



Turkey's Energy and Climate Change Policy

Kamil Kaygusuz^{1,*}, Ethem Toklu²

¹Karadeniz Technical University, Department of Chemistry, Trabzon, Türkiye

²Düzce University, Department of Mechanical Engineering, Düzce, Türkiye

Accepted 12 December 2023

Abstract

The problem of energy use and availability is common, to a greater extent, throughout the whole world. Turkey as an industrialized country depends heavily upon fossil fuels for its industrial processes. Energy input always produces some measure of pollution, since waste products occur along with the desired goods. Turkey should change its energy policy from fossils to renewables and clean energy technologies such as nuclear, wind, solar, geothermal and biomass energy. This will help relieve the economy by reducing energy importation, protect the environment by reducing carbon emissions, and provide energy independence. Turkey's total gross renewable energy potential is about 650 billion kWh annually while the economical potential was about 340 billion kWh/yr. This paper discusses Turkey's energy and climate change policy

Keywords: *Renewable energy; sustainable energy policies; climate change policy; Turkey*

1. Introduction

The Fifth Climate Change Assessment Report has shown that climate change is a reality and humans are causing further acceleration in the process.¹ According to the report, driven mostly by economic and population growth in the last decades, anthropogenic greenhouse emissions are higher than ever, especially compared to the pre-industrial era. Due to human actions, the atmosphere and ocean have warmed, the amounts of snow and ice have also diminished, and sea level has risen more than ever.² This, in turn, causes long-lasting changes in the environment, "increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems", as the report says.³ For all the reasons above, the fight against climate change has been a critical endeavour, although not observed enough by masses until lately.⁴ For several decades, Turkey has been taking part in the global efforts to fight climate change and adapt to its effects. Turkey has been a party to the UNFCCC, which aims at stabilising greenhouse gas concentrations at a level that would prevent dangerous anthropogenic interference with the climate system [1-7].

As a country located in the Mediterranean Basin, Turkey is highly vulnerable to climate change [8].

Turkey has already started to face a warming trend in temperatures above seasonal normals, floods caused by heavy rainfalls and the threat of water scarcity. The effects of climate change have been showing themselves in the last decade more frequently. It should be mentioned that the frequency of extreme temperature and natural disasters has increased in Turkey in the last few years. The biggest disaster observed in Turkey took place in July 2017, when buildings got damaged, streets flooded and trees knocked down in Istanbul due to heavy rain, large hail, and strong winds [9-12].

Like everywhere else in the world, Turkey has been experiencing extreme temperatures as well. According to the Turkish State Meteorological Service, the average temperature in November 2019 increased to 12°C, compared to the average normal temperature of 9°C. The region that got most affected by this increase was the Marmara Region, which hosts the majority of the country's population.⁸ It indicates that the average temperature in November 2019 was almost 5°C above the normal values. The air quality has also gotten worse due to the extreme changes in the temperature. The autumn temperature anomalies were stated to be exceptionally above normal with 2°C. This article will analyze Turkey's

* Corresponding author. E-mail: kamilk@ktu.edu.tr

energy policies after Paris Agreement for energy security and nature conservation. The article discusses the following topics: Turkey's energy situation, renewable energy sources, environmental impact due to energy consumption, climate change mitigation and energy security [13].

2. Turkey's Position on Significant Climate Agreements

2.1. Kyoto Protocol

The Kyoto Protocol was adopted at the third Conference of the Parties to the UNFCCC (COP3), following the negotiations initiated by the member countries of the UNFCCC, to encumber countries to reduce their greenhouse gas emissions below levels specified for each of them. The protocol required developed countries to reduce their greenhouse gas emissions below levels specified by them [6]. However, the Protocol meant to stabilise greenhouse gas emissions through non-binding commitments. Turkey was not among the first countries which have ratified the Protocol [7]. It was because Turkey, as a member of OECD, was included in both Annex I and Annex II of the UNFCCC together with the developed countries when it was adopted in 1992. According to Annex I, Turkey had to make a commitment to reduce its emissions unconditionally; and had to provide financing and technology transfer to the developing countries according to Annex II [8].

However, claiming to be a "developing country", Turkey objected to the obligations developed countries had to meet according to the Convention. For this reason, Turkey continued to negotiate in order to have its name removed from both Annex I and Annex II for years, however this request was denied every time.⁹ Turkey, deciding to try another strategy, claimed to be in the early industrialisation phase and proposed to be removed from only Annex II, under the "common but differentiated responsibility" principle at the COP6 in 2000. Turkey became a party to the UNFCCC as the 189th member on 24 May 2004, in a position different from other Annex I countries. Turkey could only become a party to the Kyoto Protocol, however not taking a part in the Annex B of the Protocol, it did not undertake any emission reduction commitments [9-13].

2.2. Paris Agreement

The COP21, realised in Paris on 12 December 2015, turned out to be a milestone for the fight against climate change. It was the conference in which the landmark agreement for climate change, Paris Agreement, was opened for signature among the leaders of more than 170 countries. The main

purpose of the Agreement was to limit the global temperature increase to below 2°C above preindustrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels by 2100. The agreement encumbers its parties "common but differentiated responsibilities": while developed countries must lead the way in terms of absolute greenhouse gas emission reduction and should financially assist the most vulnerable countries, developing countries are expected to enhance their reduction efforts depending on their circumstances [6-9].

The agreement also aims to provide a solid transparency framework in order to enhance the transparency of the actions taken and assess the global collective efforts every five years. Hence, it would be easier to achieve the Paris Agreement goals [15]. Turkey is also one of the signatories of the Paris Agreement. According to its Intended Nationally Determined Contribution (INDC), Turkey has pledged up to 21% reduction in its greenhouse gas emissions from the Business as Usual level by 2030 [12-15].

As it can be seen in Figure 1, Turkey basically pledges to reduce the increase in its greenhouse gas emissions, compared to the business-as-usual scenario, which suggests a very weak ambition. In fact, Turkey's Intended Nationally Determined Contribution (INDC) has been severely criticised by many for lacking ambition. According to Climate Action Tracker, Turkey's INDC is critically insufficient as it is not consistent with the Paris Agreement's goal of holding global warming to below 2°C. It is also important to mention that if all governments put forward commitments in the same range as Turkey's, it is expected that global warming would exceed 4°C [13].

Turkey recognises climate change as a threat and remains committed to the Paris Agreement unlike countries ruled by climate deniers such as the US and Brazil. Turkish Minister of Environment, Urbanization and Climate Change Murat Kurum also underlined Turkey's commitment in the COP25, by saying "This is a long-term process, but no matter how the negotiations are concluded, we will continue to stand on the side of the world is concerned with climate change" [5-8]. While this is a positive development, Turkey has a long way to go. Since the other developing countries do not look at Turkey's Access to Green Climate Fund favorably, Turkey should start to look for alternative ways to achieve an ambitious climate goal. UN Secretary-General

Antonio Guterres and COP₂₅ President Carolina Schmidt had said before that they would help Turkey access other sources of finances in case the Green Climate Fund is unavailable for Turkey. Figure 2

GHG Emissions and sinks by sector, 1990-2018. Table 1 shows Turkey’s greenhouse gas emissions by the years [5].

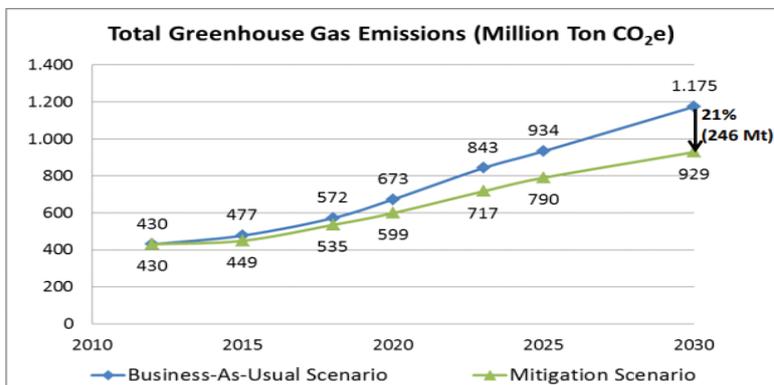


Figure 1. Turkey’s present and future total greenhouse gas emissions (MtCO₂-eq).

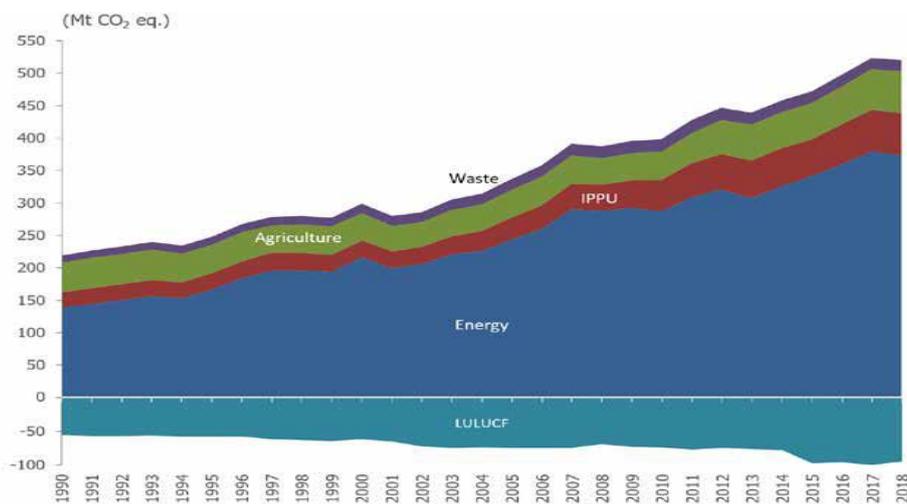


Figure 2. Turkey’s GHG Emissions and sinks by sector, 1990-2018

Table 1. Greenhouse gas emissions in Turkey (MtCO₂-eq)

| | 1990 | 2000 | 2010 | 2015 | 2018 |
|------------------|-------|-------|-------|-------|-------|
| Total Emissions | 219.4 | 298.8 | 398.9 | 472.6 | 523.5 |
| CO ₂ | 151.5 | 229.8 | 314.4 | 381.3 | 420.4 |
| CH ₄ | 42.4 | 42.6 | 51.4 | 51.4 | 58.1 |
| N ₂ O | 24.8 | 24.7 | 29.6 | 35 | 39.2 |
| F-gases | 0.6 | 0.8 | 3.6 | 4.9 | 5.8 |

3. The current energy situation in Turkey

As stated earlier, the energy sector is the main culprit behind the rising greenhouse gas emissions trend in Turkey [9-12]. In 2018, the energy sector solely was responsible for about 71.6% of all greenhouse gas emissions. According to the Turkish Ministry of Energy and Natural Resources (MENR), total primary energy consumption amounted to 146.5 million tonnes of oil equivalent (Mtoe) in 2020.

Turkey was the 18th biggest consumer of total primary energy in the world; it was also the 5th biggest consumer in Europe. Accordingly, the share of total primary energy consumption in Turkey was 1.1% in the world. The total primary energy consumption grew by 0.5% in 2018, compared to the 2017 levels. Table 2 shows Turkey’s energy production and consumption in 2020 (Mtoe) [15-18].

Table 2. Turkey's energy production and consumption in 2020 (Mtoe)

| Energy source | Production | Consumption |
|----------------------------|------------|-------------|
| Hard coal | 0.64 | 25.54 |
| Lignite | 14.15 | 14.15 |
| Oil | 3.36 | 34.20 |
| Natural gas | 0.38 | 40.10 |
| Hydropower | 6.72 | 6.72 |
| Geothermal (heat/electric) | 10.58 | 10.58 |
| Wood & Wastes | 3.40 | 3.40 |
| Wind | 2.14 | 2.14 |
| Solar | 1.80 | 1.80 |
| Total | 43.17 | 138.63 |

Mtoe: Million tons of oil equivalent

On the other hand, the consumption per capita was relatively smaller in Turkey than that of many European countries and both developed and developing countries. In fact, the table demonstrates that Turkey is one of the European countries with the lowest primary energy per capita consumption. The consumption per capita in 2020 was 76 GJ per capita. When the consumption is sorted by fuel, it can be seen that Turkey consumes fossil fuels (oil, coal and natural gas) quite more than renewables. According to the MENR, oil was the most preferred primary energy power (34.1 Mtoe) in 2020, followed by coal (39.7 Mtoe) and natural gas (40.1 Mtoe). While the share of oil and natural gas dropped in 2020 compared to 2017 due to Covid-19 pandemic. According to the MENR, Turkey's lignite reserve has increased over 11 billion tonnes since 2005 and reached 14.3 billion tons [18].

Turkey has begun to work on establishing nuclear power generation in the last few decades. Turkey already started the construction of its first nuclear power plant, Akkuyu Nuclear Power Plant, in 2018 with the cooperation of the Russian Federation and it is expected that the first unit of Akkuyu Nuclear Power Plant will be commissioned in 2023. Furthermore, Turkey signed an international agreement with Japan in 2013 for the construction of the second nuclear plant project which was supposed to take place in Sinop; however, the incompatibility in cost and project schedule with Japan and France resulted in the halting of the project. Despite some perceptions, this does not mean that Turkey has cancelled the project. While Japan has already withdrawn for the project, Minister of Energy and Natural Resources Fatih Dönmez indicated recently that the construction might continue in the case Turkey reaches into an agreement with another supplier in the future.¹⁰⁻¹⁸ The cancellation of the project was actually welcomed by the

environmentalists in Turkey, since nuclear power can also jeopardise the environment if handled wrong. Fukushima and Chernobyl accidents have been the biggest examples in this regard. Thus, Turkey must pay attention to some areas such as the safety of nuclear installations, protection against radiation, radioactive waste management as well as protection of nuclear facilities against malicious attacks [19-29].

Turkey also started the TurkStream gas pipeline will directly carry Russian natural gas to southern Europe through the country. It is expected that 16 billion m³ of gas will directly enter Turkey with no intermediate country. After that, another 16 billion m³ of natural gas are aimed to be transferred to the European market by using second pipe-line, especially south-eastern European countries such as Bulgaria, Greece, North Macedonia, Serbia and Hungary.²¹⁻²⁴ With the TurkStream project, Turkey aims at becoming a "regional energy hub" and ensuring the security of natural gas supply, while taking advantage of lower costs for natural gas imports. However, there are also some opinions which imply that it might jeopardise Turkey's supply security since Turkey would be even more dependent on Russian natural gas with the project. Moreover, Turkey has already started drilling operations for natural gas and oil in the Eastern Mediterranean in order to reduce its energy dependence on foreign resources [18].

Hydroelectricity is sometimes known to be renewable and climate-friendly domestic energy source and Turkey has consumed 6.7 Mtoe hydroelectric power in 2020. According to researchers, big dam projects can jeopardise the river ecosystems and fish population and they can harm the forests, wildlife habitat and agricultural lands. It also releases methane, a quite strong greenhouse gas emissions contributes to climate change eighty times greater than carbon dioxide over a 20-year period. In

torn, it is also affected by climate change and droughts: therefore it is possible to encounter energy supply security issues [20-29].

Most importantly, renewable energy has been playing a great role in expanding power generation in Turkey for the last decade. Turkey has a high renewable energy potential due to its good-climate geographical location. It could top the list of the countries with the renewable energy capacity by taking advantage of its solar, wind and geothermal energy potential. Also, as a waterstressed country, Turkey could benefit from renewable energies since it can meet its demand for electricity without consuming water and releasing greenhouse gas emissions.

Turkey’s climate change strategy demonstrates Turkey’s aim to increase the share of renewable energy in electricity generation to 70% by 2030. Within this framework, all the technical and hydraulic potential will be utilized, and 20,000 MW of wind power and 600 MW of geothermal power

generation capacity will be reached [30]. On the other hand, the Eleventh Development Plan of Turkey foresees that the share of renewable energy in electricity generation will go beyond the expected and increase to 39% [15-18].

According to the data given by MENR, the share of renewables in electricity generation has been increasing since hydroelectric power plants supplied 36% of the electricity generated in 2020, followed by wind power plants (8.8%), geothermal (3.6%), solar power plants (3.5%) and biomass (1.8%). With the potential Turkey has, it can further increase this share in the near future. Especially considering that the cost of installing renewable energy has new lows due to technology improvements. Figure 3 shows source-based development of licensed electricity generation by years. Also Figure 4 shows the distribution electricity generation by energy sources in 2020 [15-18].

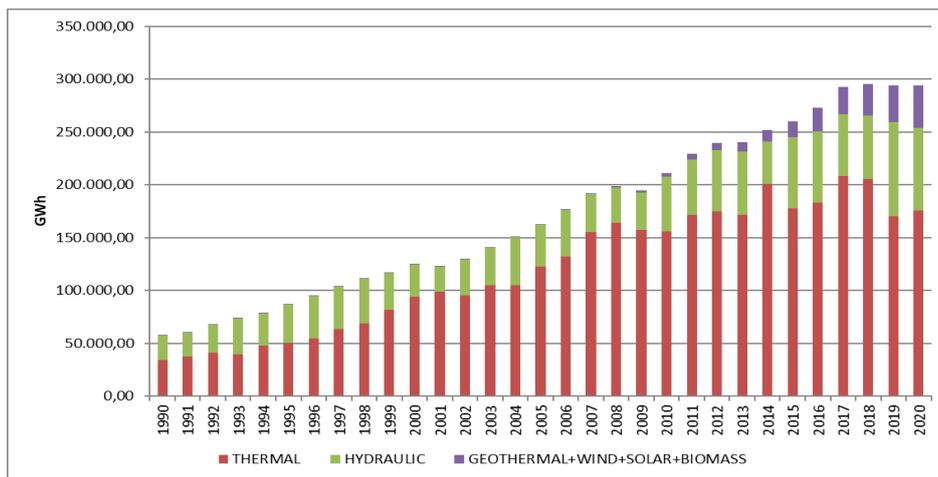


Figure 3. Source-based development of licensed electricity generation by Years (GWh) [17]

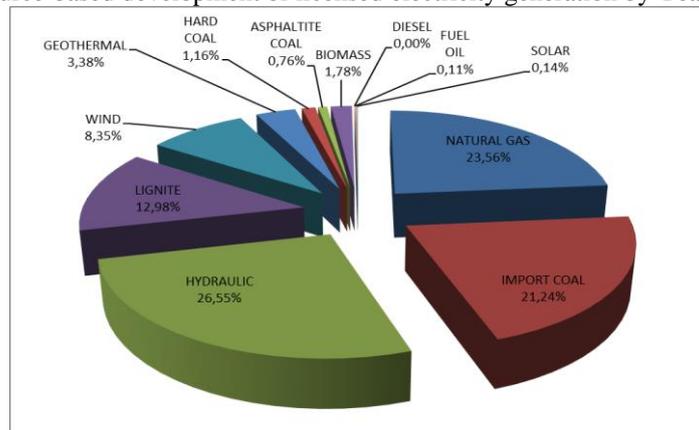


Figure 4. Turkey’s electricity generation by energy sources in 2020 [17].

In 2020, the Energy Market Regulatory Authority will start to implement “Green Tariff” aims at

providing electricity produced by only renewable resources. This way, the consumers will be able to

choose whether they want to use a more environmentally friendly alternative. However, the prices stemming from this tariff are expected to be higher than the current price tariff. In line with the Green Tariff, residential consumers are likely to pay 63% higher than the current price tariff, while businesses are likely to pay 23% higher [22]. The prices are on the expensive side at the moment however it is expected that they will “decrease with the support and incentives the country gives to the renewable energy sector” [23]. These could create great opportunities for Turkey to switch from fossil fuels to renewable, and thus drop the greenhouse gas emissions further [15-29].

wind, hydropower, biomass and geothermal energy, diversity of energy sources, liberalization of energy markets, and energy efficiency. The rapid pace of urbanization, the positive demographic trends, the economic expansion and rising per capita income are the main drivers of the energy demand. The energy demand is estimated to increase around 4 – 6% per year until 2030. The Turkish government has made it a priority to increase the share of renewable sources in the country’s total installed power to 30% by 2025 (see Figs. 5-7). Renewable energy has been one of the important topics on Turkey’s energy agenda. The Turkish government has made the last decade significant energy reforms. The significant progress that has been made in the field of renewable energy started after the enactment of the Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy (Renewable Energy Law, REL) in 2005 [15-29].

4. The role of renewables in climate change mitigation

4.1. Introduction

Turkey’s energy policies are based on energy supply security, renewable energy sources such as solar,

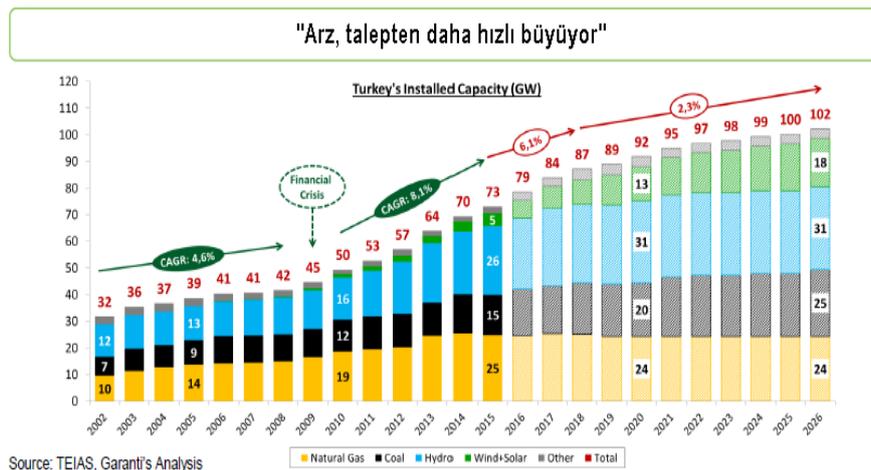


Figure 5. Turkey’s energy supply and demand by energy sources [29].

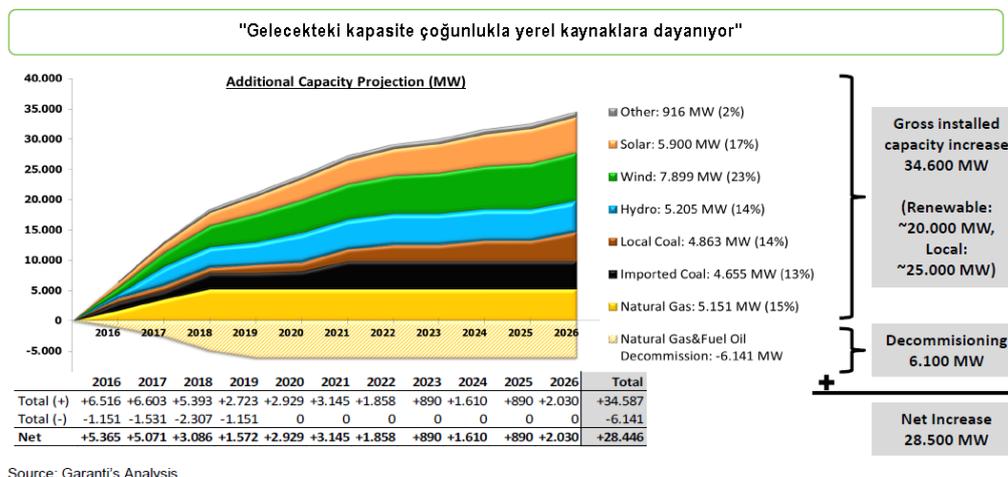


Figure 6. Turkey’s installed capacity by energy sources [29].

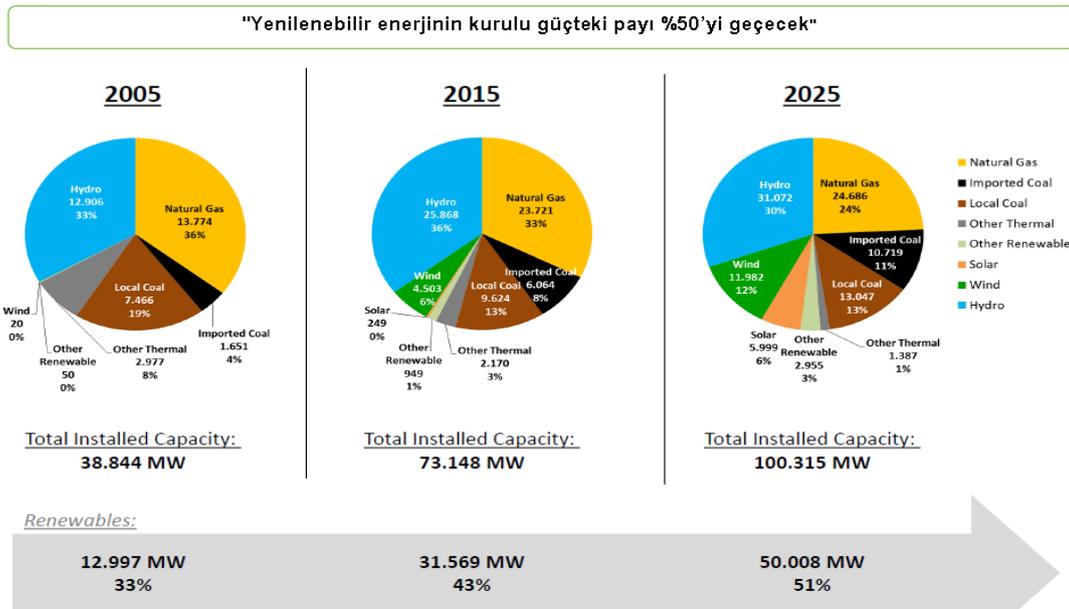


Figure 7. The share of renewable energy sources in total installed capacity for Turkey [29].

According to the Ministry of Energy and Natural Resources (MENR), the total amount of investments required to meet the energy demand in Turkey by 2030 is estimated to be around USD 120 billion. Turkey's ambitious vision for 2030, envisages especially interesting targets for the renewable part of the energy sector. These targets include:

- At least 35,000 MW installed capacity for hydropower plants;
- At least 20,000 MW installed capacity for wind power plants;
- At least 10 000 MW installed capacity for solar power plants;
- At least 3 000 MW_e geothermal energy; and
- At least 2 000 MW_e installed capacity for Biomass energy.

In Turkey, especially in the near past, losses in transmission and distribution and savings which could exceed 50% in some segments have been overlooked and policies trying to meet the increase in demand by new energy supply as well as protecting private sector benefits have been followed. Generally, imported energy sources were used to meet energy requirements and costly investments were made for imported fuels and external dependency in energy has increased significantly. In contemporary societies, energy policies and activities should target a supply of energy that would meet the requirements of citizens and community.

For a proper energy planning and programs aiming welfare of society, planning is a must.

So, this planning must be based on the concentrated use of more and more renewable energy resources. This planning studies are also considers energy consumption trends, demand side energy management and more efficient use of energy. It is known that manufacture of energy equipment locally, minimize negative effects to the environment and climate change, protection of rights and benefits of people living in regions where energy investments will be made and facilitate all these actions through participatory mechanisms [15-17].

In Turkey, the economy is fragile and facing serious crises every seven or eight years. So, the investors do not bother with detailed computations and believe electricity prices will always stay at high levels. On the other hand, the experience and management capacities of investors and even do not review feasibility of the projects for which bank finance is requested. In Turkey, it is assume that they are on safe side if the debtor provides secure guarantees. The Energy Market Regularity Association (EMRA) was rejected the planning concept and applications. Table 3 gives the number of Renewable Energy Resources Support (YEKDEM) participants by years in Turkey. As shown in Table 3, the hydropower projects are maximum which 463 participants and grand total was 821 in 2020. Table 4 also shows the distribution of renewable installed capacity by energy sources. Also, as shown in Table 4, the hydropower installed capacity is 12 435 MW in 2020.

Table 3 Number of YEKDEM participants by years [15-18].

| Energy source | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---------------|------|------|------|------|------|------|
| Solar | - | - | 2 | 3 | 9 | 17 |
| Hydropower | 126 | 388 | 418 | 447 | 463 | 463 |
| Wind | 60 | 106 | 141 | 151 | 160 | 165 |
| Biomass | 34 | 42 | 57 | 70 | 100 | 126 |
| Geothermal | 14 | 20 | 29 | 37 | 45 | 50 |
| Grand Total | 234 | 556 | 647 | 708 | 777 | 821 |

Table 4 Distribution of renewable installed capacity by sources (MW) [15-18].

| Energy source | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---------------|-------|--------|--------|--------|--------|--------|
| Solar | - | - | 12.9 | 13.9 | 81.7 | 162.7 |
| Hydropower | 2 116 | 9 960 | 11 096 | 11 706 | 11 589 | 12 435 |
| Wind | 2 732 | 4 320 | 5 239 | 6 200 | 6 496 | 6 440 |
| Geothermal | 390 | 599.2 | 752.1 | 996.8 | 1 253 | 1 438 |
| Biomass | 185 | 203.7 | 300.0 | 349.2 | 503 | 671.2 |
| Grand Total | 5 424 | 15 083 | 17 400 | 19 266 | 20 922 | 21 146 |

4.2. Hydropower

Turkey's theoretical gross-viable hydropower potential is 433 billion kWh annually and the technically-viable potential is 216 billion kWh. The economically viable potential, however, is 140 billion kWh. Annual energy consumption per capita in Turkey has reached 4,300 kWh. As of the end of 2021, 46% of the potential was in operation, and 30% was in the process of being built. Turkey continues to take steps towards developing the investment environment based on competition within the electricity generation sector, which has been opened up to the private sector, 800 licenses were obtained in 2021 with a total capacity of 14,615 MW for building hydropower plants [15-18].

In 2021, there were 746 hydropower plants, with a total installed capacity of 31, 500 MW. This is the equivalent of 43% of the total potential and 38% of our electricity output came from hydraulics. The maximum feed-in tariff price of electricity obtained from hydropower is 8.6 USD cents/kWh. On the other hand, run-of-river hydropower installed capacity of about 12,724 MW in Turkey. Approximately 50% of the additional potential of 41 TWh could be realized as small hydroelectric plants (SHP), with installed capacities of less than 10 MW. The share of SHP potential in the total, which is 3% at present, would be 14%.

4.3. Bioenergy

In almost all developing countries, biomass (bioenergy) provides the essential ingredients of life such as food, fuel, shelter, fodder, fibre, income and

among many others. In addition, biomass acts as an essential medium for sustaining the earth's ecological balance through by the photosynthetic process. Also biomass acts as a enrichment, conservation of natural vegetation and soils and production of long-term secondary energy fuels such as biodiesel and bioethanol. On the other hand, as a renewable energy source, biomass or bioenergy should, in theory, be able to meet all the requirements of its numerous competing uses, for as long as the balance between photosynthesis, resources extraction, biodegradation and resources regeneration can be maintained with a positive balance of resources [15-18].

Among the renewables, biomass seems one of the most interesting because its share of the total energy consumption in rural regions of Turkey is relatively high at 16%. In Turkey, the implementation of biomass-based energy programs will not, of course, be a definitive solution to the country's energy problem, but it will bring new insight for efficient energy use in the household sector, especially in rural areas where 33% of the population live (Turkey's total population is 85 million). The total biomass energy potential of Turkey is about 40 Mtoe. The amount of usable biomass potential of Turkey is approximately 18 Mtoe [18]. The electrical production from usable biomass has a net impact of 7.6 billion USD in personal and corporate income and represents more than 350,000 jobs [15].

In Turkey, there is a total 4 million ha of degraded coppice forests for energy forestry applications. The improvement of degraded coppice forests is a very

important activity, as important as forestation. Converting coppice forests into productive energy forests to meet the continually increasing fuel requirements prevents the destruction of highly productive forests. At the end of 2020, 724 ha of energy forest have been established. In Turkey, 34 biodiesel facilities received processing license for biodiesel production. Total biodiesel production capacity of all these facilities is 561,217 tons. The biodiesel production is 21,876 tons in 2013. Estimation at least 1.2 million ton/year biodiesel and 0.7 million ton/year bioethanol production capacity based on 2.7 million hectare agricultural land. Also, Turkey has 1.5 - 2 Mtoe biogas potential [15, 20, 25].

4.4. Solar energy

Turkey's solar energy potential is very good for both solar water heating and electricity generation. It is estimated that it has 4.2 hours of insulation time on average per day and 1514 kWh/year.m² solar radiation level in Turkey. The only available rooftop area for PV modules is 611 km² and energy gain from this area will be 90 billion kWh/year. Apart from this area, it is determined that the area which has more than 1650 kWh/m² irradiation level is about 4600 m² in Turkey. That means this solar energy potential equals to a natural gas plant with a power of 54,300 MW.

The hot water heating system installations cover about 14 Million m² surface. Turkey is the second big country at hot water heating systems all over the world. It is expected that there will be 3 million installations of private homes which has totally power of 3.000 MW. In addition, the target of installed PV power plant by 2020 is 20.000 MW. On the other hand, with a total new installation of about 1,765,100 m² of flat plate collectors and 968,300 m² of vacuum tube solar collectors in 2020.

Turkey's annual solar irradiation is 2,737 hours and about 7.5 hours a day. Simple solar collectors for hot water generation are pretty common especially in the countryside, but photovoltaics are still rather a rare sight. So far, solar systems with a total capacity of approx. 330 MW have been installed, almost 250 MW of which was last year. But now the sector expects stronger growth of the Turkish PV market. For this year an expansion of at least 500 MW is expected and 51 MW of new systems joined the grid. Reasons for the upturn are the further sinking costs, increased interest from local banks and investors, the currently due allocation of licenses for the construction of larger systems, as well as rising electricity prices and growing electricity demand.

The required investments in the Turkish energy sector by 2023 have been officially put at US\$ 130 billion [27-29].

4.5. Wind power

In Turkey, South of the Marmara region, coastal and some inner parts of the Aegean region, the eastern part of the Mediterranean and locations with rugged mountains in Eastern Anatolia have promising wind energy potential. Turkey has more than 48 GW economic wind capacity and wants to harness this huge potential via the private sector at a cost-effective manner. Turkey has the serious wind energy potential. Turkey has 11GW stock of the current Project and the capacity of 20 GW for the national goal in 2023 in terms of wind Energy, therefore, Turkey plays a vital role in the European market. In the future Turkey will probably play an important role in shaping the investment opportunities [27-29].

In Turkey, it was possible to produce annual energy of 22,807 GW/year from a total wind power plant area of 629 km² which corresponds to a 35.26 GW/year per 1 km². Turkey added 1750 MW of new wind power in 2021 for a total installed capacity of 10,963 MW. On the other hand, Turkey's best wind resources are located in the provinces of Çanakkale, Izmir, Balıkesir, Hatay and Istanbul. As of the end of 2014, the Aegean region had the highest installed wind capacity with a total of 1,486 MW, followed by Marmara region with 1,359 MW and the Mediterranean region with 543 MW [27-29].

4.6. Geothermal energy

Turkey is the seventh most promising country in the world in terms of geothermal energy potential. The western part of Turkey is an area of plentiful geothermal activity that undergoing significant exploration and exploitation, but with relatively little volcanism. With the new additions, there are more than 290 geothermal sites discovered in Turkey and approximately 95% of them are low-to-medium enthalpy sites mostly proper for direct-use applications. Even though the geothermal energy potential of Turkey was theoretically estimated as 31,500 MWt and recently increased to 60,000 MWt, the proved potential by drilling activities (4209 MWt) and natural discharges (600 MWt) is only 4809 MWt. As of today, 58% of the proved capacity (2705 MWt) is used for geothermal heating, consisting of residence heating (805MWt), greenhouse heating (612 MWt), thermal facilities heating (380MWt), balneological use (870MWt) and heat pump implementations (38MWt) [15-17].

5. Results and Discussions

As a country that is vulnerable to climate change but also has the capacity to fight with it, Turkey must take more climate action. Starting with more environmentally friendly and sustainable practises in both industry and agriculture; Turkey should place “sustainable development” in the centre of its growth strategy. For this to happen, Turkey must firstly ratify the Paris Agreement and update its climate and energy commitments in line with its goals. On the other hand, COVID-19 pandemic recently showed that it is actually possible to cut back greenhouse gas emissions in a short time. To avoid being infected by this disease, people had to stay home and abstain from traveling unless it was necessary, and factories had to either shut down or reduce their operations. Moreover, most countries closed their borders to the other countries, and domestic and international flights had to be suspended indefinitely. All these, in turn, led to the decrease in air pollution and greenhouse gas emissions.¹⁻¹⁰

According to the data of air quality measuring stations belonging to the Ministry of Environment and Urbanisation and several municipalities, the particulate matter (PM₁₀) air pollution rate in the 29 municipalities of Turkey decreased by 32% in April. Furthermore, the measures taken in the fight against COVID-19 led to a decrease in daily greenhouse gas emissions in Turkey by 17.4% as of 30 April 2020. However, these gains might be lost in the not too distant future. Minister of Environment and Urbanisation Murat Kurum stated recently that the six thermal power plants, which were shut down due to their lack of environmental investment in the beginning of the year, were granted one-year temporary working licenses. This has been criticised by several environmental organisations along with the Hunutlu Thermal Power Plant which is planned to operate in Adana. However, Turkey must stop investing in coal plants as soon as possible.

Climate policies are not prioritised by politicians in Turkey yet, however this is bound to change in the near future. A public opinion survey⁶⁶ on climate change perception shows that at least 60% of the citizens are concerned about climate change. Respondents are especially concerned about the climate disasters, as approximately 70% of them stated that climate disasters increased in the recent years. Furthermore, 52% of the respondents indicated that “the impacts of climate change are already being felt right now”, while 12% said that they will be felt in the upcoming 10 years. While concerned about the impacts of climate change, the majority of the

respondents do not believe that the central government exerts any effort to tackle it. According to the survey, only 16% of the respondents think that the existing efforts are sufficient, while 55% of the respondents find them insufficient.

On the road to sustainability, states are not the only ones who should act on the climate crisis. Local administrations, even the citizens have a role to play in the fight against climate change. The same public opinion survey also demonstrated that approximately 60% of the respondents think that local governments do not make sufficient effort in the fight against climate change. This is concerning since local governments cannot be excluded from the fight against climate change. On the contrary, due to the close proximity to its community, local governments can act rapidly and more accurately since they tend to be more knowledgeable about the community and the location they are responsible for. Especially considering that 94% of the population in Turkey resided in cities in 2021, which is quite above the global average of 56%, local governments also should put forward greenhouse gas emission inventories and strategies to tackle climate change. The first municipality to put forward a climate action plan in Turkey was Gaziantep Metropolitan Municipality. Gaziantep Metropolitan Municipality aimed at reducing its greenhouse gas emissions by 15% compared to the 2011 levels by 2023 by the means of this plan.⁶⁹ While some of the metropolitan municipalities such as Istanbul, Bursa, Antalya, Izmir, Kocaeli, Denizli, Kahramanmaraş, Hatay have published climate action plans, some of them (Erzurum, Aydın, Konya etc.) are in the preparation phase.

With a population of more than 15.5 million, which makes up about 19% of the entire Turkish population, Istanbul is known to be the biggest city of Turkey.⁷⁰ The capital city Ankara and Izmir follows Istanbul with the populations of approximately 5.6 million and 4.3 million inhabitants respectively. Thus, it is important for these cities to take action as soon as possible, along with the vulnerable cities that are on the Mediterranean coast. Since Istanbul is the city with the highest greenhouse gas emissions in Turkey, Istanbul Metropolitan Municipality has started to take a step in this regard. In line with this commitment, Istanbul Metropolitan Municipality has also pledged to increase its climate ambitions put forward by the previous administration. Before, Istanbul aimed to reduce the increase in its greenhouse gas emissions by 33% in 2030 compared to the business-as-usual scenario.

However, this was deemed to be insufficient for the C40 Deadline 2020 Programme, which is why Istanbul Metropolitan Municipality is now committed to prepare a climate action plan that is in line with the Programme. Recently, Mayor of Istanbul Ekrem Imamoğlu also declared that Istanbul Metropolitan Municipality has already provided electricity consumption from renewable energy sources by 0.03%, and expressed his intention to increase this rate to 18% in 2025, which will be the end of his term of office. Moreover, Imamoğlu also remarked that in a short time they would like to announce the year Istanbul will reach 100% renewable energy goal.

On the other hand, individuals are also very important in the fight against climate change. It was the European youth who have set the EU in motion with their protests all over Europe, asking for more ambitious climate action. The most important examples to these protests are Fridays for Future led by the Swedish teenager Greta Thunberg and Extinction Rebellion movements. These movements did not remain restricted to the EU, as the protests spread all over the world in a short time. As a result of these movements, the protesters, the youth in particular, became “agents of change” since they could make their voices heard loud and clear to the European authorities. As seen by this movement, by asking for more and being mindful of their carbon footprint, individuals can also play an important role in the fight against climate change.

Turkey also took a part in this movement. Turkish youth came together with several civil society organisations and called for more concrete steps to be taken in the fight against climate change during the Fridays for Future. However, it demonstrated the fact that the media does not do well enough to raise attention on climate change, since the number of Turkish activists was quite lower than that of their peers in Europe. While Turkey indeed desires to be a part of the international climate regime, things have to change drastically in the near future for that desire to actualise. In sum, in order to avoid getting excluded from the newly-founded climate regime, it is necessary for Turkey to work harder and put forward stringent climate policies. However, at the same time, the media should attract more attention to climate change and the citizens should take more concrete steps to avoid climate change.

6. Conclusions

Turkey's energy demand is increasing very fastly and the energy policy focuses on the supply of energy for

economic growth and humans demand. As a result of this energy supply policy, import of oil and gas has increased, negatively affecting the current account deficit, and more power plants have been built. Turkey has enough renewable energy sources for power and heat demand. Especially solar, wind, hydropower, bioenergy and geothermal can meet most of the energy demand. Contrary to the arguments claiming that renewable energy cannot provide baseload power; one can rely 100% on renewable energy sources to generate power 24 hours a day by simply installing storage technologies such as heat storage or power storage systems, or by utilizing geothermal systems and biofuels to back up your solar or wind systems. Furthermore, biofuels have the potential to replace fossil fuels in Turkey, as they can be grown by humans en masse.

Considering the fact that Turkey is rich in renewable energy resources together with the aim of diversifying energy supply, the maximum level for domestic, renewable resources in the production of electricity has been targeted within the framework of the national energy policy. Turkey, being the 17th largest economy in the world and 6th largest in Europe, is experiencing a steep increase in its demand for energy. Therefore, Turkey has initiated a forward-looking and innovative energy policy in which renewable energy plays a significant role. On one hand, by 2023 Turkey plans to have an electricity generation mix in which the share of renewable energy accounts for 30% of overall need as well as having 10% of the requirements of the transportation sector met by renewable energy. There is also a commitment to reduce by at least 20% the amount of energy consumed per unit GDP in the year 2023.

Turkey's per capita greenhouse gas (GHG) emissions are below the G20 average, but are rising. Total GHG emissions have more than doubled since 1990. Turkey would need to reduce its emissions to below 365 MtCO₂e by 2030 and to below 226 MtCO₂e by 2050 to be within its emissions allowances under a 'fair-share' range compatible with global 1.5°C. Turkey's intended 2030 national emissions reduction target is to reduce emissions 21% below what it calls a business-as-usual scenario, equivalent to 999 MtCO₂e, by 2030; however, with current policies, its emissions are projected to be between 730-884 MtCO₂e in 2030. All figures exclude land use emissions and are based on pre-COVID-19 projections.

In Turkey's latest energy strategy for 2030, total targeted renewable energy capacity has increased

from 76 GW to 87 GW. This energy targets are possible, because the share of renewable energy generation in the power mix is 53% in 2021. This milestone was primarily achieved, however, due to low overall demand rather than recent additions to the grid, with solar and wind generation prioritised due to its low cost. The energy transition in Turkey has been framed solely as an engineering problem with technological solutions, while no public debates have addressed spatial and social considerations, energy equity, or energy justice.

Turkey's GHG emissions have increased by 134% (1990-2018) and the government's proposed climate targets for 2030 is not in line with a 1.5°C pathway. Projections under current policies show 2030 emissions will be below the government's modest target. In 2030, global CO₂ emissions need to be 45% below 2010 levels and reach net-zero by 2050. Global energy-related CO₂ emissions must be cut by 40% below 2010 levels by 2030 and reach net-zero by 2060. Turkey's emissions are projected to continue to grow until at least 2030. Turkey is on track to overachieve its climate mitigation targets based on current policies, indicating significant potential for the government to scale up climate action, ratify the Paris Agreement, and submit a stronger NDC. Emissions will need to be substantially lower than current levels in 2030 in order for Turkey to become 1.5°C compatible.

Acknowledgement

The authors acknowledged to Turkish Academy of Science for financial support of this study.

References

- [1] The Global Climate in 2015-2019, WMO, 22.09.2019, Retrieved in July 2020 <https://library.wmo.int/>(accessed 25 December 2021)
- [2] Pachauri, P.K., Meyer, L.A. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, 2014, Retrieved in June 2020 from <https://www.ipcc.ch/report/ar5/syr/>
- [3] Sensoy S., Demircan M., State of Climate in Turkey in 2019, Turkish State Meteorological Service, January 2020, Retrieved from <https://mgm.gov.tr/>(accessed 10 September 2020).
- [4] Bostanoğlu, N.M. Where does Turkey stand on the International climate regime. Economic Development Foundation, November 2020, İstanbul.
- [5] Statistics of Greenhouse Gas Emissions. 1990-2018, TURKSTAT, Retrieved in May 2020 from <https://web.tuik.gov.tr/tr/bulletindisplay-from-search/>(accessed 10/11/2021).
- [6] United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, Republic of Turkey Ministry of Foreign Affairs, Retrieved in January 2022 from http://www.mfa.gov.tr/united-nations-framework-conventionon-climate-change-_unfccc_-and-the-kyoto-protocol.en.mfa
- [7] Paris Agreement. UNFCCC, Retrieved in July 2021 accessed from <https://unfccc.int/process-and-meetings/the-paris-agreement/>
- [8] Republic of Turkey, Intended Nationally Determined Contribution, UNFCCC, Retrieved in September 2021 from <https://www4.unfccc.int/sites/submissions/>
- [9] European Commission. 2021 Turkey Report, Retrieved on 19 November 2021. <https://ec.europa.eu/files/20190529-turkey-report.pdf>(accessed 17 January 2022)
- [10] Turkey's Energy Profile and Strategy, Republic of Turkey Ministry of Foreign Affairs, Retrieved in June 2020 from <http://www.mfa.gov.tr/>(accessed 08/12/2021).
- [11] ETKB, Enerji ve Tabii Kaynaklar Bakanlığı. Bakanlığın 2021 Yılı Bütçesi TBMM Plan ve Bütçe Komisyonunda, Republic of Turkey, 11.11.2020, Retrieved in November 2020 from <https://enerji.gov.tr/haber-detay?id=724>
- [12] Koronavirüs Tedbirleri Sera Gazı Emisyonunu Azalttı, Ministry of Environment, Urbanisation and Climate Change, 12.06.2021, from <https://www.csb.gov.tr/>
- [13] Istanbul Climate Change Action Plan Summary Report 2018, Istanbul Metropolitan Municipality and İSTAÇ, from <https://www.iklim.istanbul/>(accessed 01.01.2022)
- [14] Greenpeace. Energy [r]evolution: a sustainable Turkey energy outlook. Turkey, 2015.
- [15] IEA, International Energy Agency. Energy Policies of IEA Countries: Turkey 2021 Review, OECD/IEA, Paris, 2021.
- [16] MENR, Ministry of Energy and Natural Resources. Energy Statistics in Turkey. available from <http://www.enerji.gov.tr> (accessed date 16 September 2021).
- [17] EPDK, Republic of Turkey Energy Market Regulatory Authority. Electricity Market Sector Report 2020. Ankara, 2021.
- [18] TEIAS, Turkish Electricity Transmission Company. Percentages of electricity generation by primary energy resources in 2020. TEIAS, Ankara, Turkey, 2021.

- [19] WWF, World Wide Fund for Nature. Turkey's renewable power: alternative power supply scenarios for Turkey. WWF, Istanbul, Turkey, 2014.
- [20] DSI, State Hydraulic Works. Energy sources and hydropower in Turkey. Retrieved 10 July 2020, from DSI: <http://www.dsi.gov.tr/docs/hizmet- alanlari/enerji.pdf>
- [21] Kaygusuz, K. Sustainable energy, environmental and agricultural policies in Turkey. *Energy Conversion and Management* 2010; 51: 1075-84.
- [22] Kaygusuz, K. Energy services and energy poverty for sustainable rural development. *Renewable and Sustainable Energy Reviews* 2011; 15: 936-947.
- [23] Bilgen, S., Keleş, S., Sarikaya, I., Kaygusuz, K. A perspective for potential and technology of bioenergy in Turkey: Present case and future view. *Renewable and Sustainable Energy Reviews*, 2015; 48: 228-239.
- [24] Kaygusuz, K. Energy for sustainable development: a case of developing countries. *Renewable and Sustainable Energy Reviews* 2012; 16: 1116-1126.
- [25] TURKSAT, Turkish Statistical Institute. Environmental statistics compendium of Turkey, Ankara, Turkey, 2014.
- [26] Süzer, HS. Why Turkey should aim for 100% renewable energy? *Journal of Turkish Policy Quarterly* 2013; 12(2): 1-13.
- [27] Turkey's climate transparency report in 2020. at: www.climate-transparency.org
- [28] Turkey Energy Outlook 2020. Available at <https://enerji.mmo.org.tr/yayinlar/>
- [29] TSKB, Türkiye Sınai Kalkınma Bankası. Energy Outlook 2020. TSKB, İstanbul, 2020.