1\lambda_2\left(C_\rho - H_\rho\right)\right]^2}$$

Lemma 1: *If* $C_\rho > H_\rho$ *then* $\frac{\partial \lambda_2}{\partial \rho} > \frac{\partial \lambda_1}{\partial \rho}$ *there is a positive monotonic relationship between the degree of financial centralization and the shares of the natural gas and renewable energies sectors.*

It becomes obvious that under the current conditions, the renewable energies sector develops asymmetrically less than the natural gas sector, whose role in economic growth in advanced and emerging economies remains strong. Hence, the centralized provision of credit facilitates the provision of soft budget constraints to companies that run natural gas and renewable energies projects, with the latter becoming even more dependent on state-sponsored bailouts than the former.

As Figure 5 indicates, there is much less investment provided for renewables compared to the estimated needs for the smooth development of green transitions. Evidence from a global sample from the Organisation for Economic Co-operation and Development (OECD) suggests that, while 2013 was a year when a global maximum was achieved in terms of renewables investments, the total sum invested decreases toward the end of the 2010s.[10] In addition to that, geothermal power and bioenergy appear to have attracted the large majority of investment for most of the measured period, whereas in 2019 the share of other renewable energies such as wind and solar power increased, albeit without even approaching the designated target of USD 6.3 billion per year. This lack of investment can be explained not only by the political instability related to Russian foreign policy in Eastern Europe and Eurasia but also by the highly centralized nature of energy project financing, which favors government-owned banks or financial institutions with government mandates to provide energy credits to the private sector. Central government intervention has a significant impact on the conditions of the collateral requested by energy companies as well as the attachment of the project profitability to the repayment horizon of the credit received.

Figure 5: Investment Needs – Renewable Energies



Source: OECD, 2021.[11]

IV. Policy Recommendations for Turkey

Turkey's financial system has been under major pressure since the start of the ongoing financial and currency crisis in 2018. At the same time, the progress of the green power transformation in the Turkish economy, particularly through the two waves of YEKA auctions for wind power, have strengthened the role of the central government and the centralization of the banking system, which was expected to provide credits to the winning groups of Turkish and German companies. Furthermore, Turkey's global comparative advantage in geothermal energy remains relatively underdeveloped, despite the fact that Turkey is the fourth largest geothermal producer in the world after the United States, the Philippines, and Indonesia.

While coal has been the main target of green transitions, the predominance of natural gas in industrial electricity production has posed significant limitations on the development of renewable energies and technologies, particularly for emerging economies that will invest in clean energy only if the expected returns on growth and energy consumption are risk-free and cost-efficient. There is no reason to believe that decarbonization will be followed by the exit of natural gas from industrial production; nevertheless, if the achievement of the Sustainable Development Goals (SDGs), as defined by the United Nations, still has some real-world implications, then it is necessary to provide a policy roadmap that will render the financing of renewable energy projects less government-dependent and more attached to transnational and international financing models and initiatives. Turkey, as an economy that combines elements of both an advanced and an emerging economy, can be a unique policy laboratory in that direction:

Policy Recommendations

- The introduction of bottom-up financing schemes with the participation of local banks, regional and local governments, and international institutions will disentangle green transitions from political competition and the survival incentives of the incumbent government. In the case of Turkey, the decentralization of the YEKA auction model with stronger involvement of local and regional actors would not only facilitate price efficiency and short-term financing, as it does now, but it would also achieve longer-term financing from a multitude of domestic and international financial institutions at a much lower risk level. This would allow for the de-facto decentralization of energy financing and the focus of larger banks on fewer energy projects with a higher expected return.
- The Pareto optimal solution of bottom-up financing for renewable energies is likely to have positive externalities for local civil society and, particularly, environmental groups and organizations that intend to advance decarbonization but not at the expense of local ecosystems, livelihoods, and cultural heritage. Conditionalities related to the protection of local ecologies are more likely to be introduced by a decentralized financing instrument that takes into account both possible

reputational costs for incumbent local governments and the corporate social responsibility parameters for the companies involved, for example, in wind or hydroelectric energy projects. That way, there is also a significant empowerment of subnational institutions and their preferences, which often may be at odds with central government priorities.

- The creation of a Regional Renewables Fund for Turkey through the initiative of the European Union, the support of the European Investment Bank, and the participation of bilateral and multilateral aid donors and international financial agencies would give credibility to this paradigm change without abandoning the positive policy features of the YEKA auction model. This fund would support the decentralization of the Turkish financial system and would lead to higher levels of transparency and accountability in the selection and financial support of renewable energy projects at the local level.
- Reforming Turkish intergovernmental relations in the direction of decentralization and reinforcement of subnational fiscal capacity can increase state capacity at the regional and district levels, while allowing subnational governments to provide collateral to local banks for the provision of green energy credits.
- Particularly for the poorer provinces and districts of Turkey, the introduction of public-private partnerships with the participation of central and local governments as well as private actors can minimize the risk of credit provision for renewable energy projects in those areas. That way, consortia of Turkish and international energy companies can carry the risk of project implementation, while local and central bureaucracies can design the set of targets to be fulfilled and also provide financial guarantees for the completion of the project in case of financial or political crises.

V. Concluding Remarks

In this policy brief, I discuss the policy and market design constraints to green transitions with a particular focus on political economy and liquidity challenges that slow down the speed of green transitions, preserve the centralization of credit provision, and reveal the preponderance of natural gas over renewable energies for industrial production. The ex-ante shares of natural gas and renewable energies in the economy predict the ratio of optimal rents that the government can derive from those two sectors toward the objective of its survival in office. Financial centralization consolidates the role of natural gas in industrial production. Particularly, when it comes to Turkey, as well as other major OECD and emerging economies, bottom-up financial instruments and fiscal decentralization are the key measures for the faster advancement of green transitions.

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Notes

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