Wind Energy
Turkey's Renewable Solution to Energy

Executive Summary:

The past ten years have seen a revolution in the renewables energy market. As increased energy demand places more and more pressure on the acquisition of traditional fossil fuel resources we can see that some countries as well as companies are turning to the alternative or renewables market in order to supplement traditional supplies. The three major reasons for the increasingly complex energy market have primarily to do with rising demand from the developing world, fears of reliable fossil fuel resources as well as pressure from international agreement such as the Kyoto Protocol on Climate Change. Since the renewables market has been traditionally neglected, there were many initial financial and technological barriers. As the price of fossil fuels has begun to rise, sometimes seeing oil hovering around $150 USD a barrel, investment in renewables has begun to rise simply because the generation of this energy is becoming relatively cheaper; considering the price of oil. Renewable energy technology has also improved greatly in the last decade and allowed easier production.

Wind energy is one the most promising types of the renewable energy for many reasons; yet primarily because it is abundant and produces essentially clean energy. Although renewables as whole only account for about 12% of the world energy production and wind represents less that 1% of that, the opportunity to supply the world with cheap and clean energy on a large-scale is beginning a real possibility. There are opponents who voice concerns about aesthetics and inefficiency but new development in this market are attempting to quell these arguments. In addition to onshore wind farms there have also been great developments in offshore wind farms which allow countries access to more energy.

As a country with a population in excess of seventy million, Turkey is a nation that is seeing a remarkable growth in its population and its economy. These increases are having an unprecedented impact on energy demands. With its energy-import based economy, Turkey dependents on other countries to supply its domestic and industrial needs. Yet with the latest global energy crisis, Turkey has realized the dangers of being over reliant on foreign sources and has begun to turn to renewables as a possible solution. With enormous potential it is estimated that Turkey has the ability to generate 166 TWh of electricity per year from wind resources and "could represent the highest share in technical wind energy potential in Europe".[1] As of 2003 Turkey's total electricity usage was just under 125 TWh, meaning that could all this potential wind energy be harvested, although due to Betz Law this is not likely, Turkey could perhaps cover its own electricity demand. One day it may even begin to export some of the electricity and change its reputation to an exporter of energy rather then an importer.

Major changes have occurred over the last decade have spurred development in this sector. Beginning with a few small wind farmers with primarily foreign investment, the market has grown quite quickly in the past two years. The two major events that have influenced these changes were primarily the increased research which resulted in the Turkish Wind Atlas, reveling some remarkable information about Turkey's wind potential and secondly, the 2005 Renewable Energy Law which made it both economically and legally much easier to set up wind energy projects in the country. If we look at the present situation we can see that Turkey is on target to have nearly 1.500 MW of wind energy possible by 2010. This will account for about 3% of the overall electricity consumption in Turkey and will lessen the

[1] RNCOS, Industry Research Solutions. "Wind Power: Opportunities in Emerging Markets," RNOCOS Publications. (2008)

burden on foreign sources. While there are still certain barriers such as the outdated national grid, Turkey is taking large steps to remedy these issues.

This paper will explore each one of these topics in detail with the help of recent research and literature. Furthermore when available both figures and tables have been added to enhance the readers understanding and conception. The paper's primary goal is to briefly outline the present of the global renewables market and use these parameters to examine the situation in Turkey. With analysis of recent events in both the private and public sector a better understanding of the wind energy market in Turkey can be outlined. Finally, with a review of the present operating facilities in Turkey, the reader will recognize the priority that renewables as a whole but especially wind energy is being given in the country. This last investigation will help make it easier to draw conclusions about the future of this industry in the country.

Introduction

With the global demand for energy rising at an unsustainable rate, all countries are looking for ways to increase energy supply so as to meet this rise. In the past, traditional resources such as petrol or coal were sufficient enough to meet these needs but there now exists a variety of pressing factors in addition to rising demand that are creating a more complex energy market. Lawrence Goldstein of the Energy Policy Research Foundation of Washington claims, "this is the world's first demand-led energy shock,"[2] yet other factors such as legitimate environmental concerns as well as the questionable availability of reliable and consistent supplies have recently begun to affect this sector in new and precarious ways.[3] A short list of events underlying these three primary factors include: an increased demand for gasoline in developing countries such as China and India; a global rise in consumerism as more individuals demand access to electricity, cars, and consumer goods; as well as geopolitical factors such as political tension in the Gulf, violence in Nigeria or even unpredictable atmospheric phenomena such as hurricanes in the oil-producing Gulf of Mexico.[4] As a result of these factors, many countries can no longer rely on the longstanding relationships that they have had with suppliers in affected regions. The combination of these factors is why countries have begun to look to the alternative energy market as a way to help meet domestic energy needs.

Although renewable energy in the form of biomass, hydro, and wind has been employed for centuries by humans, they have only recently begun to be exploited on such a large scale. In the decades leading up to the present, individuals, companies and

[2] "Rising global demand for oil provoking new energy crisis," *New York Times*, November 8, 2007. Online Edition, http://www.nytimes.com/2007/11/09/business/worldbusiness/09iht-09oil.8260085.html?_r=1&pagewanted=2 (accessed October 10, 2009).
[3] See chart in Appendix 1 "Oil Production Reduction"
[4] New York Times page 2

governments did not see the need to invest in the alternatives market simply because cheap oil was so abundant and accessible, oil prices averaged $20 a barrel throughout the 1990s.[5] This lack of attention paid to the renewables sector was quite logical at the time because the cost of investment per megawatt as seen in table 1 below is significantly different. Alternatives such as hydro and wind energy incur a nearly 50% higher cost per megawatt than traditional fossil fuel technologies.

Table 1. Average investment costs (per MW) in 2007 – based on type of generation facility and resource[6]

Resource	Cost in Turkish Lira	Cost in USD
Coal	1,250 YTL	Apx. $1,050
Natural Gas/LPG/Fuel Oil	1,000 YTL	Apx. $850
Hydroelectricity	1,600 YTL	Apx. $1300
Wind*	2,000YTL	Apx. $1300

We must take into consideration that the chart reflects 2007 prices, yet after adjusting for inflation, the 1990's prices for traditional sources versus renewable sources would still be remarkably higher since the sector was in its infancy. Coupled with the abundance of "cheap oil", the 1990s saw companies looking to maximize profits via low cost energy to consumers, governments looking to supply inexpensive energy to citizens and individuals looking to minimize their own energy costs, it is easy to understand why the renewables market had such a slow start. Yet with the recent energy crisis, it would appear that the world has seen 2 other major crises in the past 40 years, including the shortages of the early 1970s and 1980s. Since abundant fossil fuels are harder and harder to come by, countries have begun to realize the pressing need to expand their horizons when it comes to energy production and supply.

[5] Ibid

[6] Gunler Law Office Associates, "Turkey: Renewable Energy Market Opportunities And Legislation In Turkey," Mondaq (April 3, 2008) : online edition, http://www.mondaq.com/article.asp?articleid=59066

Renewables Sector Growth

As fossil fuels or the easy accessibility to them become scarcer, people are becoming more and more aware of the abundant energy that in fact exists in nature. Renewable energy is defined as, "energy derived from natural processes that do not involve the consumption of exhaustible resources such as fossil fuels and uranium".[7] In addition to being an energy source that can theoretically be inexhaustible, renewables also have many benefits that include producing few or no hazardous emissions or pollutants and making a minimal impact on the environment.

As one of the fastest growing sectors on the planet, the renewable energy sector has begun to "generate" a great deal of interest on the part of consumers, the private sector and even governments. Not only does this sector have intelligent economic arguments supporting it, there are also a variety of environmental as well as geopolitical points that have been aforementioned. With the invention of more advanced technology to help maximize, harvest and distribute alternatives, the potential for many countries to develop an internal sector is becoming more and more of a reality. Countries are beginning to understand, in either voluntary or involuntary ways, that it is possible to use the natural resources that exist within their own boarders as opposed to looking abroad or to traditional fossil fuels.

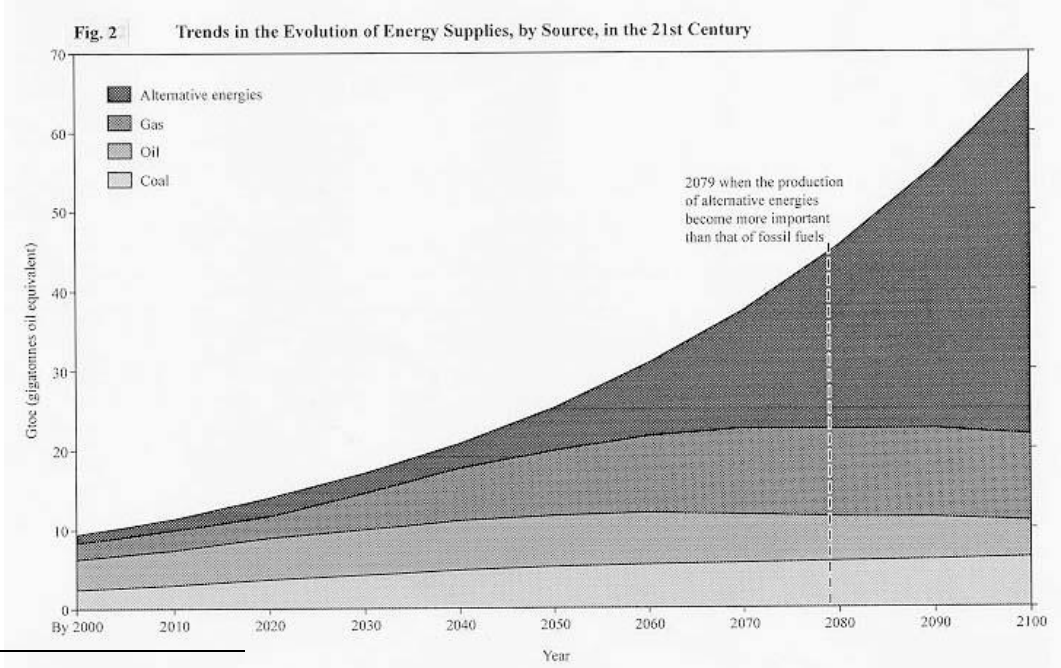
What should also be mentioned as an aside is that the "tremendous" growth that has been generated is relative. Many countries did not have or barely had an alternatives market ten years ago and so beginning from zero and establishing the legal cannon to deal with as well as devising the physical infrastructure to manage renewable sources can be considered

[7] "Renewable Energy," Chicago Tribune Topic Section, Online Edition, http://www.chicagotribune.com/topic/environmental-issues/renewable-energy/06001000.topic (accessed October 19, 2009).

quite an accomplishment for many countries, especially in the developing world. This growth may also refer to the soft growth of the unprecedented acceptance that renewables have begun to garner. It would appear that regardless of the production output of alternative plants, many countries have come a long way with respect to their perspective on accepting renewable energy technology.

Yet for all the interest and growth that has occurred in individual countries or regions it is clear with a glance at Figure 1 below that the trend in the energy market is still heavily reliant on traditional fossil fuels such as oil, coal and gas. It is predicted that renewables will rise steadily in their importance over the course of the 21st century but that it will not be until nearly the end of the century, 2078-2079, that the tide will begin to turn in favor of renewables as a preference over "traditional" sources. This term is in quotations because perhaps when renewables take over the energy market they will be considered the new "traditional" sources.

Figure 1: Trends in the Evolution of Energy Supplies by Source in the 21st Century[8]



8 Kungl Krigsvetenskapsakademien, "Trends in the Evolution of Energy Supplies by Source in the 21st Century," Kungl Krigsvetenskapsakademien, http://www.kkrva.se/images/energi/odell_fig2.jpg (accessed October 10, 2009)

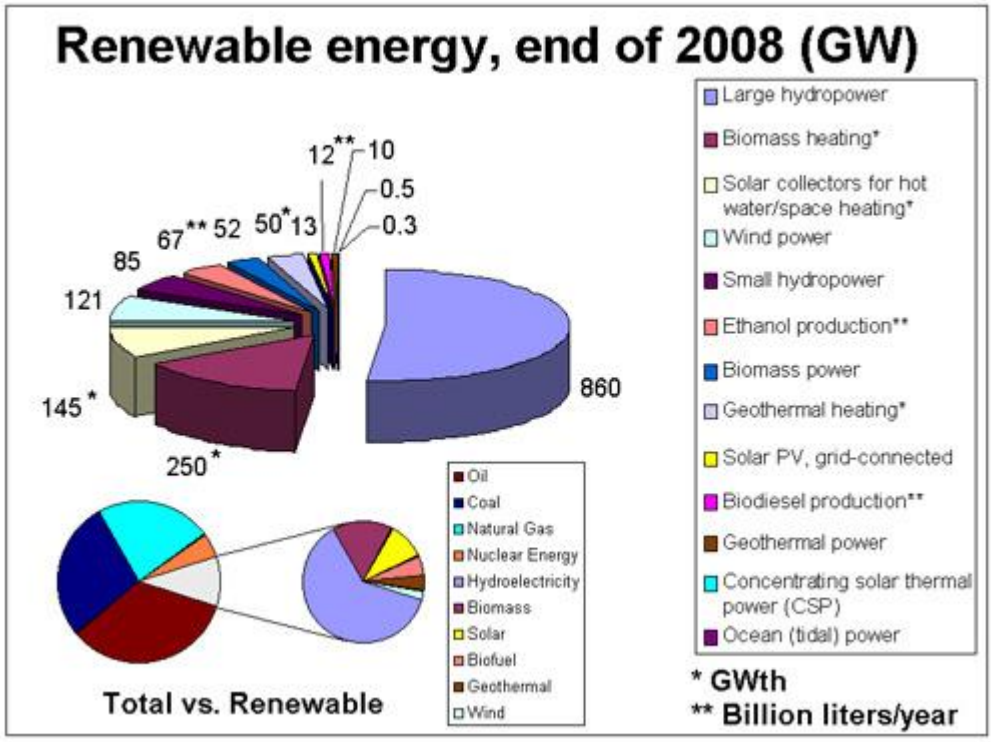
Yet the question that occupies the thoughts of many individuals and scientists is whether or not this date will be to late for the development of a stable and functioning global renewables sector. While this paper does not purport to answer this question, it is obvious that humans will need to find some replacement for traditional resources because Hubert's Peak is an inevitable concept and the amount of traditional resources is in fact finite even should they last another century or more. There are a variety of different renewable energies, and the sector as a whole has seen tremendous growth in the last decade, yet this paper is not sufficiently long enough or detailed enough to analyze all of them so it will focus purely on one of the most praised in the renewables market, wind energy.

Present Global Wind Energy Context

As aforementioned the forecast for global energy use is quite alarming. As energy needs continue to rise, renewables are looking more and more appealing to nearly every country that does not have a natural supply of fossil fuel resources. Wind energy for many reasons has been proposed by many regions including Europe and America as the renewable that can help avoid another energy crisis. In order to be able to examine the present role of wind we will examine certain figures over the last ten years of wind energy history. Understanding what existed before and what exists now is an important part of recognizing how attitudes and feelings toward wind energy are changing. Although 2007 and 2008 were monumental years for wind energy, the market is still relatively underdeveloped and wind energy world wide accounted for less than 1% of total world energy output. As a whole the renewables market accounts for only 12% of the global energy consumption total. Looking at Figure 2 below we can see the importance that is still placed on traditional supplies. Although slowly the variety and number of renewable technologies has risen there is still an

overwhelming dependence on fossil fuels. It is clear there is also great room for improvement in this area.

Figure 2: Renewable Energy end of 2008 (MW) [9]



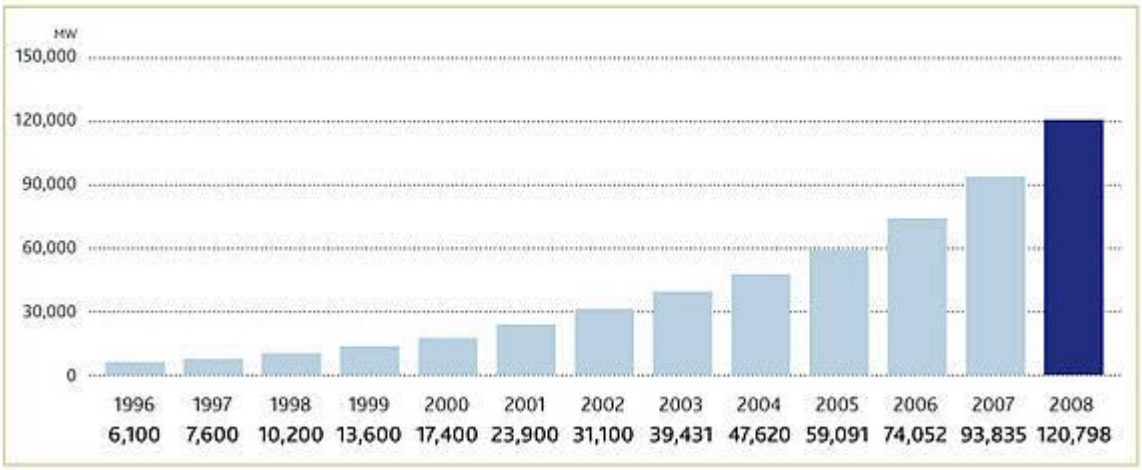
Nearly all of the energy that is generated by Wind farms is in the form of electricity that can be transfer into a national grid and then distributed to consumers in the area. If we consider that electricity can be generated easily from wind power as long as it is harnessed properly, we can understand the ability for the global capacity to increase.

Looking at the total global cumulative installed capacity in 2008 we can see that according to Figure 3 below it was 120,798 MW. As we look over the last 12 years of

[9] The Green Technology Blog, "Renewable Energy end of 2008 (MW)," Renewable Energy end of 2008 http://www.thegreentechnologyblog.com/wp-content/uploads/Global-Energy-Capacity-Distribution-2008.jpg (accessed October 12, 2009).

development we can see that wind energy sector has made some dramatic increases with "global wind power capacity continuing to grow at an average cumulative rate of over 30% per year".[10] The 2008 global increase alone was 27% over the 2007 figure. What is more, the GWEC predicts "the global wind market to grow by over 155% from its current size to reach 240 GW of total installed capacity by the year 2012."[11] This translates to approximately 500 TWh of electricity up from 200 TWh in 2007 and will provide the world with nearly 3% of its electricity production.[12]

Figure 3[13]



Furthermore if we look forward ten years, we can see that according to the World Wind Report of 2008 "wind energy will be able to contribute in the year 2020 at least 12% of global electricity consumption. By the year 2020, at least 1'500'000 MW can be expected to be installed globally."[14] This amount still pales in comparison to the amount of fossil fuels that are

[10] Global Wind Energy Council, "Wind is Global Power Source," GWEC website, http://www.gwec.net/index.php?id=13&L=0 (accessed October 12, 2009).
[11] Global Wind Energy Council. "Foreword," *Global Wind 2007 Report* . (2008): 11
[12] Ibid pg 11
[13] Ibid pg 9
[14] World Wind Energy Association. "Highlights," *World Wind Energy Report 2008*. (2008):4

consumed but it is a clear indication that renewables, especially in the form of wind energy are making an impact on the world energy market.

Why Wind?

There are of course many reasons why wind is becoming a popular renewable to turn to but in addition to the three most urgent reasons of increased demand from developing countries, questions about finite and easily accessible supplies and environmental concerns, I would like to offer the social pressure that is being seen in Europe. As leaders in Europe have begun to realize the impact that renewables can have on their respective nations both financially and socially, the countries have collectively organized and set goals for themselves. Europe now has a legally binding target, the Renewable Energy Directive that it has set for Member States to meet by 2020 in which 20% of all energy sources must be from renewable sources.[15] This obligation was placed on energy producers as to help the countries meet Kyoto Protocol promises to lower emissions. I would argue that pressure to take social responsibility is playing a large role in the European investment in the sector.

What is most important about these targets is that the power industry has been cited as one of the largest polluters. This industry contributes 38% of the CO2 released into the atmosphere as well as 25% of all emissions;[16] therefore it makes logical sense that this industry be asked to lower its emissions. Other renewables and wind energy especially allow the possibility for countries and companies to meet these goals. The United States also has set some very lofty goals for itself with its Renewable Portfolio Standards. China as well has made it a point to heavily invest in renewables simply because its economy is growing at such

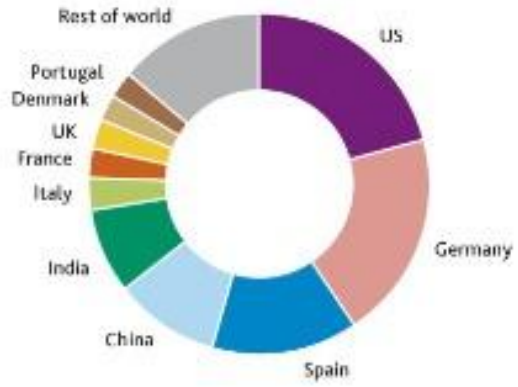
[15] European Wind Energy Association. "Renewable Energy Directive," *Wind Energy Statistics*. (2009) : 2
[16] Global Wind 2007 Report, pg 3

a great rate and it is presently unable to meet its domestic hunger for energy. In addition to this, China is home to some of the world's most polluted cities and must find ways to reduce its reliance on coal and other polluting technologies.[17]

It is of no surprise therefore that Figure 4 below demonstrates that the leaders in wind energy production are the United States, Germany, Spain and PR of China. The countries that have a substantial and organized program dedicated to following through on the promises of renewables development are the leaders in the industry. Moreover, other countries should look to these wind energy leaders models' for guidance. As we can see from Figure 4 below the top four produces of wind energy account for nearly 64% of the entire world total. As the date for the UN Climate Change Summit in Copenhagen nears we will begin to see how individual countries have dealt with their two fold problem of reducing emissions yet increasing energy to fuel economies.

Figure 4: (Wind Energy)[18]

TOP 10 TOTAL INSTALLED CAPACITY 2008



	MW	%
USA	25,170	20.8
Germany	23,903	19.8
Spain	16,754	13.9
China	12,210	10.1
India	9,645	8.0
Italy	3,736	3.1
France	3,404	2.8
UK	3,241	2.7
Denmark	3,180	2.6
Portugal	2,862	2.4
Rest of world	16,693	13.8
Total top 10	**104,104**	**86.2**
World total	**120,798**	**100.0**

[17] Ibid, pg 12
[18] Ibid pg 8

Win-Wind Situation

As the heading suggests wind energy is invaluable and has a great potential for nearly every country on the planet. When we look at the wind energy sector we can understand why many countries, should they have the access to this renewable resource, are beginning to harvest the energy. There are a variety of advantages that wind energy can contribute but they can mostly be summed up under the following headings of economic, environmental, social contributions:

Economic Considerations:

One issue that clearly preoccupies consumers, governments as well as the private sector is the cost of producing, providing and distributing energy. Yet wind energy has a great deal of economic arguments in its favor. One of the primary reasons that wind energy has been touted as economically favorable is that it produces jobs. In the present economic crisis, industries tend to be shedding jobs but according to the GWEC "over 440,000 people are now employed in this industry, and that number is expected to be in the millions in the near future."[19] In addition to this benefit, the jobs are not just relegated to the energy production sector. The companies that produce the materials to construct turbines also have a vested interest in pushing the wind energy agenda. Another favorable quality that seems to flow to the economic argument is that often wind energy production plants can revitalize rural economics. Since wind turbines must be built on large tracks of land, they are often located outside of urban centers because they are generally not constructed around large buildings or structures. This means investment in the rural areas with the potential for jobs.

[19] World Wind Energy Report 2008, pg 4

We can also see a savings in transportation costs. Unlike energy from mining or gas wind energy does not need to be transferred because the energy is produced at the site then distributed or connected to other infrastructure. This results in a saving of funds that may otherwise have been spent on transportation or perhaps mining costs. Wind energy can also produce a price stability effect. Rather than be subject to the instability of the global market, local wind energy can be produced and distributed in the local area without concern for international hiccups. Finally one of the most compelling reasons for wind energy is that it is cost effective. Although in the 1980's there were prices such as 40 cents per kWh, in certain parts of the world the price has dropped significantly to 2.5-5 cents per kWh.[20]

Social Considerations:

Wind energy also has some serious social considerations for participating countries. With the production of this renewable energy, countries would have the ability for individual energy independence meaning no longer needing to rely on foreign sources. By not having to purchase supplies from off shore, countries will be more supporting their own internal industry. Additionally, it should be mentioned that there is no disruption to agriculture. As aforementioned often wind parks are located in rural areas because of the amount of open clear land they require. Also, having a wind park in the same vicinity as agriculture plots does not cause any detriment because the park would not interfere with the ability to cultivate crops. Finally, wind energy can be found in large wind parks around the world but there is also a great deal of wind energy produced on a smaller scale. Individual farms have the ability to have individual turbines that produce enough to meet their energy needs with out having to put land aside for nonuse. These individual turbines can feed back into the local economy and

[20] Windustry, "Why Wind Energy?" Windustry, http://www.windustry.com/wind-basics/learn-about-wind-energy/wind-basics-why-wind-energy/why-wind-energy (accessed October 14, 2009).

can be used to support the idea of local ownership which as aforementioned supports local and rural economies. [21]

Environmental considerations:

Probably one of the largest arguments in favor of wind energy has to do with the environmental benefits. The wind energy that is produced is done so without the production of pollutant and climate warming CO2 gases. Although there is a great deal of energy that goes into producing turbines and other materials that perhaps can generate these gases, the energy itself is quite clean. This brings up another point which is that without the pollutants that are generated by fossil fuels, wind energy helps to keep the air clean. It also helps to conserve water. According to Windustry, the same amount of energy produced by wind energy takes a nuclear power plant 500 times more water and a coal plant nearly 600 times more water. We can also mention that unlike coal or other resources that require mining and the carbon footprint associated with those industries, wind energy is free from these impacts. Finally, since large wind parks are generally located outside of urban areas in wind open spaces this can lead to land preservation and more open space. [22]

Disadvantages of Wind Energy

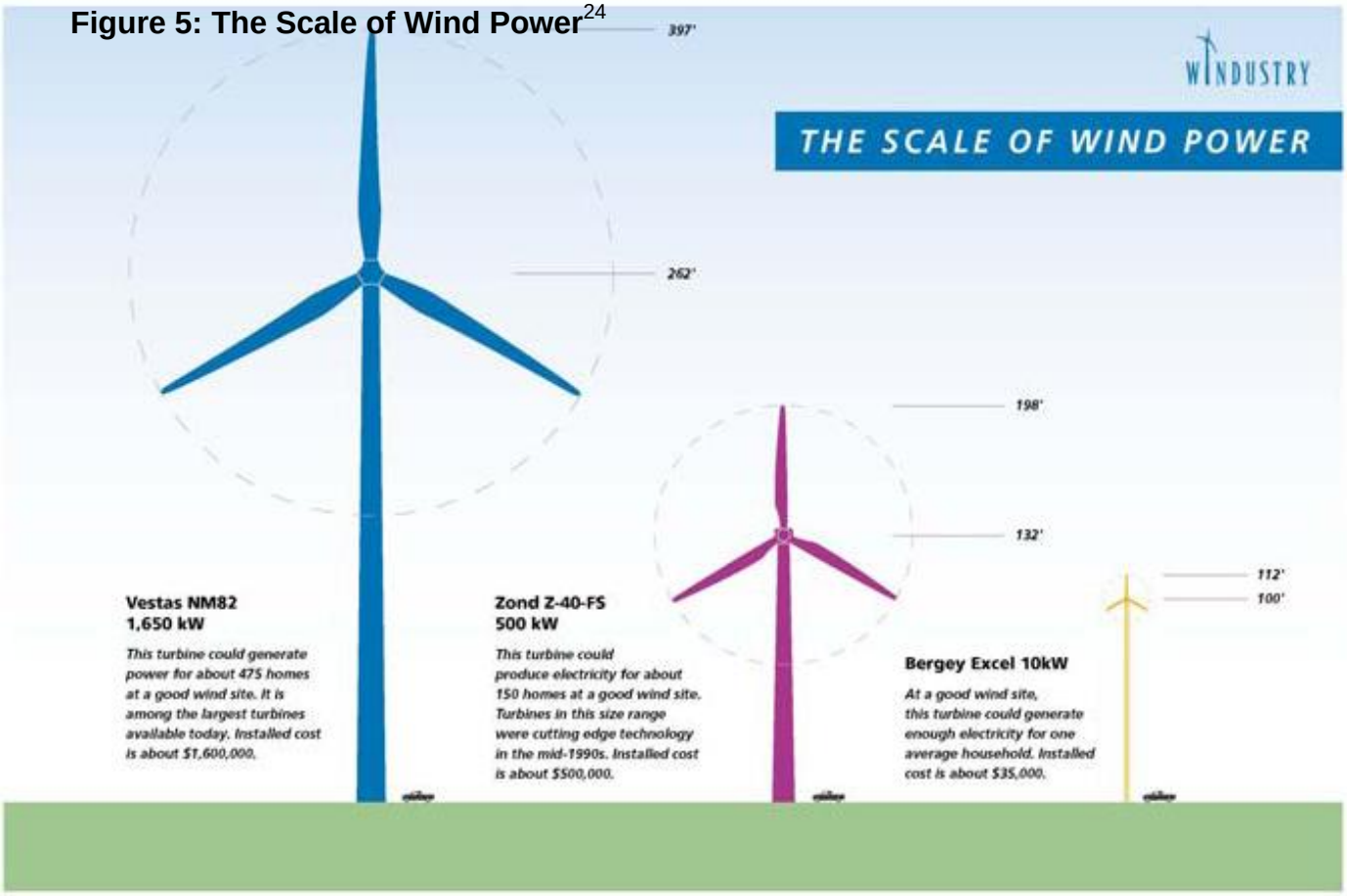
As with every type of renewable energy source, there are also disadvantages to wind energy. One major argument that is brought up to dissuade individuals in favor of wind energy is that the energy is only available when the wind blows. This can lead to issues such as wind parks not running at full capacity and have citizens, who have footed the bill for construction, wondering what economic advantages they are in fact receiving. Also along the same line of

[21] Ibid
[22] Ibid

argumentation is the fact that during times of extreme wind, some turbines need to be shut down as to ensure that they will not be damaged. Another point that is often brought up is the aesthetic factor. Although some individuals do admire the construction and design of wind turbines, others complain that they can ruin a landscape. These are individual preferences and some companies have tried to get around these issues by painting the turbines neutral colors or improving on the design but it is obvious that some individuals will see them as aesthetically pleasing and others will not. Additionally, there is the issue of noise. While in the past decade a great deal has been done to reduce the noise production by wind turbines, local residents may still have complaints. Yet with future technology it is clear that this may be able to be reduced further. When we consider ecological complaints, there are obvious cases of birds or bats being injured by rotating turbines but this issue must be address by selecting a noninvasive environment for the turbines. Bugs have been known to accumulate in turbines and reduce production but this is merely a product of regular maintenance. What perhaps can be mentioned as ecologically disruptive is the construction and installation phase of the wind park. These phases could see large earth moving equipment introduced into the local environment. Once again precautions should be taken to avoid these potentially disruptive yet easily avoidable problems. Finally, some individuals many mention the initial investment and cost of the turbine themselves. As can be seen in Figure 5 below, certain turbines can cost millions of dollars. It may take a certain amount of time in years to recoup the initial investment and so this should be carefully calculated as to understand the time require to make the venture profitable.[23]

[23] Ibid

Figure 5: The Scale of Wind Power[24]



[24] Ibid

Analysis of Offshore Wind Energy:

One last topic that should be addressed prior to our analysis of wind energy in Turkey is an introduction to Offshore wind energy. While both Onshore and Offshore contribute significantly to the renewables sector there are some slight differences that I would like to highlight before moving on to a detailed analysis of Turkey because some future projects plan to construct offshore facilities.

Onshore wind farms are the more commonly known and recognized methods of generating wind energy. In fact there are only 8 countries that have operating offshore farms and all are in Europe. According to the American Wind Energy Association, as the advantages of wind energy have become clear, especially in Europe there is a realization that "offshore wind turbines tend to generate more power than on-shore turbines because wind speeds are generally higher and the wind is steadier offshore".[25] What this means is that more of the renewable resources can be captured and transmitted back to the mainland. An additional factor is the recognition that land, in Europe especially, is a finite resource. Since many people congregate in urban centers there is very little room for large-scale wind farms on the land itself because of the need for space to be unobstructed by buildings. By putting the farms farther out to sea, the previously unobtainable steady flow of energy can be harvested. Additionally, since the farms are farther out to sea and unobstructed, larger turbines to generate maximum energy production can be constructed and sent back to the local grid in an easy manner with shorter transmission lines that can avoid bottlenecks. [26]

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[25] American Wind Energy Association, "Offshore Factsheet," AWEA Website, http://www.awea.org/pubs/factsheets/Offshore_fact_sheet.pdf (accessed October 16, 2009).

[26] Ibid

Yet the offshore environment is quite challenging with its rougher weather conditions which may prevent routine maintenance and the effect that salt has on equipment. Therefore research and development must be continued in order to ensure that offshore farms are economically viable.[27]

[27] Ibid

Why Wind Works For Turkey:

While some regions are endowed with plentiful hydroelectric or geothermal resources, Turkey is a country that happens to have a great deal of all renewable resources. As a developing country, Turkey is on the road to developing a strong and reliable renewables market. Present statistics show how nearly 24% of energy generated is via Hydro projects. Yet this paper has the goal to analyze one market in Turkey that has enormous potential should it find proper investment and attention, wind energy.

As we consider Turkey's need for energy we can clearly recognize that the country must begin to look to renewables as the answer to its present import based energy sector. Many ideas have been posited for the use of renewable sources from hydro to biomass but the most promising alternative energy is clearly wind energy. This section of the paper will build on the energy segment of the last homework which analyzed the entire alternatives sector but instead focus only on the present situation in the wind energy sector as well as examine the three most remarkable wind energy projects in Turkey as of today. Additionally, it will examine the projects from their feasibility to provide a significant percentage of renewable energy to Turkey as well as their potential for expansion and ultimately make conclusions about what the future the industry has in the country.

There are many indicators that demonstrate the increasing priority that wind energy and renewables as a whole are being given in Turkey. Perhaps one of the most telling indicators of the importance that wind energy is beginning to occupy in Turkey is the choice for Istanbul as the location of the 9th World Wind Energy Conference in 2010. This important conference is not only a networking opportunity but also an information session for

individuals. Additionally, the wind energy profile is further being raised by another key conference in the area of wind energy, the Wind Power Conference on December 7-9 of this year.

Over the past few years a great deal of research has been conducted in Turkey as to the availability and feasibility of the wind energy in the country. As a result, Turkey's image in the wind energy market has improved greatly and has drawn a great deal of attention from investors both at home and abroad. According to the RNCOS report, Wind Power: Opportunities in Emerging Markets, it is estimated that, "Turkey has the huge potential to generate 166 TWh of electricity per year from wind resources and represents the highest share in technical wind energy potential in Europe".[28] Should Turkey be able to generate all this energy it would not only be able to more than meet its demand for electricity, which is according to International Atomic Energy figures, was 124.88 TWh, but it might even be able to export this electricity to its neighbors. This would be a great change because traditionally Turkey has been a net importer of energy in the amount of approximately 70%.

Table 2: Electricity Consumption Republic of Turkey[29]

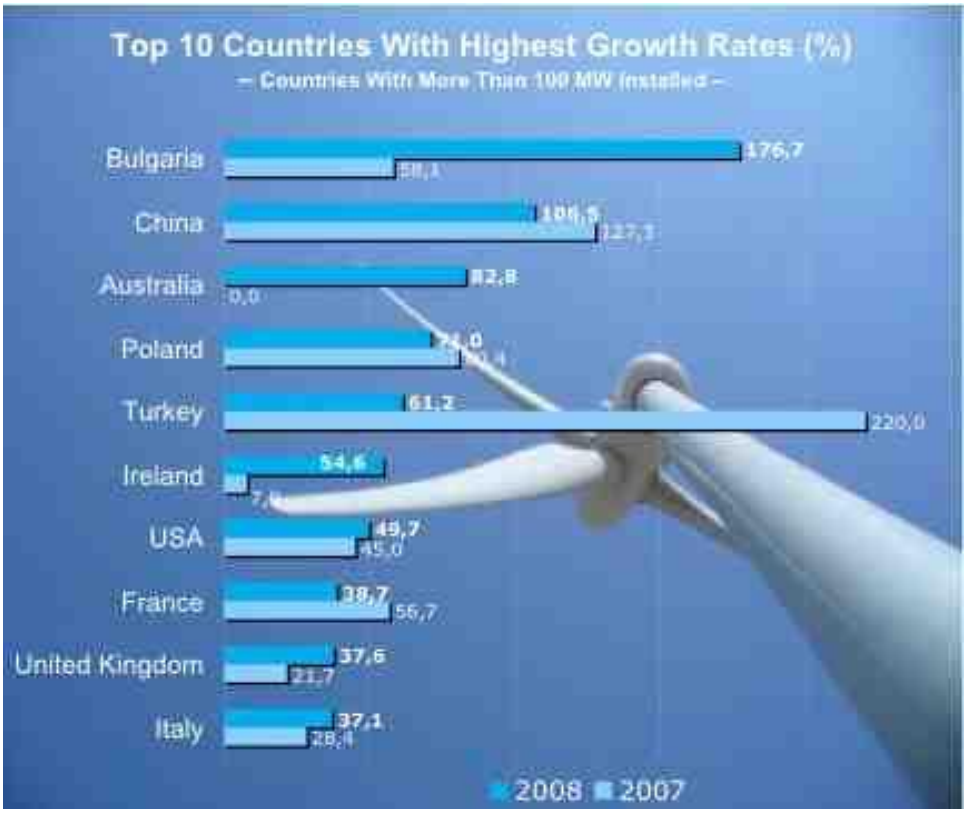
Year	Data Source	Value	Notes
2003	**U.S. DOE (2005)**	124.88 TWh	(provisional)
2002	**U.S. DOE (2005)**	117.85 TWh	-
2001	**U.S. DOE (2005)**	112.55 TWh	-
2000	**U.S. DOE (2005)**	114.00 TWh	-
2000	**Eurostat (2004)**	95.87 TWh	-

[28] RNCOS, foreword

[29] International Atomic Energy Agency Publishers, "Energy and Environmental Data Reference Bank: the Republic of Turkey," International Atomic Energy Agency ttp://www.iaea.org/inisnkm/nkm/aws/eedrb/data/TR-elp.html (accessed October 18, 2009).

A quick glance at Figure 6 provided by World Wind Energy Report in 2008 and we can recognize that there was a 220% increase in wing energy MW from 2006-2007 and an additional 61% increase from the 2007 production year to 2008. Now these percentages may seem remarkable but we have to remember that the Turkish wind energy market is in its infancy and the curve has been so steep because in previous years the energy produced in this field was negligible. At the end of 2008, Turkey had a total installed capacity of 333 MW and rank 25th in the world for wind energy production. Presently, Turkey has nearly 490 MW of installed capacity, and by the end of 2010 it is estimated to reach over 1,500 MW.[30] What is significant about this figure is that it will represent about 3.5% of the country's total energy capacity; this once again demonstrates that Turkey is making a real push to integrate renewables such as wind into its energy market.

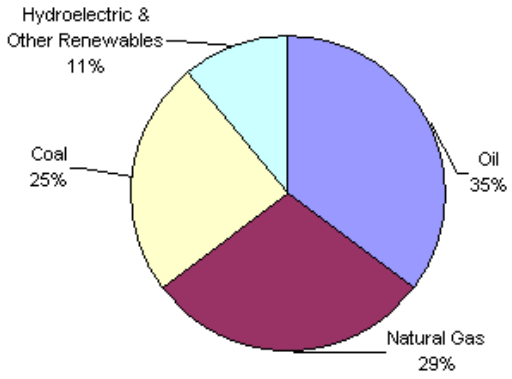
Figure 6:[31]



[30] Invest Turkey, "Turkish wind energy growing fast with feed-in-tariff in the pipeline," Invest Turkey, http://www.invest.gov.tr/haber_display.aspx?haberID=19028 (accessed October 16, 2009).
[31] World Wind Energy Report 2008, pg 6

What is becoming more and more apparent is that Turkey and the developing world in general have great potential for renewables. The Turkish government has begun to realize that Turkey is a prime candidate simply because its natural resources make it possible to reduce its reliance on foreign sources. It is time for Turkey, as a large energy import economy, to change direction in energy policy.

Figure: 7 **Total Turkish Energy Consumption in 2006 (BTU)** [32]



Source: EIA International Energy Annual 2006.

For obvious reasons, any country that is primarily dependent on non-domestic sources for energy supplies is in a precarious situation, simply because it means that the country itself is not completely able to set its own price for energy. In fact being reliant on outside sources makes Turkey vulnerable to the unpredictable forces of the petrol market. Presently over 70% of its energy sources are brought in from abroad; mainly Russia and its eastern neighbors and 80% of its sources are from nonrenewable sources. Forces outside its control such as tensions in Niger or the former Soviet Block countries' cool relations with powerhouse Russia are completely beyond Turkey's control and do nothing to calm nerves

[32] Energy Information Administration, "Turkey Energy Data, Statistics and Analysis - Oil, Gas, Electricity, Coal," Energy Information Administration, http://www.eia.doe.gov/emeu/cabs/Turkey/images/Oil%20Production%20and%20Consumption.gif (accessed October 20, 2009).

about reliable and consistent supplies. This type of reliance also has significant repercussions for Turkey's economy. Having a heavily agricultural as well as textile economy, these two industries require a great deal of energy in order to produce goods. As the price of foreign energy increases, so will the decrease the bottom lines of Turkish companies.

The 2005 Energy Law In Turkey

One of the major changes in Turkey that has helped increase the support for wind energy as well as renewables as a whole is the 2005 Renewable Energy Law. See Appendix 1 for a summary of law's major points. In short, there were many changes that the law oversaw including defining renewables, which had not been defined before in a legal context. Although this may sound quite unbelievable, Turkey did not even have a Ministry for Environmental Affairs until 1991. So in fact the development of this law has actually come in relatively quick time.

One of the major advantages that the Law has helped Turkey with is its quest for European Union Membership. While admission to the club still may be a few more years off, the energy sector is trying to bring itself in line with EU legislation so as to streamline the integration when it happens. This includes "supporting renewable sources, including wind power, by giving a government guarantee to purchase electricity at a set price for a period of 7 years." What perhaps was disturbing about the law was that there was a tariff of 5 euro cents per kWh of electricity. This may seem like a good tactic but in fact it is purported to be lower than in other European countries meaning ultimately that investment in this sector would not be as high as it might have been with a higher tariff.[33] The increased tariff might make the market more attractive to other investors and therefore as of August there was a proposal before the government to raise this to 8 eurocents per KWh which is waiting ratification.[34] It is clear however with the institution of this Renewable Energy Law as well as the Turkish Wind Atlas (to be mentioned later) a great deal of interest was stimulated and

[33] Renewable Energy World.com, "Turkey Looks to exploit Wind Energy Potential," Renewable Energy World.com, "http://www.renewableenergyworld.com/rea//news/article/2007/09/turkey-looks-to-exploit-wind-energy-potential-49947 (Accessed October 22, 2009)

[34] Invest Turkey

“licenses were granted to 93 new wind projects which deliver a total installed power of 3.363 MW. Out of these projects, there are powers plants which correspond to an installed power of 1.100 MW which are presently under construction.”[35]

[35] Ibid

Turkish Wind Energy's Present Situation

As a result of the amount of interest that has been generated, there has been a major push to get wind projects in Turkey into public view. For example, the Global Wind Energy Council states that in 2008, "a record number of 751 projects were received by EMRA in one day, totaling 78 GW".[36] Immediately following the 2005 Renewables Law, the, EMRA issued about 5,000 MW worth of licenses for wind energy generation."[37] In total, the Market Authority EMRA has licensed 78 projects constituting 2,900 MW of capacity while almost 78,000 MW of license applications have been filed."[38] Due to some infrastructural problems, Turkey does not have the luxury of approving them all and therefore many of them are still on the waiting list.

The change in the energy law as well as the higher priority wind energy was receiving over the past 2 years is what has helped to make renewable energy the second largest domestic sources for energy production after the coal. According to the Ministry of Energy, "In 2006, the energy produced from renewable sources has reached to the amount over 10,8 Mtoe, which is 11% of the Total Primary Energy Sources" [39] As interest in this field begin to grow so too will wind energy's capacity. The market has just begun to take of and the Ministry of Energy also with the government is making an effort to keep renewable projects in the public's mind so as to increase support for them.

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[36] *Global Wind 2007 Report* , pg 61

[37] Global Wind Energy Council, "Country profile: Turkey," GWEC website, : http://www.gwec.net/index.php?id=133 (accessed October 19, 2009).

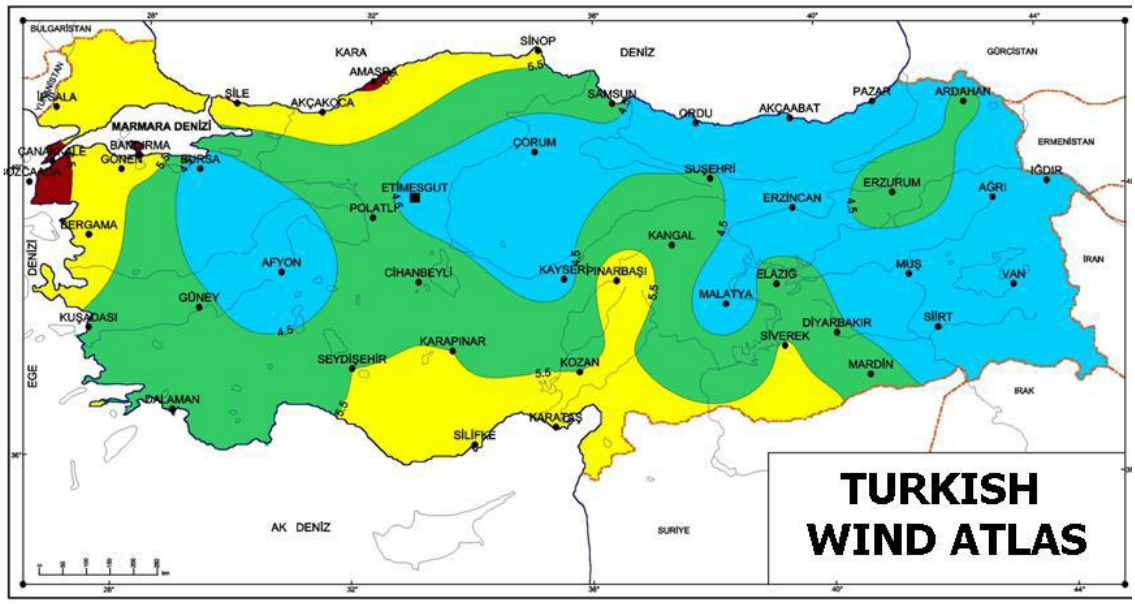
[38] Ibid

[39] Ministry of Energy and Natural Resources for the Republic of Turkey, "Yenilenebilir Enerji Kaynaklari Bilgi Notu," MOE website, http://www.enerji.gov.tr/index.php?dil=en&sf=webpages&b=ruzgar_EN&bn=231&hn=&nm=40717&id=40734 (accessed October 19, 2009).

The Turkish Wind Atlas

One measurement that has allowed investors to understand the potential that Turkey has for wind energy is the Turkish Wind Atlas, which was developed in 2007. After the research was conducted, it was clear that Turkey has great potential for the exploitation of this renewable source. We can understand that the increased investment in wind projects coincides with the publication of this telling atlas.

Figure 8*:* Turkish Wind Atlas[40]



Wind resources at 50 m above ground level for open plains (roughness class 1)

v (m/s)	**> 7.5**	**6.5 – 7.5**	**5.5 – 6.5**	**4.5 – 5.5**	**< 4.5**
P (W/m²)	**> 500**	**300 - 500**	**200 - 300**	**100 - 200**	**< 100**

With this instrument, which measured wind speed at 50m above ground level, it has been estimated that perhaps 5,000 MW capacity can be installed in areas where the wind speed is higher that 8.5 m/s. Turkey does not have too many of these locations but there are

40 Turkish State Meteorological Service, "Turkish Wind Atlas." Turkish State Meteorological Service, http://www.meteor.gov.tr/2006/arastirma/files/TurkishWindAtlas.pdf (accessed October 15, 2009).

a few located around the mouth of the Dardanelles Strait. It should be mentioned that there already exist onshore wind farms in these areas but more are proposed to be built in the coming years. According to the RNOCS Report, Wind Power: Opportunities in Emerging Markets, Turkey has nearly 781,000 Sq. km tracts of land that technically represent strong wind power generation potential."[41] What this represents is significant areas of land that can be reserved for wind farms. Plus since the overall land area is quite high it also increases the likelihood that many different farms can be developed in appropriate places.[42] Furthermore there are quite a few regions in Turkey, south of the Dardanelles, close to Izmir that can see wind speed reach 7.0 m/s and these according to the Wind Atlas could have a plant with 48,000 MW capacity wind power installed.[43]

Barriers to Wind Energy in Turkey

Turkey has seen a lot of movement in the wind energy sector in the past 2 years but not all of it is good news. While there has been a great deal of research as well as interest on the part of investors due to the change in legislation, there are some technical problems that still pose great barriers to the full exploitation of wind energy in Turkey. One of the main entry barriers for wind developers is the condition of the national electricity grid. In general the overall infrastructure in Turkey, from railroads to sanitation to energy delivery systems is quite lacking. Power shortages as well as outages are frequent problems even in large city such as Istanbul. These are trying to be remedied but it seems that the country is applying a band aid solution to repairing the old and insufficient grid rather than implementing new systems for energy delivery. With the great number of projects that have been awarded, in the wind energy sector alone, there must be assurance by the government that these new energy

[41] RNOCS, foreword
[42] Ibid
[43] Ministry of Energy and Natural Resources

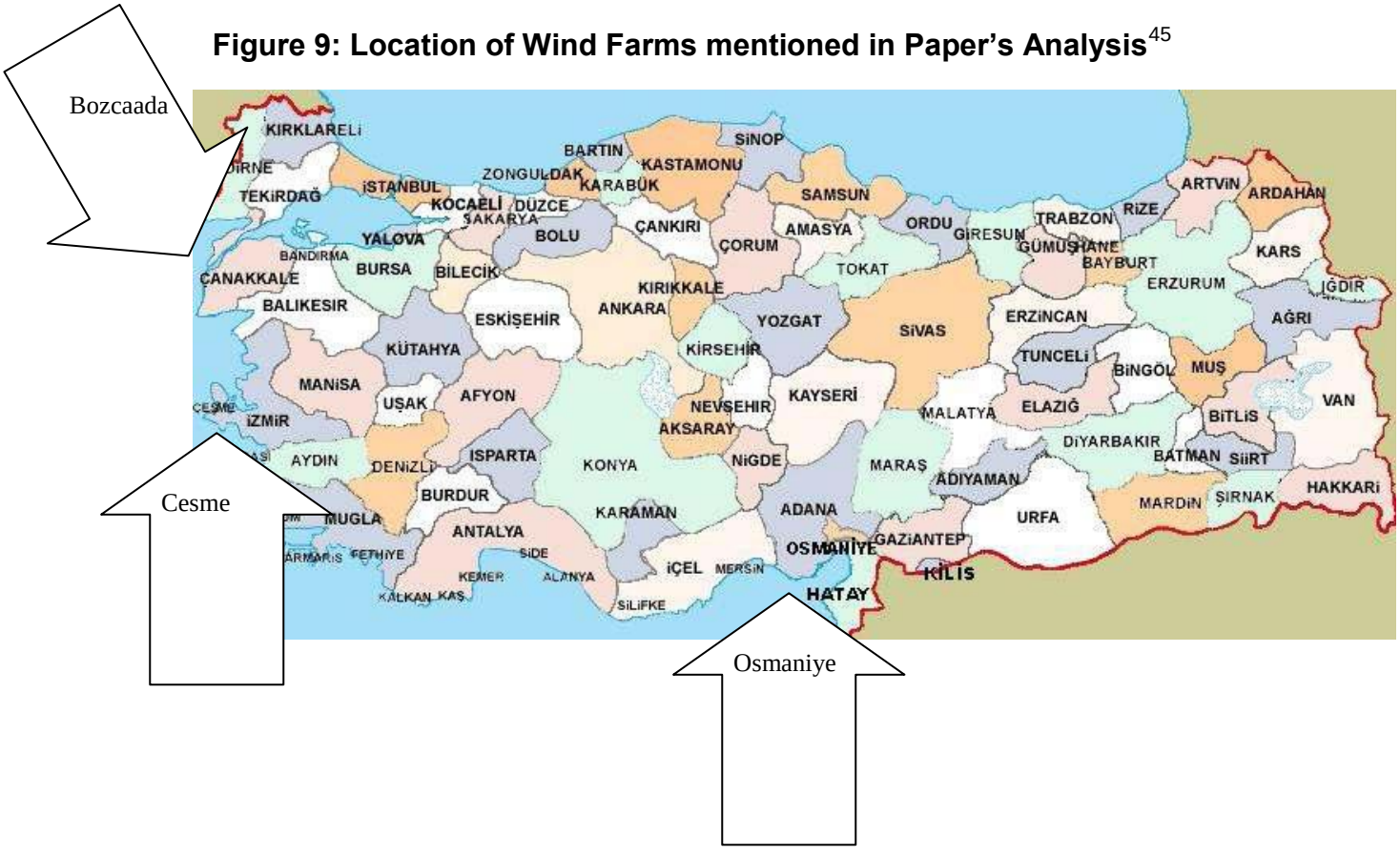
generating plants will be able to smoothly connect with the national grid. Without the proper streamlining there is a large possibility that the these power outages and shortages will continue but the only difference being that the newer systems with the extra energy being generated have the possibility of overloading the grid and causing fluctuations or instability as in recent history. According to Eurelectric's Power Outages 2003 study, "wind power was one of the contributors to critical outages, and the country's grid will require substantial investments in order to mitigate these outages in the future."[44] Due to all the interest and investment that is occurring in the Turkish wind energy market, there needs to be substantial investment in the securing that the national grid will be able to operate with this higher influx of energy from all renewable sources.

44 "Turkish Wind Energy Growing Fast with Feed-In-Tariff in the Pipeline," *Reuters Online Edition,* August 10, 2009, *h*ttp://www.reuters.com/article/mnEnergy/idUS325544061320090731 (accessed October 25, 2009).

Individual Wind Farm Analysis

This survey has selected three wind farms in Turkey, each with a specific quality or characteristic that makes it stand out from the other projects and make it worth highlighting for its significance to the Turkish wind energy market These are Bozcaada Wind Farm, Izmir-Cesme Wind Farm and the Osmaniye Wind Farm; all of which are highlighted on the map below. For a complete list of all current and projected wind energy projects please see Appendix 1.

Figure 9: Location of Wind Farms mentioned in Paper's Analysis[45]



45 Zorlu Enerji Grubu, "Bahce Ruzgar Enerji Santrali (135 MW) Projesi icin Cevresel ve Sosyal Etki Degerlendirmesinin Teknik Olmayan Ozti," Zorlu Enerji Grubu Website, http://www.zoren.com.tr/TR/COMPANIES/companies10. (accessed October 25, 2009).

Bozcaada Wind Farm

As an island located in the Aegean Sea, Bozcaada sits at a prime location for wind energy and corresponds to the Turkish Wind Atlas rate of between 7.0 and 8.0 m/s. Presently there exists 18 wind turbines on the island that produce and estimated 10.2 MW of wind energy. While this is not an enormous amount of energy compared to the other projects which will be mentioned, 4 of the turbines supply enough energy for the island of about 2,000 people. The other 14 turbines send the energy to the mainland of Cannakale and distribute it there. The island's wind energy farm has some interesting firsts that make it relatively important to the development of wind energy in Turkey. This is a joint venture between the German company Enercon and a Turkish trust that owns the land. The project was finished in 2000 and was unique because it was the first and largest wind energy project of its kind in Turkey and remained the largest producer of wind energy in Turkey until 2006 when a project in Bandirma by GE Energy that generates 30 MW surpassed it in 2006.[46]

Another unique aspect of the venture is that Enercon sells the energy produced back to the Turkish government at a bulk rate. The Turkish government then distributes this energy to the consumers in Turkey. So essentially, a foreign company recognized the potential of wind energy programs in Turkey and decided to develop this alternative resource. This project was developed before the Turkish Wind Atlas and basically provided hard data to the Turkish government that wind projects were productive and feasible in the eastern Aegean region.

After recognition of this renewable energy was acknowledged and assisted with the 2005 Renewables Law, wind projects began to be sponsored by the Turkish government at a

[46] Global Wind Report 2007, pg 61

higher rate. Since the release of the Bozcaada results, the Turkish government has begun to support larger and larger wind energy projects through out the region due to the enormous potential. It is as if the Bozcaada project taught the Turkish government a lesson about realizing and utilizing valuable natural resources. It is assumed that with proper maintenance the Bozcaada wind farm will stay operational until 2015 or perhaps 2020 depending on the condition of the turbines. What is clear is that all the time it will be generating clean energy for the island.

Cesme Wind Farm

For the last two years, the Cesme Wind Farm has held the title of largest and most productive wind farm in Turkey. According to the wind atlas it corresponds to and average wind speed of 5.5 to 6.5 m/s. With 49 turbines, the farm has an installed capacity of 39.2 MW.[47] Until 2009 this was physically the largest park in terms of turbines. It was surpassed this year by the Osmaniye farm which will be mentioned shortly. This is quite a significant plant for Turkey because it demonstrates how an industry in Turkey which requires development, energy and its second largest industry, tourism can work together. Prior to the construction of the plant there were the standard objections from local environmental groups but there were also lots of objections by local tourism operators who complained that the number and sight of the turbines would ruin their business. Cesme located on the confluence of the Mediterranean and the Aegean Seas, is one of the most popular tourism spots in Turkey. It is known for its long sandy beaches as well as its beautiful views of the Mediterranean.

[47] Ibid, pg 61

As can be seen by the figure below, the total 2008 revenue for tourism in Turkey was 22 billion USD. Should Cesme's environment be damaged for any reason, it is obvious that the tourism sector in the region would suffer. Yet to the surprise of many in the local tourism board, the wind farms in fact did not damage the local revenue. Some even believe that it has increase revenue and generated interest because many tourists are driving out to see the wind farm and there has been an increase in awareness. While no longer the largest producing farm or the farm with the most number of turbines, the Cesme plant continues to add to the local economy by providing electricity to the national grid. This electricity is strongly relied upon during the tourist season which lasts from May to September. It is assumed that this plant will be active for the next 10-12 years and be able to efficiently provide wind energy for the region. Without the Cesme farm, the industry would once again have to rely on fossil fuels for energy. The Cesme farm is an example of how the tourism and energy are not mutually exclusive but rather how they have the potential to work together.

Figure 10: Exports and Tourism Revenues (Turkey 2002-2008)[48]

[48] Investturkey.gov.tr

Osmaniye Wind Farm

Since the early beginnings of the wind energy market in Turkey much of the effort in developing wind farms has been focused on the Aegean and Mediterranean Sea areas which lie in western Turkey. Yet the release of the Turkish Wind Atlas made it is clear that certain parts of central Anatolia correspond to high rates of wind speeds as well and can justify investment. Presently the recently finished and most discussed wind plant in Turkey is located in the Gokcedag Mountains of southeastern Turkey in the province of Osmaniye. This was the first major project constructed out of the Aegean area and the largest of its size in Turkey to date (it is soon to be surpassed by a project to be completed in 2010 in Manisa).[49] The project was actually very labor intensive and was sponsored by Zorlu Energy group, a wholly Turkish venture. What this says about the Turkish wind energy market is that companies have begun to recognize the importance of using and investing in their own natural resources. Unlike what we have seen with the other two major wind energy installations, which were initiated and funded by foreign companies, this is the first all Turkish wind energy farm of this size in Turkey.

With this project Turkey has doubled is electricity produced from wind energy. The Osmaniye has an installed capacity of 135 megawatts (MW) and an expected annual electricity generation of 466.742 MWh.[50] One remarkable aspect of the project is that it is not located on the traditional wind energy producing west coast of Turkey and purports to be the largest in the country. With 54 General Electric Energy turbines each one has a capacity of 2.5 MW each. According to the statistic provided by the company, the turbines are of the 3

[49] GWEC, Country Profile

[50] TUV Rheinland, "Rotor Elektrik Uretim Osmaniye Wind Farm Project," TUV Rheinland Website, http://www.tuv.com/de/en/rotor_elektrik_uretim.html (accessed October 26, 2009).

rotor blade type and have a diameter of 100 meters (this type of turbine can be observed on page 17 of the text). Operating at wind speeds as low as 19 mph these turbines are suppossedly 12% more efficient than the previous model.[51] The wind farm is doing a great deal to combat climate change because “it is expect to reduce emission of greenhouse gases by an estimated 302.675 tCO2e/year during the first 7 year crediting period.”[52]

What is also important about the project is that during the course of its construction it has helped generate jobs in the region and will continue to maintain the jobs of wind energy specialists at the farm. This region has traditionally been neglected by domestic investment and the Osmaniye plant has helped to revive the local community as well as reduce the reliance on foreign energy supplies.[53]

[51] Renewableenergyworld.com
[52] TVU Rheinland
[53] Carbon Off Sets Daily, “Rotor Elektrik Uretim Osmaniye Wind Farm (Zorlu)” Carbon Off Sets Daily Website, http://www.carbonoffsetsdaily.com/projects/rotor-elektrik-uretim-osmaniye-wind-farm-zorlu-10748.htm (accessed October 26, 2009).

Results and Conclusions:

As we can see in the last two years in Turkey there has been an explosion in the wind energy market and the renewables market in general. One major conclusion we can make with respect to the global energy situation not just that of Turkey is that world-wide energy demand is growing at an alarming rate. With a rate increase in Turkey cited at 8% and world rate of 2%[54]. What obviously follows in that this rate is unsustainable and alternative methods must be devised in order to meet this seemingly insatiable need.

Secondly, we can understand from the data presented in the paper, that wind energy, although less that 1% of the total world's presently generated energy has great potential to help countries meet their energy deficiencies. While there are concerns such as costs of installation as well as efficiency issues, it should be mentioned that new wind farms are not anymore expensive to construct than a new fossil fuel plant. Wind energy also offers an unlimited supply and produces very little to no emissions that would contribute to climate change. As countries are trying to reduce their carbon footprint it makes logical sense to begin with the energy sectors.

Thirdly, we can conclude that Turkey, as a developing nation, has the possibility to generate an incredible amount of wind energy that most likely will be delivered in the form of electricity. With such great potential, the country, should it receive sufficient investment in its renewables market, has the ability to lessen its nearly 70% energy import burden. Energy independence would allow Turkey to offer domestically generated energy at a lower cost to consumers as well as lessening the trade deficient. It obviously will give a boost to the

[54] Wikipedia contributors, "World energy resources and consumption," Wikipedia, The Free Encyclopedia, http://en.wikipedia.org/w/index.php?title=World_energy_resources_and_consumption&oldid=298677237 (accessed October 15, 2009)

industries such as textiles or agriculture because lower energy prices can therefore be passed onto the consumers and there will be an over reduction in market prices without the companies' bottom line suffering.

Finally, a fourth conclusion we can make is that the wind energy market in Turkey is just beginning to take off. With the explosion in application for wind farms as well as the present number of farms under construction it is obvious that the Turkish government is beginning to realize the potential domestic renewable resources hold for the country. Although the market may have been slow to start, with most of the activity occurring in the last two years, the government has wasted little time in trying to make projects possible. These small steps taken by the government have allowed for a change in public attitudes that seem more supportive of wind energy. These projects need to continue because they are slowly raising the profile and possibility of renewable projects in the country.

When we try to make predictions and generalizations about mankind we can see that Turkey as with many other countries has opened the door to renewable energy. Although it may have started late, Turkey is making an attempt to fix its fossil fuel use patterns and change to alternative resources. One remarkable fact is that as a country in the developing world, Turkey has a virtually untapped supply of hydroelectric, geothermal, wind and solar energy, the country is full of renewable resource potential. A statement like this means that the developing world especially countries such as China and India also need to be convinced that it is in their best interest to opt for renewable energies in order to preserve resources and to prevent further pollution of the environment. Turkey's priorities, while not entirely focused on renewable energies are moving in the correct direction. If we can see a country with the

limited economic and structural resources like Turkey practicing these renewable energy procurement methods we have some hope for the future of other countries.

Recommendations:

It is obvious that the Turkish wind energy sector has a great deal of work ahead of it. The significant steps that it has made in terms of changing its legal cannon and beginning to construct and implement large scale wind plants are to be commended. Yet Turkey should not be content with these present projects. There are potentially hundreds of recommendations that could help Turkey to create a cohesive renewables program but I will limit them to four headings: political, technical, social and economic recommendations.

Principally, what I recommend for Turkey is the development of a comprehensive plan for the future that involves not just wind energy but the maximization of all renewable resources. As we have seen with the EU and the United States, organized and goal oriented programs have helped to greatly improve the efficiency as well as amount of energy produced in wind farms. To date Turkey has no collective wind energy policy and in fact has accepted a lot of applications for projects but has yet to make decisions about whether or not to implement them. By having the government make a definitive statement about establishing clear targets for wind energy production and CO2 emissions reduction, the private sector can begin to work on their individual steps to meet these goals. Having recently signed the Kyoto Protocol, Turkey is at a crossroads and needs to continue down the path of renewable energy in order to help it meet the targets set forth by this international agreement.

Turkey also has a lot of work to do with technical energy infrastructure. With the increase in both demand and supply of energy via renewables, I suggest that the Ministry of Energy needs to create an updated centralized national grid that can ensure that this energy can be received and transferred properly. Should this energy overload the system there would

be a greater likelihood that power shortages and outages would occur. Additionally it would defeat the purpose of increasing the investment in renewables if the energy can not be adequately utilized once it is in the system. Another benefit that is a byproduct of improved infrastructure is conservation. If the infrastructure were improved there would be less energy wasted. The old transmission lines and national grid in fact are major energy wasters and should be recognized in order to make improvements.

A social aspect that can definitely be improved upon in Turkey is better education of both the population at large and government officials. The Turkish energy policy is still heavily dependent on importing fossil fuels, and this has some obvious and hidden costs for Turkey. I recommend that the Ministry of the Energy work with the Ministry of Environment to establish a training program for elected officials, and eventually the public. It is clear that elected officials needs to make informed decisions and they are unable to do this if they can not recognize the significance of renewable projects when they are produced as proposals in government. Educating the public means citizens would be able to voice their concerns about certain precarious projects such as the 3 proposed nuclear power plants to be built in 2012. This education would also allow individuals to put more pressure on the government to approve renewable projects.

The economic recommendations that I can make are simply to do with raising the tariffs on alternative energy production as to stimulate investment in the area. Another suggestion that could be made would be to have the government reserve funds for more wind energy projects or subsidize the wind energy sector or turbine production sector so as to make the technology cheaper to produce with the objective of initially lowering renewable energy prices and allowing them to eventually become cheaper than traditional fossil fuels.

Appendix 1

Text of 2005 Renewable Energy Law[55]

_ Turkey has substantial renewable energy resources which are mainly hydropower, wind, solar and biomass. Renewables are the second largest domestic sources for energy production after the coal. In 2006, the energy produced from renewable sources has reached to the amount over 10,8 Mtoe which is 11% of the Total Primary Energy Sources.

_ Electricity generation from renewables is 26% of the total energy generation in 2006. Renewable energy supply in Turkey is dominated by hydropower and biomass. The contribution of wind and solar is limited but expected to increase.

_ The economically usable hydropower potential of Turkey is determined as 130,000 GWh per year, of which 35% has been exploited. 9% of the potential is under construction and the rest (56%) is at project level. It is projected that hydroelectric power plant capacity will be reached to 35000 MW by the year 2020.

_ According to the Turkish Wind Energy Potential Atlas, it has been calculated that 5000 MW capacity of wind power plant can be installed where annual wind speed is higher than 8,5 m/s. Also, 48000 MW capacity of wind power plant can be installed where annual wind speed is higher than 7,0 m/s. Wind energy investors can reach all site information for wind parameters.
Installed wind power capacity in Turkey has reached from 20 MW to 250 MW. Additionally, new applications, nearly 85000 MW, were applied for the getting production license.[56]

_ Technical solar energy potential is 76 MTEP and 12 million m_2 solar collectors has been presently used in Turkey. This means that solar collector usage is 0,15 m_2 /person. Total photovoltaic applications are approximately 1000 kW and mainly used where transmission of electricity is not economically feasible. It is expected widespread used depending on decrease of prices and increase the efficiency in the future. Furthermore, according to the Turkish Solar Energy Potential Atlas, it was calculated that 380 billion kWh/year energy can be produced from concentrated solar thermal power plants.

_ Total geothermal potential is 500 MWe and 31,500 MWt. Currently, only 10% of this capacity is used for heating 71 000 residential and two geothermal electricity generation plants with 20 MW and 7 MW capacities are under operation, and the one with 25 MW capacity is under construction.

_ Turkey's main biomass sources are agricultural, forestry, animal and organic wastes. Biomass potential is 8,6 million TOE and the amount of 6 million of this potential is being used.

[55] Ministry of Energy and Natural Resources

Table 3: [57]

Figure 3
Oil production in six of the eight largest oil producing nations declined in the first 10 months of 2006.

2005 Production Rank	Country	Average Daily Production Jan-Oct 2005	Average Daily Production Jan-Oct 2006	% Change	Decline Due to Geological Limitations?
1	Saudi Arabia	9,560	9,228	-3.5%	Unknown
2	Russia	9,007	9,197	2.1%	
3	United States	5,232	5,121	-2.1%	Yes
4	Iran	4,141	4,029	-2.7%	Unknown
5	China	3,616	3,684	1.9%	
6	Mexico	3,330	3,293	-1.1%	Yes
7	Norway	2,705	2,491	-7.9%	Yes
8	Venezuela	2,570	2,515	-2.1%	Unknown

Notes: Based on January 2007 data of the US Energy Information Administration
Production in thousands of barrels per day.
Announced OPEC cutback began 11/1/2006, so should not affect these figures.

Table 4: List of All Wind Projects in Turkey:[58]

Tablo:1 Türkiye'de İşletmede Olan Rüzgar Enerji Santralları (RES) (04.02.2009)

Türkiye'de kurulu bulunan ve kurulması planlanan rüzgar enerji santralları ile ilgili özet tablo aşağıda verilmektedir.

Türkiye'deki Rüzgar Santralları *Wind Projects in Türkiye*					
Şirket	**Mevkii**	**Üretime Geçiş Tarihi**	**Kurulu Güç (MW)**	**Türbin imalatçısı**	**Türbin adet ve kapasitesi**
Company	*Location*	*Comm. Date*	*Installed Cap. (MW)*	*Turbine manufacturer*	*Turbine capacity*
Alize A.Ş.	İzmir-Çeşme	1998	1.50	Enercon	3 adet 500 kW
Güçbirliği A.Ş.	İzmir-Çeşme	1998	7.20	Vestas	12 adet 600 kW
Bores A.Ş.	Çanakkale-Bozcaada	2000	10.20	Enercon	17 adet 600 kW
Sunjüt A.Ş.	İstanbul-Hadımköy	2003	1.20	Enercon	2 adet 600 kW
Yapısan A.Ş.	Balıkesir-Bandırma	I/2006	30.00	GE	20 adet 1.500 kW
Ertürk A.Ş.	İstanbul-Silivri	II/2006	0.85	Vestas	1 adet 850 kW
Mare A.Ş.	İzmir-Çeşme	I/2007	39.20	Enercon	49 adet 800 kW
Deniz A.Ş.	Manisa-Akhisar	I/2007	10.80	Vestas	6 adet 1.800 kW

[57] Our Finite World, "Oil production in 6 of the largest 8 oil producing nations decline in first 10 month of 2006," Our Finite World Blog, http://gailtheactuary.files.wordpress.com/2007/03/largest-8.jpeg (accessed October 15, 2009).
[58] Ministry of Energy and Natural Resources

Anemon A.Ş.	Çanakkale-İntepe	I/2007	30.40	Enercon	38 adet 800 kW
Doğal A.Ş.	Çanakkale-Gelibolu	II/2007	14.90	Enercon	13 adet 800 kW + 5 adet 900 kW
Deniz A.Ş. (*[1])	Hatay-Samandağ	I/2008	30.00	Vestas	15 adet 2.000 kW
	Manisa-Sayalar	I/2008	30.60	Enercon	38 adet 800 kW
İnnores A.Ş.	İzmir-Aliağa	I/2008	42.50	Nordex	17 adet 2.500 kW
Lodos A.Ş.	İstanbul-Gaziosmanpaşa	I/2008	24.00	Enercon	12 adet 2.000 kW
Ertürk A.Ş.	İstanbul-Çatalca	I/2008	60.00	Vestas	20 adet 3.000 kW
Baki A.Ş. (*[2])	Balıkesir-Şamlı	II/2008	90.00	Vestas	38 adet 3.000 kW
Dares A.Ş. (*[3])	Muğla-Datça	II/2008	10.00	Enercon	27 adet 800 kW + 8 adet 900 kW
İŞLETMEDEKİ KAPASİTE TOPLAMI *CAPACITY UNDER OPERATION*			**433.35**		
Ayen A.Ş.	Aydın-Didim	I/2009	31.50	Suzlon	2.100 kW
Ezse Ltd. Şti.	Hatay-Samandağ	II/2009	35.10	Nordex	900 kW
Ezse Ltd. Şti.	Hatay-Samandağ	II/2009	22.50	Nordex	2.500 kW
Rotor A.Ş.	Osmaniye-Bahçe	II/2009	135.00	GE	54 adet 2.500 kW
Mazı-3 Res Elk. Ür. A.Ş.	İzmir - Çeşme	II/2009	22.50	Nordex	9 adet 2500 kW
Kores A.Ş.	İzmir-Çeşme	II/2009	15.00	Nordex	2.500 kW
Soma A.Ş.	Manisa-Soma	II/2009	140.80	Enercon	176 adet 800 kW

İNŞA HALİNDEKİ KAPASİTE TOPLAMI *CAPACITY UNDER CONSTRUCTION*			**402.40**		
Alize A.Ş.	Balıkesir-Susurluk		19.00	Enercon	17 adet 800 kW ve 6 adet 900 kW
Borasco A.Ş.	Balıkesir-Bandırma		45.00	Vestas	15 adet 3000 kW
Alize A.Ş.	Tekirdağ-Şarköy		28.80	Enercon	14 adet 2000 kW ve 1 adet 800 kW
Alize A.Ş.	Balıkesir-Havran		16.00	Enercon	8 adet 2000 kW
Alize A.Ş.	Çanakkale-Ezine		20.80	Enercon	10 adet 2000 kW ve 1 adet 800 kW
Belen A.Ş.	Hatay-Belen		30.00	Vestas	10 adet 3000 kW
Alize A.Ş.	Manisa-Kırkağaç		25.60	Enercon	32 adet 800 kW
Boreas A.Ş.	Edirne-Enez		15.00	Nordex	6 adet 2.500 kW
Doruk A.Ş.	İzmir-Aliağa		30.00	Enercon	15 adet 2.000 kW
Yapısan İnş. Elk. San.Tic. A.Ş.	İzmir-Aliağa		90.00	Nordex	36 adet 2500 kW
Doğal A.Ş.	İzmir-Aliağa		30.00	Enercon	15 adet 2000 kW
Doğal A.Ş.	İzmir-Foça		30.00	Enercon	15 adet 2000 kW
Poyraz A.Ş.	Balıkesir-Kepsut		54.90	Enercon	61 adet 900 kW
Bilgin Elektrik Üretim A.Ş.	Manisa-Soma-Kırkağaç		90.00	Nordex	36 adet 2500 kW
Bares Elektrik Üretim A.Ş.	Balıkesir-Kepsut		142.50	Nordex	57 adet 2500 kW

TÜRBİN TEDARİK SÖZLEŞMESİ İMZALI PROJE TOPLAMI	**667.60**	
PROJECTS WITH A TURBINE SUPPLY CONTRACT		
GENEL TOPLAM	**1.503.35**	**MW**

NOT:
(*[1]) Tesis toplam kurulu gücü 60 MW olup 30 MW için tevsii çalışmaları sürmektedir.
(*[2]) Tesis toplam kurulu gücü 114 MW olup 24 MW'lık tevsii çalışmaları sürmektedir.
(*[3]) Tesis toplam kurulu gücü 28.8 MW olup kalan 18.8 MW için kabul çalışmaları sürmektedir.
www.eie.gov.tr/turkce/YEK/ruzgar/TURKiYE_RES_20090204.doc