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Introduction

- 1 Gradual increase in energy consumption due to the global increase in population and urbanisation movements in parallel to the developing industry and advancing technology force people to search for new and environment friendly energy sources. On-time, economic, safe, constant and clean energy procurement has become one of the most important problems of the day when energy requirement has increasingly more significance not only in industry but also in the daily lives of people. As to the aforementioned importance of energy, the gradual increase in the demand towards energy causes fossil energy sources to be rapidly consumed. Diversifying energy sources and presenting renewable energy sources alongside with the traditional ones have become more and more important to establish a sustainable balance in energy procurement.
- 2 Energy consumption of Turkey gradually increases in parallel to its attempts towards becoming a developed country. It is an energy importer country due to the lack of enough conventional energy sources which can be accepted as the driving motor of development. Electric energy demand of our country annually increases by 8 pct on average (Yiğitgüden, 2001, 2).
- 3 Our country, just as the majority of all world countries, faces some short and long term problems in energy procurement. Turkey should at first attempt to increase the amount of energy acquired from new and renewable energy sources to cover basic requirements of society and realise economic expansion, refrain as much as possible from local and global environmental problems caused by energy consumption and production and especially reduce foreign-dependency in energy. This is valid for not only our country but also other countries of the world as the aforementioned problems

shall be solved not only for today but also for the next generations and it can be achieved not by the countries themselves but by the joint effort of all.

- 4 In this study, we are going to render information on the energy from wind power which is better revealed in recent studies to be an important energy source for Turkey and attempt to explain the importance of wind power potential to cover the electric requirement of our country and its possible role in the future with some suggestions to develop wind energy in our country.

Situation of Wind Energy in the World

- 5 Wind energy is the most advanced and widespread renewable energy source being the most convenient in commercial terms. Being a clean energy source, wind energy is environment friendly having no possibility of extinction as long as the sun exists. It is an ever growing energy source despite its being continuous and despite the fact that it is not exactly known whether available amount will be at hand when required. For instance, while the world established wind power is 24 322 MW in 2001, it has raised to 196 630 MW in 2010 (World Wind Energy Report 2010, 6). The data clearly reveal the fact that the established world wind energy power is doubled once in every three years. Although the established power of wind energy has recently increased in the countries in the Asian Continent, 43,7 pct of the established power of world wind energy is in the European Continent, according to 2010 data (World Wind Energy Report 2010, 15). The USA, Germany, Spain and Denmark with other European countries and China and India are among the countries with the most amount of established wind energy reaching up to 203 000 MW. Electricity produced out of wind power corresponds to 21 pct of overall electric production of Denmark, 18 pct of Portugal, 16 pct of Spain and 9 pct of Germany (World Wind Energy Report 2010, 10). The data is significant in a way to indicate the importance of the role of electricity procured out of wind power in covering the requirements of the country.
- 6 According to 2010 data of Balkan countries being under the influence of almost similar wind systems to Turkey, our bordering neighbour Greece has 1 208 MW of wind energy established power, while Bulgaria has above 375 MW of established wind power (World Wind Energy Report 2010, 19). Based on a comparison with our neighbors, the significance of the potential of our country is blatant, only when we consider the great surface area of our country.
- 7 It is known that pioneering countries at global level as well as Turkey support further energy production out of the renewable energy sources through legal regulations, incentives, tax exemptions and lending facilities.

Energy Sources of Turkey

- 8 Energy is indispensable both for economy and social and cultural life. Accordingly, it is an irrevocable necessity to present consumers constant and safe energy. The ever increasing energy demand, especially electric energy consumption, gains parallel to development. When we analyse energy consumption data in our country, we see the rate of this increase augment by doubling every ten years.
- 9 When we have a look at energy statistics of our country, we see that a significant amount of the consumed energy is constituted by fossil fuels. The overall share of fossil

fuels nowadays to cover the required energy is generally around 80 pct. According to 2008 data, Turkey provides 31,5 pct of the energy it consumes from oil, 31,3 pct of the natural gas, 29,6 pct from coal and 7,6 pct from hydraulic and other renewable energy sources. However, 93 pct of the oil consumed, 85,8 pct of the coal and 97,5 pct of the natural gas is imported. When we make a general evaluation, we see that around 65-70 pct of the overall consumed energy is imported (WEC-TNC, 2009, 88). The energy demand of Turkey is anticipated to augment in the future which would lead to a rise in foreign-dependency. The overall energy demand of the country is envisaged to reach 126 millions tons oil equivalent (Mtoe) in 2010 and 222 Mtoe in 2020 (WEC-TNC, 2009, 89).

Table1 - Distribution of Turkish Energy Consumption According to Sources (In thousand toe)

Year	Hard Coal	Lignite	Asphaltite	Oil	Natural Gas	Hydro-Electric	Geo-thermal	
							Elec	Heat
1970	2 883	1 628	15	7 579	-	261	-	23
1980	2 824	4 299	240	15 309	21	976	-	60
1990	4 997	12 941	119	22 700	3 110	1 991	69	364
2000	9 390	18 156	9	31 072	13 729	2 656	65	648
2008	13 859	21 074	271	30 756	33 604	2 861	68	1 011

Year	Wind	Sun	Wood	Animal, Vegetable waste	Overall
1970	-	-	3 845	2 128	17 862
1980	-	-	4 730	2 953	31 412
1990	-	28	5 361	1 847	51 527
2000	3	262	5 081	1 376	82 447
2008	71	420	3 679	1 123	108 797

Source: Turkish Energy Report 2009, World Energy Council Turkish National Committee, p.88, Ankara.

- 10 The overall electric production of Turkey reached 198,2 billion kWh at the end of 2008. 49,7 pct of the produced electric energy was acquired from natural gas, 16,8 pct from hydraulic, 29 pct from coal, 3,8 pct from fuel oil. While 82,7 pct of electric production was from thermal power plants in 2008, 17,2 pct was from renewable energy sources. As it is clear in Table 2, electric production of our country generally relies upon natural gas. Around 2/3 of energy requirement of Turkey is covered by import which may cause unexpected problems to be confronted in achieving its sustainable development

targets. It is required to use alternative energy sources to procure the required energy in a way to reduce external dependence. In this respect, the political stability recently attained by Turkey enhanced some enterprises on energy procurement to be realized. For instance, Nuclear Power Station tender, having been on the agenda for long years without being finally realized due to various reasons, is opened and a concrete step is taken to benefit from nuclear energy. Moreover, with the enforcement of renewable energy law, it is aimed to have possible developments not only in wind energy but also in solar, geo-thermal, bio-mass energy and energy production out of various wastes. It is always possible for the decision-makers to be influenced by changing governments when it comes to the realisation of long-term plans in developing countries as Turkey. The political stability having attained in our country after so many years seems to have created appropriate environment for both medium and long-term preparation of energy policies and the realisation of these plans. Alternative energy sources led by local and renewable sources are required to reduce energy dependency of the country. Activating alternative sources will provide energy supply security and reduce energy dependency on foreign countries. Therefore, hydroelectric production shall be initiated in Turkey not only on big rivers but also on small rivers pouring out the Black Sea coast. Besides, electric requirement of Turkey should be covered through the establishment of solar panels and wind energy facilities and thus foreign-dependency shall as much as possible be reduced.

- 11 Besides making hydroelectric power plants more widespread in the Black Sea region having the most amount of rainfall in Turkey, electric energy shall be procured through solar panels established on the southern slopes of Toros mountains having convenient conditions to produce solar energy and through the production centres to be established in the Southeast Anatolian Region. Besides, considering especially western and north western regions of our country are important fields for wind energy procurement, geographical superiority and convenience of various regions of Turkey have high importance in terms of our economic development.

Turkey Electric Energy Production

- 12 The established electric capacity of Turkey increases in time. For instance, it was 9 122 MW in 1985, while it increased more than double in 1995 when compared to the figures of ten years ago to reach 20 954 MW and by the end of 2008, it augmented to overall 41 817 MW. When we have a look at the distribution of overall established capacity in terms of sources, we see 33 pct is covered by hydroelectric, 36 pct by natural gas and the remaining 11 pct by other sources. The established capacity according to sources is shown in graph 1.

Graph 1 - Distribution of Turkey's Established Electric Power Production According to Sources (2008)

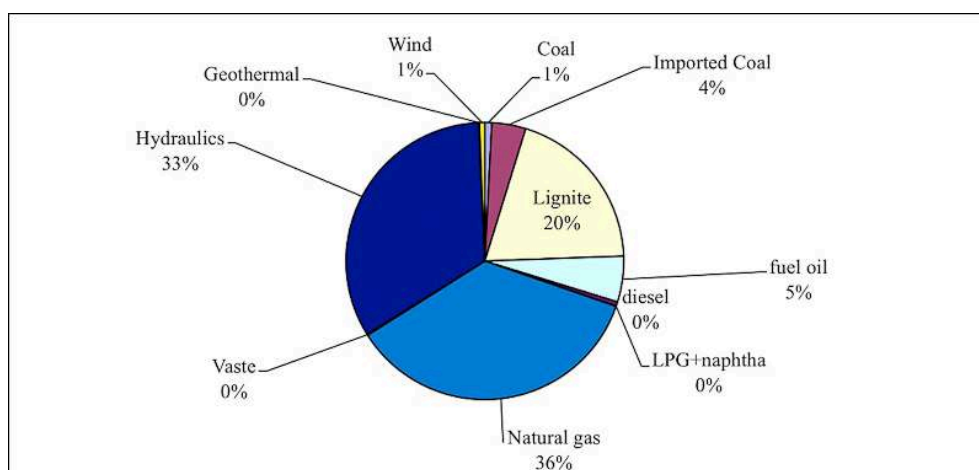


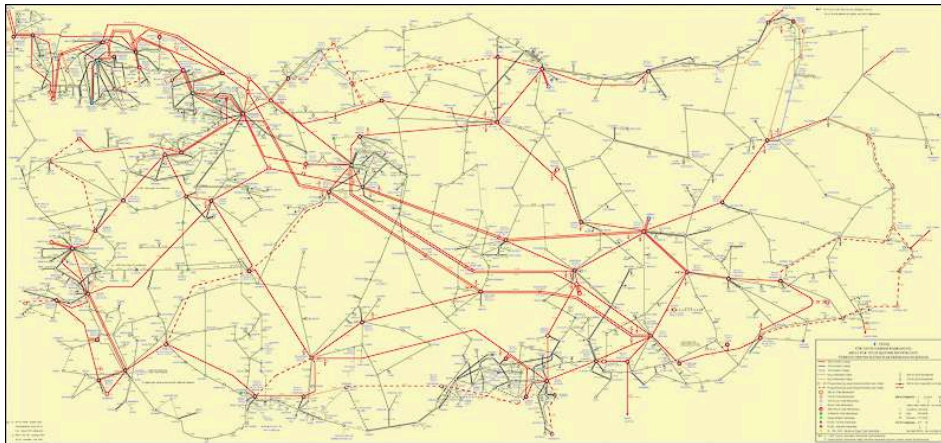
Table 2 - Distribution of Turkey's Electric Production According to Fuel Types (as GWh)

Year	Coal	Fuel Oil	Natural Gas	Renewable Energy Sources and Waste	Hydraulic	Geo. and wind	Overall
1985	15 28	7 82	58	0	12 045	6	34 219
1990	29 81	3 43	10 92	0	23 148	80	57 543
1995	28 47	5 72	16 79	222	35 541	86	86 247
2000	38 86	9 11	46 17	220	30 879	109	124 922
2005	43 93	5 43	73 45	122	39 561	153	161 956
2008	57 16	7 19	98 85	219	33 270	1 009	198 418

Source : World Energy Council Turkish National Committee Working Group Reports and TEIAS Statistics.

- 13 As Map I displaying electric production and distribution in Turkey shows us, although the electric transmission lines develop in northwestern-southeastern axis, they are dispersed around the entire country leading us to the assumption that there would not be serious problems in transmitting electric production to be realised based on the wind power to consumption sites or in overcoming possible problems.

Map 1 - The Map of Turkey Electric Production-Transmission Electrification



Source : TEIAS

Winds in Turkey

- 14 Turkey is under the influence of different pressure systems due to its geographical position in the world. Our country being under the influence of different pressure systems in different seasons, is under the influence of Island High Pressure system in winter located on Siberia expanding its impact area to southern latitudes of Turkey. Considering air streams related to this system, we may mention strong and dashing winds from north and especially north eastern directions. Moreover, as a result of the eastern movement of frontal systems on Mediterranean and especially in Adriatic, western side of Anatolia is under the influence of western and north western winds. This impact is occasionally witnessed until the end of spring when the Polar air mass draws back to northern latitudes.
- 15 One of the leading atmospheric events influencing our country in summer results from the Azores High Pressure centre. The Azores High Pressure centre moves on the surface of the land in a way to settle on Europe causing constant winds from the north especially in the western regions of Turkey. The speed of the wind even more increases with this local and site winds strengthened by the sea breeze starting at 10.00-11.00 am to get stronger in the afternoon to be finalised at around 20.00 and etesian wind in northwest direction in western Anatolia. Therefore, western regions are also under the impact dashing north eastern winds caused by the strong gradient of Azores High Pressure centre and Basra Low Pressure centre in the east. In the meanwhile, Basra Low Pressure Centre moves on south and south eastern regions of Turkey in a way to affect all Central Anatolian Region, East and South Eastern Regions and the Black Sea coasts. Southern and eastern regions of Turkey are generally under the impact of winds in south and south-eastern direction.
- 16 Undoubtedly, local topographic conditions have an impact on the direction and force of the wind, alongside with the general air circulation. In cases when air movements caused by local conditions show parallelism to winds caused by general atmospheric phenomena, the strongest winds occur, otherwise weak winds or static weather is witnessed.

- 17 Atmospheric phenomena influencing Turkey shall be meticulously dealt with as meteorological factors having fundamental effect on the existence or lack of winds with high energy production potential.

Wind Power in Turkey

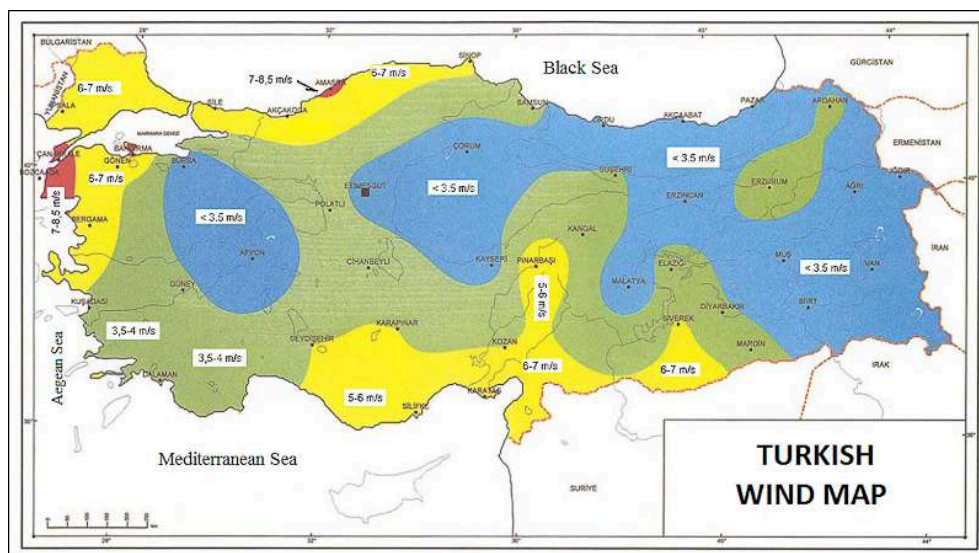
- 18 Just as studies on wind energy do not date back to old times in our country, the imbalance of the development phases is also striking. Electric Affairs Research Administration (EIE) was the first institution initiating studies on energy production from wind power in the middle of 1980s. Although there is no legal arrangement concerning wind energy, the first EIE studies are composed of research activities realised to detect the wind potential of Turkey.
- 19 The first wind turbine in Turkey was established in 1986 in Cesme with 55 kW power to cover the electric requirement of Altinyunus touristic facilities. This wind turbine could annually produce an average of 100 000 kWh electric energy and has no significance other than being the first application in our country. The first wind power station in Turkey is the auto-production power station facility of 1,5 MW power in Cesme-Germiyan location with three wind turbines each having 500 kW of power. The wind energy power station in Cesme-Alacati having started its operation in 1998 with Build-Operate-Transfer model is recorded as the second wind power station in our country. Alacati Wind Energy Power Station includes 12 turbines with 600 kW power having 7,2 MW of size. The second wind energy power station built with Build-Operate-Transfer model is the facility of 10,2 MW established power put in operation in Bozcaada in 2000 with 17 turbines each having 600 kW power.
- 20 The aforementioned facilities may be accepted as the pioneers of wind power stations in Turkey. Many Wind Energy Power Stations having recently and more specifically during the last few years spread around the country in the succeeding period are bigger in size and stronger.
- 21 Studies conducted in our country aspire to lay the infrastructure of the wind energy sector yet in its beginning phase in Turkey and sustain its efficient development in the short, middle and long term. One of those studies, perhaps being among the most important of all, is "Turkish Wind Atlas" and the other is the legal arrangements required in this field. Once these basic requirements are covered, Turkey could stop years of languor in electric production out of wind power and made it possible to realise many new projects.

Turkey's Wind Energy Potential

- 22 Different figures used to be uttered on how much electricity could be procured out of the wind potential of our country before the preparation of Turkey Wind Atlas. The main cause of this difference in figures was the insufficiency of data towards energy production out of wind power.
- 23 As a result of the Turkey Wind Atlas prepared by Electric Affairs Research Administration (EIE) and calculations made on it, Turkey's technical wind energy potential is stated to be around 88 000 MW.(Wind Energy Estimate System, 2003, 19).

- 24 The data had encouraged many investor companies active in energy sector to establish wind energy stations and cause them to make their wind calculations in fields they believed they could built their own wind energy farms.
- 25 Both Turkish Wind Atlas data and results of field experiences indicated that few engineering companies other than EIE and State Meteorology Administration (SMA or DMI in Turkish since 2008 www.dmi.gov.tr) made wind speed calculations especially in Izmir, Balikesir, Canakkale and Hatay, but after the enforcement of the Electric Market Law no. 4628 more domestic and foreign investors started to be interested in wind energy production sector. Regulations to promote private sector entrepreneurs to invest in wind energy could not be realised until 2005 in the regulation on electric market. However, with the enforcement of the Renewable Energy Law no. 5346 in 2005, electricity procured from renewable sources was secured under purchasing guarantee paving the way for wind energy projects. Within this framework, alternatives were presented concerning the sales of electric energy to be produced out of renewable sources in the free market.
- 26 Studies in our country concerning the speed, direction and energy power of the winds were initiated under the joint initiative of EIE and SMA-DMI. The importance of these studies stems from the fact that calculations towards direct energy production were conducted. Wind speed almost throughout the country led by the coastal regions was detected, as indicated in the below map, Turkish Wind Map was prepared leading wind energy sector to enter a different development phase.

Map 2 - Turkish Wind Map



Source : EIE General Directorate, 2003, Ankara.

Table 3 - Potential Amounts of Energy Related to Turkish Wind Map

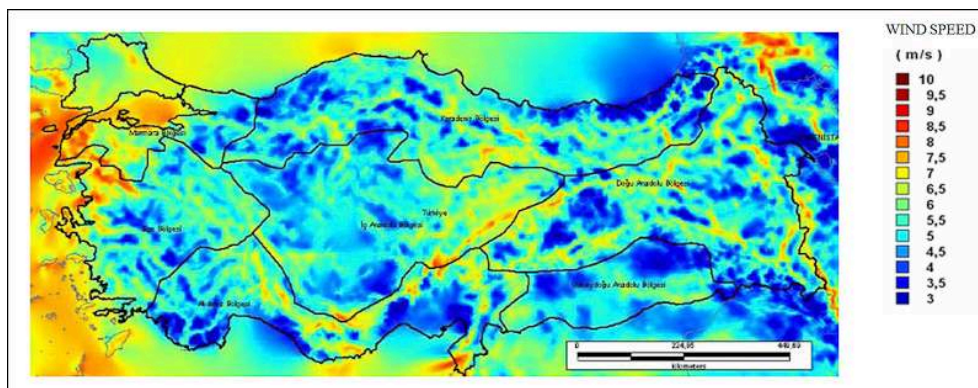
	Class	Area (Km2)	Potential Energy (MW)
	1	0	0
	2	5 038	1 662

3	168 759	41 656
4	370 767	44 659
Overall		87 977

Source : Wind Energy Estimation System, T.R. Ministry of Environment and Forest State Meteorology Administration, p.19., 2003, Ankara.

- 27 An economic RES investment requires wind speed of at least 7 m/s (Çalışkan, 2010, 11). The most striking feature of the distribution of winds at that speed or more in 50 m. of elevation above ground is, as it is clear in Map 2nd and 3rd, is the fact that almost all Marmara, Aegean and Mediterranean coasts (except the gulfs of Antalya, Mersin and Iskenderun) starting from the Central Black Sea have strong winds. Kapidag Peninsula and its surrounding in Southern Marmara coasts, the entire Gelibolu Peninsula, the route starting from Dardanelles ranging up to Candarli Gulf at south-south eastern direction, the entire Karaburun Peninsula, Bodrum and Resadiye Peninsulas, the mountainous area from the Region of Lakes to Taseli Plateau on north-western, south-eastern direction, southern side of Amanos Mountainous area in the eastern Mediterranean, the route starting from the Erciyes Mountain in Central Anatolia to Beydaglari in Eastern Anatolian region in south-western, north-eastern direction and the line between Amasya-Tokat in the Central Black Sea region, Palandoken Mountains in the Eastern Anatolian region right next to Erzurum and its surrounding, the field between Malatya and Bingol, Karacadag and its surrounding, Agri Mountain and its surrounding and the line extending on Turkish Iranian border are among the leading areas for wind power.
- 28 Depending on the wind speed of the aforementioned areas with respect to energy production, they also have favourable wind intensities. When it comes to energy production out of wind power, the most efficient factor on the amount of energy to be procured is the speed of the wind. The more wind speed in a specific area, the more the amount of energy to be produced. The wind intensity also has an impact, though very limited, on the possible energy production. 3rd Map shows the distribution of wind power intensity in 50 m. of elevation above ground.

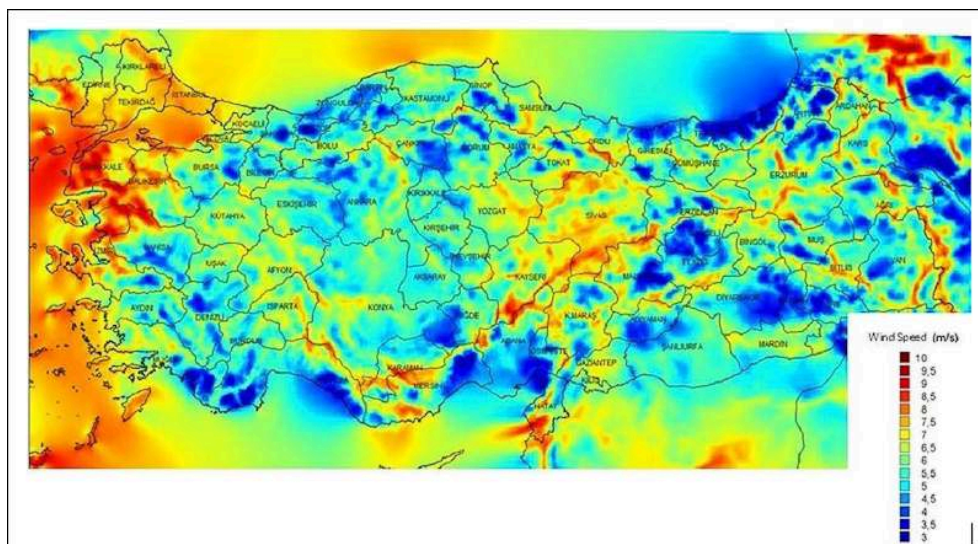
Map 3 - The Distribution of Average Wind Speed in 50 m. of Elevation Above Ground



Source: Mustafa Çalışkan, 2007, Wind Energy Potential of Turkey, EIE, p:11, Ankara.

- 29 When we have a look at Table 4 prepared out of the average wind speed distribution in 50 m. of elevation above ground in Turkey, we see 63,7 pct of the overall potential power is distributed to fields of middle class winds, 22,2 pct to fields of good class winds and 14,1 pct to fields of perfect class winds. In case electricity is produced out of the entire winds with more than 6,8 m/s of speed, it would be possible to establish wind power energy with 131 756 MW of established power requiring around 3,5 pct of the country area to be used. However, when only areas with good and perfect class winds are used, it would be possible to establish wind power stations of 47 849, 44 MW power.
- 30 It is understood that there is a parallelism between the power intensity distribution and the average capacity factor in 50 m. of elevation above ground in Turkey and the distribution of wind speed calculated in 50 m. of elevation above ground.
- 31 Capacity factor is one of the most significant indicators in the evaluation of a turbine. The capacity factor is defined as the rate of energy produced by the system to the energy to be produced in nominal power (Mathew,2006, 12). The capacity factor reflects how efficient the turbine uses energy available in the wind spectrum. The lower the speed of a turbine to initiate electric production is, the higher the capacity factor of the turbine. Similarly, the higher the speed of a turbine to exit from electric production is, the higher the capacity factor (Hau, 2006, 8). On the other hand; entry-exit wind speeds of a turbine are not the only parameters having an impact on capacity factor. The type of the turbine used and the wind regime of the place of installation are also other important parameters(Cetin, 2008, 22 ve Cetin, 2006, 14).

Map 4 - Wind Energy Potential in Turkey Above an Average of 100 m. of Elevation Above Ground



Source : Mustafa Caliskan, 2007, Wind Energy Potential of Turkey, EIE, Ankara.

- 32 As it is well-known, wind speed does not linearly increase in line with the elevation above ground from earth, but instead it logarithmically augments. Accordingly it is possible to produce more energy due to increasing wind speed up to a certain elevation above ground from earth. Winds of 100 m and more are used in energy production in parallel to the rise of wind turbine height of today's wind energy power stations. Having a look at the map 4 showing the distribution of wind speed at 100 m height, we can well say that they show parallelism to the distribution of wind speed of 50 m

elevation above ground. The basic difference between maps showing wind speed of 50 m and 100 m of height is not the change of areas having strong winds but the extension of the area of efficiency. In other words, it is possible to establish wind power stations in a wider area.

- 33 When we generally evaluate the distribution of wind potential according to geographical regions, we can say that Aegean, Marmara and Eastern Mediterranean regions come to the forefront. As is seen in Map 2 and Map 3, it is calculated to be 6,0-7,0 m/s in Marmara, Western Black Sea and Eastern Mediterranean coasts, 5,0-6,0 m/s in West Mediterranean coasts, 7,0-8,5 m/s in North western Aegean coasts and 4,5-5,5 m/s in inner areas. Power intensity in 50 m of elevation above ground, which is significant to establish turbines, in places with 4-5 m/s of average annual wind speed at 50 m of elevation above ground mostly exceeds annual average of 500 w/m². Estimated figures resulting from the researches conducted in the field, technical wind energy potential of Turkey, established power and average efficiencies are available in table:4.

Table 4 - Areal Distribution of Wind Speed, Power and Potential Energy Amount in Turkey

Wind Source Degree	Wind Class	Wind Power in 50 m. (W/m ²)	Wind Speed in 50 m. (m/s)	Overall Area km ²	Windy Land (as %)	Potential Energy Power (MW)
Medium	3	300 - 400	6,8 - 7,5	16 781,39	2,27	83 906,96
Good	4	400 - 500	7,5 - 8,1	5 851,87	0,79	29 259,36
Perfect	5	500 - 600	8,1 - 8,6	2 598,86	0,35	12 994,32
Perfect	6	600 - 800	8,6 - 9,5	1 079,98	0,15	5 399,92
Perfect	7	>800	>9,5	39,17	0,01	195,84
Overall				26 351,28	3,57	131 756,40

Source: Wind Energy Estimation System, 2003, T.C. the Ministry of Environment and Forest State Meteorology Administration, p.21. Ankara.

- 34 In Table 4, the amount of electricity possible to be produced out of the wind power in 50 m. of elevation above ground from earth is evaluated. The data reveal the fact that the overall capacity of energy power stations possible to be established depending on wind power is around 132 000 MW. Considering the fact that the overall power of stations established for electric production purposes is 41 817 MW and the calculated wind power potential is, though theoretically, around three times more than the overall established power in 2008, the wind power has great significance. This calculated amount, though the wind power potential is not accurately figured out, is a valuable indicator for Turkey which covers around 2/3 of the annual energy consumption through import, showing the great potential of wind power. On the other hand, even the energy potential of wind power classified under the category of 'good' and 'excellent' is higher than the current overall established power.

- 35 The amount of energy consumed per capita in our country is below world average. As a developing country, wind power is accepted as a significant potential in covering the ever increasing energy requirement gradually growing during this progress. The entire amount of investments in energy production out of wind power has up until now been realised by the private sector. This is highly possible to be the same also in the future. Therefore, the cost of energy production out of wind power is little if any. The task of the state is restricted to realising legal regulations. However, the importing cost of fossil energy sources as oil, hard coal and natural gas is considerably high. The development acceleration having recently attained in energy production out of wind power is mostly related to energy policies. Coming up with energy strategies and applying them on a sustainable level will only be possible in making these approaches state policies. Although Energy Market Regulatory Authority is responsible for the monitoring and regulation of energy sector in Turkey, it is significant question whether this development attained in wind energy would be persevered in possible government amendments.
- 36 The studies have shown that countries can at least 15 pct of their overall electric production from wind energy without the requirement to make any amendments in their existing electric transmission systems (Sarıkayalar and Attar, 1998, 4).
- 37 The overall wind energy potential of our country is calculated to ranges between 40 000 – 80 000 MW. Turkey's wind energy potential can be calculated as such: We can assume that the area of Turkey is 776 000 Km² (77 600 000 hectares). 776 000 hectares of land would be used, if only 1 pct (international standard, 0,5 pct for Europe) of the overall area will be opened to wind energy production. Considering overall 77 600 turbines would be used for 10 hectares of land (technical standard), a turbine of 1 MW capacity produces around 2 500 000- 3 000 000 kWh of energy annually. This would amount to overall 200 billion kWh of energy production (Akın and Zeybek, 2005, 2).

Last Status of Wind Electric Power Station Projects

Table 5 - The Connection Status of Wind Power Stations

Application Capacity	MW
September 3rd, 2002 – June 4th, 2004	2 992
January 1st, 2006 – July 6th, 2006	4 886
Overall	7 878
Capacity Accepted by TEIAS to Have Appropriate Connection	4 916
Overall Applications as of November 1st, 2007	78 151
Capacity Accepted by TEIAS to Have Appropriate Connection for Application not Coinciding Based on Field and Substation	2 356
Capacity Accepted by TEIAS to Have Appropriate Connection for Application Coinciding Based on Field and Substation	5 097

Overall	7 453
Sum of Capacity Accepted as Appropriate	
Overall Licensed RES Capacity	3 259

Source : Bahadır, M., Ersoy, Ş., 2010, Rüzgar Enerji Enerjisi Santralleri Üretim Tahminin Bilinmesinin Önemi, Türkiye Elektrik Üretim AŞ., p.13, Ankara.

- 38 As is seen in Table 5, although the number of overall applications to establish wind energy power station in Turkey exceeded 78 000 MW, the overall licensed wind energy power station capacity is almost four times more than the established capacity of 2008, which may indicate that the established capacity of our country would significantly augment in the close future and this increase would continue in the medium and long range. Naturally this expectation could only be actualised if current energy policies are proceeded in the future. On one hand, demand to energy in Turkey increases day by day, while on the other hand the country has only restricted reserves in terms of energy sources, which requires us to benefit more from wind power both as a local and renewable energy source in covering the energy demand.

Development of Turkey's Wind Energy Established Power

- 39 We may say that in our country electric production through wired up wind energy was initiated in 1998 and the progress of wind energy power stations' established power showed a stabile increase up until the enforcement of "Renewable Energy Sources" (YEK) law. However, with the enforcement of YEK law, it is seen in table 6 that the established capacity augmented in 2006 by 150 pct when compared to the previous year, by 186 pct in 2007, 149 pct in 2008 and around 120 pct in 2009. These figures are quite high when compared to recent world average being 25-30 pct. Turkey would become one of the leading countries in wind energy in the middle term if the acceleration of this augmentation is sustained and our country would have a wind energy share impossible to be overlooked in overall electric production.

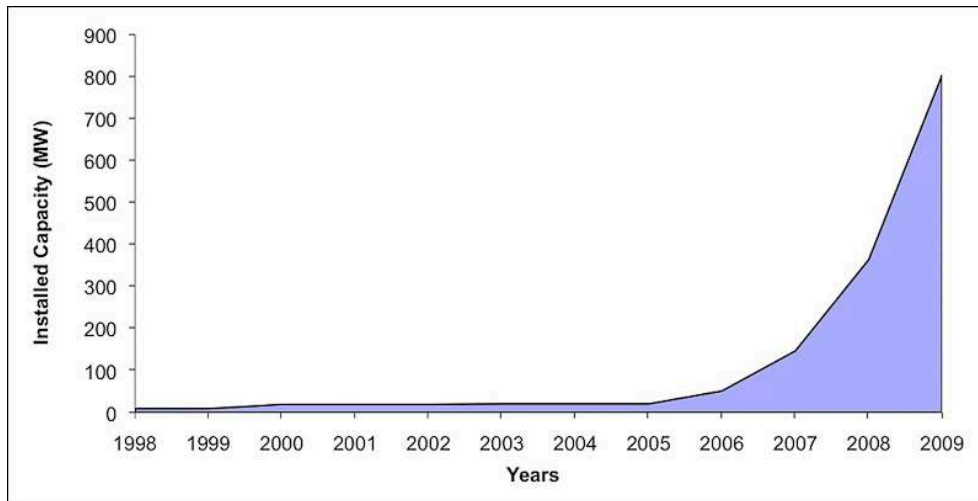
Table 6 - Change in Time of Turkish Wind Energy Established Power (in terms of MW)

Years	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Established Power	8,7	8,7	18,9	18,9	18,9	20,1	20,1	20,1	51	146,3	363,7	803

Source : World Energy Council Turkish National Committee

- 40 3 553 MW of license applications to EMRA-EPDK to produce electricity out of wind power have up to now received license. A total of 803 MW of established power in wind stations have been in operation by 2009. 772 MW of it being 85 pct has been in operation in the last four years, while 438 MW corresponding to 48 pct of it has been in operation only in 2009. Considering 431 MW of wind capacity among EMRA-EPDK licensed private facilities would be temporarily approved in 2010, the continuation of the augmentation tendency is obvious (Yaman, 2010, 4).

Graph 2 - Development of Wind Energy Power Stations in Turkey



- 41 Nowadays, most of the wind energy power station projects are being evaluated and analysed by EMRA-EPDK. Turkey Electric Distribution Company (TEDAS) has agreed upon a total of 4 916 MW of proper connection related to projects held before November 1st, 2007 applications 3 284 MW of which is licensed. The established wind power in Turkey is envisaged to augment to 1 546,15 MW in the forthcoming few years with the activation of licensed stations in construction phase (<http://www.epdk.gov.tr/lisans/elektrik/yek/yek.html>).
- 42 Methods concerning wind estimate figures can be expected to develop with the increase of the amount of electricity produced out of wind power transferred to national energy network. In today's conditions, it seems to be the most convenient solution to use different models as weather estimate reports used in wind energy estimates, statistical data of the region where the wind energy power station is located, readiness of the units, advanced statistical calculation methods and problems confronted in transferring the produced electricity to the interconnected system or evaluating results of the combination of all these methods at hand. Such studies are very significant since it would then be possible to integrate more wind energy in the system with the increase of the use of different estimate models and accuracy rates.

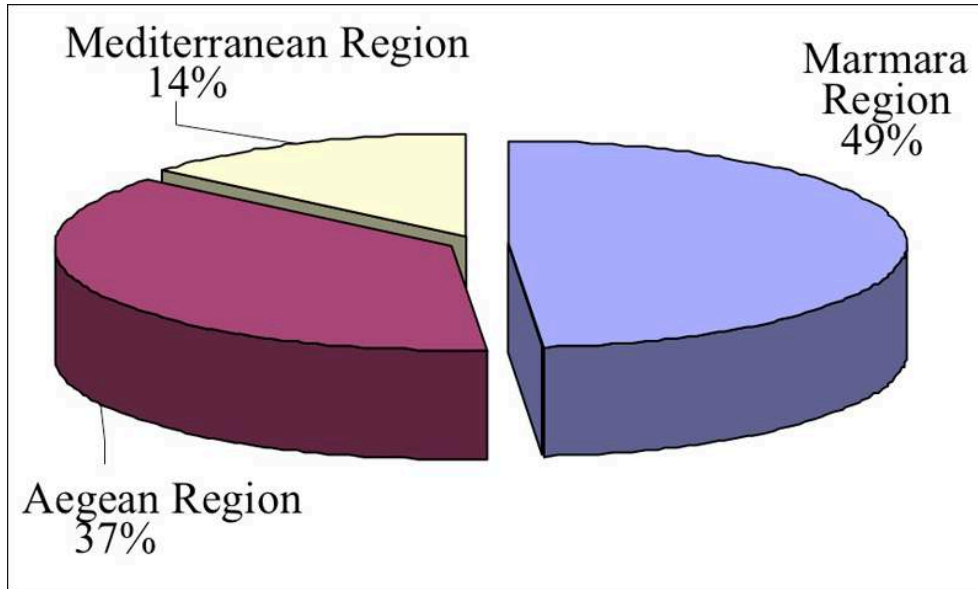
Table 7 - Wind Energy Power Stations Active in Turkey (15.02.2010)

Location	Company	Established Power (MW)
Izmir-Çeşme	Alize Enerji Elektrik Üretim A.ş.	1,5
Canakkale-Intepe	Anemon Enerji Elektrik Üretim A.ş.	30,4
Manisa-Akhisar	Deniz Elektrik Üretim Ltd. şti.	10,8
Canakkale-Gelibolu	Dogal Enerji Elektrik Üretim A.ş.	14,9
Manisa-Sayalar	Dogal Enerji Elektrik Üretim A.ş.	34,2

Istanbul-Catalca	Ertürk Elektrik Üretim A.Ş.	60
Izmir-Aliaga	İnnores Elektrik Üretim A.Ş.	42,5
Istanbul-Gaziosmanpaşa	Lodos Elektrik Üretim A.Ş.	24
Izmir-Çeşme	Mare Manastır Rüzgar Ener. Sant.ve Tic.A.Ş.	39,2
Istanbul-Hadimkoy	Sunjüt Sun'i Jüt San. ve Tic. A.Ş.	1,2
Istanbul-Silivri	Teperes Elektrik Üretim A.Ş.	0,85
Balikesir-Bandırma	Yapısan Elektrik Üretim A.Ş.	30
Balikesir-Samli	Baki Elektrik Üretim Ltd.Şti.	90
Mugla-Datca	Dares Datça Rüzgar Enerji Santrali San. ve Tic. A. Ş.	29,6
Hatay-Samandag	Deniz Elektrik Üretim Ltd.Şti.	20
Aydin-Didim	Ayen Enerji A.Ş.	31,5
Canakkale-Ezine	Alize Enerji Elektrik Üretim A. Ş.	20,8
Balikesir-Susurluk	Alize Enerji Elektrik Üretim A. Ş.	18,9
Osmaniye-Bahce	Rotor Elektrik Üretim A.Ş.	77,5
Izmir-Bergama	Ütopya Elektrik Üretim San. ve Tic. A. Ş.	15
İzmir-Cesme	Mazı-3 Rüzgar Enerji Santrali Elektrik Üretim A. Ş.	22,5
Balikesir-Bandırma	Akenerji Elektrik Üretim A.Ş.	15
Balikesir-Bandırma	Borasco Enerji ve Kimya San. ve Tic. A. Ş.	45
Manisa-Soma	Soma Enerji Elektrik Üretim A. Ş.	52
Hatay-Belen	Belen Elektrik Üretim A.Ş.	15
Tekirdag-Sarkoy	Alize Enerji Elektrik Üretim A. Ş.	28,8
Izmir-Urla	Kores Kocadağ Rüzgar Enerji Santrali Üretim A. Ş.	15
Izmir-Cesme	Ares Alaçatı Rüzgar Enerjisi Sant. San. ve Tic. A. Ş.	7,2

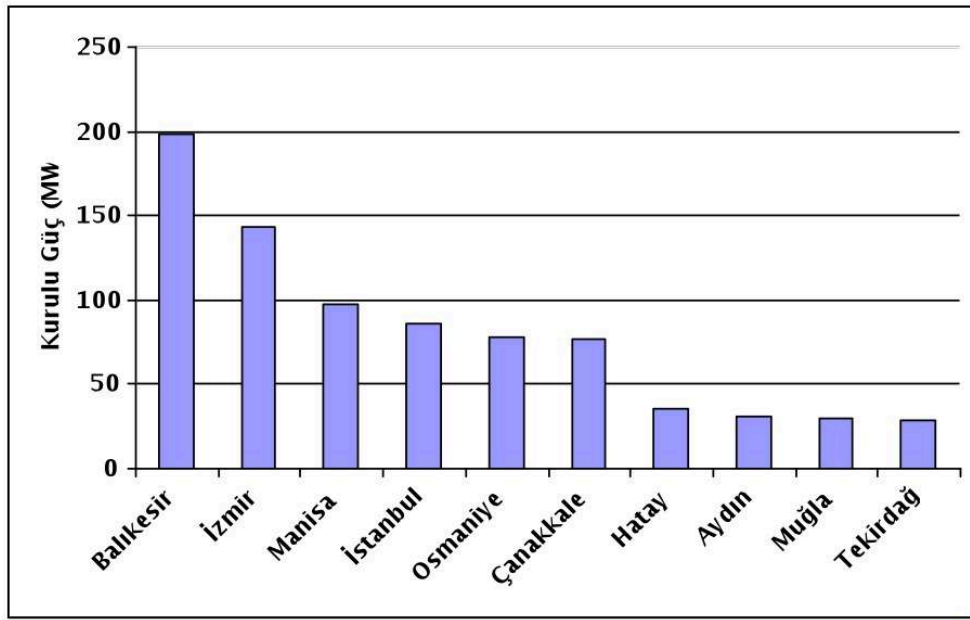
Canakkale-Bozcaada	Bores Bozcaada Rüzgar Enerji Sant. San. ve Tic. A. Ş.	10,2
Overall Capacity		803,55

Graph 3 – Distribution of Wind Energy Power Stations in Turkey According to the Regions



- 43 Having a look at Table 7, we come to see that the existing wind power stations are active only in the three of the seven geographical regions of the country, being Marmara, Aegean and Mediterranean regions. While Marmara ranks first with 390,05 MW of established power, Aegean region with 301 MW of established power ranks second to be followed by the Mediterranean region with 112,50 MW of wind power energy station established capacity.

Graph 4 : Distribution of Wind Energy Power Plants in Turkey According to Provinces



- 44 Considering the distribution of wind energy power station according to provinces, Balıkesir ranks first, as is seen in graph 4, having almost 25 pct of the overall capacity. İzmir ranks second with 18 pct of share, while Manisa, again a city from the Aegean region, ranks third to be followed by a total of eleven provinces led by İstanbul producing electricity out of wind power. In the near future, the number of provinces with active wind power stations is expected to be further augmented.

Wind Energy Power Stations of Turkey

- 45 The first wind power station of our country being Alize A.Ş. started its operations in 1998 with 1,5 MW of established power in Cesme. Again in ARES A.S. with 7,2 MW of established power was put in operation in Cesme, Alacati to be followed by BORES A.S. which was activated in Bozcaada in 2000 with 10,2 MW of established power. Turkey's established wind power increased with new wind power stations opened year by year and by the end of 2009 it reached 803 MW. As is seen in Map:5, wind power stations are active in Marmara and Aegean regions, alongside with provinces in Eastern Mediterranean region.

Map 5 - Distribution of Wind Energy Power Stations in Turkey

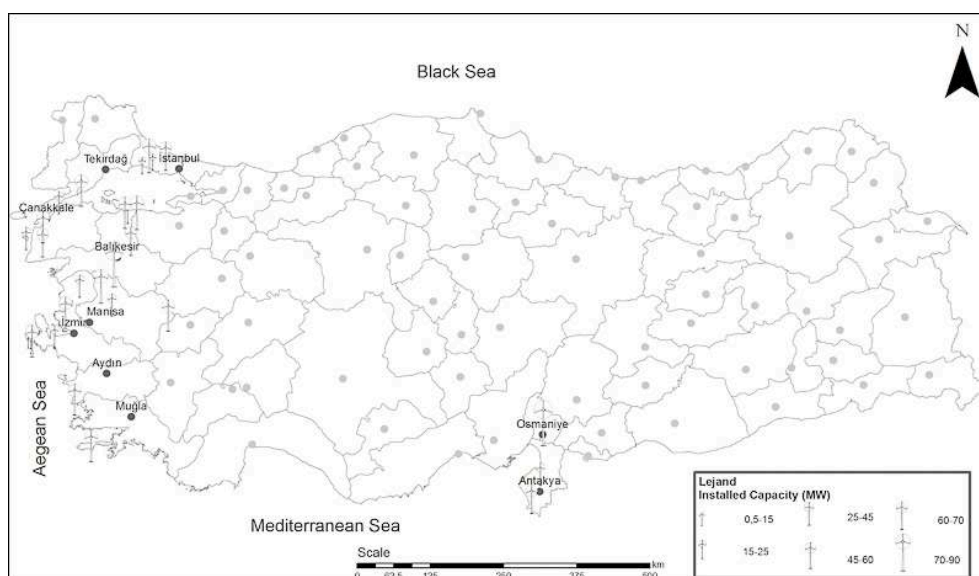


Table 8 : Electric Production of Some Active Wind Energy Power Stations

Name of the Power Station	Production Years	Amount of Overall Energy Produced During the Year (kWh)		Established Power (MW)	Capacity Factor (%)	
		Min.	Max.		Min.	Max.
Alize RES	1999-2008	3 055 795	5 144 728	1,5	23,3	39,2
ARES	1999-2008	13 389 055	18 720 840	7,2	21,2	29,7
BORES	2000-2008	30 495 210	39 029 690	10,2	34,1	43,6
BARES	2006-2008	112 784 255	117 247 090	30	42,9	44,6
MARE	2006-2008	102 526 690	115 274 480	39,2	29,9	33,6
SUNJÜT	2006-2008	2 343 884	2 48 067	1,2	22,3	23,6
Anemon Aş	2008	84 111 000		30,4	31,6	
Deniz Aş	2008	31 171 830		10,8	32,9	
Yuntdağı RES	2008	98 052 674		42,5	26,3	
Sayalar RES	2008	53 941 610		30,6	20,1	
şamlı RES	2008	60 885 370		57	12,2	
Sebenoba RES	2008	46 762 069		20	26,7	

Çatalca RES	2008	80 052 700		60	15,2	
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Source :SENKAL, A.,CETİN, NS.,EDAS,G., 2009, An Overall Look at the Capacity Factors of Wind Power Stations with Large Power Established in Turkey, p.42-44, İzmir.

- 46 Turkey has a capacity to produce an average of around 2 billion kWh electric annually which corresponds to around 1 pct of annual electric production of the country when it uses its 803 MW of established wind power station potential it currently has. As is seen in Table 8, it would be more convenient to consider ALIZE, ARES and BORES' data in evaluating the electric production wind power stations in our country, as they were all activated at earlier dates.
- 47 As the electric production amount of wind power stations change according to their established power, it would be more accurate to consider capacity factors to make a healthy comparison. When we evaluate wind power stations which have been in operation for relatively longer terms, we see their capacity factors are high above the world average 30 pct. Considering the data of the first three power stations, it is observed that only ARES is a little behind world averages, while BORES, for instance, has very good results as 45 pct. However, it is to be emphasized that the amount of electricity produced per year may vary up to 40 pct depending on this factor. This is perhaps the most important issue when it comes to energy production out of wind power.
- 48 Wind power stations were naturally started to be established firstly in terrestrial areas and they continue to be built on such places. However, in the forthcoming period wind power potential of Turkish coasts is required to attract the attention of the sector. Wind power stations to be built on sea are important especially for Marmara which is an inland sea. Apart from Marmara coasts, Aegean coasts, Western Black Sea coasts and Eastern Mediterranean, especially Iskenderun Gulf coasts, have convenient natural conditions for the construction of wind power stations on sea. Although the cost of wind power stations to be established on sea is a little higher than the territorial ones, these power stations work more efficiently than the latter which would enhance the power station to pay for itself with additional production. Besides, the private sector shall be encouraged to invest in wind power stations off shore under state support, since it is important in terms of technology acquisition.

Results and Suggestions

- 49 World energy requirement is still mostly covered from fossil energy sources. Apart from the fact that these sources will extinct in the future, the prevention of environmental problems caused by the consumption of fossil fuels forces countries to evaluate their energy sources and use existing sources more efficiently. Adverse impacts of the use of indispensable energy sources for the existence of humanity require more careful and planned actions.
- 50 Although Turkey has an important potential in terms of energy production out of wind power, only 1 pct of the electricity produced in 2008 is received out of wind power. It should be emphasized that the state and private sector representatives have responsibility to benefit from this potential in an efficient way. For instance, the state shall solve problems in transmission infrastructure in a way to increase capacity to be

transmitted in national energy system and wind power station entrepreneurs shall more attentively deal with criteria required for the connection to the transmission system. As is known, the entire wind power stations in our country are realised as private sector investments. The task of the state has been restricted to enforce legal arrangements in a way to pave way for the sector.

- 51 A serious increase has been recorded in our country especially during the last few years and it is anticipated that this increase would continue. We need to state that wind power station utilisation is not at the desired level, though. A long term planning is obligatory for the required energy to be procured on-time at sufficient amounts under a safe and incessant system. However, basic data shall be accurately detected to make such a planning. The transmission system should be ameliorated, bureaucratic studies shall be coordinated, incentives to encourage the use of wind energy sources especially in electric energy shall be reflected to legal arrangements in analysing world examples and forefronting social benefit, financial problems of wind power station projects shall be resolved, research and development studies of our universities in energy production out of wind power shall be supported, wind energy production of our country shall increase, some hardware of wind turbines which are mostly imported shall be enhanced to be made in our country to promote the future of wind power stations in Turkey.
- 52 It may be stated that the existing wind energy power stations and the ones that are currently being built in Turkey are sympathized by the public due to their potential contribution to the solution of the energy problem perhaps partly because of their yet limited amount. However, depending on the size and increasing number of wind energy power stations, it is controversial whether this optimism will continue or not in the future considering the fact that wind energy power stations are partly in conflict with especially agriculture and tourism sectors. The fact that wind energy power stations established in our country are present in coasts with intense tourism activity may lead to problems between energy production and tourism activities in time in terms of the land use. It is possible to overcome such problems only with the help of long term development plans showing regard to country requirements and social benefit in both sectors.
- 53 In case wind energy power stations become widespread in the future, though not coming into prominence today, the overall distribution of wind energy power stations in the country seems to be among issues to be taken into consideration. The studies reveal the fact that many different regions of our country are appropriate for wind energy production. However, wind conditions vary for each region. Accordingly, the distribution of wind energy power stations in the country shall be spread to fields with different wind regimes, energy procured out of wind power, being a discontinuous source, shall thus be covered continuously.
- 54 We need to keep in mind that different researches have calculated that wind energy potential of our country recently corresponds to the amount of electricity received out of all the fossil and renewable energy source. Turkey being among the developing countries covers almost two thirds of its energy consumption through import. Domestic production shall be augmented to more easily overcome possible problems to be faced by our country in its progress towards development. Considering the wind energy potential it has, it is evident that we need to benefit from wind energy a lot more as a national and clean energy, though it cannot be claimed that this source has

power to solve all our problems. However, it is to be interrogated whether the existing energy policies would be sustained in the future or not. The answer of this question is so important that it will determine the fate of energy procured out of wind power.

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RÉSUMÉS

L'énergie en Turquie est aujourd'hui fournie par l'énergie fossile. De plus, la Turquie est dépendante de l'extérieur en matière d'énergie pour son économie et les secteurs divers qui en ont besoin. En Turquie, parallèlement aux informations ci-dessus, 83% de l'électricité de l'an 2008 provient des sources d'énergie fossile. Les perspectives d'avenir prévoient que la demande d'énergie de la Turquie augmentera et l'effet naturel de cette croissance sera l'augmentation du taux de dépendance énergétique à l'égard des autres pays. Les travaux effectués démontrent que, parmi les sources d'énergies renouvelables de la Turquie, le pouvoir hydraulique et le potentiel d'énergie éolienne sont les plus importants et que chacune de ces deux sources ont des potentiels techniques pour la production de l'électricité. La multiplication des centrales éoliennes au cours de ces dernières années est à relier à des facteurs comme la préparation de l'Atlas d'Énergie Éolienne Turc, la disposition des lois afin d'aider les entrepreneurs du secteur privé et l'augmentation des prix du pétrole. Les centrales éoliennes fonctionneront dans la région de Marmara, la région d'Egée et dans la partie de méditerranée orientale de la Turquie où se manifestent plus souvent les vents violents. Il est probable que quelques autres centrales seront construites dans d'autres régions que celles citées précédemment.

Covering its energy requirement from fossil energy sources for the most part, Turkey relies on outside sources to procure energy required for its economy and different sectors. Similarly, Turkey had produced 83 pct of the overall electricity in 2008 out of fossil energy sources. Future projectors indicate that the energy requirement of our country would augment and foreign-dependency in energy would thus increase accordingly. The on-going studies state that especially hydraulic power and wind energy potential, as part of the renewable energy sources of Turkey, are highly important and each of these two sources has the technical potential to cover the electric production in 2008. The recent increase in the number of wind energy power stations can be related to the preparation of Turkish Wind Atlas, the preparation of legal arrangements to support private sector entrepreneurs and the rise in oil prices. Wind energy power stations are active in Marmara, Aegean region and the Mediterranean region witnessing more constant and

strong winds and are anticipated to be founded in other geographical regions as well in the future.

INDEX

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