



MACROJOURNALS

# The Journal of **Macro**Trends in Energy and Sustainability

## **TURKEY'S NEW ENERGY SOURCE: WIND ENERGY AND IT'S REGIONAL CAPACITY**

**Fatih AZMAN\***, **Hasan Ali AKYUREK\***, **Ahmet Tayfur AKCAN\***, **Emrah AYHAN\*\***,  
**Ugur ERDOGAN\*\*\***

*\*Necmettin Erbakan University, Turkey*

*\*\*Inonu University, Turkey*

*\*\*\*Selcuk University, Turkey*

### **Abstract**

*There is a need for sustainable energy policy to ensure sustainable development in today's world. Energy is an indispensable resource to raise social welfare and increase its global competitiveness. People in the information age need energy to reach the information. Therefore the countries should create its' own energy resources. Because of constantly increasing population it requires a sustainable energy policy. For these reasons the need for energy in the countries is increasing every day. Wind energy is one of the most important sustainable and renewable energy source for developing countries. Wind energy is clean and steady unlike fossil and nuclear energy which will end in future. In this study, Turkey's wind energy potential was examined. Turkey has a high potential for wind power because of its geographical location. In the study sectional aspects of wind energy was examined and it is given information about the future of wind energy in Turkey.*

*Keywords: Energy, sustainability, Turkey wind energy potential, sustainable development*

### **1. INTRODUCTION**

The need for the energy of the people in the world are increasing due to the progressive technology. Fossil fuels used in electricity production available is limited and it is decreasing day by day. These resources will be exhausted one day. Therefore energy saving efforts continued and work continues at a great pace on the production of electricity using renewable resources. Studies for use in electricity generation from renewable sources reduce dependence on foreign. For this reason importance of electricity generation from wind increases in Europe in the world in recent years.

The energy needing for the sustainability of human life is continuous and it is necessary to ensure the quality and it is safe. Worldwide fossil resources, as well as the necessary heating fuel has a very wide range of applications. The reserves of fossil fuels are not considered adequate for the future. It also requires obtaining and greatly advanced technology and financial resources in terms of storage. Gradually reducing the share of oil in total energy demand, making strict and efficient use of energy resources, to benefit as much as possible from renewable energy sources are the measures to be taken. (Kurban, 2003:1; Golding, 1976:3). One of the renewable energy resources is wind energy. Wind energy is one of the oldest energy sources used by humans since B.C 2800. Wind energy has found area of usage in the past years with the aim of obtaining water pumping and generate electricity in rural areas in the past 50 years. Today, wind energy has now taken its place in the energy sector as an alternative source of energy production. Conventional energy sources to alternative energy sources are listed in Table 1.

Table 1: Alternative Energy Types

<b>Alternative Energy Type</b>	<b>Source/Fuel</b>
Nuclear energy	Uranium etc.
Solar energy	Sun
Wave energy	Oceans and seas
Natural gas	Underground sources
Geothermal energy	Groundwater
Hydro energy	Rivers and dams
Hydrogen	Water and hydroxides
Biomass, biodiesel, biogas	Biological waste and oils
Wind energy	Wind

A growing population and energy needs can not be supply due to the industrialization of our country with limited resources in 21st century. The gap between energy production and consumption increases rapidly. Therefore it becomes increasingly important from our own resources more effectively to benefit. In order to meet the rapid increase in energy demand will need to take advantage of renewable energy resources in a rational way. For this they need to increase public investments. It will also be useful in shifting private sector investment in this area.

Natural gas is one of the commonly used energy source in the world today. Natural gas is considered to be a reliable and clean source of energy. According to published reports the demand for natural gas increases day by day growing countries of the world. However, the natural gas reserves in the country where it is stated enough for 60-80 years. Furthermore the increase in natural gas prices in recent years have occurred in the country have begun to point to other energy sources.

Developing non-polluting energy production systems and using for the development of clean production systems would be wise. Therefore, studies and research on the resources are made in addition to conventional energy sources, new and renewable energy sources, known as solar, wind, geothermal, hydrogen, sea-wave energy. Today the world has reached the level of production capacity million kWh per year of renewable energy sources (Kavas, 2004). Increasing wind energy production progressing day by day becoming one of the world's most important energy source.

Wind energy is a natural, renewable, clean and infinite energy kind. The sun heats the earth nonhomogeneous and an airflow occurs. This airflow called wind. Wind energy production is the most advanced and commercially available in renewable energy sources, it is also the fastest growing. Wind energy is the energy of carbon independent production process, so this source is called "clean energy" because it does not cause atmospheric pollution. Wind energy is an indigenous, do not depend on external, natural and inexhaustible, Non-CO<sub>2</sub> emissions, providing fossil fuel savings, no radioactive impact and rapid technological development resource. It can also be activated at short notice and can be removed in a short time (Dereli, 2001). Additionally it has employment opportunities and there is no risk of price increases.

Generating electricity from the wind began 100 years ago. It focused on 20-100 kW machines prior to 1950s (TUSIAD, 2010). Designed in the 1980s, new technology and reduced material costs and improved again with wind turbines, it has opened a new era for wind power.

The use of wind energy production begins to develop after the oil crisis of the 1970s. 1580 mw of wind farms are established in the years 1980-1985 in the United States of America. Installed power value reached 1946 mW by the end of 1998. Denmark, the Netherlands and Germany start to set up wind farms have developed rapidly in Europe (TUBITAK, 2011).

## **2. WIND ENERGY ADVANTAGES AND DISADVANTAGES**

Wind energy is a clean and renewable energy sources but as in all types of energy wind energy has advantages and disadvantages. These can be explained as follows.

Because of the clean, non-polluting, can be used directly, continuous and domestic factors of wind it reduces fossil fuel consumption (Bayraç, 2011:40).

The most important contribution to the environment of wind turbines is that it does not generate harmful gases resulting from combustion of fossil fuels. Therefore, wind energy does not cause the greenhouse effect and acid rain. According to the Kyoto Protocol signed in Japan in 1997 industrialized countries must reduce the amount of greenhouse gases 5% until 2012 lesser than the level in 1990 (Bayraç, 2011:40). According to this protocol renewable energy

sources must be preferred to reduce the airborne release of gases that cause global warming. Wind energy in many parts of the world, there is enough potential and promising among renewable energy sources for the future.

The average enterprise of turbines can be used for 20-30 years, it is advantageous in terms of operation and maintenance costs for a long time to spread (Mehel, 2009:6).

Wind turbines begin producing energy in a short period of 4-5 months. However nuclear energy begins 6-7 years, natural gas 1,5-2 years, hydro energy 2-10 years. (Acar ve Doğan, 2008: 680).

A typical wind farm consisting of 20 turbines covers 1 km<sup>2</sup>. Approximately 1% of this area as the use turbine installation location. The remaining sites are evaluated for farming-farming or natural land form (Bayraç, 2011:40).

Wind energy sector creates employment and contributes to economic and social development. The wind energy industry currently employs 400,000 people. It is expected that this number will increase in the years to reach 1,000,000 people (GWEC, 2010). Turbine blades and other components manufacturers, produced electricity selling/distributing enterprises, consultancy, which require engineering and R&D expertise, installation maintenance, finance, marketing and so on. In numerous technical and administrative business is creating new employment opportunities.

Wind turbines do not emit radiation and do not fire. Also turbines are not complex machines and they are automatic. They worked flawlessly throughout their lifetimes thanks to periodic maintenance.

Because of the wind speed is variable each zone can not be established wind power plant. The resulting energy is to connect directly to the main transmission line is the healthiest way to overcome this wind variability (Mehel, 2009: 7).

Wind farm tools required to install and be imported from abroad, the majority of the equipment increases the installation costs of the turbine. To resolve this problem, it is necessary to encourage domestic production (Bayraç, 2011:41).

The local residents is affected negatively by wind noise and visual pollution generated by the turbine. However, turbine technology is increasing day by day. The turbine noise level is below 40 dB whisper 150-200 meters away (Karacan, 2007: 290). Therefore, noise pollution is negligible for wind power plants.

### **3. STATUS OF WIND ENERGY IN TURKEY AND EUROPE/WORLD COMPARISONS**

WASP (Wind Atlas Analysis and Application Program) software package is used for Turkey Win Atlas which prepared by the Danish Meteorological Organization and also used in the preparation of the European Wind Atlas. This program was carried out on-site inspections for showing homogeneous distribution on Turkey for 96 meteorological stations. Turkey Wind Atlas has been prepared using data from 45 of them this station. According to the wind atlas prepared for 50 m height wind energy potential is high especially in the Aegean and Marmara and western Black Sea coast and in the eastern Mediterranean coast (DMİ, 2011).

Turkey's land areas have 400 billion kW/year gross potential of 120 billion kWh/year and technical potential of 50 billion kWh/year economic potential. Gross potential is 160000 mW, technical potential is 48000 mW and economic potential is 20000 MW in Turkey. 8200 mW potential is available in Turkey's coastal regions (Acar ve Doğan, 2008: 680). Technical potential of wind in the area of Turkey's sea is estimated 60000 mW (150 billion kW/year) (Kılıç, 2009: 19).

Turkey's best wind resource areas of the coastline are located near the top of the mountains or high ridges and open space. It has been set 47.849 mW wind energy potential for Turkey considering 7 m/s wind speed. The first small power plants has been started in 1995 by made with build-operate-transfer model. Turkey's first wind power plant is built in Çeşme (DMI, 2011). It's name is Alize Germiyan and it's power is 1,5 MW.

As shown in Table 2 the share of total energy production of the wind power generation installed capacity is 5.7% from total energy production in Turkey by looking at data as of 30 September 2015. There are also 106 units of wind power plant in Turkey.

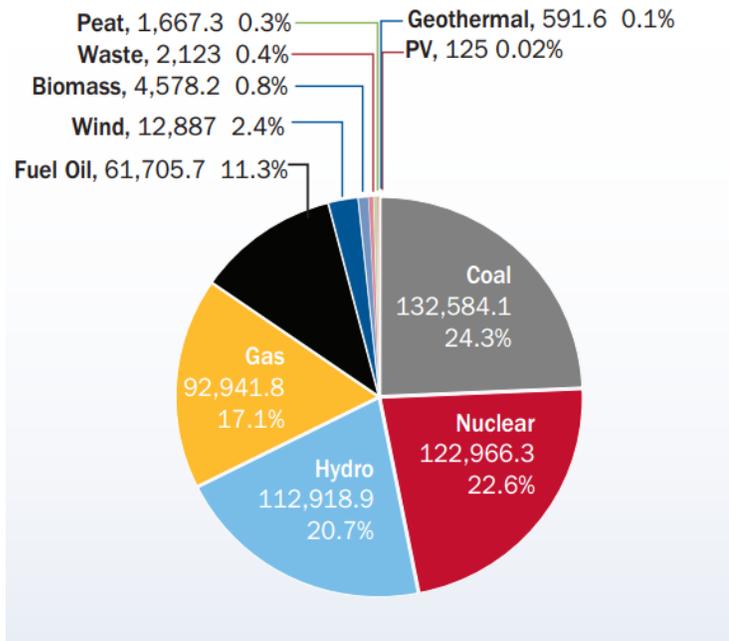
Table 2: Distribution of Energy Type in Turkey

FUEL TYPES	INSTALLED POWER (MW)	ADDITIVE (%)	NUMBER OF PLANT (PIECE)
FUEL-OİL + DIESEL	742,3	1,0	15
COAL + LIGNITE	8.729,4	12,1	25
IMPORTED COAL	6.064,2	8,4	8
NATURAL GAS + LNG	21.495,7	29,8	240
WASTE+PYROLYTIC OIL	320,5	0,4	66
MULTI FUEL (SOLID+LIQUID)	657,8	0,9	7
MULTI FUEL(LIQUID+N. GAS)	3.883,8	5,4	38
GEOHERMAL	581,4	0,8	17
HYDRAULIC (DAM)	18.126,2	25,1	89
HYDRAULIC (RIVERS)	7.231,6	10,0	451
<b>WIND</b>	<b>4.144,2</b>	<b>5,7</b>	<b>106</b>
SOLAR (UNLICENSED)	178,6	0,2	279
<b>TOTAL</b>	<b>72.155,6</b>	<b>100,0</b>	<b>1.341</b>

Source: TEİAŞ (Turkey Electricity Transmission Inc.), 2015

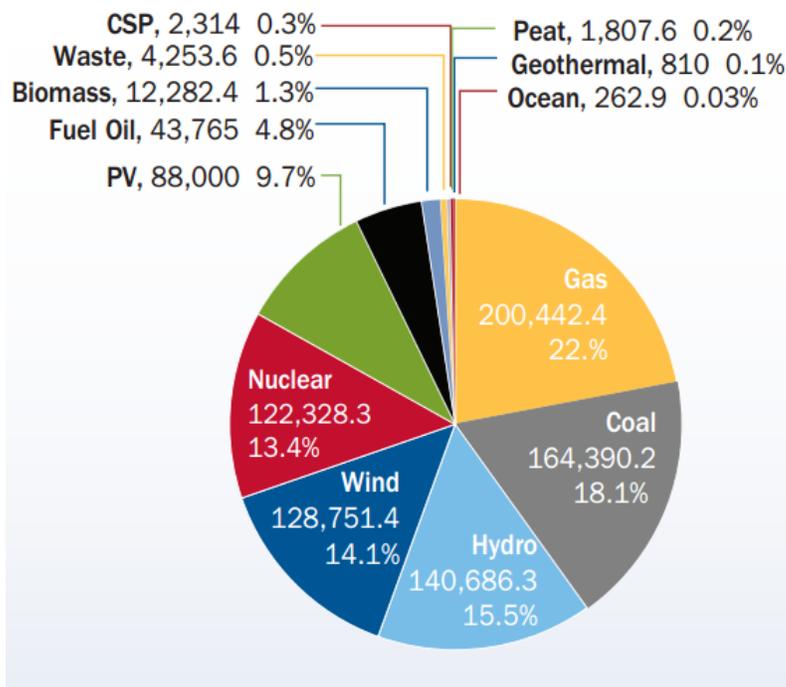
As shown in table 3 and table 4 it is observed that 14.1% share of total energy production of wind energy production in 2014 in Europe. Wind energy production is 2,4% in 2000. It reached 14% in just 14 years. This shows that the importance of wind energy and its contribution to world energy supplies.

Table 3: European energy type distribution (2000)



Source: EWEA (The European Wind Energy Association), "Annual Statistics" 2000

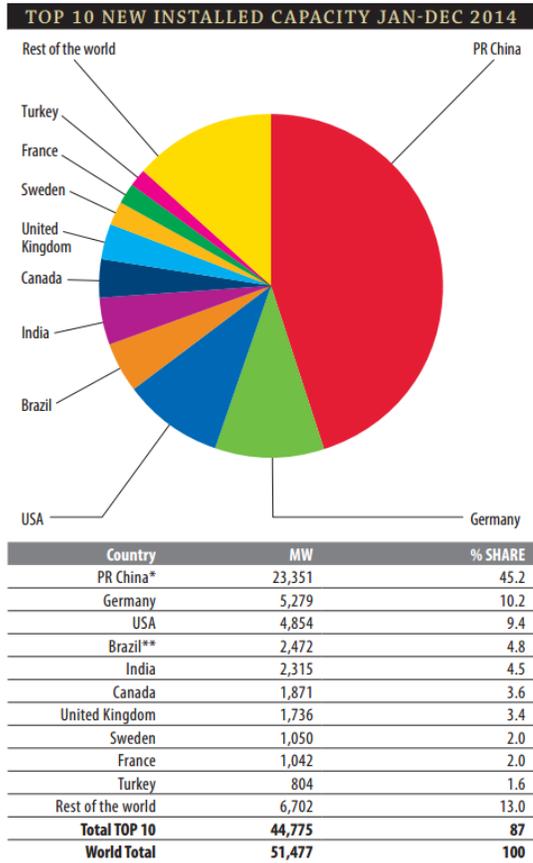
Table 4: European energy type distribution (2014)



Source: EWEA (The European Wind Energy Association), "Annual Statistics" 2014

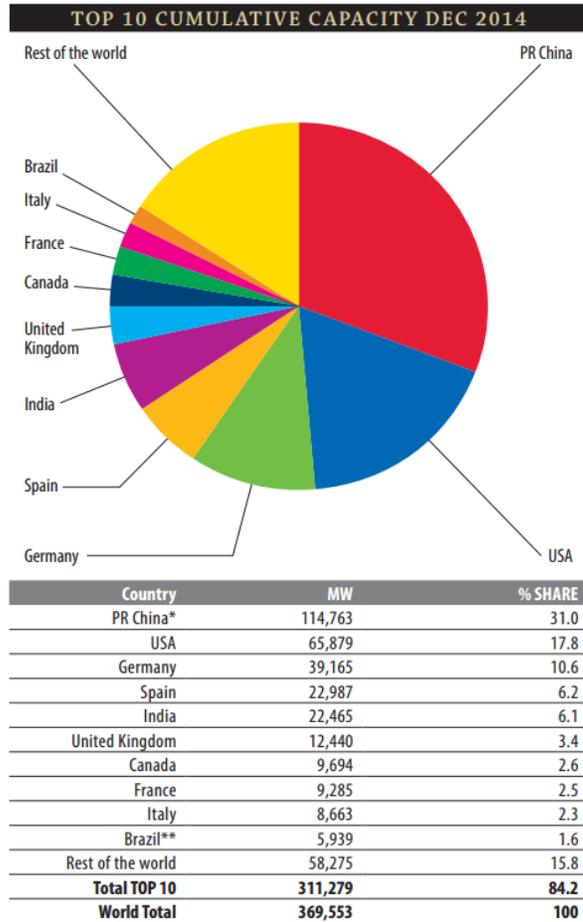
The world's largest wind energy producer is China. China has 31% of world such a large part of the world wind energy followed by America, Germany, Spain and India. Turkey is located in top 10 in terms of wind energy power in world. As it is shown in the following tables Turkey established the 1.6% in the world of wind energy plants that established in world. The largest share of wind power plants with 45.2% still belongs to China that established in 2014 (EWEA, 2014).

Table 5: Established Wind Energy Power in the World (2014)



Source: GWEC (Global Wind Energy Council), "Global Wind Statistics" 2014

Table 6: Total World Wind Energy Power in the World (2014)



Source: GWEC (Global Wind Energy Council), "Global Wind Statistics" 2014

#### 4. THE FUTURE OF TURKEY WIND ENERGY AND IT'S ROLE IN DEVELOPMENT

If the current energy consumption is even double in 2020 there are prospective studies that world's electricity consumption will be supplied 12% with wind energy. According to data of 2015 the share of all types of energy produced by wind energy in Turkey is 5.7%. It is not difficult to achieve the targeted goal of 12% for 2020 (TUREB, 2012). Sustainable development is needed for a sustainable energy policy. Sustainable energy policies are needed wind energy which is clean and infinite. At this point because of it can be renewable every day and it will continue as long as the world exist enough consideration should be given to wind energy.

Table 7: Installed Power with Existing Regulations and TUREB'S Proposals

Years	Arrangements will be made available with installed power (MW) (Annual)	<u>Installed Capacity with TUREB's Proposals (MW) (Annual)</u>		Installed Capacity with Existing Regulations (Cumulative)	Installed Capacity with TUREB's Proposals (Cumulative)
		Foreign Production	Local Production		
2012	-	-	-	2300	-
2013	620	580	-	2920	3500
2014	740	760	-	3660	5000
2015	820	680	-	4480	6500
2016	780	720	100	5260	8100
2017	810	690	100	6070	9070
2018	790	710	200	6860	11400
2019	680	720	200	7540	13000
2020	720	680	300	8260	14700
2021	840	560	300	9100	16400
2022	750	650	400	9850	18200
2023	770	630	400	10620	20000

Source: TUREB (Turkey Wind Energy Association), "Turkey Wind Energy Roadmap", 2012

## 5. CONCLUSION

It is necessary to diversify the sources used in electricity generation. Problems may occur in the future because of source providing and the risk of price increases. In this context, countries must put target to produce like existing hydraulic resources, wind, solar, geothermal energy which is not depend on outside, natural and inexhaustible and not harm the environment. For these reasons countries should set targets to raise the required rate. They should make the necessary legal arrangements and should take concrete steps in this regard.

Energy has an important place in three fundamental components of sustainable development which include social stability, economic growth and environmental protection. Energy must be produced continuously and reliably in the context of sustainable development objectives. Efforts to increase the use of renewable energy sources in the world especially in Europe continues. Although Turkey has serious potential for the renewable resources working on this issue it has not yet reached the desired level. Turkey just like other countries. Turkey has adopted legal framework and implement ambitious targets for expanding the use of renewable energy sources.

In the framework of sustainable development, Turkey considers the possibility of depletion of non-renewable resources that compatible with the country conditions and long-term sustainable implementation of an energy policy is an unavoidable reality. It is extremely important for the country's economy for the development of wind energy which is not depend on outside, developed technology, high employment creation potential, cheap and safe.

Consequently one of the most important thing for sustainable development is energy. The wind energy is one of the infinite source in nature. If it gives the necessary importance to energy it will be enough the energy needs of countries in development and they will progress rapidly about sustainable development.

## ACKNOWLEDGMENT

This work was supported by Research Fund of the Necmettin Erbakan University. Project Number: 152518001-402.

## REFERENCES

- Acar, E. ve Doğan, A. (2008), Türkiye'nin Rüzgar ve Hidrolik Enerji Potansiyeli ve Çevresel Etkilerinin Değerlendirilmesi, *VII. Ulusal Temiz Enerji Sempozyumu Bildiri Kitabı UTES' 2008*, 17-19 December 2008, İstanbul., s. 675-682.
- Bayraç, N. (2011), Küresel Rüzgar Enerjisi Politikaları ve Uygulamaları, *Uludağ Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 2011:37-57
- Dereli S. (2001), "Rüzgar enerjisi", Ankara; Tübitak Yayını s. 13
- DMİ, Rüzgar Atlası (<http://www.dmi.gov.tr/FILES/genel/sss/ruzgaratlası.pdf>, Last Access 23.08.2015).
- DPT, (2001), Devlet Planlama Teşkilatı (DPT), "8. Beş Yıllık Kalkınma Planı, Elektrik Enerjisi Özel İhtisas Komisyonu Paporu", Ankara, 2001. (<http://ekutup.dpt.gov.tr/enerji/oik585.pdf> Last Access 11.10.2015)
- EWEA, (2014) "Annual Statistics" (<http://www.ewea.org/fileadmin/files/library/publications/statistics/EWEA-Annual-Statistics-2014.pdf>, Last Access 01.11.2015)
- Golding, E.W. (1976), "The Generation of Electricity by Wind Power", London,
- GWEC, (2014) "Global Wind Statistics" ([http://www.gwec.net/wp-content/uploads/2015/02/GWEC\\_GlobalWindStats2014\\_FINAL\\_10.2.2015.pdf](http://www.gwec.net/wp-content/uploads/2015/02/GWEC_GlobalWindStats2014_FINAL_10.2.2015.pdf), Last Access 05.11.2015)
- Karacan, A. R.(2007), *Çevre Ekonomisi ve Politikası-Ekonomi, Politika, Uluslararası ve Ulusal Çevre Koruma Girişimleri*, Ege Üniversitesi Ya.,İİBF Ya. No: 6, İzmir.
- Kavas, A.O.(2004), "Enerji Politikaları, Üretimi ve Fiyatlandırmaları", *Mimar ve Mühendis Dergisi*, 33, P. 9-15.
- Kılıç, N. (2009), Dünyanın Önemli Doğal Kaynağı: Rüzgar Enerjisi, *İzmir Ticaret Odası, Ar-Ge Bülteni*, June-Ekonomi, İzmir ([http://www.izto.org.tr/NR/rdonlyres/7475BDA1-95B7-4855-B351ADCE4362AFE/12474/r%C3%BCzgarenerjisi\\_nk%C4%B1l%C4%B1c.pdf](http://www.izto.org.tr/NR/rdonlyres/7475BDA1-95B7-4855-B351ADCE4362AFE/12474/r%C3%BCzgarenerjisi_nk%C4%B1l%C4%B1c.pdf), Last Access 12.09.2015)
- Kurban, M.(2003), Elektrik Enerjisi Üretiminde Rüzgar Enerjisinin Yeri ve Önemi, I. Ege Enerji Sempozyumu ve Sergisi , Denizli, 22-24 May 2003
- Mehel, N (2009), *Dünya'da ve Türkiye'de Rüzgar Enerjisi: Potansiyeli, Kullanımı ve Almanya-Türkiye Karşılaştırması*, Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Enstitüsü Basılmamış Yüksek Lisans Tezi,Eskişehir.

TEİAŞ, (2015) Kuruluş Ve Yakıt Cinslerine Göre Kurulu Güç,  
(<http://www.teias.gov.tr/yukdagitim/kuruluguc.xls>, Last Access 12.10.2015)

Topçu, S., Menteş Ş. S., Yurdanur, S. Ü., Aslan Z. (2001), “Rüzgar Enerjisi Potansiyelinin belirlenmesinde Yer Seçiminin Önemi: Sinop Örneği”, TMMOB Makine Mühendisleri Odası, II. Çevre ve Enerji Kongresi, İstanbul, 2001, p. 145-154.

TÜBİTAK, 21.Yüzyılın Enerji Teknolojileri,  
(<http://www.tubitak.gov.tr/btpd/btspd/enerji/icindekiler.html>, Last Access 29.10.2015)

TÜSİAD, Türkiye Açısından Yeni ve Yenilenebilir Enerji Kaynaklarının Yeri,  
(<http://www.tusiad.org/turkish/rapor/enerji/html/sec10.html>, Last Access 29.10.2015)

TUREB, (2012) Türkiye Rüzgar Enerjisi Yol Haritası,  
([http://www.tureb.com.tr/dosyalar/Turkiye\\_Ruzgar\\_Enerjisi\\_Yol\\_Haritasi.pdf](http://www.tureb.com.tr/dosyalar/Turkiye_Ruzgar_Enerjisi_Yol_Haritasi.pdf), Last Access 01.11.2015)