© 2015 IJSRSET | Volume 1 | Issue 6 | Print ISSN : 2395-1990 | Online ISSN : 2394-4099
Themed Section: Science and Technology

Study and Investigation of Wind Turbine Farm in Iraq

Ahmed Y. Qasim*, Raad S. Mahmood, Aammal K. J. , Fatin H. Waryoosh, Sabeha Sh. K.
Ministry of Industry and Mineral, Al-Karama General State-Iraq

ABSTRACT

In this paper, was the study of wind speed data in different areas of Iraq. The data show that the province of Basra which taken the mean wind speed value of five years, located on the north of Arabian Gulf perfectly suitable for establish a project wind farm by the fact that the wind speed is acceptable, has also been design and calculation of the power and energy that can be obtained from the wind turbine. The results showed that the proposed wind energy power generating system is a good choice and can be implemented in Basra to provide enough power for small towns and rural areas.

Keywords: Wind Turbine; Wind Farm; Power Generate; Energy

I. INTRODUCTION

The Electricity sector is the major player in producing Carbon dioxide (CO_2) which makes up the vast majority of greenhouse gas emissions.

One strategy for reducing CO_2 emissions in Iraq can be done by using renewable energy system for electric generating; the wind turbine is one of this systems. Wind energy is one of the cheapest and cleanest of renewable energy technologies. It is very important to use this wind resource to generate electricity because wind power is clean, quiet, and efficient. Wind power is the conversion of wind kinetic energy into a useful form, such as mechanical or electrical energy that can be harnessed for practical use by using wind turbines. The wind is the natural energy that generates due to the irregular atmosphere heating, the uneven earth's surface and also due to rotation of the earth As discussed earlier that many researchers used the wind energy to generate electrical power by using wind turbine The wind turbine and the indication generator (WTIG) Schematic diagrams are show in figure (1) wind turbine Induction generator system comprises of two main components which are an induction generator and a mechanical power turbine .the power captured by the wind turbine is converted into electrical power by the induction generator and is transmitted to the grid by the stator winding .The generators stator winding is connected directly to the grid and the rotor is driven by the wind turbine. The most important factor to consider in the construction of a wind energy facility is the site's wind resource. A site must have a minimum annual average wind speed in the neighbourhood of 11-13 mph (4.8 - 5.7 m/s) to even be considered [1, 2].

The precise balance of these lifecycle stages will vary between wind farm projects depending on whether they are on or offshore, their scale and location, as well as specific design and installation features. The wide range of studies of wind farm lifecycle emissions are unanimous in demonstrating that the emissions arising from the extraction and use of raw materials in the turbine and associated infrastructure dominates the lifecycle – typically being responsible for around 90% of emissions. The contribution from operation, maintenance and decommissioning is more modest. [3]

II. METHODS AND MATERIAL

A. Power generation by wind Mechanical Turbine

The mechanical Turbine is the most essential and important part of the wind turbine. A wind turbine extracts and converts the energy in wind into electrical energy via wind that flows over and causes lift of the wind turbine blades that turn an electricity generator. The electrical power generation is totally depended upon the mechanical power produced by the turbine the mechanical output of the turbine isdirectly proportional to the wind speed air density and the surfacearea swept by the rotor. The mechanical power of a wind turbine can be described by the following equation Eq. 1:

$$P_m = Cp(\rho A/2)V^3_{wind} \quad (1)$$

Where:

Pm =Mechanical output power of the turbine (w)
Cp =power coefficient of the turbine
ρ =Air density (kg/m^3)
A =Turbine swept area (m^2)
V_{wind} = wind speed (m/s)

The power coefficient Cp is also a parameter in the case of power regulation [4, 5]. It is a function of the tip speed ratio λ and the blade pitch angle β in degrees that is,

$$Cp\,(\lambda,\beta) = C_1(C_2\frac{1}{\epsilon} - C_3\epsilon\beta - C_4\beta^x - C_5)e^{-C_6\frac{1}{\epsilon}} \quad (2)$$

where the values of the coefficients C1 to C6 and x depend on turbine type. β is defined as the angle between the plane of rotation and the blade cross section chord. For particular turbine types C1 = 0.5, C2 = 116, C3 = 0.4, C4 = 0, C5 = 5 and C6 = 21, Ɛ is defined by:

$$\frac{1}{\varepsilon} = \frac{1}{\lambda+0.08\beta} - \frac{0.035}{1+\beta^3} \quad (3)$$

The fundamental equation that governs the power output of a wind turbine is [2]:

$$P = \eta\, P_m \quad (4)$$

where: P - power produced by the wind turbine (Watt).
η is wind turbine efficiency that consists following factors and calculated by following formula:

$$\eta = C^* Ng^* Nb \quad (5)$$

where C = Cl or Cd (or resulting of them) - are lift and drag factors respectively and depend on the shape and form of the blades or vanes and on orientation of the wind flow with respect to the object; Ng – generator efficiency (80% or possibly more for a permanent magnet generator or grid-connected induction generator); Nb - gearbox/bearings efficiency (95% for a good design).
The Instantaneous Energy obtained from the wind turbine can be described by the following equation Eq. 4:

$$Energy = \int_0^t P\,dt \quad (6)$$

The theoretical wind energy extraction limit of a HAWT is 59,36% (Betz law) (meaning the theoretical maximum energy in the wind that can be extracted by a HAWT is 59.36%). In general, also taking into account conversion losses for example, the power coefficient (cp) of a wind turbine is in the order of 30 to 40% [6, 7]. Except this one there are other energy losses in a complete wind turbine system (the generator, bearings, power transmission, etc.) and only 10% -30% of the power of the wind is ever actually converted into usable electricity.

B. Wind Farm Energy for electricity generation

The employment of wind energy for the electricity generation is one of the most diffused technologies for the exploitation of renewable energy source .A wind farms is a group of wind turbines located in the same place to generate bulk quantity of electricity energy. These wind farms are mostly consist of several hundreds of individual wind turbines and are located on highly windy areas and are spread over an area of hundreds of square miles. but the land between the turbines may be used for agricultural or other purposes. A wind farm can also be located offshore. Based on the selected location the wind farms can be categorized into two different type:

1) Off shore wind farm
2) On shore wind farm

Atypical onshore wind farm of average yearly wind speed data in Basra city for simulation and demonstration of the mechanical power.

Stronger wind speeds are available offshore compared to on land, so offshore wind power’s contribution in terms of electricity supplied is higher. [8]

Usually sites are screened on the basis of a wind atlas, and validated with wind measurements.

Meteorological wind data alone is usually not sufficient for accurate siting of a large wind power project. Collection of site specific data for wind speed and direction is crucial to determining site potential. [9, 10]

TABLE I
AVERAGE WIND SPEED FOR FIVE YEARS IN CITIES AT DIFFERENT LOCATION IN IRAQ

CITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Basra	4.16	4.14	4.56	4.98	5.1	6.64	6.56	4.88	4.9	5.02	4.52	4.2
Baghdad	2.3	3.2	3.5	3.4	3.3	4.1	4.2	3.3	3.1	3.0	2.4	2.5
Nasiriya	2.3	3.0	3.1	3.3	3.2	4.4	4.0	3.6	3.3	3.1	2.3	2.3

III. RESULTS AND DISCUSSION

When studying the wind speeds data in the provinces of Iraq that has been provided to us by the Meteorological Department, it emerges that the Basra province Located in the southern of Iraq, and overlooking to the Arabian Gulf is suitable for install a power generation projects from wind turbines to the fact that the wind speed within the acceptable range.

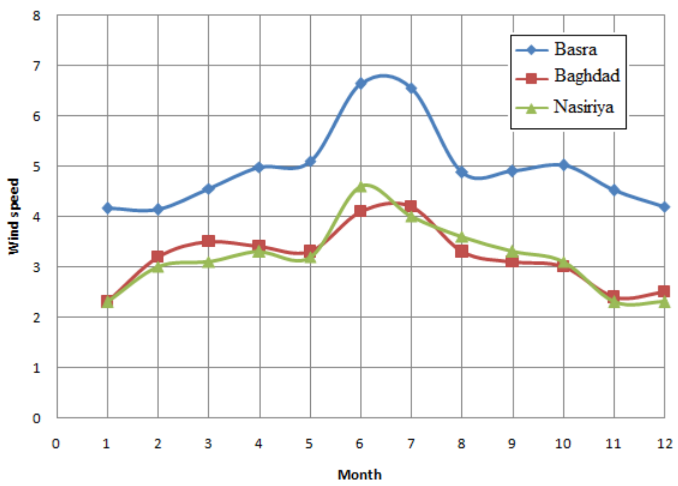

Figure 1 : Mean wind speed for five years with month in different location in Iraq

The equations are represented and calculated by MATLAB software program for the purpose of calculating the instantaneous power and energy generated from the one wind turbine and calculate the amount of annual energy.

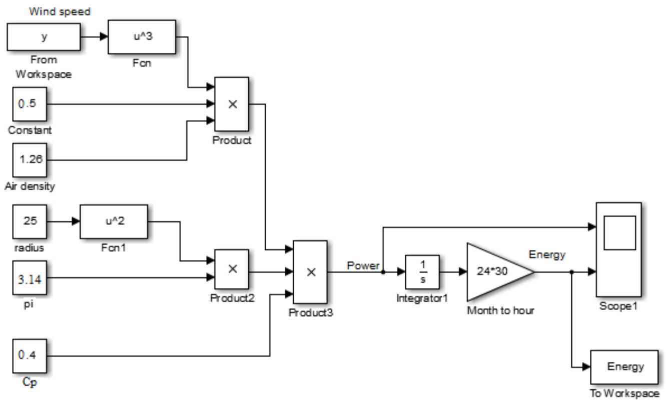

Figure 2 : The Block diagram for wind Turbinr

The mechanical output generated by the wind turbine on monthly wind turbine on yearly wind average speed can be calculated by substituting the wind turbine parameters in the table (2), the output mechanical power for the wind turbine is strongly affected by the wind speed as illustrated in the graph show in Figure (3).

TABLE II
WIND TURBINE PARAMETERS

Air Density(ρ)	1.22
Blade Length (L)	50
Swept Area (A)	2827.44
Power Coefficient (Cp)	0.40
No. of turbine in farm	20

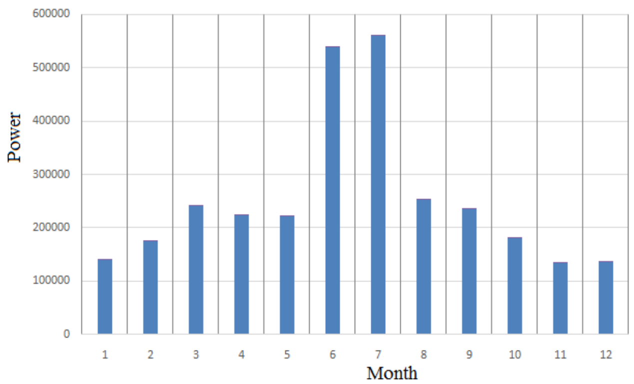

Figure 3 : Output mechanical power with average wind speed per month

The data shown in Figure (3) used with Matlab software in block diagram in Figure (2) for represents a wind turbine simulink model for simulating the effecting parameters, specially turbine radius, air density, wind speed, power coefficient. The model calculates the output power for one year period with one month step according to specified wind speed. The produced energy also calculated in the model and the output data (power, energy) plotted using a scope and sent to a work space file for processing.

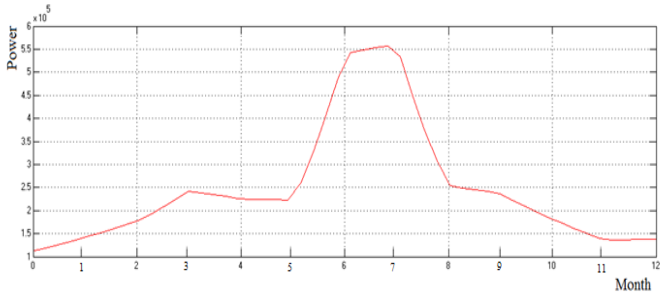

Figure 4: The output Power with month for wind turbine

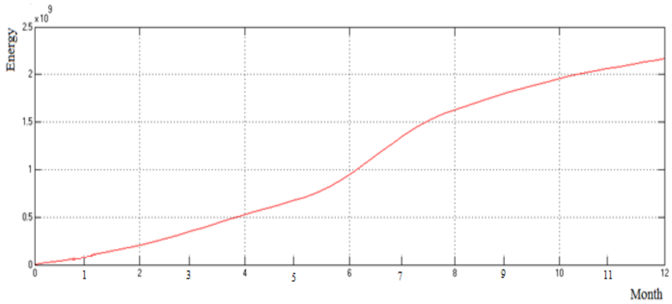

Figure 5: The energy obtained for one wind turbine with month

Results obtained from figure (4) show the total energy generated per year. The total energy for one turbine at one year is (2.2 X109 W.hr) as shown in figure (5) and the total energy generated from one wind turbine calculate by Integration of power over the year by use Eq. 6.

Environment Study

Greenhouse gases trap heat and make the planet warmer, Human activities are responsible for almost all of the increase in greenhouse gases in the atmosphere, For the 2012 year, Iraq's Total Carbon Dioxide Emissions from the Consumption of Energy (Million Metric Tons) have been 120 which include 101.2 for CO_2 Emissions from the Consumption of Petroleum and 1.7 for $C0_2$ Emissions from the Consumption of Natural Gas for the domestic usage, in addition to 17 for $C0_2$ Emissions from the Flaring of Natural Gas.., The largest source of greenhouse gas emissions from human activities in Iraq is from burning fossil fuels for electricity, heat, and transportation besides the flared gases inside oil fields and refineries.

Generation of electricity and heat was the large producer of CO_2 emission and was responsible for 41% of world CO_2 emission in 2010 [11].

Future development of emission intensity of this sector depend strongly on the fuel used to generate electricity and on the share of non-emitting sources ,such as renewable and nuclear as well fossil-fuel plant equipped with carbon capture and storage (CCS).

By 2035 the world electrical demand will be more than 70% higher than current demand .The total world CO_2 emission at 2010 is 30.3 Gt and the world CO_2 emission due to electricity and heat production is 12.5 Gt while the Iraq CO_2 emission is 104.5 Mt(which present 0.836% from the world emission) and the emission due to electricity and heat production is 50.3 Mt [9] .

One of the primary reasons for adopting wind energy has been to reduce carbon emissions from the electricity supply. The average emissions from power generation are approximately 500 gCO_2 e/kWh and lowering the carbon intensity of the grid is, therefore, vital if the emissions reduction targets set out in the 2008 Climate Change Act is to be realised. The Committee on Climate Change recommends a target of 50 gCO_2 e/kWh for the grid system in 2030. Attaining this level is a considerable challenge, especially if electrical demand increases with the adoption of electric vehicles and heat pumps for domestic heating. There are two main areas where wind energy impacts on greenhouse gas emissions: the emissions embodied within the wind turbine and associated infrastructure, and the overall reduction in system emissions.[9]

Ton of CO_2 emissions per Year = energy generated MWh X $tonCO_2$/MWh

In this system the energy generated for one turbine is (2.2) Gwh; from Table (3) the fuel of natural gas emission 400 gCO_2/KWh that will lead to produce (880) ton of CO_2 for one turbine. the farm consist of 20 turbine so it save emission of (17600) ton of CO_2 in the case the fuel is natural gas and (29480) ton of CO_2 in case the fuel is fuel oil and (44000) ton of CO_2 in case the fuel is petroleum coke and (30360) ton of CO_2 in case the fuel is fuel Gas/ Diesel oil.

TABLE III
WIND TURBINE PARAMETERS

Fuel	gCO_2 / kWh
Anthracite *	920
Coking coal *	780
Other bituminous coal	860
Sub-bituminous coal	920
Lignite	990
Coke oven coke *	770
Coal tar *	720
BKB/peat briquettes *	800-1500
Gas works gas *	420
Coke oven gas *	420
Blast furnace gas *	2200
Other recovered gases *	2000
Natural gas	400
Crude oil *	630
Natural gas liquids *	480
Refinery gas *	400
Liquefied petroleum gases *	500
Kerosene *	650
Gas/diesel oil *	690
Fuel oil	670
Petroleum coke *	1000
Peat *	750
Industrial waste *	400-2000
Municipal waste (non-renewable)*	450-3500

IV. REFERENCES

[1] S.M. Ali, A.S. Mahdi and Auday H. Shaban ,Wind Speed Estimation for Iraq using several Spatial Interpolation Methods British Journal of Science , Vol. 7 (2) December 2012

[2] Wilson, Reginald, Business Strategies for Electrical Infrastructure Engineering: Capital Project Implementation, IGI Global Publication, 2013

[3] WIND ENERGY implications of large-scale deployment on the GB electricity system, Royal Academy of Engineering. 2014

[4] R. Alejandro, L. lvaro, G. Vzquez, D. Aguilar and G. Azevedo, Modeling of a Variable Wind Speed Turbine with a Permanent Magnet Synchronous Generator, IEEE International Symposium on Industrial Electronics (ISIE), Seoul-Korea, July 5-8, 2009.

[5] P. O. Ochieng, A. W. Manyonge, Mathematical analysis of tip speed ratio of a wind turbine and its effects on power coefficient, nternational Journal of Mathematics and Soft Computing, Vol.4, No.1 (2014), p61 - 66.

[6] Wind Resource Assessment in Australia – A Planners Guide, CSIRO, V1.1, October 2003

[7] Madsen & Krogsgaard. Offshore Wind Power 2010 BTM Consult, 22 November 2010. Retrieved: 22 November 2010.

[8] Munson BR, Young DF. Okiishi TH. Fundamentals of Fluids Mechanics 4th ed. 2002; John Wiley & Sons, Inc.

[9] [9] Wind energy-- the facts: a guide to the technology, economics and future of wind power page 32 EWEA 2009. Retrieved 13 March 2011.

[10] Jump up^ "WINData LLC - Wind energy engineering since 1991". *WINData LLC*. Retrieved28 May 2015.

[11] CO2 Emission From Fuel combustion High Lights by International Energy Agency (iea) 2012.