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Investigation of Wind Energy Potential Evaluation in Kerman, Iran

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Abstract

Energy consumption trend has been very rapid and alarming in recent years. This trend in developing countries and in particular in Iran is much higher than the global average. An accepted fact is that the world required energy is growing rapidly for societies and we also have cheap fossil energy sources that certainly, in a few decades will be finished but slowly. Human should use of clean and renewable energy for keeping these valuable fossil resources to future generation and prevent than environmental damages that created by these resources and answer to increased demand for energy. In this study we will review of wind energy potential evaluation in Kerman.

Keywords: Wind power, Wind energy, Renewable energy, Electrical energy, Kerman province, Iran.

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1. Introduction

In recent years, duo to the non-renewable energy resources are running out of, the renewable energy resources have attracted great attention. The growing of global warming (Jacobson, 2009) due to increase of concentrations and reduce of agricultural production and increasing of population, energy consumption (Sun, 1998) and environmental pollution are good reasons for using of renewable resources. The renewable energy resources are available in all part of the planet (Koroneos *et al.*, 2003) in the margins and remote areas while supplies of fossil fuels found only in certain countries (Goldemberg and Coelho, 2004). The renewable energy resources are free and compatible with the environment, too. In Iran according to designed and built windmills, the application of wind energy goes back to 200 years before Christ. Iran's geographical position has made the wonderful resources of solar and wind energy (Keyhani *et al.*, 2010) that provided a good platform to expand use of wind turbines and calculations to estimate the potential of wind energy in Iran. In Iran, windy areas have provided suitable location to extend of the operation of the wind turbines. In many parts of the country water resources are scarce (Abbaspour *et al.*, 2009) and there is in fact possible to produce hydroelectric power, or due to being away from large industrial and urban centers of the country, supplying fuel to the fuel vapor is cumbersome. The first step in the construction of wind farms, known, Feasibility study to evaluate the possibility of establishing a wind power plant in terms of technical, economic and necessary infrastructure in one particular site is determined using wind turbines. Kerman is in southeastern of Iran and because of have windy climate, the wind energy potential has studied in Kerman province. Accordingly, in this paper, we will study wind energy potential in Kerman province.

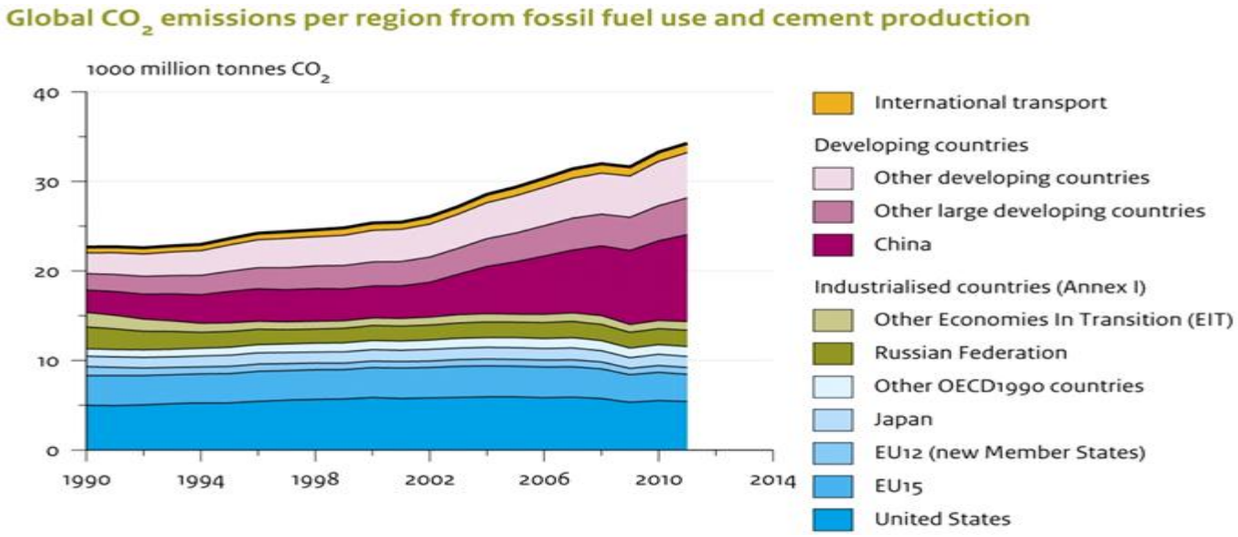


Figure-1. Global CO_2 emissions from fossil fuel use and cement production, 1990–2011 (Olivier, 2012)
Source: http://www.pbl.nl/en/publications/2011/long-term-trend-in-global-co2-emissions-2011-report

2. Wind Energy in the World

Wind power plays a central role in the world's energy supply over the next few years. With huge amounts of clean, affordable power, it can buy us time in the fight against global warming while revolutions in energy efficiency and solar power gain momentum. In less than five years wind power could prevent more than a billion tons of carbon dioxide (CO2) that emitted by dirty energy each year (Olivier, 2012).

Wind Energy Could Generate Nearly 20 Percent of World's Electricity by 2030:

Wind power could be supplying up to 19 % of the world's electricity and avoiding more than three billion tons of CO2 a year. Annual reductions in CO2 from existing wind power farms were about 372million tones in 2013. This expected to rise to 899 million tons annually by 2020 and 1521 tons per year by 2030. Council Global Wind Energy (2014) By 2050, 25-30 percent of global power could come from operation the wind. According to a report Greenpeace International, in 21 October, 2014, there is also good news for jobs. Around 600,000 people currently work in the wind power industry. That figure could rise to around 1.5 million by 2020 and exceed 2 million jobs by 2030.Wind power is a perfect technology to achieve early reductions in carbon pollution and to keep the window open to avoid global warming crossing the 2°C 'danger' threshold. Time is short for meeting of climate protection targets and guarantees this that global emissions peak and decline during this decade.

Global Wind Energy Outlook:

Greenpeace and the Global Wind Energy Council (GWEC) report on wind energy and its prospects up to 2050

Production and Share of Electricity Supply:

The rated exit, rotor diameter and average height of wind turbines have steadily increased over the years, while the average size of turbines varies substantially by country and region; the average turbine installed in 2013 was 1.93 MW, against an average of 1.34 MW for all currently operating turbines worldwide, continuing the steady increase since the beginning of the industry. This trend expected to continue as larger and larger machines developed for the offshore industry, and larger and more efficient turbines developed to extract the most energy from new sites also for repowering old sites, many of whose turbines are approaching their design lifetimes of 20 years.

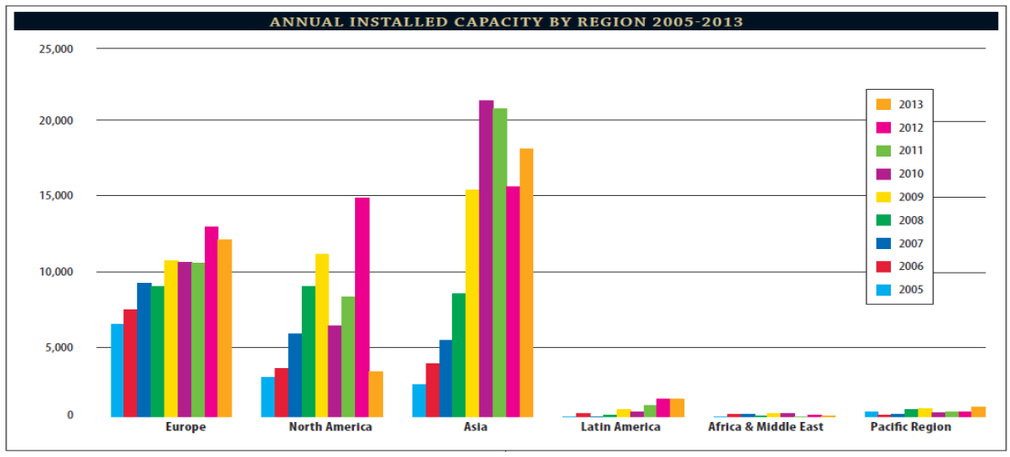
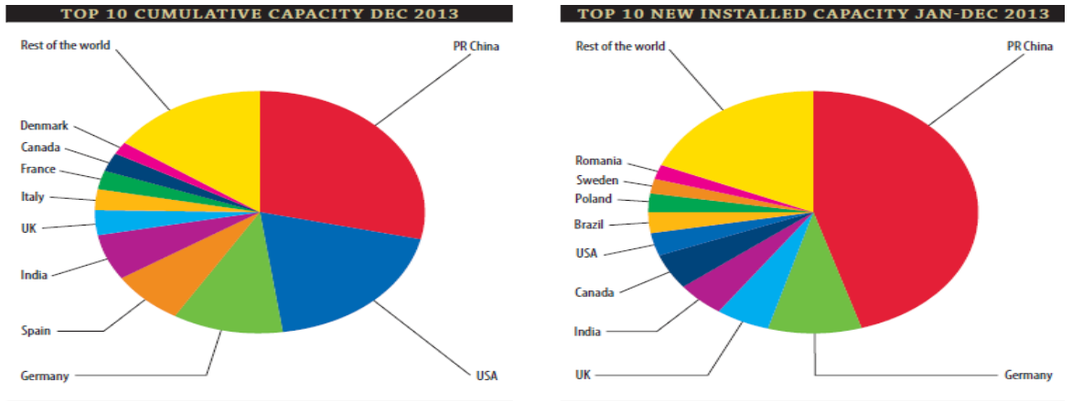


Figure-2. Annaul installed capacity by region 2005-2013 Source: GWEC – Global Wind 2013 Report
Source: www.gwec.net

Top 10 countries where wind turbines are used most efficiently updated article with new information:



Country	MW	% SHARE
PR China	91,412	28.7
USA	61,091	19.2
Germany	34,250	10.8
Spain	22,959	7.2
India	20,150	6.3
UK	10,531	3.3
Italy	8,552	2.7
France	8,254	2.6
Canada	7,803	2.5
Denmark	4,772	1.5
Rest of the world	48,332	15.2
Total TOP 10	**269,773**	**84.8**
World Total	**318,105**	**100.0**

Source: GWEC

Country	MW	% SHARE
PR China	16,088	45.6
Germany	3,238	9.2
UK	1,883	5.3
India	1,729	4.9
Canada	1,599	4.5
USA	1,084	3.1
Brazil	953	2.7
Poland	894	2.5
Sweden	724	2.1
Romania	695	2.0
Rest of the world	6,402	18.1
Total TOP 10	**28,887**	**82**
World Total	**35,289**	**100.0**

Source: GWEC

Figure-3. GWEC – Global Wind 2013 Report
Source: www.renewableenergyworld.com

Asia: China and India Remain At the Top

For the sixth year in a row, Asia was the world's largest regional market for wind energy, with capacity additions totaling just total of 18.2 GW. McHenry (2009) In terms of annual installations China achieved its leadership position, by adding 16.1 GW of new capacity in 2013, a significant gain over 2012 when it installed 12.96 GW of new capacity. In 2011, the new annual installed wind power capacity in China (excluding Hong Kong, Macao and Taiwan) was 17.63 GW. By the end of 2011, its cumulative installed capacity was more than 62 GW. In 2011, China was the world's second-largest wind producer, generating 73 billion kWh, a level about 64% higher than in 20104. In 2012, wind-generated electricity in China amounted to 100.4 billion kWh, accounting for 2 percent of the country's total electricity output, up from 1.5 % in 20115. Wind power generated 134.9 billion kWh of electricity in 2013, up 34 percent year on year, contributing 2.6 % of total electricity production in the country (Saidur, 2010; Lauha, 2012).

The Global Status of Wind Power in 2013:

More than 35 GW of new wind power capacity had brought online in 2013, but this was a sharp drop compared with 2012, when global installations were in excess of 45 GW. China, the largest overall market for wind since 2009, had a good year, and one more time regained the top spot in 2013. In 2012, some of the countries with more than 1,000 MW installed capacity was 24: including 16 in Europe; 3 4 in Asia-Pacific (China, India, Japan & Australia); 3 in North America (Canada, Mexico, US) & 1 in Latin America (Brazil). By the end of last year six countries had more than 10,000 MW in installed capacity including China (91,412 MW), the US (61,091 MW), Germany (34,250 MW), Spain (22,959 MW), India (20,150 MW) and the UK (10,531 MW) (Lauha, 2012).

3. Wind Energy in Iran

Iran is a country located in the Middle East Asia and the weather in the area of low pressure. The country is affected by two main in summer (Winds that blow in from the Atlantic and the Indian Ocean) and winter (Winds from the Atlantic and the Mediterranean and Central Asia are blowing) (Chaparzadeh, 1999; Mirhosseini *et al.*, 2011).

Wind power in Iran by about 6,500 megawatts of electrical power can be generated annually that the amount of energy obtained from approximately 45 sites in various parts of the country (Chaparzadeh, 1999; Mirhosseini *et al.*, 2011). But at the end of 2013, the country was only able to produce 100 MW of electricity in this way, compared with global production at the time (nearly 320 gigawatts) share is very small (Mostafaeipour *et al.*, 2011).

for examining Figure 3 the map shows an approximation of the current wind Iran, we can see that the area north of the Caspian Sea and southeast of the country have very good potential for harnessing wind energy.

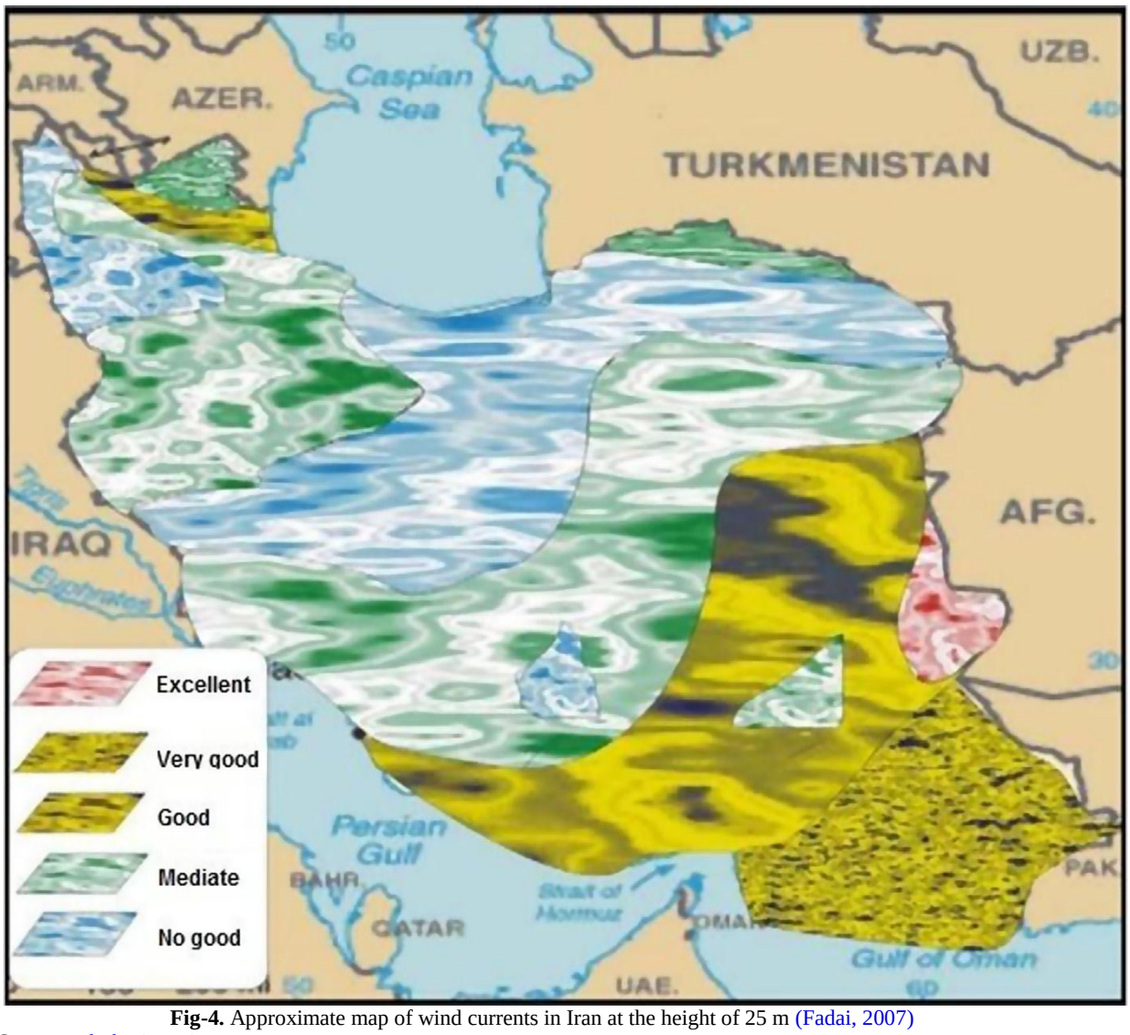


Fig-4. Approximate map of wind currents in Iran at the height of 25 m (Fadai, 2007)
Source: sedaghat.iut.ac.ir

The first wind power plants in Iran with a capacity of 500 kW were installed in Manjil and Rudbar in Gilan Province in 1994 that their annual production of wind power is more than 1.8 gigawatt hours of electricity (Mirhosseini *et al.*, 2011). The average wind year in these two regions is equal to 3600 hours with an average speed of 15 meters per second and 3400 hours with an average speed of 13 meters per second, respectively.

5 years later, the 27 wind turbines had installed in Manjil, Rudbar and Harzevil. Harzevil is near Manjil that is about 500 meters higher than it. Binalood in Khorasan Razavi province and Lutak in Sistan Baloochestan province are other locations of Iran having wind turbine that Meanwhile, Binalood with 66 turbines of 43560 kW capacities And Manjil with 21 turbines of 7750 kW are record in this field. Wind energy production capacity in iran (Fig. 4) is about 100 MW which Compared with 10 countries shown in Fig. 2 is negligible. Clearly, China is the world's record of 91,324 megawatts.

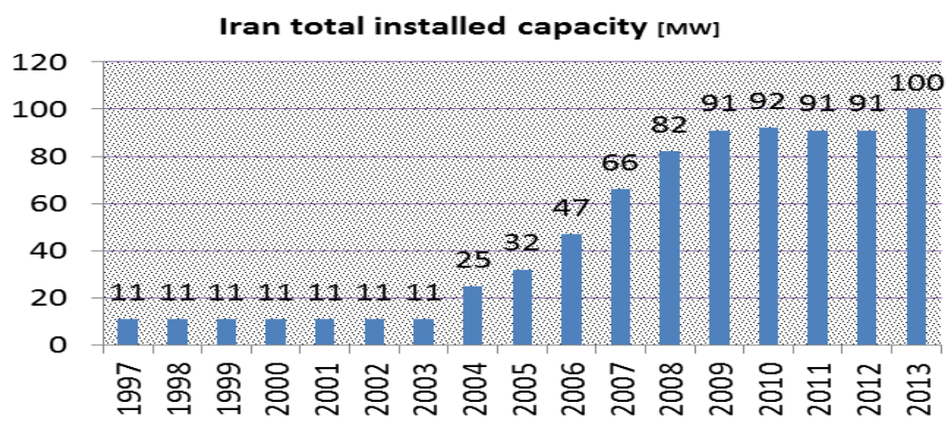


Fig-5. Development of wind turbine installation capacity in Iran.
Source: (http://www.thewindpower.net/country_en_38_iran.php, n.d).

Wind energy potential and also economic assessment have been studied in some other locations in Iran such as Yazd (Mostafaeipour *et al.*, 2011) and Tehran (Keyhani *et al.*, 2010) Semnan (Weigt, 2009) and Manjil (Mostafaeipour and Abarghooei, 2008). Najafi and Ghobadian (2011) estimated the power generation capacity of Iran were 128 MW in 2008, and it was the thirty-eighth country in this field. Ghorashi and Rahimi (2011) and Bakhoda *et al.* (2012) Presented Issues About the energy situation and problems and ways to improve it in of Iran. The mean wind speed, the wind speed distribution function, and the mean wind power density data at 10 m, 30 m and 40 m heights for 68 different sites in Iran, were studied by Alamdari *et al.* (2012) for the year 2007. Wind speed data can analyze by Weibull probability function. Wind potential energy for the three regions Binalood, Kerman and Yazd had evaluated by Mostafaei pour group (Mostafaeipour, 2010; Mostafaeipour, 2013; Mostafaeipour *et al.*, 2013). They realized that Binalood had good potential for installation of large wind turbines. They also studied economic evaluation and applications of three small wind turbines for city of Kerman in Iran. Dehghan (2011) showed that in the city of Yazd solar energy more economical than wind energy. Mousavi *et al.* (2012) showed that power generation using wind energy competitive with conventional methods and recommendations for its development in Iran. In this paper, we evaluated the potential of wind energy in the city of Kerman. Wind speed data for this study was the city's Meteorological Organization.

4. Description of Kerman

Kerman is located in central part of Kerman province in the southwest of Iran. It is located in **30°28'N** latitude and **57°08'E** longitude. The city is about 1756 m above the sea level, third elevated city among provincial capitals in Iran. The township of Kerman is limited from north to Ravar city and South Khorasan province, from east to Sistan-Baluchestan province, from west to Zarand, Rafsanjan and Bardsir cities and from south to Jiroft and Bam cities (Bakhtiari, 2004). Kerman has always been influenced by various regional and local winds. The winds moderate climate of the province is experiencing significant changes. The monsoon winds mainly dry in March, April and May and the wind blow from the Southwest to the Northeast and East with dirt and gravel. Strong winds, especially in the southern and eastern regions in the province of intensified air temperature. The winds, especially in the areas of Bam and surrounding areas affected by the 120-day winds of Sistan. In contrast, western and north-western winds also blow in the province that are in winter and spring rains.

5. Wind Energy in Kerman

Wind power density is an essential factor in locating places suitable for the installation of wind turbines. At kerman synoptic stations, wind power density in Kahnooj, Shahrbabak, Rafsenjan and Baft at heigh of 10 meters from ground level was 439.55, 299.7, 292.68 and 259.48 W/m3 respectively. Meanwhile In the classification of areas suitable for wind turbine installation based on available wind power at 10 meters from ground level, wind power density raging from 200 to 250 W/m3 is considered most efficient wind turbines have been designed for a wind speed of 3 meters per second. Meanwhile lowest most probable monthly wind speeds for studied stations at an altitude of 50 meters (the height of the installation of most wind turbines) at all studied stations except Bam, more than 3 meters per second, can be safely observed in Kahnooj, Rafsanjan,Shahre Babak and Baft stations , respectively 8.86, 7.77 and 7.11 m. The difference between the most probable wind speed and the wind speed carrying maximum energy in Rafsanjan, Baft, Sirjan, Shahrbabak, Kahnooj, Anar and Miandeh-Jiroft, annually, are less than 5 which show the trivial difference between the maximum probability of wind speed and the wind speed which provides the highest amount of energy in these places. Finally, the wind power density at 50 meters above ground level, and other mentioned features, Kahnooj, Shahre Babak and Rafsanjan synoptic stations are obtained the potential for the installation of wind turbines and extraction of wind power (Mahdi *et al.*, 2015).

6. Conclusions

Global warming, Climate change, and the recent worldwide economic crisis have emphasized the need for low carbon emissions while also ensuring economic feasibility. In this paper, the status and potential of wind power in Kerman province in Iran investigated. With planning detailed for the future, drastic reductions in the fossil fuel consumption can achieve by implementing the correct technologies. Wind turbine technology is one of the most favorable options that decision makers should consider for providing the clean energy for different purposes. Iran has undoubtedly significant potential for harnessing wind energy in many locations. This study indicates that small wind turbine projects at the kerman province site are feasible.

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