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TURKEY'S FOREIGN DEPENDENCE ON ENERGY AND WIND POWER AS AN ALTERNATIVE ENERGY RESOURCE

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ABSTRACT

Negative impacts of fossil fuels on the environment and the search for energy alternatives to petroleum spurred many countries to turn to renewable energy resources. At present, these energy resources, including wind power, are preferred around the world because they are both clean and renewable. Turkey is a country dependent on foreign energy. Although it is not rich in fossil fuels, Turkey is dependent mainly because such resources are not favored owing to the nation's high potential for wind power. Nevertheless, wind power holds a very low share in the country's energy production. Cost, technical concerns, public opposition and environmental problems are the causes of this low share. The objective of the present study is to give details of the problem of Turkey's energy foreign dependence and determine the wind energy potential in Turkey. In the present study, the goal is to describe the country's potential for clean, local wind power and to propose recommendations for the policy-makers.

Keywords: Turkey, Energy, Wind Power, Renewable Energy, Energy Dependence.

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TÜRKİYE'NİN ENERJİDE DIŞA BAĞIMLILIĞI VE ALTERNATİF ENERJİ KAYNAĞI OLARAK RÜZGAR ENERJİSİ

ÖZ

Fosil yakıtların çevre üzerindeki olumsuz etkisi ve petrole alternatif enerji kaynağı arayışı, birçok ülkenin yenilenebilir enerji kaynaklarına yönelmesine neden olmuştur. Günümüzde, içinde rüzgarın da bulunduğu bu enerji kaynakları, hem temiz hem de yenilenebilir olmaları nedeniyle Dünya'da tercih edilmektedir. Türkiye, enerjide dışa bağımlı olan bir ülkedir. Fosil yakıtlar açısından zengin bir ülke olmamasına rağmen, temel enerji kaynağı olarak bu kaynakların tercih edilmesi enerji bağımlılığındaki temel nedendir. Türkiye, rüzgar enerji potansiyeli yüksek bir ülkedir. Ancak, rüzgarın ülkedeki enerji üretimindeki payı çok düşüktür. Maliyet, teknik kaygılar, public opposition ve çevresel sorunlar bu düşüklüğün nedenleridir. Bu çalışma hem Türkiye'nin enerjideki dışa bağımlılık sorunu ortaya koymayı hem de rüzgar enerjisinin bu sorunun çözümündeki yerini bulmayı amaçlamaktadır. Çalışma ile; temiz ve yerel olması nedeniyle değerlendirilmesi gereken rüzgar enerjisinin, ülke potansiyelinin ortaya konulması ve politika yapıcılar için öneriler sunulması hedeflenmiştir.

Anahtar Kelimeler: Türkiye, Enerji, Rüzgar Gücü, Yenilenebilir Enerji, Enerji Bağımlılığı.

Jel Kodları: Q20, Q42, Q48

INTRODUCTION

Energy comes from the Greek word "energia" meaning "effective power." It is sub-classified into groups such as a mechanical (kinetics and potential), thermal, chemical, ray, nuclear and fission energy based on various criteria (Ulutas, 2005). Energy is classified as renewable and non-renewable based the source's sustainability capacity. The cycle of an energy resource is the criterion in this classification. Resources of a long formation process such as petroleum, coal and natural gas are called non-renewable; resources such as sun, wind, water, geothermal, and biomass are called renewable resources.

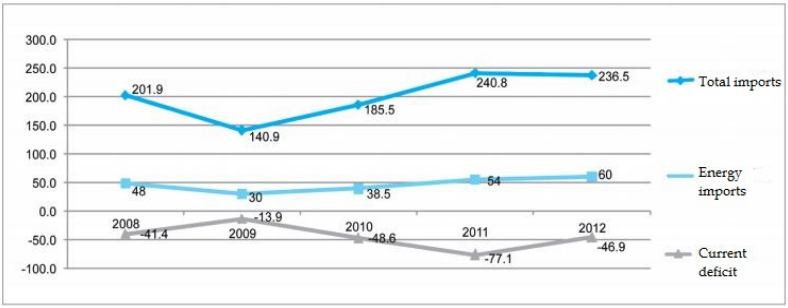
Petroleum, natural gas and coal are fossil fuels. Worldwide, these resources have been used as the main energy resource. The Industrial Revolution increased the demand for such resources. However, the petroleum crisis that started in the 1970s gave rise to the search for resources alternative to petroleum. As a result, the concept of "renewable energy resources" emerged and these resources have been given greater importance. These resources, including wind power, are currently used as energy resources in many countries.

Turkey has great potential for renewable energy resources. High diversity of geographical formations and climate, as well as the geological structure of the country, are factors bolstering this potential. Turkey has poor petroleum and natural gas reserves in contrast to its potential from the renewable resources. Nevertheless, energy production in Turkey is heavily based on fossil fuel production. Still, most of the fossil fuel needs of the country are met through imports.

Unfortunately, using imported energy resources causes certain problems in Turkey. Because, energy imports are an major rate in total imports of Turkey and the most important problems are a current deficit and energy foreign dependence (Figure 1). In Turkey where the current deficit is above, 7% of GDP (Terzi, 2014) petroleum and natural gas imports are shown as the cause (Özata, 2014). Currently, 27.5% of primary energy demand is met with local production, hence, a foreign dependence of 72.5% in 2012 is expected to rise to 80% in the upcoming years (TPAO, 2014).

Numerous studies have been conducted on energy resources in Turkey. The majority of these focused on renewable energy technologies. Some stipulated the potential of Turkey for renewable energy resources but did not focus on the wind potential. Although there are some studies on wind potential, technical analyses were made without considering the existing energy problem. The objective of the present study is to explain the details of Turkey's existing foreign-dependence problem and determine the role of the wind power as a solution. Another distinctive aspect of the study is the list of solutions proposed. Determining the economic and social impacts of using fossil fuels in the country is another objective. For this study, Turkey's energy resources have been analysed individually and aspects have been supported with various data.

Figure 1: Total imports, energy imports and current deficit of Turkey (billion dollars)



Source: (Karagöl and Mıhçıokur, 2013)

1. Turkey's Energy Sources and Foreign Dependence on Energy

In recent years, Turkey has experienced rapid growth[1]. The energy demand of the country has accordingly increased with industrialization, population and urbanization. In Turkey, a country of 78 million persons, energy use (kg of oil equivalent per capita) is 1,546 and electric power consumption per capita is 2,790 kWh (The World Bank (WB), 2012). Worldwide, this is one of the highest consumption rates, and demand grows by 8% annually. Projections

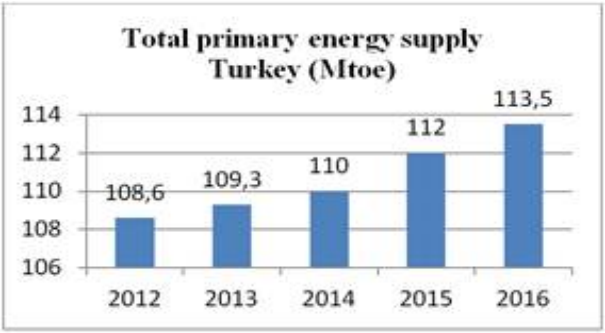
1 Turkey is the 17th largest economy of the World (International Energy Agency (IEA), 2010)

show that the energy demand of 45 Bcm in 2012 will increase to 81 Bcm in 2030 (Rzayeva, 2014).

Oil has been one of the main energy sources in Turkey, accounting for some 28% of the country's total primary energy supply (TPES) in 2011. The share of natural gas in the country's TPES significantly increased from 5% in 1990 to 32% in 2011. Coal is also a large energy source in Turkey, whose share in the country's TPES increased to 30% in the same year. Renewable energy including hydro energy provided 10% of TPES (International Energy Agency (IEA), 2013)

Total primary energy supply of Turkey 110 million tons of oil equivalent (Mtoe) the year 2014, and there are 112 Mtoe in 2015 and 2016 to 113.5. This figure is show Turkey's total primary energy supply is increasing from year to year (Figure 2).

Figure 2: Total primary energy supply of Turkey

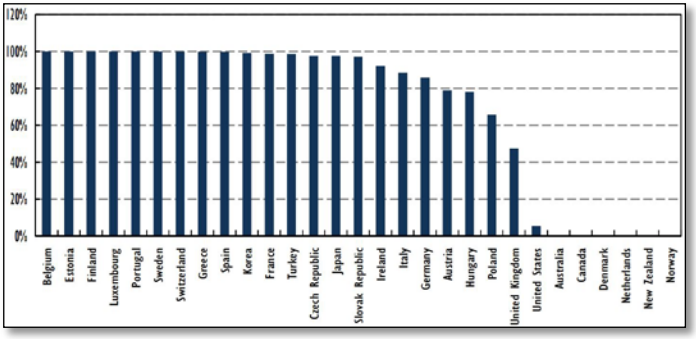


Source: The World Bank (WB), 2012.

2.1. Natural Gas

Natural gas is an important energy resource for Turkey. But in Turkey, the natural gas production has never met the demand. Figure 3 shows the dependent on natural gas imports of the countries that the member of International Energy Agency (IEA). Most IEA member countries depend on imports to meet their domestic gas needs. At the other end of the spectrum, sixteen IEA countries have an import dependence exceeding 90% with nine of these countries being essentially 100% dependent on imports to meet domestic gas demand (International Energy Agency (IEA), 2014a). Turkey is the twelfth ranks on the list in terms of natural gas import dependence (Figure 3).

Figure 3: Natural gas import dependence (2012)



Source: International Energy Agency (IEA), 2014a

Natural gas production was 212 mcm/y in 1990 and 632 mcm/y in 2012. However, the natural gas demand of the country in 2012 was 71 times higher than the production, a figure expected to be 100 times higher in 2018. In Turkey, net import volume was 3,256 mcm/y in 1990 and it increased by 13 times to 44,622 mcm/y in 2012. The foreign-dependency ratio has always been above 90% in Turkey; however a new record is expected in 2018 with 99% (Table 1).

Table 1: Natural gas key information of Turkey (1990 - 2018)

	1990	2000	2005	2010	2011	2012*	2018**
Production (mcm/y)	212	639	897	682	761	632	595
Demand (mcm/y)	3 468	14 835	27 375	38 127	44 686	45 254	59 653
Transformation	2 585	8 845	15 157	20 708	21 570	0	-
Industry	814	2 098	3 839	7 901	9 878	0	-
Residential	49	3 218	5 747	5 888	8 779	0	-
Others	20	674	2 632	3 630	4 459	0	-
Net imports (mcm/y)	3 256	14 196	26 478	37 445	43 925	44 622	59 059
Import dependency (%)	93.9	95.7	96.7	98.2	98.3	98.6	99.0
Natural gas in TPES (%)	5	17	27	30	33	32	-

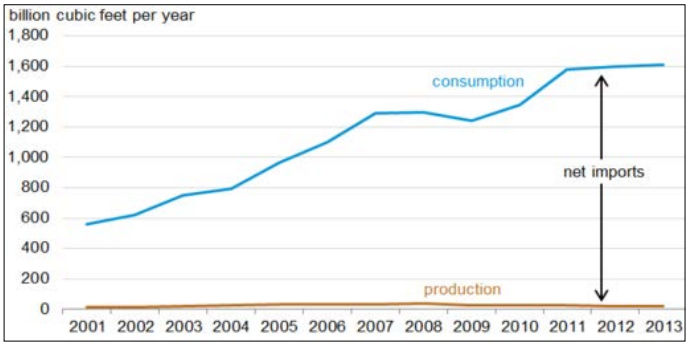
* 2012 data are estimates.
** Forecast.

Source: International Energy Agency (IEA), 2014a

This graph of Turkey natural gas production and consumption in 2001-2013 clearly shows Turkey's foreign-dependent position. Consumption of around 600 bcf/year in 2001 increased to 1600

bcf/year in 2013. Because production has never reached to the level of 100 bcf/year, the net import ratio has increased. The net import ratio of about 6x in 2001 broke a new record as it rose to about 16x in 2013 (Figure 4).

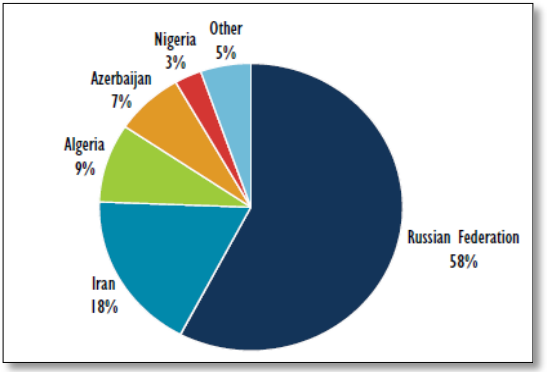
Figure 4: Turkey natural gas consumption and production 2001 – 2013



Source: Energy Information Administration (EIA), 2014

Turkey imports natural gas from various countries. Russia leads with 58%, followed by Iran, Algeria, Azerbaijan and Nigeria with 18%, 9%, 7% and 3%, respectively (Figure 5). Because more than half of the imports are from Russia, Turkey is heavily dependent on one country for natural gas. This situation also makes the Turkish economy fragile because a substantial part of the energy is used in industry.

Figure 5: Natural gas imports by source



Source: International Energy Agency (IEA), 2014a.

2. Coal

Coal is an another resource used by Turkey as an energy source. The country produces 31% of its electricity consumed at thermal power plants fuelled with coal (16% lignite, 1% asphaltite coal, 1% hard coal, 13% imported coal). 18% of the coal used in thermal power plants is produced locally and 13% of the coal is imported (Karakış, 2014). Turkey never met its coal demand with local resources in 2001-2012. The levels of coal production and consumption were almost equal in 2001. However, this ratio increased by 3 times in 2012 as a result of increased consumption (Figure 6). Increased dependence on imported coal not only increased the current deficit, it also led energy security efforts of the country to a dead end (Acar, Kitson, & Bridle, 2015).

Turkey is third among countries planning the most extensive coal investments in the world (Shearer, Ghio, Myllyvirta, & Nace, 2015) and these plans involve increasing the capacity of coal power plants to 80 GW by 2020 (Friedman, 2015). Achievement of this plan means carbon emissions of 340 $MtCO_2$ in 2020 and 250 $MtCO_2$ in 2030 (Climate Action Tracker (CTA), 2015) in addition to the current level[2]. Turkey presented a letter of intention to the UN in September 2015 stating that it plans to reduce its carbon emission to 21% by 2030.[3] However, the plans for increasing the share of coal among its energy resources conflict with the letter of intention. Because lignite is predominantly in Turkey's energy production and it is the most polluting type of coal. Therefore, Turkey's greenhouse gas emission is expected to increase by 94% by 2030 if all of the planned coal plants are put into operation (Doukas and Acar, 2015).

In addition to its environmental effects, coal consumption in Turkey has tremendous effects on human health. A research by HEAL (HEAL, 2015) showed that pollution caused by coal consumption in Turkey leads to 2,876 premature deaths, 3,828 new chronic bronchitis complaints, 4,311 hospital admissions and 637,643 lost working days each year. 2.9 billion - 3.6 billion Euro is spent annually for the

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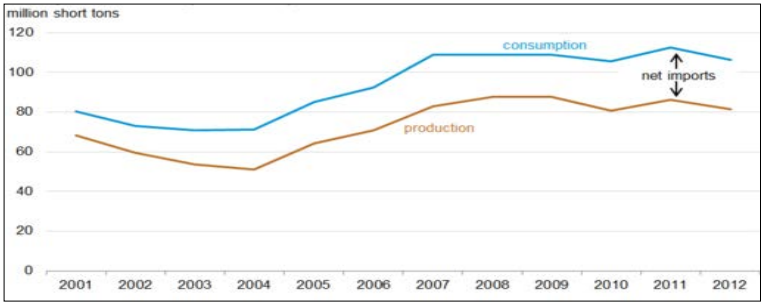
2 Greenhouse has emission was 459.1 $MtCO_2$ in 2013.

3 This figure does not indicate a reduction over the actual greenhouse gas emission in 2013, instead, it represents a reduction over 1.175 $MtCO_2$ that is estimated for the year 2030. For detailed information: (UNFCCC, 2015)

treatment of diseases caused by coal-burning pollution. This situation shows that using coal for energy production leads to damages more than benefits when external costs are also taken into account (Acar, Kitson, & Bridle, 2015).

Figure 6: Turkey coal consumption and production 2001 – 2012



Source: Energy Information Administration (EIA), 2014.

2.3. Hydropower

Hydropower is an energy resource favored all over the world because it is a clean, renewable, cheap, and a national resource with low impacts on the environment (Kaygusuz, 2010). There are two methods used to generate electricity from hydropower. The most common is accumulating flowing water in a reservoir by building a dam. The other method uses a pumped storage plant. Both methods are based on the principle of generating electricity by turning generators with hydropower. Contemporary hydro turbines can convert up to 90% of the existing energy to electric energy. The efficiency of the best fossil fuel plant is only 50% (Akpınar, Kömürcü, & Kankal, 2011).

Sixteen percent of produced energy in Turkey is by hydropower, making it an important energy resource for the country. There are 25 hydrological basins in Turkey where the amount of water per person is 1583 m^3. Turkey has an overall natural hydropower potential of 430 TWh, which is about 1.1% of the worldwide and 13.75% of the European potential. However, only about 30% (130 TWh) of the potential is deemed to be economically feasible (Kick, 2011). In Turkey, there are 542 hydropower plants with a total installed power of 25,648 MW. Production in these power plants meets 26.11% of the nation's electricity consumption (Enerji Atlası, 2015).

The main problem for Turkey generating electricity by hydropower is the instability of rainfall due to a semi-arid climate prevailing in the country. Instability of the rainfall reduces the water quantity in dam basins and the energy output declines. In addition, in recent times, reactions arose from the public about building dams in areas with high endemic populations such as the Eastern Black Sea region. This reaction is based on the claim that dams would have adverse impacts on the natural life of the region. Both limited water resources and increased public opposition to the hydropower plants reduce the potential energy that can be generated from hydropower in the country.

2.4. Geothermal

Turkey is seventh in the world with geothermal resources, which are particularly high in number particularly in the west of the country. More than 227 geothermal resources have been discovered in Turkey. These geothermal resources consist of 2,000 hot and mineral water resources at temperatures within the range of 20°C – 287°C (Mertoglu, Simsek, & Basarir, 2015). Although the country started using geothermal resources in 1972, only 710 MW of energy have been produced so far (Ulutas, 2005). Turkey's geothermal energy potential is estimated to be 60,000 MW (Mertoglu, Simsek, & Basarir, 2015). Thus, the current production capacity is far below this potential.

2.5. Petroleum

In addition to electricity generation, petroleum is commonly used in daily life in Turkey. Although it is neighbor to rich petroleum basins, Turkey's petroleum reserves are poor. Turkey has proven reserves of approximately 229 million barrels of oil, most of which is in the Hakkari Basin in the southeast of Turkey (Ulutas, 2005). Turkey's petroleum production was 72.5 kb/d in 1990 and declined to 44.9 kb/d in 2012. The demand increased 6.5 -fold to 477 kb/d in 1990 and it reached to 670.5 kb/d as a result of 15-fold increase in 2012. This figure is expected to increase by 17 fold and become 745.7 kb/d in 2018. Turkey was not able to meet its petroleum demand in any of the periods in 1990-2018 and the ratio of dependence to petroleum imports increased to 93.3% in 2012. This ratio is expected to become 94% in 2018 (Table 2).

Table 2: Petroleum key information of Turkey (1990 – 2018)

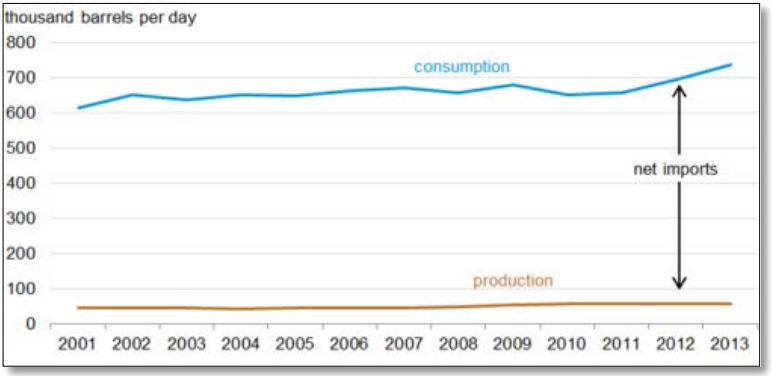
	1990	2000	2005	2010	2011	2012	2018*
Production (kb/d)	72.5	52.8	43.5	48.3	45.6	44.9	43.4
Demand (kb/d)	477.0	662.8	647.5	649.8	655.3	670.5	745.4
Motor gasoline	74.0	83.6	61.9	47.3	44.9	41.2	-
Gas/diesel oil	153.7	184.8	216.8	300.1	310.8	327.8	-
Residual fuel oil	119.8	141.5	117.8	20.2	18.7	19.8	-
Others	129.6	252.9	251.1	282.3	280.9	281.7	-
Net imports (kb/d)	404.5	610.0	604.0	601.5	609.7	625.6	702.0
Import dependency (%)	84.8	92.0	93.3	92.6	93.0	93.3	94
Refining capacity (kb/d)	725.0	690.9	714.3	630.0	630.0	630.0	-
Oil in TPES (%)**	44	40	34	29	27	27	-

* Forecast.
** TPES data for 2012 are estimates.

Source: International Energy Agency (IEA), 2014a.

Turkey's petroleum production did not meet the nation's consumption in 2001-2013. The net import ratio that was approximately 6x in 2001 became 8x in 2013 (Figure 7). This situation indicates that the demand for petroleum is not at a peak point and will continue to increase. Failure to meet the nation's consumption with the nation's production makes Turkey a foreign-dependent country in petroleum. Foreign dependence in petroleum that is such an essential part of daily life makes the country's social and economic life fragile.

Figure 7: Turkey's petroleum consumption and production 2001 – 2013



Source: (Energy Information Administration (EIA), 2014)

In 2012, fossil fuels in Turkey formed 90% of the nation's total primary energy supply, natural gas composing 32%, coal 30% and petroleum 27%. Renewable energy resources composed 10%. At present, the major renewable resources in Turkey are hydropower (4%) and biofuels (3%) (International Energy Agency (IEA), 2014b). The primary energy consumption is growth year by year in Turkey. Turkey has 1.0% share of World primary energy consumption and its consumption changed %7 in 2015 over 2014 (Table 3).

Turkey primary energy consumption was 52,9 mtep in 1990 and 120,29 mtep in 2013 and it has increased 127,39%. Turkey's energy production don't provide for its energy demand (Table 4). This is show that Turkey is depend on other countries for energy.

Table 3: Primary energy comsuption of Turkey by sources (2010 – 2015)

(Million tonnes oil equivalent)	2010	2011	2012	2013	2014	2015	Change 2015 over 2014	2015 share of World total
Oil	31.8	31.1	31.6	32.7	34.4	38.8	12.5%	0.9%
Natural gas	35.1	36.8	37.3	37.6	40.2	39.2	-2.4%	1.3%
Coal	31.4	33.9	36.5	31.6	36.1	34.4	-4.7%	0.9%
Hydroelectricity	11.7	11.8	13.1	13.4	9.2	15.1	64.6%	1.7%
Other renewables (solar, wind, geotermal etc.)	0.9	1.3	1.7	2.3	2.8	3.8	34.4%	1.0%

Source: (BP, 2016)

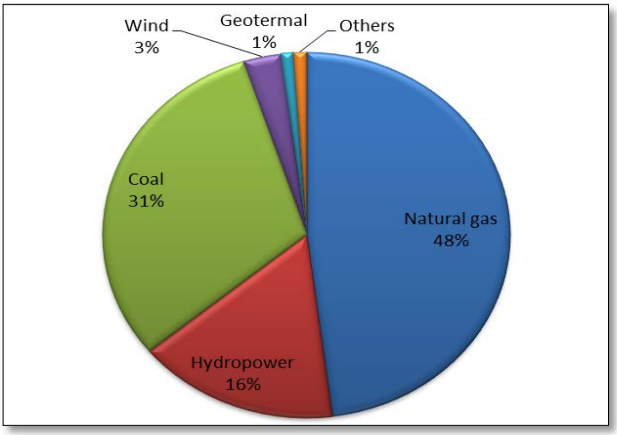
Table 4: Turkey's Energy Balance (1990 – 2013)

	1990	2013	Change
Total Primary Energy Consumption *(million tep)*	52,9	120,29	↑ %127,39 ↑
Total Domestic Production*(million tep)*	25,6	31,94	↑ %24,78 ↑
Total Energy Import *(milllion tep)*	30,9	96,29	↑ %211,62↑
Share Of Domestic Production In Total Primary Energy Consumption	% 48	% 26,6	↓ - %44,58 ↓

Source: (EİGM, 2014)

As a result, of the petroleum crisis that began in the 1970s, many countries turned to renewable energy resources. Fossil fuels compose 79%, 48% being natural gas and 31% coal in Turkey's electricity production. The share of renewable resources in the electricity production of the country is around 21%. The share of wind power in the electricity production is as low as 3% (Figure 8). These figures show that the dominance of fossil fuels continues in Turkey.

Figure 8. Turkey's electricity production portions based on the type of resources



Source: (Karakış, 2014).

Turkey has a great renewable potantial but this potantial don't use sufficiency. Turkey's renewable energy potantial is 332 GW, installed capacity is 28.97 GW and unused capacity in %90.63 of overall capacity. This is an indication that Turkey is not assess the renewable energy sources (Table 5)

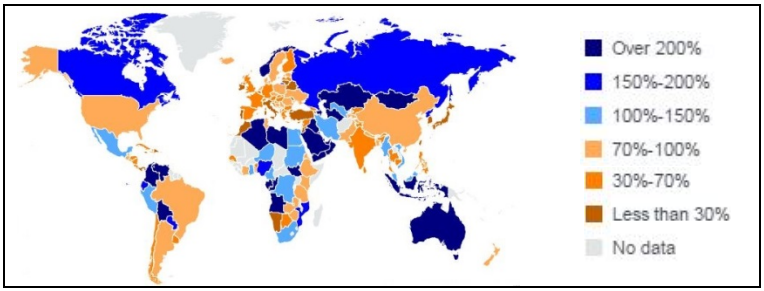
Table 5: Turkey's renewable energy potential and usage ration

Source	Installed Capacity (GW)	Overall Potential (GW)	Unused capacity in % of overall capacity
Hydro energy	23.66	52	64.15
Run-off-the-river hydro		14	
Wind energy	4.5	48	90.63
Solar energy	0.32	217	99.85
Bioenergy	0.15	0.6	75.00
Geothermal (power)	0.34	2	83.00
Total power generation	28.97	332	90.63

Source: (Richert, 2015)

With about less than 30% rate of meeting its own energy, Turkey is among the group of countries that can not be self-sufficient in terms of energy. This is an indication that Turkey is dependent on foreign countries in respect to energy (Figure 9).

Figure 9: World energy self-sufficieny by country (%)



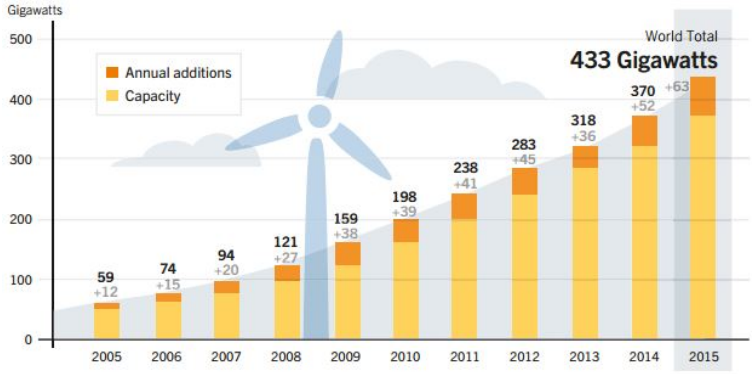
Source: (International Energy Agency (IEA), 2013)

2. Wind Energy Potantial in Turkey

Wind energy is the fastest growing energy source in the world and wind power is one of the most widely used alternative sources of energy today. It is a clean and renewable source of electricity

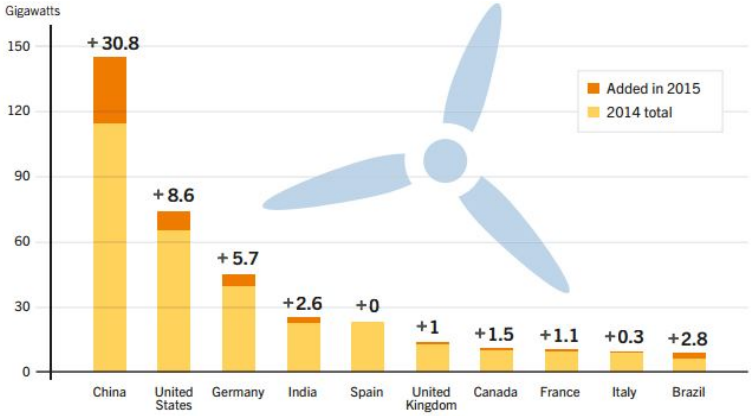
(Oğulata, 2003). Wind power experienced another record year in 2015, with more than 63 GW added – a 22% increase over the 2014 market – for a global total of around 433 GW (Figure 10). China led for new installations, followed distantly by the United States, Germany, Brazil and India. Others in the top 10 were Canada, Poland, France, the United Kingdom and Turkey (Figure 11 and Table 6) (REN21, 2016).

Figure 10: Wind power global capacity and annual additions, 2005–2015



Source: (REN21, 2016)

Figure 11: Wind power capacity and additions, Top 10 Countries, 2015



Source: (REN21, 2016)

Table 6: Wind power global capacity and additions, Top 10 Countries, 2015

	TOTAL END-2014	ADDED 2015	TOTAL END-2015
		GW	
TOP COUNTRIES BY ADDITIONS			
China	97.3/114.6	33/30.8	129.3/145.4
United States	65.4	8.6	74
Germany	39.2	6	45
Brazil	6	2.8	8.7
India	22.5	2.6	25.1
Canada	9.7	1.5	11.2
Poland	3.8	1.3	5.1
France	9.3	1.1	10.4
United Kingdom	12.6	1	13.6
Turkey	3.7	1	4.7

Source: (REN21, 2016)

3.1. Policy Making in Turkey for Wind Power

Turkey is a candidate country for EU membership. Accordingly, Turkey is affected by EU wind power policy. A determining factor in EU's policies is protection of the environment, which can be aided renewable energy resources. The EU enacted Directive 77/EC in 2001 guaranteeing to meet 22% of its electricity consumption with renewable resources and, in the Directive 30/EC, it stated that these resources will be supported. In addition, Directive 28/EC enacted in 2009 made it compulsory to meet 20% of the energy consumption with renewable resources (Bayraç, 2011). The EU attaches importance to wind power in addition to the other renewable resources. Therefore, a target has been set to increase the number of wind turbines in the EU to 90,000 by 2030 (Karaca & Erdoğdu, 2012). All of the aforementioned steps reflect the effect of environment in the energy policies of the EU. Thus, energy policy of Turkey that is a candidate to become an EU member is affected by the environmental and energy policies of the EU.

The desire to reduce foreign dependence in energy affected Turkey's wind power policy-making process. Turkey meets 48% of its energy needs from its own resources and imports the rest. However, primary energy production is expected to become 81 Mtoe and import volume is expected to become 226 Mtoe by 2020 (Kiliç, 2006). Turkey meets 60% of its energy consumption with petroleum and natural gas but is

foreign-dependent for the rest. In addition, importing a substantial part of the natural gas from Russia leads the energy security of Turkey to a dead end (Ulutas, 2005). Policies are being developed concerning alternative energy resources in the country in an attempt to find a solution to reduce the dependence.

Increased public awareness of the environment also impacted policy-making for wind power in Turkey. 81.2% (308.6 million ton) of the greenhouse gas emissions in Turkey is caused by the energy sector. Fossil fuels are the cause of 85% of the emissions in the energy sector (Aydemir, 2015). In Turkey, where the current energy resources lend a high share to the formation of greenhouse gasses, the situation causes important environmental and social problems. Public opposition has increased as a result of the problems encountered, leading the government to make environment-friendly energy policies.

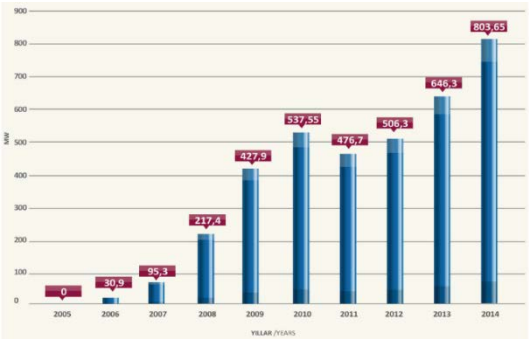
Turkey enacted laws and developed incentives in parallel with the EU in order to support other renewable energy resources in addition to wind power. Electricity Market Law No. 4628, Law No. 5346 on Using Renewable Energy Resources in Electricity Production, and Energy Efficiency Law No. 5627 have all been put into force for this purpose. Some of the incentives provided for wind power are: buying guarantees, 85% reduction in various fees for the first 10-year period, charging 1% of the license application fee, and exemption from various taxes for 8 years. In addition, the law allows allocating state lands for wind turbines and granting license for installing electric power plants using renewable energy resources in protected areas such as national parks. These incentives provided by Turkey have led to a substantial increase in the amount of electricity generated from wind power.

3.2. Wind Power Potential and use in Turkey

Theoretically, Turkey is second among European countries in wind power potential. The gross potential is 400 TWh/year and technical potential is 120 TWh/year in terrestrial areas of Turkey where the gross potential is 160 GW and technical potential is 48 GW. Turkey's economic wind power potential is estimated to be 50 TWh/year and the installed wind power required to use this potential is 20 GW (Gençoğlu & Cebeci, 2001).

In Turkey, electricity generation the use of wind power can be studied in two periods. Law No. 5346 is the deterministic factor in this classification. Period I is the period between the initial production in 1998 (Cesme-Germiyan) and 2006 when the law was put into force; Period II is the period after the year 2006. In Period I, (1998-2006), there was limited interest in wind turbines; only three were installed in these years (Özgören, et al., 2012). Limited incentives and the fact that wind power was seen as an unprofitable investment kept investors away. In Period II, there has been increased interest in wind power from investors. Incentives introduced with Law No. 5346 contributed to this increase. Annual installed power of wind turbines was 30.9 MW in 2006 and increased to 803.65 MW in 2014 as a result of incentives (Figure 12).

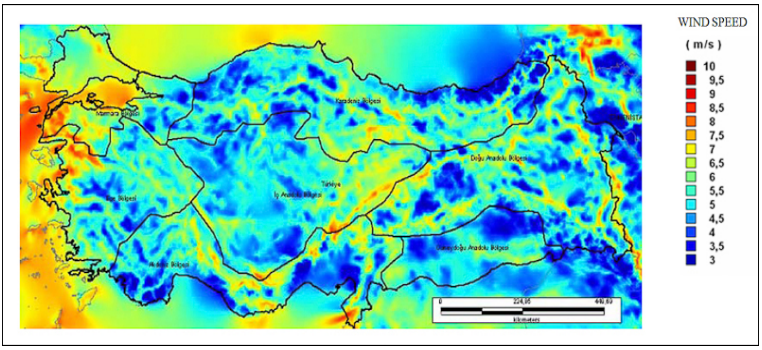
Figure 12: Annual installed power of wind turbines in Turkey (MW)



Source: Turkish Wind Energy Association (TWEA), 2015

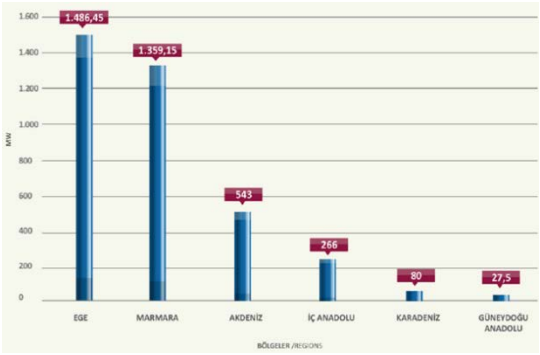
The wind power potential of Turkey is determined by the Ministry of Energy and Natural Resources (MENR). MENR developed a Wind Power Potential Atlas (WPPA) of 50 m intervals. The Aegean (Ege) and Marmara regions have the highest potential, and for cities, Canakkale, Balikesir, Izmir, Manisa and Hatay offer the highest potential (Figure 13). Present installed power of active wind turbines by regions and cities is in keeping with WPPA, that is, the Aegean and Marmara regions hold the highest rank (Figure 14) and Balikesir, Izmir and Manisa are the top cities in terms of wind power potential (Figure 15).

Figure 13: Distribution of average wind speed in 50 m. of elevation above ground



Source: (Çalışkan, 2007)

Figure 14: Regions according to installed capacity for operational wind power plants (MW)

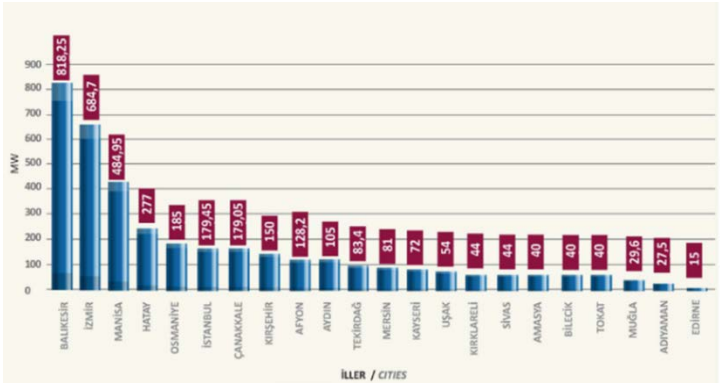


Source: (Turkish Wind Energy Association (TWEA), 2015)

The local government developed a series of plans within the scope of "2023 targets" for the 100th anniversary of the republic. The "Turkey National Renewable Energy Action Plan" was been declared in December 2014 within the scope of energy targets. The plan calls for increasing the share of renewable energy resources of total energy production to 30%. The production capacity of wind power is meant to be increased to 20 GW. Accordingly the efforts for building the new wind turbines have been accelerated in Turkey. The Marmara Region holds the top rank of regions with 513.9 MW wind turbines under

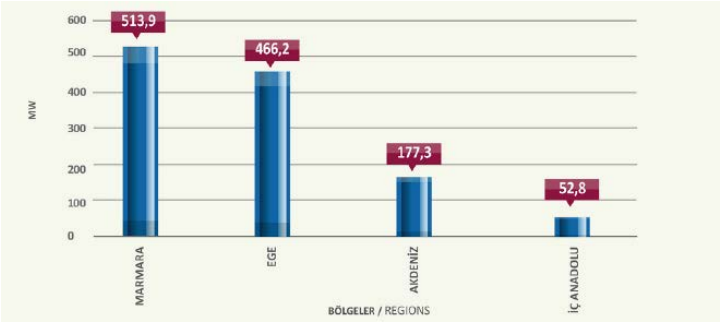
construction. The Aegean (Ege) Region, second with 466.2 MW, is followed by the Mediterranean (Akdeniz) and Central Anatolia (İç Anadolu) Regions (Figure 16). Izmir is the leading city with 247.7 MW of wind turbines under construction. In addition to Izmir, Aydin and Mugla, the Aegean Region has the cities with the highest number of wind turbines under construction (Figure 17). Figures 10 and 11 show the wind turbines installed in Turkey by taking WPPA into consideration. This situation proves that Turkey is carrying out plans for increasing the installed wind power capacity.

Figure 15: Cities according to installed capacity for operational wind power plants (MW)



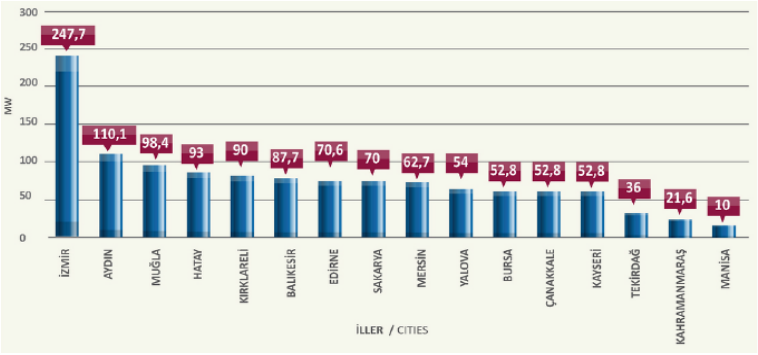
Source: (Turkish Wind Energy Association (TWEA), 2015)

Figure 16: Regions according to installed capacity for operational wind power plants under construction (MW)



Source: (Turkish Wind Energy Association (TWEA), 2015)

Figure 17: Cities according to installed capacity for operational wind power plants under construction (MW)



Source: (Turkish Wind Energy Association (TWEA), 2015)

3.3. Wind power development problems in Turkey

Although Turkey has 48 GW energy potential, the installed power increased only to 4,000 MW in the last 15-years. Obviously, there are problems in Turkey relating to wind power development. Erdoğdu (Erdogdu, 2009) , specified these wind power problems as follows:

- High costs in wind power production
- Technical concerns
- Public opposition
- Environmental impacts

3.3.1. High costs in wind power production

In general, electricity production using wind power is more costly, namely 4.7 -7.2 cents/kWh, compared to the conventional fuels (Erdogdu, 2009). Operational costs of a wind power plant in Turkey are approximately 35.000 €/MW. 54% of these costs relate to service and maintenance, 17% to TETC system use fees, 11% to land, servitude and forestation, 6% to operational costs for switchyards, 4% to general expenses, 4% to staff, 2% to insurance, 1% to occupational health expenses, and 1% to unforeseeable expenses (Hamamcı, 2015).

All the aforementioned expenses raise concerns about investing in wind turbines.

Bureaucratic process is the other factor increasing the cost of wind power plants in Turkey. The wind power investment process in Turkey comprises five stages:

- Application and competition
- Provisional license
- Licensing
- Construction
- Business Administration

Investors in Turkey go through a challenging wind power production process particularly because of licensing and permit procedures. For instance, commissioning of a wind power plant takes six years starting from the date of application (Hayfavi, 2014). Permits from 61 agencies are required to commission a plant (Kocagöz, 2015). This bureaucratic challenge affects investors negatively and holds them back from investing in wind turbines.

3.3.2. Technical Concerns

Large-scale wind power plants can lead to various difficulties in power system operations and planning (Erdogdu, 2009). Intermittent and unstable, wind power can lead to distorting effects at the connection points to the grid system. These distorting effects create restrictive factors for the connection of turbines, particularly at weak points of the system (Uygun & Eker, 2009). All of the technical materials used in wind turbines in Turkey are imported. Although some turbine components are manufactured locally, the production of such components depends on the foreign turbine companies. Quality and certification requirements of these foreign companies about the components create challenges for the local producers (Altuntaşoğlu, 2011). In addition, infrastructure problems and an insufficient number of technical staff in Turkey act as barriers. All of the aforementioned problems either increase the cost or reduce the efficiency of wind

power plants. Accordingly, investors have concerns about investing in wind power plants.

3.3.3. Public Opposition

In recent years, there has been public opposition in Turkey to wind power plants. This opposition is apparent particularly in the country's western regions where there is a high potential for wind power. For instance, opposition continues in an organized manner under the umbrella of non-profit organizations in Cesme on the Aegean coast and where opponents believe an increase in the number of wind turbines will adversely affect tourism. This opposition is often referred to as the NIMBY (Not In My Back Yard) syndrome, which is described as "public opposition" against the use of land acquired for certain investments in close vicinity to settled areas (Palabıyık, Yavaş, & Aydın, 2010) and is seen in many areas where wind power plants are developed (Erdogdu, 2009). NIMBY refers to intense, sometimes emotional, and often adamant local opposition to siting proposals that residents believe will result in adverse impacts (Kraft & Clary, 1991, p. 300). In the risk literature NIMBY is frequently characterized as a phenomenon that keeps striking over and over again whenever a community has been chosen to host a hazardous facility or a facility that will carry some cost to the local residents (Hermansson, 2007, p. 23).

3.3.4. Environmental Problems

Environmental impacts of wind turbines are limited to the immediate environment, but they are still subject to many debates. Leung and Young (Leung & Yang, 2012) classified the environmental impacts of wind power as noise and visual effect, effects on animal and birds, and climate change.

Noise is the main cause of oppositions to wind turbines. The noise generated by the turning of turbine blades varies based on size, technology and wind speed. For instance, the noise generated by a wind turbine with a hub height of 10 m at wind speed of 8 m/s is around 40 dbA (Keith, Michaud, & Bly, 2008). Within settled areas the opposition to wind turbines increases as the distance to the plants diminishes.

The visual dimension is another environmental impact of wind turbines. Modern wind turbines with a hub height of 40 - 130 meters and a blade length of 20 - 60 meters entail severe visual impact. Some people see wind turbines as the symbol of clean energy while others see them as visual pollution (Katsanu, Zafiraki, Kondilli, & Kaldellis, 2011).

Animal lovers are concerned about the impact of wind turbines on habitats of birds and other animals. It is a known fact that birds are killed by wind turbines. However, it should not be disregarded that a higher number of birds are killed as a result of such human activities as urbanization and the destruction of forests.

4. Conclusion

Turkey is a country with high energy demand due to industrialization, population and urbanization. Meeting a substantial part of this high energy demand with fossil fuels makes it a country dependent on foreign energy imports. Turkey's energy demand is expected to increase incrementally in the coming years, and so the country's dependence on foreign energy will also increase. Unfortunately, foreign dependence in energy poses risks for the energy security and social life of the country.

Turkey has high potential in terms of the renewable energy resources. The local government desires to increase the share of renewable resources in the energy production of the country in order to reduce energy foreign dependence. For this purpose, a series of incentives have been put into place.

Wind is a favored resource all over the world because it is clean and renewable. Although Turkey has a technical wind power potential of 48 GW, the potential cannot be completely exploited. Cost, technical concerns, public opposition, and environmental impacts keep Turkey from using its wind power potential to its full extent.

Wind power is one of the most important resources that can be used to meet Turkey's energy demand and reduce its foreign dependence on energy. However, it will not be possible to use this resource as hoped for unless existing problems are solved. For this purpose,

incentives must be increased to reduce the cost to investors. In addition, the time spent commissioning wind turbines must be reduced. The bureaucratic procedures must be shortened and the relevant authorities must work in coordination.

The limited number of technical staff in the country is another important problem. The relevant authorities must provide training for technical persons. In addition, incentives must be increased in order to encourage local companies to produce the necessary technical materials.

Finally, public opposition against wind power plants should not be disregarded. Relevant companies and authorities must act jointly to address the NIMBY syndrome. Public opposition must be taken into account particularly in settled areas having both high wind and tourism potential. The reasons for the opposition must be clearly determined and the demands of the public must be taken into consideration.

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ÖZET

Petrol, doğalgaz ve kömür fosil yakıtları oluşturur. Bu kaynaklar, Dünya'da uzun bir süre temel enerji kaynağı olarak kullanılmıştır. Sanayi İnkılabı ise bu kaynaklara olan talebi daha dar artırmıştır. Ancak 1970'lerde başlayan petrol krizi, özellikle petrole alternatif kaynak arayışını gündeme getirmiştir. Bu arayış sonucunda "yenilenebilir enerji kaynakları" kavramı ortaya çıkmış ve bu kaynaklara bir yönelim olmuştur. Rüzgarın de içinde olduğu bu kaynaklar, günümüzde birçok ülkede enerji kaynağı olarak kullanılmaktadır.

Türkiye, yenilenebilir enerji kaynakları potansiyeli açısından zengin bir ülkedir. Yerşekilleri ve iklim özelliklerinin kısa mesafede değişmesinin yanında jeoloik yapısı bu potansiyeli artıran faktörlerdir. Türkiye, yenilenebilir kaynakların aksine petrol ve doğalgaz açısından fakir bir ülkedir. Bu duruma rağmen, Türkiye'de enerji üretimide fosil yakıtların ağırlığı vardır. Ülkenin fosil yakıt ihtiyacı ise ithalat ile karşılanmaktadır.

Enerji üretiminde ithal kaynakların kullanılması Türkiye'de bazı sorunlara neden olmaktadır. Bu sorunların başında cari açık ve enerjide dışa bağımlılık gelir. 1970'lerde başlayan petrol krizi sonucunda birçok gelişmiş ülkede yenilenebilir enerji kaynaklarına bir yönelim olmuştur. Türkiye'deki enerji profili ise bu yönelimin tersi bir görünüm sergilemektedir. Türkiye'nin kaynak türlerine göre enerji üretiminde % 79 ile fosil yakıtlar büyük bir orana sahiptir. Bu oranda doğalgazın payı % 48, kömürün ise % 31'dir. Ülkedeki enerji üretiminde yenilenebilir kaynakların oranı % 21 civarındadır. Rüzgarın enerji üretimindeki payı ise % 3 gibi oldukça düşük bir rakamdır Bu durum enerji ihtiyacı gün geçtikçe artan Türkiye'de fosil yakıtların ağırlığının devam ettiğini göstermektedir.

Enerjide dışa bağımlılığın azaltılmak istenmesi, Türkiye'de rüzgar enerjisine yönelik politika oluşturulmasında etkili olmuştur. Tükettiği enerjinin büyük kısmını ithal kaynaklardan karşılayan Türkiye, enerji ihtiyacının % 48'ini kendi kaynaklarından karşılar. Ancak 2020 yılına kadar birincil enerji üretiminin 81 Mtoe, ithalatin ise 226 Mtoe olacağa tahmin edilmektedir. Tükettiği enerjinin % 60'ını petrol ve doğalgazdan sağlayan Türkiye'de ernerjide bağımlılık oldukça yüksek düzeydedir. Ayrıca kullandığı doğalgazın büyük kısmının Rusya'dan ithal edilmesi Türkiye'yi enerji güvenliği açısından da zora sokmaktadır. Bağımlılığın azaltılmasında çözüm, ülkedeki alternatif enerji kaynaklarına yönelik politika geliştirilmesinde aranmaktadır.

Türkiye, Avrupa'da en büyük teorik rüzgar enerji potansiyeline sahip ikinci ülkedir. Karasal alanlarında 400 TWh/yıl brüt ve 120 TWh/yıl teknik potansiyeli olan Türkiye'de; brüt potansiyel 160 GW, teknik potansiyel ise 48 GW'tır. Türkiye'nin ekonomik rüzgar potansiyelinin 50 TWh/yıl ve bunun değerlendirilmesi için gereken kurulu rüzgar gücünün ise 20 GW olduğu hesaplanmıştır.

Türkiye'de rüzgardan elektrik üretimi iki döneme ayrılabilir. Bu ayrımda 5346 sayılı kanun belirleyicidir. İlk üretimin başladığı 1998 (Çeşme – Germiyan) ile kanununun çıktığı 2006'ya kadar olan kısım I. Dönem; 2006 sonrası ise II. Dönem olarak tanımlanabilir. I. Dönemde (1998 – 2006) rüzgar santrallerine ilgi oldukça azdır. Bu dönemde sadece üç rüzgar santrali kurulmuştur. Teşviklerin yetersizliği ve karlı bir yatırım olarak görülmemesi bu dönemde girişimcileri rüzgar enerjisinden uzak tutmuştur. II. Dönemde ise yatırımcıların rüzgar enerjisine ilgisinde artış vardır. Bu artışta 5346 sayılı kanunun getirdiği teşvikler etkili olmuştur. 2006'da rüzgar enerji santalleri için yıllık kurulum gücü 30,9 MW iken, 2014 yılında 803,65 MW'a çıkması bu teşviklerin sonucudur.

Rüzgar, Türkiye'deki enerji ihtiyacını karşılamak ve enerjide dışa bağımlılığı azaltmak için ülkenin sahip olduğu en önemli kaynaklardan birisidir. Ancak rüzgar enerjisi ile ilgili var olan sorunlar çözüme kavuşturulmadan, bu kaynak yeterince değerlendirilemeyecektir. Bu amaçla, yatırımcılar için önemli bir sorun olan maliyetin azaltılması için teşvikler artırılmalıdır. Ayrıca, rüzgar tribünlerinin işletmeye açılmasının süresi kısaltılmalıdır. Bu kapsamda, bürokratik süreç kısaltılmalı ve ilgili kurumlar koordineli çalışmalıdır.

Ülkedeki teknik eleman yetersizliği önemli bir sorundur. Teknik eleman yetirştirilmesi için ilgili kurumlar tarafından eğitimler verilmelidir. Ayrıca, tribünler için gerekli teknik malzemenin yerli firmalar tarafından yapılmasına yönelik teşvikler artırılmalıdır.

Rüzgar santrallerine yönelik halk tepkisi göz ardı edilmemelidir. NIMBY sendromu kapsamında değerlendirilen bu tepkilere yönelik, ilgili firmalar ve kurumların ortak çalışma yapması zorunludur. Özellikle hem rüzgar potansiyelinin yüksek hem de turizm merkezi olan yerleşmelerde, halkın tepkisi dikkate alınmalıdır. Tepkilerin nedeni net olarak ortaya konulmalı ve halkın talepleri de dikkate alınmalıdır.