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Evaluation of Turkey's renewable energy potential in terms of 2023 energy vision

Abstract. *Turkey is a quite rich country in terms of renewable energy potential. Turkey has significant hydropower and wind energy potential with its coastal line of 7200 km and an average elevation of 1132 m. Turkey's wind energy potential is primarily focused in Aegean, Marmara and Mediterranean regions from higher to lower, respectively. Since Turkey's geological structure has a volcanic origin the existence of more than 600 hot water sources whose temperature reaches almost 100°C makes the country very rich in terms of geothermal energy.*
If Turkey uses only traditional energy sources, it simply will not have enough energy capacity for its population. Renewable energy sources have the potential to make a large contribution to Turkey's sustainable and independent energy future. Turkey aims to utilize its energy potential, including from renewable sources in a cost-effective manner. Turkey targets the share of renewable resources in electricity generation to be at least 30% by 2023. This paper included many aspects of renewable energy in Turkey as an emerging country. In addition, renewable energy policies were evaluated in terms of Turkey's 2023 energy vision.
Keywords: *Energy Resources, Renewable Energy Resources, Turkey's Renewable Energy Potential, Turkey's 2023 Energy Vision.*

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Introductıon

Energy is an important input for people's housing, industry, agriculture, and transportation needs. Energy demand is increasing over time and is expected to increase in the future. Energy production planning and increasing energy demand are among the most important elements of a country's development plans. Energy is essential to economic and social development and improved quality of life in all countries.

Energy is not only a vital force for existence of life but also for economic growth. The need for energy grows rapidly since the industrial revolution. The need for energy sources in the world is gradually increasing day by day. Energy demand will be much more in the future, parallel to population growth eswill be much more in the future, parallel to population growth especially in developing countries, industrialization, increased welfare and technological developments (Yılmaz: 2012:33). After the energy crisis between 1970-1980, the energy policies are revised by the governments. To avoid from the negative effects of the increasing prices of crude-oil on the balance of payments and also on the protection of the environment, new alternatives for energy supply are under investigation. Nuclear energy has prevented the production of about 8% of the current CO_2 emission level in the energy sector (Yim, 2006: 504).

Human energy needs have increased dramatically in tandem with technological change and economic development in recent years. Also, economic growth has become largely dependent on energy. The world energy system is focused largely on non-renewable energy sources (coal, oil, and natural gas), leading to more than 80% of the world economy's overall energy supply. Nonetheless, several significant problems have arisen in recent years, associated with the use of non-renewable energy sources such as the rising gap in the demand and supply of energy worldwide (Nematollahi et al. 2016), the growing threat of oil reserve depletion and an increase in the greenhouse gas (GHG) emissions in the atmosphere. The carbon emitted from the consumption and production of non-renewable energy sources is now acknowledged as the main cause of the ecological crisis facing mankind.

Different economies worldwide use fossil fuels, such as coal, oil, and natural gas, for improved industrialization, urbanization, and popula-tion pressure, which increases global warming and pollution in the environment (Mahalik et al., 2021) and (Mohsin et al., 2019). Mitigation strategies need to be formulated to balance greenhouse gas concentrations due to recent high rates of carbon emissions. However, a lack of global consensus on any such strategies to reduce the excessive environmental degradation has not been achieved (Mohsin et al., 2018).

Climate change poses unprecedented risks to human society. Ample scientific evidence suggests that greenhouse gas emissions are the primary contributor to climate change. Large-scale greenhouse gas emissions are mainly caused by the consumption of fossil fuels. Since the Industrial Revolution, the energy mix of most countries across the world has become dominated by fossil fuels. This has major implications for the global climate, as well as for human health. Three-quarters of global greenhouse gas emissions result from the burning of fossil fuels for energy. And fossil fuels are responsible for large amounts of local air pollution a health problem. To reduce CO_2 emissions and local air pollution, the world needs to rapidly shift towards low-carbon sources of energy and renewable technologies. Renewable energy will play a key role in the decarbonization of our energy systems in the coming decades.

Energy accounts for two-thirds of total greenhouse gas, so embracing cleaner sources is key to fighting climate change. Given the limited reserves and destructive effects of fossil fuels that meet almost all the energy requirement of the world, alternative energy sources that are renewable, more secure, and environmentally friendly are extensively researched.

The term "renewable energy" is energy from a wide range of sources, all based on self-regenerating energy sources such as wind, sunlight, running water, earth's internal heat, and biomass such as agricultural, energy crops and industrial waste and municipal waste (Bull, 2001: 1216; Demirbaş, 2006: 530). Renewable energy (RE) sources can be utilized in many areas such as electricity, transportation and heating for various economic sectors all over the world.

Globally, 260 gigawatts (GW) of renewable energy capacity were added in 2020, exceeding expansion in 2019 by close to 50 % – and breaking all previous records, The International Renewable Energy Agency (IRENA) says. More than 80 % of all new electricity capacity added last year was renewable, with solar and wind accounting for 91% of new renewables, according to the agency's "Renewable Capacity Statistics 2021". Total fossil fuel additions fell from 64GW to 60GW over the same period (IRENA Renewable Capacity Statistics 2021, 2021) [1]. By country, China was by far the largest contributor to renewables growth, followed by the US, then Japan, the UK, India and Germany [2]. The IEA predicts large capacity gains in renewable energy will become the "new normal" in 2021 and 2022, with increases similar to 2020's record total.

As a developing economy, especially in the last 20 years, Turkey's energy demand has increased rapidly. However, this increase in energy demand is met by traditional fossil fuels such as oil, coal, lignite, and natural gas. Turkey is heavily dependent on foreign energy sources. Moreover, energy consumption based on fossil fuels creates economic, environmental, and political problems. For these reasons, Turkey should evaluate domestic and clean energy resources to ensure sustainable development.

Turkey is located in a very important region in which a large portion of the world's oil and gas reserves are located due to its geographical location. Due to its important geographical position Turkey has a great role like being an energy bridge between east and west, between south and north. But Turkey's aim is not only to be a bridge also produce its own energy. Because a large amount of Turkey's energy needs are met from imported sources.

As fossil fuel energy becomes scarcer, Turkey will face energy shortages, significantly increasing energy prices, and energy insecurity within the next few decades. For these reasons, the development and use of renewable energy sources and technologies are increasingly becoming vital for sustainable economic development of Turkey. Hydropower, biomass, geothermal energy, wind power, and solar

energy are the major resources to provide Turkey with most of its renewable energy in the future. It is known that Turkey is a dependent country given its existing energy resources. In this context, renewable energy sources are extremely important for Turkey's development and social welfare.

The usage of renewable energy souce (RES) is rapidly growing in both developed and developing countries, including Turkey. Turkey has developed an action plan designed by the Ministries of Power and Natural Resources (MPNR) to reduce energy imports, increase domestic energy supply and produce 30% of the total electricity from RES by 2023. Turkey has an ambitious goal of minimizing energy imports and maximizing domestic energy supplies. This is based on the action plan proposed by the Ministry of Energy and Natural Resources to generate 30 % of electricity from renewable energy sources by 2023. Turkey's 2023 energy vision adopted "National Energy and Mining Policy" based on strengthening energy supply security, utilizing domestic and renewable resources and establishing predictable market conditions. In this article, Turkey's current energy outlook will be informed and the 2023 energy vision will be examined in terms of renewable energy.

Turkey energy outlook

Turkey is like a bridge connecting Europe and Asia. Its neighboring countries are Bulgaria, Greece, Syria, Iraq, Iran, Azerbaijan, Armenia, and Georgia. Turkey is strategically located between the Middle and Near East. It has a dynamic economy comprising a mixture of modern industry and traditional agriculture. The share of agriculture in the economy has been decreasing as industrial and service sectors continue to expand rapidly.

Turkey has the fastest growing energy demand among the Organisation for Economic Co-operation and Development (OECD) countries in the past 2 decades. In this period, Turkey ranks second to China in the increase in electricity and natural gas demand in the world. On the other hand, Turkey has a 74% import dependency to meet its energy demand. The versatile structure of Turkey's energy strategy and its energy import dependency brings international relations into prominence in this field. Like other developing countries, Turkey also faces an ever increasing electricity demand. Electricity consumption constitutes a small fraction of the total energy consumption in Turkey, although its share increases year by year (Altinay & Karagol, 2005: 850).

Turkey is a net energy importer country. The import dependence has been the main driving force behind the formulation and implementation of new policies and investment models to commission local and renewable energy resources. Turkey has a substantial amount of renewable energy potential, and utilization of this potential has been on the rise over the last decade. As of end-2020, hydro, wind, and solar resources constitute the vast majority of the country’s renewable energy resources, accounting respectively for 30.9 GW, 8.8 GW, and 6.7 GW of the total installed capacity [3].

In 2018, Turkey's primary energy supply was 143,666 mtep. 41,03 (Hard Coal, Lignite, Asphaltite, Coke) mtep and coal took the third place in the distribution of this supply to resources (Figure 1).

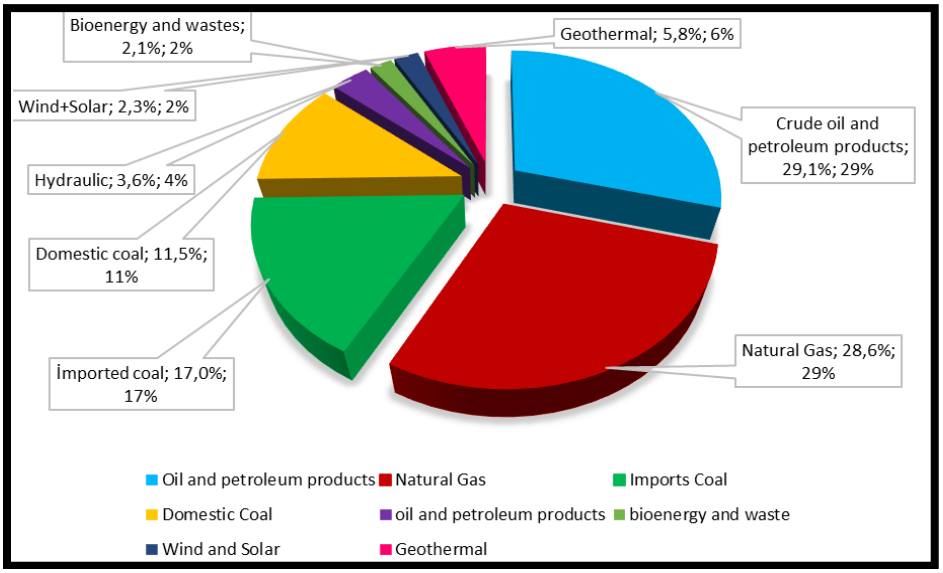


Figure 1. Distribution of Primary Energy Consumption in Turkey, 2018 (Resource: https://enerji.gov.tr/info-banknatural-resourcescoal, 2021)

Turkey has a substantial amount of coal reserves, totaling 17.3 billion tons and composed of mostly lignite (Figure 1). The main coal reserves are located in Kangal, Orhaneli, Tufanbeyli, Soma, Tunçbilek, Seyitömer, Çan, Muğla, Çayırhan, Afşin-Elbistan, Karapınar, Tekirdağ, Alpu, and Afyonkarahisar. Among these reserves, the Afşin-Elbistan field alone has 4.8 billion tons of lignite resources, which constitutes 28 percent of Turkey's total lignite reserves. The utilization of local coal reserves in line with the environmental standards for electricity generation has also been prioritized as an instrument to increase localization.

In 2018, a total of 113,248.6 GWs of electricity was produced from coal-based power plants, 50,260.1 GWs from domestic coal (Lignite-Asphaltite-Hard Coal) power plants, and 62,988.5 GWs from imported coal-based power plants. The share of electricity produced from coal-based power plants in 2018 was 37.16% in total electricity generation (Figure 2), while the share of domestic coal (lignite + hard coal asphaltite) was 16.49%. The installed power of our country's coal-based power plant corresponds to 22.02% of the total installed power by the end of June 2020. While the ratio of installed power based on domestic coal to total installed power was 12.28%, the ratio of installed power based on imported coal to total installed power was 9.74%.

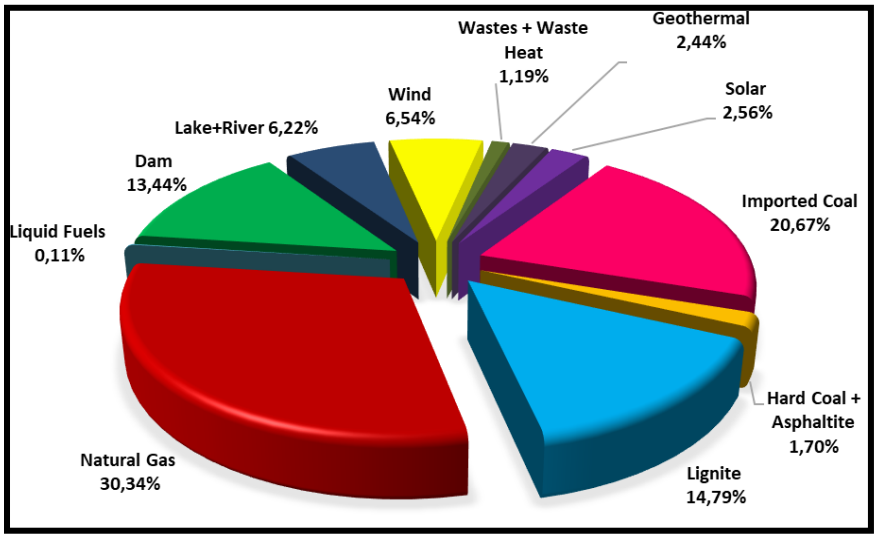


Figure 2. Share of Resources ın Electiricity Generation ın Turkey, 2018 (Resource: https://enerji.gov.tr/info-banknatural-resourcescoal, 2021)

In 2019, 153 wells were drilled by drilling 340.863 meters in our country. Crude oil production was 2.984.800 tons and the remaining producible oil reserve is 51.076.078 tons. In addition to Turkey's crude oil imports of 31 million tons in 2019, 13.7 million tons of petroleum products were imported. However, 14.3 million tons of petroleum products were exported. The countries from which we import crude oil are mainly Russia, Iraq, Kazakhstan, Iran, Saudi Arabia, Nigeria and Libya [5].

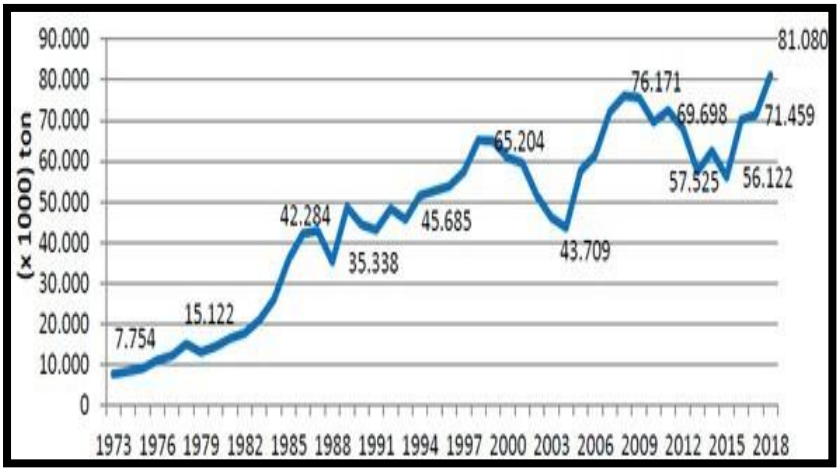
Turkey consumed about 45.3 billion m^3 in 2019, a total of 483 million m^3 of natural gas and production. The remaining producible reserve is approximately 3.36 billion m^3. With the new fields discovered as a result of the drilling performed for natural gas in our country in 2018 and 2019, natural gas production has increased in the last two years, and production has increased by 20 % in 2018 and 11 % in 2019 compared to previous years. In 2019, approximately 45.21 billion m3 of natural gas was imported. LNG imports accounted for 28 % of the total natural gas imports in 2019. In the same year, only 762 million m3 natural gas was exported to Greece [6].

Demand for energy and natural resources has been increasing due to economic and population growth in Turkey. Over recent years, the country has experienced the fastest surge in energy demand among OECD countries, and according to the International Energy Agency (IEA) forecasts, is set to double its energy use over the next decade. The projections of the Ministry of Energy and Natural Resources confirm that this trend will continue for the medium and long term.

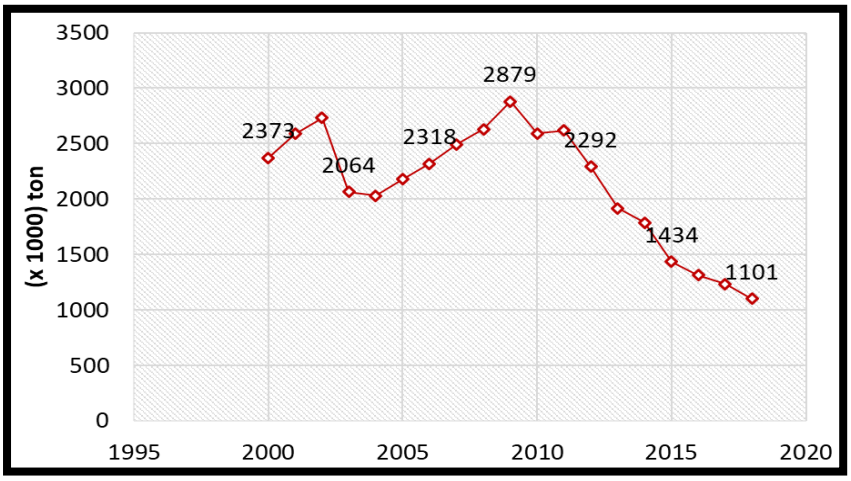
Recent energy data indicate that Turkey is a net energy importer country, depending on such imports for 73 % of its energy needs. This high rate of energy dependence has been the main driving force behind the formulation and implementation of new policies to commission local and renewable energy resources. In this respect, Turkey announced the National Energy and Mining Strategy in 2017 which identified security of supply, localization, and predictable market conditions as the main pillars to follow in energy sector. Under the Strategy, ensuring localization and reducing import dependence through utilization of domestic resources stands as a top priority for Turkey which is ambitious to generate 2/3 of its electricity from local and renewable resources by 2023.

Main indigenous energy resources in Turkey are lignite, hydraulic and biomass (Figure1, Figure 2). Power is essentially generated by thermal power plants burning fossil energy resources (Naciri & Aggour & Ahmed, 2017: 32; Dursun & Gokcol, 2011: 1227). In today's world however, instead of fossil energy sources, renewable energy has become a significant actor on the market due to some motivating factors. Increasing demand of energy, the depletion of fossil fuels (that also causes the rise of the prices), harmful nature of the fossil and nuclear power plants (more importantly the awareness of the public on the existing and probable environmental problems of them), and decreasing costs of the renewable energy utilization are some important ones of those factors (Alboyaci & Dursun, 2008; Ciric & Stipanovic, 2016).

According to the Republic of Turkey Ministry of Energy and Natural Resources; in terms of reserves and production amounts, our country can be evaluated in lignite at the world level and at the lower levels in hard coal. Together with lignite, asphaltite and hard coal, our country's total coal source is 20.66 billion tons. The lower thermal value of our hard coal varies between 6,200-7,250 kcal / kg. Although the thermal values of our lignite source vary between 1.000 kcal / kg and 4.200 kcal / kg, approximately 90 % lower heat value is below 3,000 kcal / kg [7]. Coal production in Turkey in 2018; It was realized as 83.9 million tons in total; 81.08 million tons of lignite, 1.10 million tons of hard coal and 1.75 million tons of asphaltite (Shape chart 1, Shape chart 2).



Shape chart 1. Salable Lignite Productions in Turkey by Years
(Resource: https://enerji.gov.tr/info-banknatural-resourcescoal, 2021)



Shape chart 2. Sallable Hard Coal Production in Turkey By Years
(Resource: https://enerji.gov.tr/info-banknatural-resourcescoal, 2021)

The theoretical hydroelectricity potential of Turkey's is 1 % of theoretical potential of the world, while its economic potential is 16 % of the economic potential of Europe. Turkey's hydraulic resources, which hold the most important position in the renewable energy potential of our country, possess a hydroelectricity potential of 433 billion kWh, while the technically usable potential is 216 billion kWh, and the economic hydroelectricity potential is 160 billion kWh/year. In 2018, electrical energy generated by hydroelectricity plants was 59.9 billion kWh. By the end of August 2019, electrical energy generated by hydroelectricity plants has reached 68.4 billion kWh. By the end of the 2018, 653 operational hydroelectricity power plants having a total of 28,291 MW have 31.9 % share in Turkey's total installed capacity. By the end of August 2019, hydroelectricity installed capacity has reached 28,437 MW [8].

It has been accepted that wind plants with a capacity of 5 MW can be established in Turkey at heights of 50 meters above ground level, and in areas with a wind speed exceeding 7.5 m/s. In the light of this acceptance, a Potential Wind Energy Map (PWEM) has been prepared, where the source wind details obtained using a mid-scale weather forecast model and micro-scale wind flow model are given. The wind energy potential of Turkey has been estimated as 48,000 MW. The total area which is equivalent to this potential is just 1.30% of the total surface area of Turkey [9].

The estimated wind energy potential of Turkey is 48.000 MW. Wind energy is a special focus of the country and the legal framework is favourable for investors. The Turkish government provides targeted incentives for wind power generation, such as attractive feed-in tariffs and specific tax

exemptions. In 2018, Turkey had a total installed capacity of 7.005 MW from the wind power plants in operation. At the end of 2019, there were 275 registered wind turbines with a total installed capacity of 7,591MW.

Turkey's wind power, which is expected to soon pass a 10,000 MW threshold, is concentrated more in the Aegean and Marmara provinces. Izmir with 1.635 MW is the capital of wind energy, followed by Balıkesir and Çanakkale in the Marmara region with 1.275 MW and 808 MW respectively. The Aegean province of Manisa has 736.5 MW, and Hatay in the south is the fifth largest wind city with 412.5 MW. İstanbul, Turkey's most crowded city with the highest power consumption has 398.7 MW of installed wind capacity. Turkey ranks as the world's 12th biggest wind power producer and fifth in Europe, and plans to add at least 1.000 MW both in wind and solar annually.

Turkey has high solar energy potential due to its geographical location. According to the Solar Energy Potential Map (SEM) (Figure 3) of Turkey prepared by Ministary of Energy and Natural Resources, average annual sunshine duration 2766.5 hours/year, average daily total sunshine time 7.58 hours/day, average annual radiation intensity 1527.1 kwh/m^2-year, Average daily radiation intensity 4.18 kwh/m^2-day calculated as [10].

At the end of 2018, there were 5.863 solar power plants with a total installed capacity of 5.063MW. In the future, more than 98 % of the installed capacity (4.981.2 MW) is expected to be generated by solar power plants not requiring a licence. At the end of 2019, there were 6.901 solar power plants with a total installed capacity of 5,995 MW. Turkey's solar power of 6.450 MW unlicensed and 620 MW licensed installations varies across its different installation sites. Konya, located in Central Anatolia, is the largest solar province in Turkey with 843 MW, followed by Ankara with 383.8 MW and Sanliurfa with 370 MW. Kayseri and İzmir are among the top 5 biggest solar cities with 333 MW and 291 MW of installed capacity respectively.

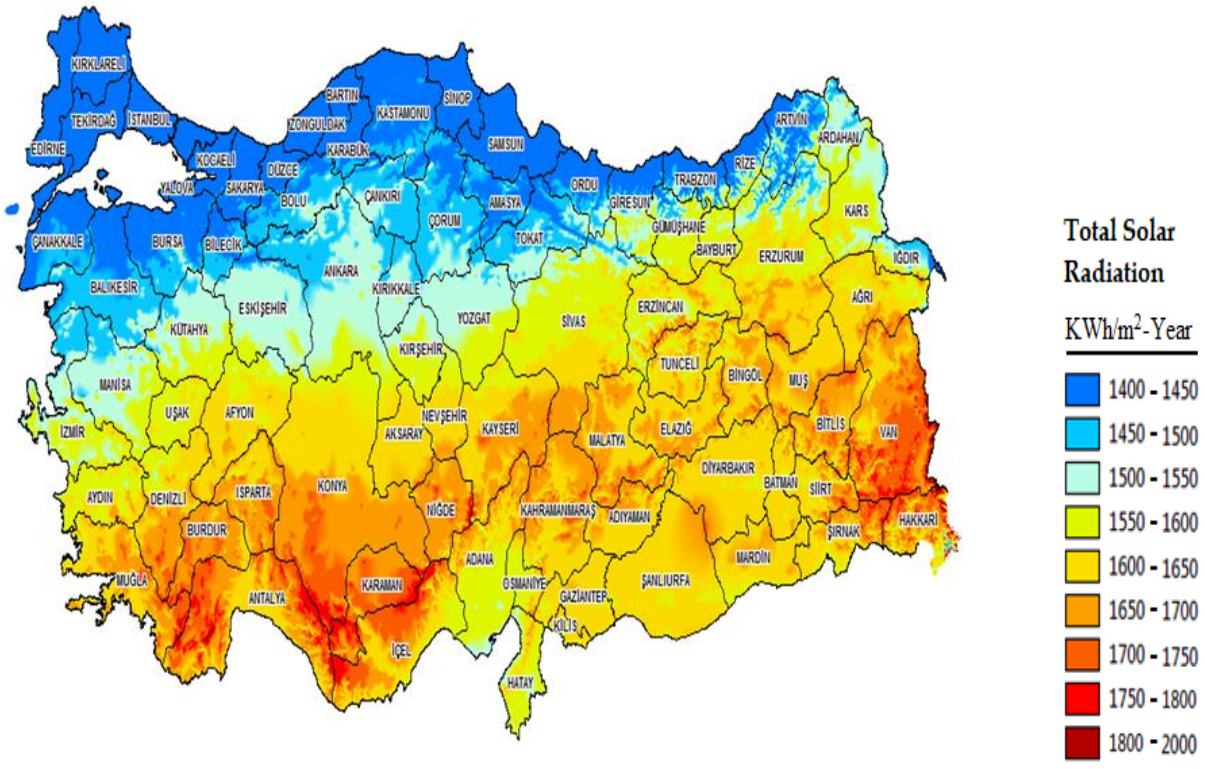


Figure 3. Solar Energy Potential Map (SEM) of Turkey (Resource: https://gepa.enerji.gov.tr/MyCalculator/, 2021).

As Turkey lies in the orogenic belt of the Alpine Himalayas, the country has a relatively large geothermal potential. Turkey's geothermal capacity is 35,500MW and 78% of areas with geothermal potential are located in Western Anatolia. Ninety percent of its geothermal resources are low and medium heat and are suitable for direct use (heating, thermal tourism, mineral extraction, etc.), while 10% are suitable for indirect use, eg for electricity generation. Turkey has more than 1,000 geothermal resources distributed throughout the country, of which 239 geothermal fields are currently in use (ie for heating, industrial purposes and thermal spring tourism) while only ten of these are used for electricity generation. At the end of 2019 there were 54 geothermal power plants with a total installed capacity of 1,514MW. Turkey is the world's fourth-biggest geothermal country in the world, according to REN21 report, accounting for 11% of global geothermal power. Turkey's geothermal installed capacity is mainly concentrated in the Aegean region. The province of Aydın has the highest geothermal capacity at 850.4 MW, followed by Denizli with 354 MW and Manisa with 349 MW.

The geothermal capacity of our country is very high. 78 % of these geothermal fields are situated in Western Anatolia, 9 % in Central Anatolia, 7 % in the Marmara Region, 5 % in Eastern Anatolia and 1 % in the other regions (Figure 4). 90 % of our geothermal resources are low and medium enthalpy geothermal areas which are suitable for direct applications (heating, thermal tourism, industrial usage, etc.), while 10 % are suitable for indirect applications (generation of electricity). First geothermal electricity generation held in 1975 was initiated by Kızıldere power plant with 0.5 MWe power.

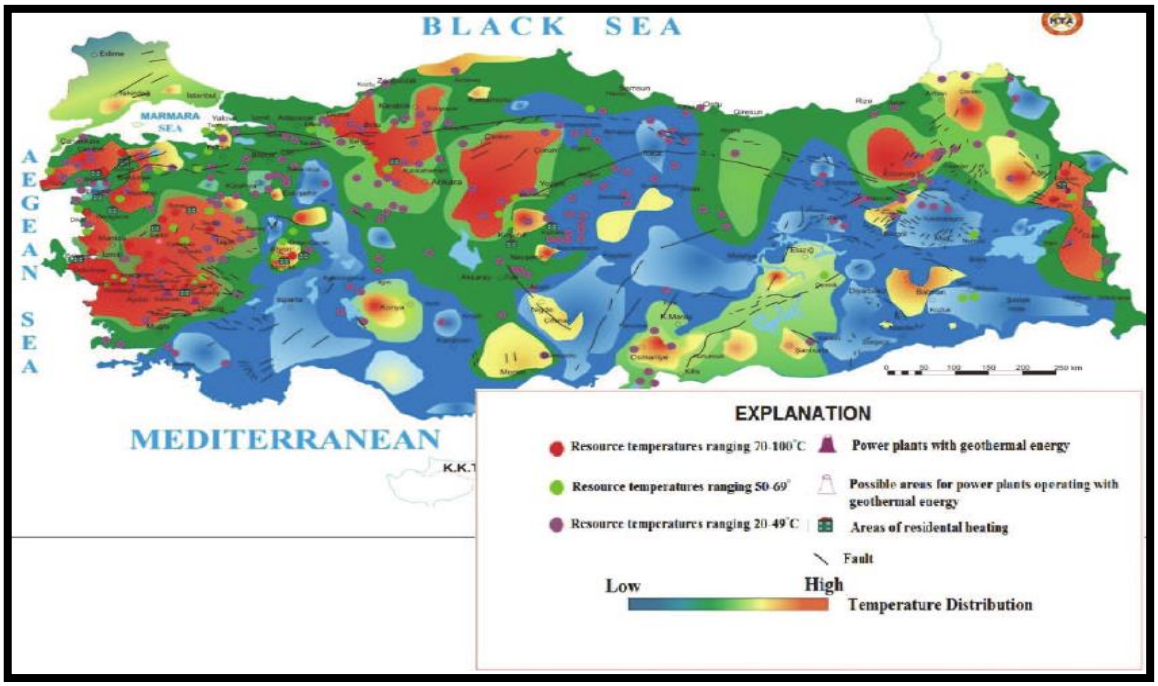


Figure 4. Turkey's Geotermal Sources and Aplication Map
(Resource: https://enerji.gov.tr/bilgi-merkezi-enerji-jeotermal-en, 2021)

It is estimated that the biomass potential in Turkey is about 8,6 million tonnes of equivalent petrol (MTEP), and biogas quantities that can be produced from biomass is 1,5-2 MTEP [11]. In 2018, Turkey generated 3,216GWh of electricity from biomass power plants with a total installed capacity of 811MW. At the end of 2019, there were 181 biomass power plants with a total installed capacity of 801.6MW. According to data from the Turkish Electricity Transmission Company, the total installed capacity of biomass power plants reached 813.6MW with 183 biomass power plants at the end of January 2020. Turkey's biomass capacity, however, is growing at a slower rate compared to other resources. Istanbul leads in biomass capacity with 139 MW, Ankara and İzmir follow with 83.9 MW and 58.2 MW, respectively.

Turkey's renewables expansion, driven by hydro, wind and solar places the Izmir province as a leader in wind power and Konya as a pioneer in solar energy, data compiled by Anadolu Agency reveals. Of the country's total renewables capacity of 50,990 megawatts (MW), hydropower stood at 31,280 MW, wind power reached 9,543 MW and solar totaled 7,070 MW. Turkey also has sizable geothermal capacity at 1,595 MW. With over $50 billion investment in renewables, renewable capacity accounted for 52.5% of the country's total installed electricity, which at the end of April reached 92,377 MW. The total renewable capacity of Turkey, which varies across the country in terms of resources, corresponds to about 1.7% worldwide. Turkey's installed hydropower capacity accounts for 3% globally, according to a recently published REN21's Renewables Global Status Report, and this ranges across 72 provinces at varying capacities. However, the country ranked second in 2020 in terms of additional hydropower capacity of about 2,500 MW after China. Şanlıurfa, a province in southeastern Turkey, leads in hydropower with 3,128 MW. The eastern province of Elazığ follows with 2,287 MW and Diyarbakır with 2,250 MW. Artvin, located in the east of the Black Sea region, has 2,167 MW of installed hydropower capacity, while Adana in the south with 1,902 MW is considered one of the top five highest hydropower capacity regions.

Turkey's per capita energy and electricity consumption are less than half of the OECD average. As a country that is still developing, compared to Turkey's OECD peers, the growth of energy services per capita will be much higher. This is necessary to accommodate increasing incomes, population growth, industrialization, urbanization, increased mobility and wider access to modern energy services.

Turkey has prioritised security of energy supply as one of the central pillars of its energy strategy, including efforts to boost domestic oil and gas exploration and production, diversify oil and gas supply sources and associated infrastructure, and reduce energy consumption through increased energy efficiency. Turkey is one of the richest countries for renewable energies. The latest development in this area, the Renewable Energy Resource Area Regulation (RERA), enables Turkey to play an even greater role in renewable energy investments. Turkey has seen considerable diversification of its energy mix in the past decade, in particular through the growth of renewable electricity generation. The commissioning of Turkey's first nuclear power facility in 2023 will further diversify the country's fuel mix.

In 2016, the government introduced Renewable Energy Resource Areas (RERA), a tender process for larger scale renewable energy projects in renewable energy zones, which are deemed most suitable for renewable power generation. To date, the support schemes have been successful in driving sizeable new investments in renewables, and the government has demonstrated a willingness to adjust the terms of the auctions for future projects to ensure investor interest. Such a planned auction of smaller capacities is planned toward the end of 2020.

Turkey has experienced impressive growth in renewables in the past decade (notably solar, wind and geothermal), driven by a favourable resource endowment, strong energy demand growth and supportive government policies. In particular, renewable electricity generation has nearly tripled in the last decade, and its share in total power generation reached 44% in 2019 (including notable growth in distributed solar generation). As such, Turkey has already exceeded its target of 38.8% of power generation from renewables set out under the Eleventh Development Plan (2019-2023). Turkey aims to continue to promote the expansion of renewable energy resources and will commission 10 gigawatts (GW) each of solar and wind capacity in the period 2017-27.

Under the Renewable Energy Support Mechanism (RESM), Turkey offers feed-in tariffs for renewable power plants, including wind, solar, biomass, hydro and geothermal. Additional support is provided if plant components are manufactured in Turkey. The scheme will expire at the end of June 2021 and the government is currently deciding on a new mechanism to replace it. According to the Presidential Decree published on 18 September 2020, the implementation period for the RESM scheme was extended by six months until 30 June 2021 due to construction delays stemming from the COVID-19 pandemic. Renewable electricity generators can benefit from RESM if commissioned before 30 June 2021 and if they apply to the Energy Market Regulatory Authority for the guaranteed price.

Though the targets of 10 GW each of additional solar and wind are commendable, there are likely more sizeable volumes that Turkey could achieve given its considerable resource endowment. As such, Turkey could look to further raise the ambition of its targets. In particular, the IEA encourages a higher expansion of wind, given its low costs.

Turkey has embarked on an ambitious nuclear power strategy to build its first nuclear power plant to limit the use of imported fuels for power generation. Turkey is planning to install three nuclear power plants (NPPs) for a total of 12 reactor units. Currently, the first NPP (Akkuyu NPP) is under construction in Mersin Province on the southern coast of Turkey and comprises 4 units with a total installed capacity of 4 800 MW. The first unit of the Akkuyu NPP is scheduled to enter into operation at the end of 2023. State-owned electricity supplier EÜAŞ will buy around half the nuclear power generated from Akkuyu for 15 years at a pre-determined price. Studies are ongoing for the construction of other nuclear power plants, according to the country's nuclear programme.

Turkey also believes that an important dimension of the country's self-sufficiency in energy and natural resources is the presence of domestic technological capacity. This strategy is reflected in a number of measures to advance R&D, innovation and technology in the country. In particular, the government has implemented policies to increase the domestic production of machinery and equipment used in energy production from renewable energy sources (including by requiring the construction of local production facilities as part of early YEKA auctions) as well as the production of necessary materials and equipment for the construction and operation of nuclear power plants. Another pillar of Turkey's energy strategy is to continue to advance the liberalisation of energy markets and improve the predictability and transparency of its pricing. Following the liberalisation and privatisation of the electricity market in 2001, electricity generation, distribution and supply were opened up to private entities and are now carried out by both private and state-owned companies.

More broadly, additional steps toward establishing more competitive energy markets and greater private sector participation will help mobilise needed investments into the energy sector. The Turkish government has made big strides toward investing in its position as a regional energy trading centre, notably for gas, with the opening of the TurkStream and TANAP pipelines, as well as ongoing investment in gas storage and LNG entry points (including floating storage and regasification terminals). The establishment of a natural gas spot market platform in September 2018 is a big step toward making Turkey an international gas trading hub, if this platform can be expanded with trade in futures contracts.

Demand for energy and natural resources has been increasing due to the economic and population growth in Turkey. It has posted the fastest growth in the OECD, with an annual growth rate of 5.5 percent since 2002. Since then, Turkey's primary energy supply has shown a two-fold increase. Turkey's growing economic performance has also been reflected on the country's electricity generation infrastructure given the dramatic rise in the total installed capacity from 31.8 GW to 95.9 GW. To satisfy the increasing needs of the country, the current capacity is expected to reach 110 GW by 2023 through further investments to be commissioned by the private sector as underlined in the 11th Development Plan for 2019-2023 [12].

One of the main goals of Turkey's 2023 energy strategy is to diversify routes and resources to strengthen its energy supply security. Turkey also aims to contribute to regional and global energy security and to become a regional trade center in energy [13-15]. The fundamental elements that constitute the international dimension of Turkey's energy strategy are:

To ensure the diversification of routes and resources in the supply of oil and natural gas, taking into account the increasing demand and import dependency,

- To contribute to regional and global energy security,
- To be a regional trade center in energy,
- To consider social and environmental impacts in the context of sustainable development in every phase of the energy chain,

- To increase the share of domestic and renewable energy in electricity production,
- To include nuclear power in its energy mix.

Turkey continues its efforts towards increasing the share of renewable energy sources in the national energy mix and adding nuclear power to its energy mix, in line with the goals of reducing its energy import dependency, maximizing the use of indigenous resources and combating climate change. In accordance with the National Energy Policy adopted in 2017, increasing the use of domestic and renewable energy resources is among the main priorities. Furthermore, Turkey has ranked 5th in Europe and 12th in the world in terms of installed capacity in renewable energy. The share of renewables in Turkey's installed power reached to 52% at the beginning of 2021 [15].

Turkey aims to be a center in energy trade in its region. In accordance with this aim, Turkey has undertaken and carried out several important natural gas and oil pipeline projects in the region. Bakû-Tbilisi-Ceyhan Crude Oil Pipeline (BTC), South Caucasus Natural Gas Pipeline (SCP), Bakû-Tbilisi-Erzurum Natural Gas Pipeline (BTE), Turkey-Greece Natural Gas Interconnector (ITG), Trans Anatolian Natural Gas Pipeline (TANAP), and TurkStream are among the projects within this scope [16, 17].

Electricity consumption of Turkey at the year 2023 is estimated to be around 530,000 GWh. Turkey plans to supply 30% or 160,000 GWh of this demand from renewable energy sources according to the recently avowed government agenda Vision 2023. However, the current installed renewable energy capacity is around 60,000 GWh. Today, Turkey's energy market is one of the world's fastest growing markets in terms of demand and supply. Turkey is a country with vast renewable energy resources and it has been trying to fully maximize this potential [18-22].

Turkey needs to transition its energy system rapidly in order to reduce its reliance on imports, which account for 3 out of 4 units of Turkey's total primary energy supply. With a growing population and economy, the country's imported energy costs have reached alarming levels, driving a significant share of Turkey's current account deficit. Turkey's population grew from 70 million only a decade ago to 83 million people in 2021. This increasing demand has driven rapid growth of the country's energy system, including in conventional fossil fuels and renewable energy. Unquestionably, Turkey's top policy priority is to secure its energy supply and keep up with the demand to sustain its economic growth as its population increases. Prioritizing the use of domestic renewable energy will reduce Turkey's political reliance on energy exporters such as Iran or Russia as well as insulate Turkey against price shocks and fluctuating energy prices. According to the Turkey 2023 vision, Turkey aims to be in the top 10 economies in the World by 2023. Turkey wants to evaluate its high solar potential and use opportunity to achieve its economic targets [23-27].

Conclusıon

Seventy-two percent (72%) of the total primary energy supply (oil, natural gas, coal) is imported by Turkey, which is undoubtedly a huge burden on the Turkish financial system. Due to Turkey's current 8% annual boost in power loads (Tükenmez & Demireli, 2012), there is a dire need to enhance power production. According to studies, the major contributor to the rise in demand is the industrial sector. Industrial sector power demands are anticipated to reach 97–148 TWh due to the export of industrial goods and agricultural processed goods to the European open market without any customs duty (until 2020) (Dilaver, 2011). In order to meet the requisite power supply and demand, Turkey's 2023 vision (Melikoglu, 2013) plans to deploy alternative power technology resources to produce 160,000 GWh of electricity by 2023. After accomplishing this goal, Turkey will be less reliant on conventional fuel and can do away with the carbon tax (Tükenmez & Demireli, 2012).

Turkey has prioritised security of energy supply as one of the central pillars of its energy strategy, including efforts to boost domestic oil and gas exploration and production, diversify oil and gas supply sources and associated infrastructure, and reduce energy consumption through increased energy efficiency. The guiding principles of Turkish energy policy continue to be market reform and energy

security. Rapid economic and population growth in the past two decades have not only driven strong growth in energy demand but also an associated increase in import dependency.

These energy ambitions are enshrined in the Vision 2023, Turkey's economic development strategy to 2023, the year that marks the 100th anniversary of the Republic of Turkey. Vision 2023 comprises a number of energy targets which aim to make Turkey one of the ten largest economies in the world with annual exports of USD 500 billion. In the area of energy, Vision 2023 aims at promoting indigenous energy resources, including coal (lignite), raising the share of wind and geothermal energy in the electricity mix to reach 30%; reducing energy consumption by 20% below 2010 levels, through improved efficiency and starting up two or three nuclear power plants.

Turkey has seen considerable diversification of its energy mix in the past decade, in particular through the growth of renewable electricity generation. The commissioning of Turkey's first nuclear power facility in 2023 will further diversify the country's fuel mix. Notwithstanding many positive changes Turkey has made toward liberalising its energy markets and diversifying its energy sources, the government should ensure that policies in place to bolster energy security–including growth in coal-fired generation and support for various forms of electricity generation–do not impede the economic efficiency of markets and the country's longer-term decarbonisation efforts.

Electricity lies at the heart of a successful decarbonisation of energy systems. However, deregulated electricity markets do not deliver the long-term price signal needed for investment in high capital cost, low-carbon technologies. Ensuring competitive and timely investment in low-carbon solutions will require new market arrangements such as long-term supply agreements, as well as a robust and stable CO_2 price signal. Jurisdictions with regulated systems that consider introducing greater competition need to adopt market arrangements that will encourage, rather than hinder, investment in low-carbon technologies.

Turkey's growing natural gas demand, geographic location, and desire to become a regional energy hub for Europe is at the forefront of the country's geoeconomic strategy. The outcome is strongly interconnected with its foreign relations and the geopolitical considerations by more parties, international discourse about climate change, technological break-through, as well as on domestic regulatory, financial, political, and logistical constraints.

As a developing country, Turkey's population is exceed 83 million in 2020. In parallel to this development, Turkey also faces an ever increasing electricity demand. Turkey's Gross Electricity Consumption data was reported at 26.148.402 GWh in Sep 2020. Unfortunately, Turkey is presently an energy-importing country. Excluding lignite; coal, oil and natural gas reserves in country are limited. Consequently, renewable and non-renewable energy and nuclear energy must be used in order to stabilize Turkey's growth and need of electricity. Because electrical energy is inevitably essential for economic and social growth and improved quality of life in Turkey, as in other countries.

The future vision of Turkey about the energy sectorhas been presented briefly as; It has been targeted to prefer more environment-friendly, renewable energy types assisting to reduce the impacts ofenvironmental pollution and climate change in energy pro-duction and use, ıt has been planned to decrease the use of fossil fuels and pe-troleum derivatives and to access achievable and clean energyunder the title of sustainable development, increasing the share of renewable energy in buildings, cities, regions, and in all Turkey, it has been considered to gain benefiton a national and global scal, energy productivity and to provide the sustainability of thisproductivity has been preferred primarily, taking the connection of the energy sector with the economyinto consideration, the framework of the energy vision of Turkeyhas been constructed accordingly. Turkey's "Vision 2023" energy strategy involves the construction of three nuclear power plants (NPP) in different regions of the country, namely Akkuyu, Sinop and İğneada.

The energy sector is one of the most promising and developing sectors in the Turkish economy. Turkey has become one of the fastest-growing energy markets in the world, in parallel with its economic growth recorded over the last 10 years. The Turkish energy market has become a competitive

market structure by attracting private sector investments. The energy market is in a rapid growth and liberalisation process with privatisation, licensing deals and strategic alliances in the market. This privatisation programme has given the country's energy sector a highly competitive structure and new horizons for growth. In external dependency of Turkey in energy sector, Russia is the prominent country. This dependency tightens room for political manoeuvre of Turkey, gives rise to economic uncertainty, and deepens currency deficit, one of the most important economic problems of Turkey.

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Түркияда 2023 жылғы көріну шартында жаңартылатын энергия әлеуеті

Аңдатпа. Түркия жаңартылатын энергия көздерінің әлеуеті бойынша өте бай ел. Ғылыми жұмыста Түркияның гидроэнергетикалық әлеуеті сипатталған. 7200 км жағалау сызығымен және орташа биіктігі 1132 м жел энергиясының технологиялары сипатталған. Түркияның жел энергетикалық әлеуеті ең алдымен Эгей, Мармара және Жерорта теңізі аймақтарында шоғырланған. Түркияның геологиялық құрылымы вулкандық шыққандықтан, температурасы 100 ° С -қа жететін 600 - ден астам ыстық су көздерінің болуы бұл елді геотермалдық энергияға өте бай етеді.

Жаңартылатын энергия көздері Түркияның тұрақты және тәуелсіз энергия болашағына үлкен үлес қоса алады. Түркия өзінің энергетикалық әлеуетін, соның ішінде жаңартылатын көздерден үнемді түрде пайдалануға міндеттенеді. Түркия 2023 жылға қарай электр энергиясын өндіруде жаңартылатын ресурстар үлесінің кем дегенде 30% болуын қамтамасыз етуді көздейді. Ғылыми мақалада Түркияның дамушы ел ретінде жаңартылатын энергияның көптеген аспектілері қарастырылды. Сонымен қатар, жаңартылатын энергия саясаты 2023 жылға дейінгі кезеңге Түркияның энергетикалық көзқарасы тұрғысынан бағаланды.

Түйін сөздер: энергия ресурстары, жаңартылатын энергия көздері, Түркияның жаңартылатын энергия әлеуеті, Түркияның 2023 жылға дейінгі кезеңге болжамы.

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Потенциал возобновляемых энергетических ресурсов Турции в условиях видения 2023 года

Аннотация. Турция – довольно богатая страна с точки зрения потенциала возобновляемых источников энергии. В научной работе приведен потенциал гидроэнергентики Турции. Описаны технологии энергии ветра с ее береговой линией 7200 км и средней высотой 1132 м. Потенциал ветровой энергии Турции в первую очередь сосредоточен в регионах Эгейского, Мраморного и Средиземного морей. Поскольку геологическая структура Турции имеет вулканическое происхождение, наличие более 600 источников горячей воды, температура которых достигает почти 100 ° С, делает страну очень богатой с точки зрения геотермальной энергии.

Возобновляемые источники энергии могут внести большой вклад в устойчивое и независимое энергетическое будущее Турции. Турция стремится использовать свой энергетический потенциал, в том числе из возобновляемых источников, экономически эффективным образом. Государство нацелено на то, чтобы доля возобновляемых ресурсов в производстве электроэнергии к 2023 году составляла не менее 30%. В работе рассмотрены многие аспекты возобновляемой энергетики в Турции как развивающейся стране. Кроме того, политика в области возобновляемых источников энергии была оценена с точки зрения энергетического видения Турции на период до 2023 года.

Ключевые слова: энергетические ресурсы, возобновляемые источники энергии, потенциал возобновляемых источников энергии Турции, энергетическая перспектива Турции на период до 2023 года.

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