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**ENERGY INSECURITY IN TURKEY:
OPPORTUNITIES FOR RENEWABLE ENERGY**

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Abstract

Turkey's energy market has expanded over the course of the past decade at a pace that only the People's Republic of China (PRC) has approached. This shows that Turkey has serious potential. To achieve the energy targets for 2023, there is an expectation that the market must receive investments worth \$130 billion. In terms of cooperation with the European Union, renewable energy is a promising route, as both parties face energy challenges due to the limited availability of fossil fuels. Increasing the use of renewable energy in electricity generation can also play a significant role in realizing Turkey's long-term goal of forming a natural gas corridor within its borders. The National Energy and Mining Policy, which the Ministry of Energy and Natural Resources initiated, aims to reduce the dependence on external energy in favor of renewable sources. In the final quarter of 2017, energy generation from water, groundwater, wind, and solar and biological waste reached 32%, exceeding the 2023 target of 30%. When Turkey can create and develop its own renewable sources and overcome the technological and financial challenges, it could enjoy a wealth of diversity, independence, and sustainability in the energy sector. In Turkey, with its young population dynamics, producing energy from renewable sources has much more importance than in other countries. This paper, after revising the global renewable energy supply and demand conditions and the energy strategies of countries like the People's Republic of China and the European Union, will analyze Turkey's strategy for energy generation in detail. The focus will be on how the use of renewable energy will contribute to the energy security and growth of the Turkish economy.

Keywords: renewable energy, energy security, economic development, energy transition

JEL Classification: F60, N40, N50

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1. INTRODUCTION

Turkey, which is a country with strong dependence on oil and gas imports, is following a developmental strategy including increased nuclear and coal facilities and a renewable energy agenda. Turkey needs to transition its energy system with the aim of reducing its dependence on energy imports, which account for about 75% of the energy consumption of Turkey's total primary energy supply (Saygin, Hoffman, and Godron 2018). According to a report released by American Progress, Turkey needs transition for some key reasons: "Securing the energy supply and keeping up with the demand to sustain the economic growth, as the population increases is undoubtedly the most important policy priority of Turkey. Together with meeting increasing demand, the definite economic priorities of Turkey shape the energy transition. Among these priorities there are decreasing the negative environmental and economic effects of the growing fossil fuel use, creating more competitive markets, providing consumers with more energy opportunities and increasing energy investments in large and distributed generation assets" (Saygin, Hoffman, and Godron 2018). During 2017, Turkey achieved developments in renewable energy resources like wind and solar power. According to the National Energy Plan of Turkey, 30% of its electricity must originate from renewable energy resources. It is no coincidence that renewable resources can reduce Turkey's dependence on foreign resources (Kalehsar 2018). To understand better how Turkey has increased its renewable energy sources, it is important to pay attention to the motives in the larger energy strategy. Turkey primarily seeks to achieve greater energy independence and security through a reduction in its energy imports and related economic pressures (Wilson 2018).

This paper commences with a review of Turkey's attempts and plans to increase the share of renewable energy in the domestic power basket. Increasing the renewable energy share in Turkey's energy portfolio will not only reduce its dependence on foreign sources but also take advantage of the renewable energy potential in terms of both domestic energy security and good opportunities for employment. Turkey can become a hub of energy in the long run by providing the necessary conditions. The paper provides a practical solution for Turkey as well as for other energy-importing economies to improve their energy security status.

2. LITERATURE REVIEW

Hansen et al. (2019, 11) argued that there are numerous technologies to increase the renewable energy share in the energy system in Germany. This study provided details of a suitable transmission strategy that would allow the achievement of 100% renewable energy considering all energy sectors. The largest challenge in moving to a renewable model lies in the conservation and maintenance of biomass rather than the energy system costs. In spite of these issues, the study's results highlighted that there is a possibility to move to a domestic power system based on 100% renewable power within Germany. Such a move is possible while maintaining costs in line with the 2050 reference system. Pata (2018, 1121) noted that the GDP contains significant indicators of CO₂ emissions and long-term industrialization and urbanization. If urbanization and industrialization increase by 1%, CO₂ emissions will increase by 0.6674% and 0.2941%, respectively. CO₂ emissions will reduce when exports and the consumption of non-carbohydrates reduce. CO₂ emissions receive positive impacts in the free trade arena. In the Turkish context, the country has had success in reducing the CO₂ emissions arising from heating, and a preference for natural gas usage over coal is evident. In the

long run, there are two variables, financial development and coal consumption, that increase CO₂ emissions. Overland (2019, 37–40) mentioned the importance of high technology in energy transition; energy transition is all about technology and innovation. It is not foreseeable that renewable energy technologies will develop in the future. However, in some areas or others, it is likely that technological advances and cost savings will occur. One of the main goals of renewable energy research is to develop new technologies that use cheaper materials and have good prospects for success in this endeavor. Depending on how countries develop renewable energy technologies, there is acceptance that the prices of some important materials will be high, as they generate significant revenue for the exporting countries.

Regarding Turkey's growing electricity demand, Kilickaplan et al. (2018, 223) stated that this relates to the forecast of per capita electricity consumption by 2050, which is likely to match the EU average of 6036 kWh. Therefore, the current predicted per capita electricity consumption in 2050 is equal to the current population growth. The electricity demand of Turkey in 2015, and the projected electricity demand by 2050, will be divided into seven regions by population.

Austvik and Rzayeva (2017, 546) argued that the Turkish government has set a number of strategic goals, which include liberalization and the creation of a competitive domestic market and ensure the security of the natural gas supply. The government also seeks to minimize its deficit and BOTAS losses with the view of eradicating them over time by shifting the responsibilities and liabilities to private enterprises. As a NATO member, Turkey aims to find a balance between the EU and the US on one side and the Russian Federation, the Middle East and Central Asia, and the Mediterranean countries on the other. Such a step is necessary if Turkey is to hold a comfortable position as both a consumer and a transporter of natural gas resources.

Guo et al. (2019, 833–40) noted that Turkey is strategically located among 47% of the world's energy resources, which originate from the Russian Federation, Central Asia, and the Middle East. Its location is further advantageous as it is close to Europe, with 17% of the world's natural gas consumption. In this regard, Turkey is both geo-economically and geo-politically significant. Turkey has gradually become an energy hub and plays a key role in the movement of energy into Europe. A vital strategic goal for Turkey is to encourage the expansion and diversification of energy sources and the energy market while establishing itself as a key energy center.

There are some studies on renewable energy and sustainable development. Yuksel and Kaygusuz (2011, 4143) found that cost-efficient energy services that utilize a broad spectrum of renewable technologies and resources are necessary to provide energy access for all people. Simultaneously, such a move will lead to a reduction in greenhouse gas emissions and thus curtail the negative effects of energy consumption on the health of both nature and the global human population. The communications provided offered a brief explanation of such alternative and sustainable energy sources, namely renewable energy sources, their potential, and their achievements in Turkey. Many renewable energy (RE) technologies are currently commercially available, while more are becoming available on a commercial basis. In a further 5–10 years, the market will benefit from access to yet more technologies that are not yet suitable for commercial release.

There are some studies regarding the relations between the sustainable development and the sustainable supply of energy sources. Yuksek (2010, 1469) believed that sustainable development requires sustainable energy resources. One of the most important consequences of this sentence is as follows: sustainable development in society requires the provision of energy resources that are readily available and sustainable in the long term at an affordable cost and that the society can use for all necessary tasks without creating negative social consequences.

Ozturk and Yuksek (2016, 4143) pointed out that energy security, economic growth, and environmental protection are the drivers of the national energy policy in every country in the world. Greenhouse gas emissions significantly influence global warming, with approximately 80% of greenhouse gases from carbon fuel combustion having an effect. Investment and financial capabilities are key factors in increasing the share of renewable energy in the domestic energy market and electricity generation. According to Taghizadeh-Hesary and Yoshino (2019), the achievement of the Sustainable Development Goals (SDGs) and the Paris agreement targets requires investment in green energy. However, there is reluctance among financial establishments and investors to deal with such projects, as there is an expectation that the return rate will be low and they will involve high risk, particularly when compared with investment in traditional energy models. This paper offered a model that combines credit guarantees and tax returns to reduce and manage risk in an attempt to bridge the gap in large-scale green investment projects.

According to Sovacool (2016 212), “Energy transitions have been, and will continue to be, inherently prolonged affairs, particularly so in large nations whose high levels of per capita energy use and whose massive and expensive infrastructures make it impossible to greatly accelerate their progress even if we were to resort to some highly effective interventions”

Gielen et al. (2019, 46) showed that successful transformation appears to be technically feasible, with the need to introduce rapidly policies and major policy changes as concerted efforts to integrate global concerns such as climate change into local and national policy priorities (such as health and pollution, energy access, and energy security). Therefore, cost-effective solutions that please all parties and meet all goals require a dedicated policy framework. Energy transition necessitates innovative techniques targeted to the requirements of each specific renewable source.

Erşen and Çelikpala (2019, 590) stated that geopolitical problems are even more significant than the obstacles to Turkey’s energy plans: “The issue of natural gas cannot be separated from sensitive political and geopolitical issues.” This means that, although Turkey is excellently geographically positioned in terms of oil and natural gas resources, it is not immune to the effects of global conflict and/or the threat of terrorism in the region. Such factors also undermine Turkey’s plans to become an energy hub, as pipeline construction may be subject to geopolitical risks—especially the risk of military escalation between conflicting actors in the region.

According to Erdil and Erbiyik (2015, 675–6), there are some opportunities for Turkey to find high-resource potential that it can utilize for new renewable energy technologies. The growth of the demand for Turkish environmental by-products and services, including waste management, water, and the management and control of air pollution as a result of economic growth, industrialization, and urbanization, and renewable energy protection are essential to decrease Turkey’s energy imports.

3. TURKEY'S ENERGY STRATEGY

As a result of Turkey's rapidly increasing energy demand, especially for oil and natural gas, the dependence on energy imports is increasing. Domestic sources can meet only about 26% of the country's total energy demand. A summary of the key elements of Turkey's energy strategy follows:

- a. Prioritizing the activities related to energy security, considering the increasing demand and import dependency;
- b. Considering environmental concerns at all stages of the energy chain in the context of sustainable development;
- c. Establishing a transparent and competitive market by ensuring the necessary reform and liberalization; and
- d. Increasing R&D studies related to energy technologies.

In this context:

- i. Diversifying the source and route of the supply of petroleum and natural gas, which are imported hydrocarbon energy sources;
- ii. Increasing the share of domestic and renewable energy;
- iii. Increasing energy efficiency;
- iv. Aiming to include nuclear power in the energy basket.

The following pages describe Turkey's energy production, consumption, and installed power potential (Ministry of Foreign Affairs 2018). Over the past 15 years, both in Turkey and globally, developments in renewable energy have been garnering attention. Turkey imports 75% of its energy from overseas. Predictions indicate that, in 2020, the foreign energy dependence will reach 80% (Ministry of Foreign Affairs 2018). In light of this, it is clear that, to reduce its dependence on foreign energy sources, Turkey must improve and expand its own energy sources.

For Turkey, green energy offers a good opportunity, as the country's geographical position makes it well situated to making use of renewable sources, such as solar, wind, geothermal, hydro, wave, and biomass sources (Republic of Turkey Ministry of Energy and Natural Resources 2018).

Presently, renewable sources account for almost 34% of Turkey's total energy generation. Hydropower makes up the bulk of this, with solar power constituting the smallest share. Globally, there has been a rapid increase in energy production from renewable sources, and, bearing this in mind, it is necessary for Turkey to develop its own capacity for the production of such energy. In line with this, both the public and the private sector have established goals and begun to make investments in renewables. In 2015, the investments in Turkish renewable energy totaled \$1.9 billion, and this figure is steadily increasing. In 2002, Turkey's installed power capacity totaled 12,277 MW. This increased to 15,550 MW in 2009 and reached 32,275 MW in 2015. By the end quarter of 2016, the installed power capacity was 33,352 MW (Kavuz 2019).

Under its National Renewable Energy Action Plan, Turkey aims to increase its total capacity from renewables to 61,000 MW by 2023. Of this, 34,000 MW will originate from hydropower, 20,000 MW from wind power, 1,000 MW from geothermal energy, and 5,000 MW from solar power, with a final 1,000 MW coming from biomass energy. Estimations have indicated that achieving these targets will entail a cost of \$60 billion (Kavuz 2019).

Table 1: Energy Generation Capacity by Renewable Energy Sources and Targets (MW)

| Renewable Energy Sources | 2015 | 2017 | 2019 | 2023 |
|---------------------------------|---------------|---------------|---------------|---------------|
| Wind | 5.660 | 9.549 | 13.308 | 20.000 |
| Solar | 300 | 1.800 | 3.000 | 5.000 |
| Biomass | 377 | 530 | 683 | 1.000 |
| Hydropower | 25.526 | 28.763 | 32.000 | 34.000 |
| Geothermal | 412 | 559 | 706 | 1.000 |
| Total | 32.275 | 41.241 | 49.697 | 61.000 |

Source: Ministry of Energy and Natural Resources of Turkey (2018).

3.1 Renewable Energy in Turkey's 2023 Vision

The renewable energy sources that the Ministry of Energy and Natural Resources has launched to reduce the dependence on foreign energy constitute one of the important steps in the National Energy and Mine Policy. Electricity generation from sources such as water, groundwater, wind, solar, and biological waste reached 32% in the last quarter of 2017, leaving behind the 2023 target of 30%. In the last 10 years, 53% of electricity generation plant investments have targeted renewable energy (Haberler.com 2018).

Here we can outline the Turkish government's targets in the energy sector by 2023 according to the Investment Support and Promotion Agency of Turkey:

- Raising the total installed power capacity to 120 GW
- Increasing the share of renewables to 30%
- Maximizing the use of hydropower
- Increasing the installed capacity based on wind power to 20,000 MW
- Installing power plants that will provide 1,000 MW of geothermal and 5,000 MW of solar energy
- Extending the length of transmission lines to 60,717 kilometers
- Reaching a power distribution unit capacity of 158,460 MVA
- Extending the use of smart grids
- Raising the natural gas storage capacity to more than 5 billion cubic meters
- Establishing an energy stock exchange
- Commissioning nuclear power plants (two operational nuclear power plants, with a third under construction)
- Increasing the coal-fired installed capacity from the current level of 15.9 GW to 30 GW (Daily Sabah 2019).

Tied to the country's geographical location and energy consumption, Turkey has developed certain energy policies and plans that form the key determinants of Turkey's relations with Iran. An examination of Turkey's energy plans indicates that the main pillars in the Strategic Plan of the Ministry of Energy and Natural Resources of Turkey (2010–2014) are the security of the energy supply, "the regional and global

effectiveness of Turkey in the field of Energy,” natural resources, and the environment. The strategic plan aims to supply high-quality energy resources effectively and securely to all consumers adequately at low prices, paying due regard to sensitivity to environmental concerns. In addition, the strategic plan aims to create a liberal and competitive market and will continue to try to realize new production investments to meet the electricity demand within the structure of the market, production, and distribution privatization of the energy sector (Republic of Turkey Ministry of Energy and Natural Resources 2018).

Turkey, with the increase in installed capacity of renewable energy, the record price that it broke, and the implementation of new policies to improve energy efficiency, has strengthened its participation in the energy transformation taking place at the global level. It is possible for Turkey to achieve this installed power in wind and solar energy, but the planning should start today, and it needs to put into practice a flexible system that would eliminate the need for changes in production resulting from the implementation of solar and energy (Haber Turk.com 2019).

In the past ten years, Turkey was second only to the People’s Republic of China in terms of growth in the demand for natural gas and electricity. There is an expectation that the demand will continue to rise as Turkey’s economy grows. Turkey suffers from a lack of domestic energy, and currently the domestic supply is only sufficient to meet 26% of the total energy demand. Turkey has to import the rest of its energy from other countries (Ministry of Foreign Affairs 2018). With regard to such conditions, Turkey needs to recognize its own energy security and to “diversify its energy supply routes and source countries, increase the share of renewables and include the nuclear in its energy mix, take significant steps to increase energy efficiency and contribute to Europe’s energy security” (Ministry of Foreign Affairs 2018).

In Turkey’s energy strategy, energy security consists of two fields—long term and short term. Long-term energy security relates to suitable investment along the supply and demand chain to foster social and economic development. Short-term energy security is the ability of an energy system to respond directly to rapid or unexpected changes in the supply and demand. Consequently, energy security has powerful ties to the energy resources, routes, technologies, and investments needed to mobilize all of these (Yazar 2010, 3).

Necdet Pamir proposed seven principles for a social democratic approach to Turkey’s future energy policy:

- a. Government and independent regulating authorities must guarantee a secure energy supply for all citizens.
- b. Energy security entails reducing import dependency of Turkey and developing its source of local and renewable energy.
- c. It is essential to reduce CO₂ emissions for an ecologically and economically sustainable energy policy.
- d. The best way to reduce Turkey’s energy bill is using energy more efficiently and [reduce] its dependency on imports.
- e. New green jobs can be created by promoting renewable energy resources through higher incentives, but renewable energy technologies require significant R&D and local manufacturing efforts.
- f. Nuclear power has proven to be a highly dangerous and unsustainable technology that Turkey should not pursue.

- g. An integrated foreign energy policy must be designed in a way that contributes to the gradual improvement of Turkey's relations with its neighbors, as well as the opening of the EU energy chapter (Pamir 2018 6).

A national energy platform is necessary to determine the policies that the energy sector requires, representing all sections of society, such as universities, chambers of commerce, trade unions, and professionals and consumers. Through the national energy platform, the government should control the strategic plans for all the energy sectors (both new and traditional). Along with sub-sector plans, it should develop a national energy strategy; actionable plans should support this strategy (Türkyilmaz 2012 53–4).

The rapid growth of the energy demand in Turkey, especially in the 1990s, forced Turkey's energy policy makers to profit from the accessibility of Russian natural gas instead of confronting the financial trouble of the required investment in alternative energy (Bilgin 2018 148–53). The AKP administration took energy into account and paid greater attention to Turkey's foreign policy, and some energy-prospect shifts in Turkey's foreign policy are apparent:

- a. Foreign affairs are highly related to Turkey's strategy of using energy as brokerage to foster regional economic cooperation;
- b. The energy industry in Turkey, which is related to the inability or unwillingness of its conventional allies to compensate for Turkey's energy mix flaws or the potential cost Turkey would incur if it does not develop relations as much as possible with partners such as the Russian Federation, Azerbaijan, Iran, and Iraq;
- c. From the aspect of geopolitics, as Turkey would not desire to miss a chance to build an energy transit system (which would necessitate cooperation – in the region including between the Russian Federation, Azerbaijan, Georgia, Armenia, Iran, Iraq), international energy security and international security mainly fall within the influence of the MFA. From this perspective, energy cooperation is surely seen as the key policy to foster interdependency and intensify relations between Turkey and its neighbors (Bilgin 2018 148–53).

The Turkish government has drawn up multiple plans detailing its intentions for overhauling the energy sector. In January 2018, the Turkish government released the National Energy Efficiency Action Plan (NEEAP). This document set out 55 specific actions over six energy sectors (industry, transport, buildings, agriculture, energy generation, and cross-cutting), aimed at obtaining a 14% reduction in the country's primary energy demand by 2023. To fulfill this target, the government estimates that the actions will attract \$10.9 billion in investment (Saygin, Hoffman, and Godron 2018).

According to the Ministry of Energy and Natural Resources of the Republic of Turkey's Strategic Plan (2015–2019), a variety of energy resources is a major priority. Turkey is interested in benefiting from its geographic position to become an energy transporter to Europe and a regional hub for oil and gas from the Caspian Basin, Central Asia, and Iran (Yazdani 2019).

Turkey is aware of its strategic position and geopolitical advantage and thus has incorporated these considerations into its foreign policy. Despite this, Turkey requires more investment infrastructure so that it can expand the capacity of its natural gas facilities and refineries. There is some speculation that improvement in the field of energy could also improve Turkey's European relations and chances of accession to the EU (Yazdani 2019).

Despite being the biggest producer of greenhouse gases among the OECD countries, Turkey wants to balance this dependence and plans to incentivize further coal production, in particular by increasing local coal consumption. Therefore, the government plans to use its entire coal reserves by 2023 and in that time to build 70 more coal-fired thermal power plants in addition to the 25 that are already in operation. This situation clearly contradicts the 2015 G20 decision to support the transition to clean energy and the Paris Agreement target of keeping the total global warming at 1.5°C in accordance with the party countries' emission limitations to reach the goal (Weiner 2018).

With the new policy, Turkey is now also trying to focus on alternative ways to decrease the country's dependence on foreign resources. The government supposes that these objectives are achievable with the inclusion of more indigenous sources, be they renewable or nuclear. In the long term, Turkey therefore aims to consolidate its position among the energy-rich countries in the region by also increasing its storage capacity. In the Turkish National Action Plan for Renewable Energy, hydroelectric plants and geothermal energy are the leading sources of renewable energy capacity (Weiner 2018).

3.2 Renewable Energy Resources Area Regulation (YEKA in Turkish)

Within the scope of the National Energy and Mining Policy, in the scope of the "More Domestic and More Renewable" approach, by creating large-scale renewable energy resource fields (RERFs), Turkey will face issues such as the active and efficient use of renewable energy resources, the rapid realization of investments by allocating these areas to investors, and the production of the high-technology parts used in generating plants based on renewable energy resources, made or provided domestically, and the contribution to the provision of technology transfer. The RERFs mean the addition of a large solar energy capacity to the total national capacity (YEKA RES-1 Bilgi Formları 2019).

The share of the renewable energy capacity in the total capacity will increase rapidly. The production in daylight hours will have a decreasing effect on the peak of consumption. This production, which will result in a decrease in the mismatched capacity in the balancing and settlement system, may have a decreasing effect on spot market prices. This may have a negative impact on power plants using conventional welding (PWC 2018). The aim of the regulations is to allow efficient and effective use of renewable energy resources, opening new land for renewable generation, and streamlining the tendering process, thereby providing for mega-projects in contrast to the previously enacted small-scale projects. These large-scale operations will provide Ankara with an improved chance of meeting its 2023 targets (Wilson 2018).

For the wind industry, 2018 was completed with the preparations and permitting processes. The preliminary license and construction permit processes of the projects that won their bids in 2017 were completed. On September 29 2018, the final areas of the Renewable Energy Resource Areas (RERF) 1 project were officially announced. At this stage, the project sites have been clarified as 406 megawatts in Kırklareli, 294 megawatts in Edirne, 160 megawatts and 90 megawatts in Sivas and 50 megawatts in Eskisehir. Permissions will be obtained within 24 months and the licensing process will be started. Each project is expected to be operational within 36 months (Çağatay 2019).

In the first half of 2018, 140 megawatts were produced; for the second half, the data are not clear, but the expectation is that the 300-megawatt plant will become operational. In 2018, a total of 400–450 megawatts was in operation. “If the decision regarding the capacity increases expected by the sector is announced within the first three months of this year [2019], the installed capacity is estimated to be 7 thousand 400 megawatts at the end of 2019 and exceeds 8 thousand megawatts” (Çağatay 2019).

3.3 Geothermal Energy

Geothermal energy is a renewable underground energy source that is clean, cheap, and environmentally friendly. Turkey has a rich position among the countries of the world in terms of geothermal energy, since it is located on an active tectonic belt due to its geological and geographic location. There are many geothermal sources at different temperatures, with around 1,000 natural outlets spread all over the country. The geothermal potential of the country is quite high: Western Anatolia holds 78% of the potential resources, 9% are in Central Anatolia, 7% are in the Marmara region, 5% are in Eastern Anatolia, and the remaining 1% are spread across other regions.

Of Turkey's geothermal resources, 90% are low and medium temperature and are suitable for direct applications (heat, thermal cures, mineral production, etc.), and the remaining potential 10% are suitable for indirect applications (electricity production). Geothermal energy exploration has accelerated since 2004, and drilled geothermal energy explorations have increased from 2,000 m to 28,000 m; these studies have discovered high-temperature geothermal resources reaching 287.5°C. Geothermal energy generated 6.1 billion kWh of electricity in 2017. As of the end of June 2018, the installed capacity of Turkey's geothermal plants was 1.144 MW (Republic of Turkey Ministry of Energy and Natural Resources 2018).

3.4 Hydropower

The theoretical hydroelectric potential of Turkey country is 1% of the theoretical potential of the world, and its economic potential is 16% of the European economic potential. This theoretical potential is 433 billion kWh and is one of the most significant possible sources for the country. The technically feasible potential is 216 billion kWh and the economic hydroelectric potential is 140 billion kWh/year. In 2017, hydroelectric power generated 58.2 billion kWh of electricity. As of the end of June 2018, 636 hydroelectric plants (HEPs), which have 27.912 MW of installed capacity, corresponded to 32% of the total installed power in Turkey (Republic of Turkey Ministry of Energy and Natural Resources 2018).

3.5 Wind

Variable surface temperatures cause the temperature, humidity, and pressure of the air to be different, and this different pressure causes air to move. Around 2% of the solar energy that reaches the earth is transformed into wind energy. The characteristics of the wind vary temporally and locally depending on local geographical differences and the inhomogeneous warming of the earth. Two parameters express the wind: speed and direction. The wind speed increases with height, and the theoretical power changes in proportion to the cube of its speed. In spite of the disadvantages of wind power-based electricity generation applications, such as high initial investment costs, low capacity factors, and variable energy generation, the main advantages are the following:

It is a source of renewable and clean energy, and also it is environmentally friendly. There is no risk of depletion and price increase over time. Its cost has been able to compete with today's power plants. The costs of maintenance and operating are low. The technology is relatively simple to install and operate. Commissioning can take place in a short time (Republic of Turkey Ministry of Energy and Natural Resources 2018).

By 2017, wind power plants produced 15,369,548,000 kilowatt-hours of electricity. The first wind farm in Turkey began operation in 1998 in Izmir. Approximately 6.3% of the energy consumed today comes from wind power plants. Some of the 180 power plants in commission have not yet reached the installed capacity of the license, and the construction is continuing. In this context, the additional capacity of the power plants with a capacity of 409 MW will enter operation and the installed capacity will reach 7,008 MW (Energi Atlasi 2018).

With the help of 1 gigawatt (GW) from the Turkish Renewable Energy Resource Zone Project (YEKA) along with finalized wind energy tenders of around 3 GW, Turkey's investment reached around \$5 billion in 2017 alone. In terms of installed capacity, the Izmir province on the Aegean coast ranked first, with 1,333 MW of total installed capacity. Balıkesir, in the Marmara region, followed, with 1,069 MW, and the Aegean territory of Manisa was responsible for 650 MW of capacity (Hurriyet Daily News 2019).

3.6 Solar

According to the Turkey Solar Energy Potential Atlas (SEPA), there are 2,741 hours of annual sunshine (a daily average of 7.5 hours), and the annual total incoming solar energy amounts to 1,527 kWh/m² per year (a daily average of 4.18 kWh/m² per day). When the right investments are performed, Turkey, which has a very high average of 110 days of sunshine duration, is likely to turn into a fertile market for solar energy. The location for building the solar power plant will be an area of 6,000 hectares in the Yaka region, approximately 1 kilometer from the town center of Karapınar District (Republic of Turkey Ministry of Energy and Natural Resources 2019). The government will establish a photovoltaic solar module production plant with an annual capacity of 500 megawatts and an R&D center and will build a solar power plant with 1,000 megawatts of electricity. In addition, it will establish an R&D center, with planned activities for 10 years (ntv.com.tr 2019).

Turkey had reached seventh place in Europe and 13th place in the world in terms of solar production at the end of 2017. Many countries have abandoned their energy production methods that cause environmental pollution and now use solar energy for their investments. Turkey has also continued to take steps in this direction. Private companies are making investments in solar energy production systems, which are becoming increasingly important. People prefer solar energy because of its cleanness and low system price and its environmentally friendly structure (Petroturk 2019).

By the end of 2017, the expected total installed power was 82 MW in Turkey. There was a belief that the proportion of renewable energy would rise while the imported carbon-based fuel usage would decline. Unfortunately, that was not the case. Estimations have indicated that the total installed capacity of solar power-producing power plants will reach 2400 MW. The total licensed solar projects during 2017 amounted to 52 MW. Currently solar investment is possible at a low cost. The costs of solar investment are currently very low. In 2005, Law No. 5346 introduced incentive measures to encourage such investment. The guaranteed sale prices then were 5.00–5.50 \$ cents per KW/hour, while they were \$13.30 per KW/hour in 2010 (Direskeneli 2019).

3.7 Offshore Wind Potential

The expectation is that the RERF offshore wind power plant, for which the Ministry of Energy and Natural Resources is responsible, will generate an investment volume of between \$2 billion and \$3 billion depending on the changing technology costs. The largest offshore naval base in the world, which Turkey will establish, depending on the changing technology investments, will carry the distinction of being a wind power plant, and projections have indicated that it will cost between \$2 billion and \$3 billion; schedules have predicted 2023 as the date for the first electricity production from the property.

According to the RERF wind power plant specification, companies could submit their final applications for the power plant tender until 12.00 on 23 October 2018. The announcement of the tender will occur after the examination of the applications, and the investors will compete with the auction price of a ceiling of 8 dollar cents per kilowatt hour. Offshore wind energy power plants, which Turkey will hold for the first time, especially in the Thrace region, will provide the facility of “making production at the point of consumption” without the need to use land areas to meet the high energy needs. Within the scope of the project, which will use the seas more effectively in Turkey’s engineering efforts, the investor will implement “on-the-job training” with trained skilled laborers. Trained staff will gain competence in both national and international offshore platforms, including seismic studies with oil and gas exploration platforms (Haber Turk 2019).

4. CLIMATE CHANGE AND RENEWABLE ENERGY

Extreme weather events, increasing droughts, and widespread health problems all over the world stand before us as vivid evidence that climate change is already taking place. This situation is not very different from the perspective of Turkey. The geography of the country and the Mediterranean basin puts them among the most risky regions for scientists. This global threat, which is disrupting thousands of years of nature, is an area of action that affects not only the environment but also the life forms that exist, as well as the economy, and it concerns all the layers of society (Bagatir 2018). According to the Paris Summit and Paris Climate Accord, Turkey has to decrease its CO₂ emissions by around 20% by 2030. It is notable that, between 1990 and 2013, Turkey’s emissions grew by more than 100%. Using more renewable energy in the Turkish domestic energy basket would help Turkey to decrease its CO₂ emissions and succeed in reaching the Paris Climate Accord targets (Hurriyet Daily News 2018).

5. EMPLOYMENT OPPORTUNITIES IN RENEWABLE ENERGY

The main objectives of the energy policy in Turkey are open and clear: to meet the continuous demand, which is increasing every year, and especially to break the dependence on imported sources, including natural gas. To achieve these objectives, the 2009 Energy Market and Supply Security Strategic Document aimed to evaluate all lignite and hard coal resources within the country for the purpose of electricity production. The Ministry of Energy expects that, as of today, coal produces 27% of electricity; it anticipates that this rate will increase to 31% in 2030. In this context, the fifth-highest regional subsidies from the Ministry of Economy support investments in coal mining and coal-generated electricity (World Wide Fund for Nature 2019).

With the investments made in the renewable energy sector, employment will increase. They will support training in this field and the establishment of a qualified workforce together with various arrangements. Over the long term, a reduction in Turkey's dependence on foreign energy, alongside a reduction in energy bills, will provide great benefits in terms of national income, employment, the environment, investment, and naturally the diversification of energy sources, leading to energy security. Thus, Turkey will be able to become a self-sufficient country in addition to a trading hub (Direskeneli 2019).

By the end of 2017, approximately 84,000 people worked in the renewable energy sector in Turkey, largely in the solar industry. By comparison, the entire legacy electricity and gas sector employed a total of 819,000 people—and only one-third of that number had direct employment. Greater economic activity and new employment opportunities will arise from local requirements, but it is necessary to temper these against the necessary upfront costs in creating a new home manufacturing base. To avoid deficits and delays, stakeholders in the Turkish market should be mindful of all these factors when designing the country's energy transition (Saygin, Hoffman, and Godron 2019).

6. TURKISH ENERGY TRANSITION 2.0

According to Alparslan Bayraktar, Deputy Minister of Energy and Natural Resources of Turkey:

The points discussed above refer to previous developments and achievements, but the reality is that Turkish energy markets are still in a transition period. Liberalization and intensive investments are ongoing amidst climate change challenges and sustainability and security concerns. The Ministry of Energy and Natural Resources announced a detailed policy in 2017: The National Energy and Mining Policy (NEMP). This new approach brought by these policies marks the second transition period, Transition 2.0, of the Turkish energy market. This policy clearly gives detailed information about the strengths, shortcomings, threats, and opportunities of the Turkish energy sector. Based on detailed analyses, NEMP was established based on three main pillars: supply security, localization, and predictability in the markets (Bilgin 2018).

7. CHALLENGES

Turkey has good potential in renewable energy, but the major challenge for Turkey is to find a way to deliver the potential by 2023. According to the official statistics, Turkey needs \$60 billion of financial capital to achieve the goals that the strategy has set forth (Wilson 2018). Thus, it is vital that Turkey includes foreign companies in megaprojects, allowing not only for knowledge transfer but also for the sharing of the financial responsibilities. In 2017, many of the world's largest renewable energy companies participated in Turkey's two large tenders, and Ankara's success depends on maintained interest from major global players. Therefore, Turkey must continue to offer secure investment, extended use of smart grids, and further liberalization of the electricity market (Wilson 2018).

The International Finance Corporation (IFC), a member of the World Bank Group, estimated that, by 2020, the Turkish renewable market will have attracted \$28 billion of investments. The interest among overseas investors, despite Turkey's status as an energy importer, is slowly increasing as it aims to expand its renewable energy output (Daily Sabah 2019).

Across the infrastructure, green buildings, and waste management, Turkey expects \$47 billion of eco-friendly investments. It will spend around \$18.6 billion on new green buildings in line with the country's rapid industrialization and urbanization. Additionally, environmentally friendly investments in the transport industry will come to the fore, including a minimum of \$24 billion for investment in low-carbon transportation by 2020 (Daily Sabah 2019).

It is obvious that there needs to be a considerable effort to accelerate the transformation when it is analyzed in terms of financing. According to the sustainable development scenario in the report, an average annual investment of 3 trillion dollars is needed between 2017–2040 in the energy sector. Today, the amount of investment in the energy sector is 1.8 trillion dollars. As in the world, the biggest question mark for Turkey is how to provide for the funding of energy conversion. For financial sustainability, both public and private sectors need to increase their financial resources. The transformation in energy will be realized only by the decisions of the governments and the policies they will implement and with the participation of all energy sector stakeholders (Haber Turk 2018).

There are some scholarly works that propose methods to the Turkish Government to eliminate the financial barriers to achieving its goals in the energy sector. According to one of these reports, "The electricity demand outlook and financial institutions' appetite for financing renewable energy projects may have improved dramatically since the global financial crisis, but financing conditions remain difficult for investors" (Haber Turk 2018).

It has not been easy to finance investments in the Turkish renewable energy market. It has not been possible to obtain non-recourse loans, and the Turkish government has secured projects against their own assets, with repayments coming directly from the profits. However, the financing conditions have become much stricter. Although banks issue limited-recourse project finance loans, the all-encompassing price and completion guarantees that accompany them make these loans equivalent to full-recourse corporate finance loans (PWC 2018).

The new YEK Mechanism is unlikely to improve the terms of financing considerably especially for hydro and wind plants,

- For financing renewable energy projects, development and national banks are other sources.
- "Step-in rights" are provided by the Turkish legislation provides to financiers, but financiers do not think this provision sufficient
- With the spot market prices considered too low due to a supply glut and the YEK Mechanism offering no attractive alternative, the ability to conclude longer-term bilateral power purchase contracts will help project sponsors in their efforts to obtain financing (PWC 2018).

The renewable energy and climate plans in Turkey are ambitious; however, overlapping strategies and a singular focus on 2023 curtail the long-term visions. Large-scale efforts to deploy low-carbon technologies for transport, heating, and cooling have not yet accompanied the progress in renewable energy electricity generation (Saygin, Hoffman, and Godron 2018).

Turkey has another issue with its renewable energy policy: the dangerously high amount of hydroelectric power plants in installed renewable power. These power plants have almost the same regulatory and environmental problems as traditional coal-fired power plants. Turkey must act quickly to restructure its energy policy to make it more local and environmentally friendly (Hurriyet Daily News 2018).

As a report released by American Progress indicated, Turkey needs to act to achieve successful energy transition. If Turkey is to reach its target to reduce its dependence on foreign energy resources, it needs to have cooperation between all the organizations in charge of energy and regulation and set a new platform for it. Turkey must

- plan for power system transformation;
- combine the benefits of large- and small-scale investments;
- drive innovation in technology and enabling systems; and
- utilize the potential of renewable energy sources and energy efficiency in the transport, heating, and cooling sectors (Saygin, Hoffman, and Gordon 2018).

According to Alparслан Bayraktar, the Turkish Deputy Minister of Energy and Natural Resources, Turkey must pay more attention to the points below if it wants to have successful energy transition:

- Activities such as offshore exploration of oil and natural gas will go on. In the near future, Turkish Petroleum will be more active in drilling operations.
- National oil and gas exploration and production companies to become very active through international partnerships are expected.
- Foreign investors have recently attracted to assets. Therefore, many mergers and acquisitions are expected to occur in the near future (Bayraktar 2019).

Turkey's approach to new projects is based on three main principles according to which all stakeholders should mutually benefit and all risk allocation should be fair. More importantly, any project should contribute to Turkey's national and regional supply security and to regional peace, stability, and prosperity (Bayraktar 2019).

8. CONCLUSION

Policy makers must make sure that they achieve environmental sustainability in Turkey, as it plans to join the EU and become one of the 10 largest economies in the world. Additionally, as an alternative to fossil fuels, upgrading non-carbohydrate energy consumption can be a solution to Turkey's environmental pollution and reduce the impact of urbanization and industrialization on CO₂ emission levels. In this regard, Turkey should apply environmentally friendly taxes (Korkut Pata 2018, 1122).

Kilickaplan et al. (2018) stated that it is possible to achieve 100% renewable resources for Turkey with competitive costs by 2050, which fully complies with the Paris COP21 Agreement. Turkey's different geographical regions offer a wide range of valuable RE resources that it can exploit with RE technology capabilities. Examples include

hydroelectric power in east and southeast Anatolia, wind and geothermal energy in the Aegean region, and solar PV in all areas. Solar PV electricity is emerging as the biggest contributor to fulfilling Turkey's growing energy demand, supplying about 43.2% of the total demand by 2050.

Even with the launch of the first phase of the SGC in 2018, 10 BCM shows very little market share coming to Turkey in the relatively short term. There are market changes that can hinder it the long term (Austvik and Rzayeva 2017).

Public investment and management dominate energy development in Turkey. Although the current government wants to complete the liberalization, reconstruction, and privatization process in the energy sector, it has made no decisive progress so far. However, this does not mean complete withdrawal of the state from energy development. Indeed, government involvement in the formulation and implementation of favorable policies for the development of renewable energy is critical. If the government wants to ensure timely and effective investment in renewable resources, it must mobilize the extensive financial resources available to the private sector and incentivize the projects for the private sector (Yoshino, Taghizadeh-Hesary, and Nakahigashi 2019). A number of renewable energy projects, such as some special thermal power plants and solar energy, are currently commercially attractive to private interests (Yüksel 2010, 1475).

The key challenge is that renewable energies are changing the conditions for the sake of international energy affairs. Since it is likely that fossil fuels are geographically less uniformly distributed than renewable energy sources, the economic and security benefits of access to energy are evenly spread across countries, with fewer risks associated with major shipping points. In addition, there are fewer reasons for great powers to compete in valuable places. In short, international energy affairs are not about places and resources and hence they are not geopolitical. As renewable energy sources are abundant but scattered, their absorption, storage, and transportation technologies will become increasingly significant. Therefore, there may be a shift in international energy competition from controlling physical resources, their locations, and their routes to controlling technology and intellectual property rights (Overland 2019, 38).

The policy decisions for accelerating the energy transition must be consistent with the active infrastructure development. Infrastructure planning is especially important at first because of the carbon lock-in effect due to its long lifespan and inactivity. It is necessary to pay more attention to the emerging infrastructure, the distribution of network amplifiers, and the changing role of the demand and smart grids. It is also crucial to fund both the energy generation capacity and the infrastructure through rigorous policies that create a credible, predictable, and transparent investment environment (Gielen et al. 2019, 48).

The diversification of the energy consumption basket and the expansion of the energy trade with different countries favor energy security (Taghizadeh-Hesary et al. 2019). Because of the diversification of energy sources and the amount of dependence on external sources, the maintenance of safe energy sources and growth of renewable energy sources are vital. The share of renewable energy alongside other sources in Turkey is critical. There are many steps that Turkey must take, and it must act in accordance with the global perspective on renewable energy. The steps to meet the energy needs from renewable sources are thus:

- Improving the financial competitive power of renewable energy sources;
- Growing renewable energy sources simultaneously;
- Facilitating processes related to administration to integrate renewable energy sources into the national grid;
- Removing the technical barriers to electrical network connections.

The government should provide incentives to produce renewable energy sources, especially solar and wind energy (Erdil and Erbiyik 2015, 676). By investing in a low-carbon and resilient future, it will be possible to mobilize local resources, strengthen the energy supply security, ensure that trade is more balanced, produce new economic activity areas, and increase employment. This will also improve the environmental quality. Stating that the most important point is stable and sustainable growth, Hakman pointed to the report and added that we should not condemn the world to a high-carbon future to support economic growth and increase productivity (Iklim Haber 2019). The results of a study that Kilickaplan et al. (2018) conducted are consistent with Turkey's energy policy by eliminating energy resource imports and increasing the system stability from a financial and environmental perspective.

Sustainable development requires the provision of sustainable sources of energy without adverse environmental and social impacts. To achieve these goals, renewable energy facilities can play a crucial role without causing negative environmental effects. In the coming years, to meet the energy demand, Turkey should establish a systematic hydrogen energy market.

There must be incentives to invest in the production of hydrogen from the Black Sea. The country must set energy and environmental policies related to the cost of external energy, such as air quality and global climate change. All sectors, such as energy, urbanization, agriculture, industry, and tourism, must develop an awareness of sustainable development (Ozturk and Yuksek 2016).

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