Pre-feasibility Study of Hypothetical Wind Energy Project Using Simulated and Measured Data

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***Abstract*—In this study, the preliminary economic feasibility study of the project of wind power at the site of Al-Shehabi (Wasit-Iraq) was conducted using measured wind data at altitudes of 10 m, 30 m, 50 m and 52 m per 10 minutes. For the purpose of comparison, data from NASA space was used at the same location at 50 m height. The lowest unit cost of electricity from wind energy was found (0.0618 $/Kwh and 0.0786 $/Kwh) by using standard methodology Levelized cost of Energy (LCOE) equation and Net Present Value (NPV) procedure respectively. Furthermore, RETScreen software was used to perform the economic prefeasibility study of a proposed wind farm. The study concludes this site is economically feasible if a wind farm 5.0MW of ten wind turbines (EWT DW54) were erected with NPV of $11,309,956, After-tax IRR 24.7% and simple payback period 6.1 years at capacity factor of 38.34%. Finally, wind farm development will result in a reduction in greenhouse gases of 31876 tCO2 per each year. The sensitivity and risk analysis were performed and guarantee the safety of specified financial input parameters values.**

Keywords—Wind energy, RETScreen, Windographer, LCOE, NPV.

I. Introduction

The renewable energy sources which include solar, wind, hydro, geothermal and biomass are becoming ccompetitive to decrease the consumption and replacement the conventional energies through the last years. Clean energy have minimal negative effects, non-polluting generation on the environment and is currently replacing a portion of the fossil-based power generation in many parts of the world. Among the clean energy technologies, wind energy is one of the fastest growing in the global market. Due to the increase in populations and increasing of electricity demands, Iraq has a critical electricity leakage, and the traditional power systems cannot covering the increasing of electricity demand. It became essential to solve the energy shortage by solar and wind energy sources as well as provide an important source of income for the Iraqi government. The availability of wind is the most technical factors that affect the economic viability of the wind project. The depth knowledge of available wind resources is critical for investors to determine if a project is profitable in the specific site.

II. Site Description

The proposed wind farm is located at AL Shihabi region near KUT province. The region is located at position 32.77°N 46. 40°E, Fig. 1 shows the location of chosen site in eastern region near the border between Iraq and Iran.

III. Wind Data Collection

The 10-minute time series wind data was collected from the meteorological station, which was installed at AL Shihabi region and measured at 10m, 30m, 50m and 52m from 11/29/2014- 12/10/2015. Windographer data downloader was used to download hourly time series for one year for the same period of time of the collected data from AL Shihabi site. NASA hourly wind data were converted to 10 minutes for a compatibility with the measured one via Windographer software.

IV. Wind Resources and Energy Output

Wind resource evaluation is the best approach to choose wind turbine site, to predict power output, and determining economic viability of placing turbines at a particular location. Examination was made for wind speeds using Weibull distribution function and its parameters (shape and scale factors) for all four heights (10m, 30m, 50m and 52m) and NASA data at 50m [1]. International Electro-technical Commission (IEC61400-1) created and published standards for wind turbines and its relation to wind regime viability [2]. The Wind Energy Resource Atlas of the United States was created and archived in National Renewable Energy Laboratory (NREL) website [3]. The IEC classification of wind turbines and relevant wind speed and power density from NREL was introduced as wind power density classes as shown Table I [2, 3].

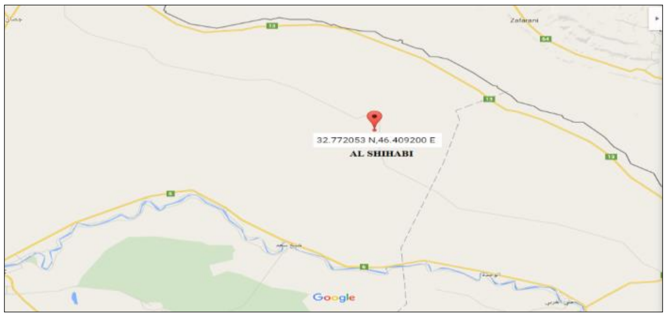

Fig.1 Location of proposed wind farm at AL- Shihabi region.

The wind resource maps estimate the resource in terms of wind power classes ranging from class 1 (the lowest) to class 7 (the highest). Areas designated class 3 or greater is suitable for most wind turbine applications, whereas class 2 areas are marginal. Class 1 areas are generally not suitable, although a few locations as hilltops with adequate wind resource for wind turbine applications may exist in some class 1 area. Even if the site lies in class 3 or above area, an investigation will still need to do for assessment of the site to see if it will work, but at least must know there is some potential. [2], [3].

TABLE I: Classes of wind power density at 50 m.

Wind Power Class	Rating	Wind Power Density (W/m2)	Annual Average Mean Wind Speed (m/s)
1	Poor	≤200	≤5.6
2	Marginal	200 - 300	5.6 - 6.40
3	Fair	300-400	6.4 - 7.00
4	Good	400-500	7.0 - 7.50
5	Excellent	500-600	7.5 - 8.00
6	Outstanding	600-800	8.0 - 8.80
7	Superb	800-2000	8.8 - 11.9

A comparison was made between measured and simulated (NASA) wind data. The wind power density shows expected electrical energy produced from the wind turbine by using wind speed data for the selected site. In this study ten models of wind turbines were considered from the library of Windographer software.

The net energy depends on average wind speed at hub height and the energy production curve of the wind turbine. The following equation was used to calculate net energy (Enet.anual) [1, 4]:-

$$E_{net.annual} = P_{net.overall} \times 8760hrs \qquad (1)$$

Where: Pnet,overall is the mean net power output over the entire data set [kW] ,8760 is the number of hours in a year.

V. CALCULATING NET CAPACITY FACTOR

The Net Capacity Factor (NCF) is expressed in (2) [1, 6]:-

$$NCF = (E_{net.annual}/(P_r \times 8760hrs)) \times 100 \qquad (2)$$

Where, Pr is the rated power capacity of the wind turbines.

VI. ECONOMIC ANALYSIS

The viability of a wind energy projects depends on its ability to generate energy at a low cost .The main parameters of the economics of wind energy project are include the following financial parameters [5-8].

- The installation costs of electrical grid extension, grid reinforcement, foundation, roads, and cables. The installation costs was taken 30% of turbine cost
- Operation and maintenance costs.
- Annual energy production.
- Turbine life time.

The cost of the wind turbine which is set by the manufacturers varies widely from one manufacturer to another. Many researchers consider the cost per kilowatt for wind turbines based on rated power as in the Table II [9-13].The cost of electricity is calculated by using two methods:-

TABLE II. Cost of wind turbines based on the rated power.

No.	**Wind turbine size (kW)**	**Specific cost (US$/kW)**	**Average specific cost (US$/kW)**
1	10 to 20	2,200 to 2,900	2,550
2	20 to 200	1,500 to 2, 300	1,900
3	200>	1,000 to 1,600	1,300

A. Levelized Cost Of Energy (LCOE) Method.

The applied LCOE method is a standard methodology [14, 15], which could be determined by four variables: capital expenditures, operational expenditures, annual energy production and the fixed charge rate (FCR; a coefficient that captures the average annual carrying charges including return on installed capital, depreciation, and taxes).The unite of LCOE is cents / kWh or $/MWh, The LCOE and FCR are given by [4, 5]:

$$LCOE = \frac{(CopEx \times FCR) + OpEx}{(AEP_{net}/1000)} \qquad (3)$$

$$FCR = \frac{d \times (1+d)^n}{(1+d)^n - 1} \times \frac{1 - (T \times PVdep)}{(1-T)} \qquad (4)$$

Where:
LCOE = levelized cost of energy ($/MWh), FCR = fixed charge rate (%), CapEx is capital expenditures ($/kW), AEPnet = net average annual energy production (MWh/ MW/yr) = MWnet × 8,760 × CFnet, OpEx is operational expenditures ($/kW/yr) = LLC + OPER + MAIN, d is discount rate (weighted average cost of capital [WACC]) (%), n is economic operational life (yr), T is effective tax rate (%), PVdep is present value of depreciation (%), CFnet is net capacity factor (%), LLC is annual levelized land lease cost ($/kW/yr), OPER is pretax levelized operation cost (operation and maintenance [O&M]) ($/kW/yr), MAIN is pretax levelized maintenance cost (O&M) ($/kW/yr). The real rate of discount (d) adjusted for inflation can be obtained from the expression [14, 16] as:-

$$d_r = \frac{(d_n + 1)}{(i + 1)} - 1 \qquad (5)$$

Where: *i* is the inflation rate.

B. Net Present Value (NPV) Method

The net present value (NPV) is the difference between the value of all benefits (cash inflows) and costs (cash outflows) of the project, discounted back to the beginning of the investment. The benefits will necessarily include the sale income of electricity unit. NPV determines cash flow at a given discount rate of the project, it is important factor of the feasibility of the project depends on to the relation of the benefit (B), the cost (C), the period (n) and the discount rate as presented in (6) [17, 18]:-

$$NPV = \sum \frac{(B - C)}{(1 + r)^n} \quad (6)$$

For our calculations, we consider the retail wind energy sale price value equal to10 ₵/KWh.

1) Production Tax Credit

Production Tax Credit (PTC) was set by the USA Congress, used to know how to support the projects for 10 years from the beginning of wind energy operation. This will lead the investors to build wind farms and harvest as much energy from the source [7]. The proposed PTC which considered in this research as Renewable Energy (RE) production credit escalation rate was 2.5 % [8], the assumed applicable tax rate 30% in Iraq for other life years of the project [19].

2) Depreciation Cost

Every year, the project would depreciate at a certain rate. The value of the project at the end of its useful life period is known as salvage value (*S*), which assumed to be 10 per cent of the initial cost at the end of 20 years of the project. The annual depreciation D_A is given by (7) [8]:-

$$D_A = \frac{C_i - S}{n} \quad (7)$$

Where: Ci = the capital investment, *n* = turbine life in years

VII. PREFEASIBILITY STUDY OF A WIND FARM

The internal rate of return (IRR) is defined as the discount rate which sets the (NPV) of a series of cash flows over the project life equal to zero. The rate which is produced by the solution is the project's (IRR). Simple payback period (SPB) represents the period to recoup the investment cost of the project.

The total initial cost (TIC) estimation is presented in (8) [6]:-

$$TIC = FS + PD + E + E + PS + BM \quad (8)$$

Where, *FS* prefeasibility study cost, *PD* development project cost, *E* engineering cost, *PS* power system cost, *BM* balance system and miscellaneous cost. The renewable energy policy is still at its primary stage in Iraq. The adopted input financial and cost analysis parameters were dependent on the RETScreen case study models. The main assumed input parameters are shown in Table III [13].

TABLE III. Input Cost parameters in RETScreen Model.

Input parameters	**Selected value%**	**Acceptable range%**
Feasibility study	1.0	Less than 2
Project Development	3	1 to 8%
Engineering cost	5	1 to 8%
Power System	71.3	67 to 80%
Balance of System &	19.8	17 to 26%
Miscellaneous	2	1 to 4%
O & M/ parts of labor	3	15%
Inflation rate (i)(%)	3	2 to 3%
Interest rate(%)	8	
Fuel cost escalation rate	2.5	
Electricity export escalation ate	5	
Discount rate(%)	4.85	3.0 to 18.0%
Debt ratio(%)	60	50.0 to 90.0%
Debt interest rate(%)	8	-
Debt term ((year))	10	-
Project life ((year))	20	20 to 30 years
Turbine availability	98%	98%

The initial costs of the implementation of the project are include the costs for preparing a prefeasibility study, performing the project development functions, completing the necessary engineering, purchasing and installing the energy equipment, construction of the balance of plant and costs for any other miscellaneous items. The energy equipment and balance of plant are the two cost categories showing the strongest dependence on the number of wind turbines that make up the wind farm.

The O&M (operation and maintenance) cost was assumed as 3.0% from totally cost. The transmission and distribution power losses in the range of (10% to 20.0%), the assumed value was taken as 8% loss in this project.

VIII. WIND POWER RESULTS.

The results of the net annual capacity factors showed that the wind turbine model (EWTDW54-500) was the highest capacity factor with a value of 38.34% which represent an excellent result from viewpoint of wind energy production. Its main characteristics at optimum rating are shown in the Fig. 2 and Table IV.

The extrapolated measured wind speed at 30m hub height was found 6.06 m/s, while it was found 6.67m/s at 50m.The wind speed of NASA at 50m was found 5.241m/s, it's less than the extrapolated measured wind speed within 13.5% and gives inaccurate indications about the viability of wind power. The maximum net annual energy production values 2,191,918(kWh/yr), 2,084,388(kWh/yr), 1,679,169(kWh/yr) from wind turbine models of Gamesa G58- 0.85 MW, EWT DW54-900 and EWT DW54-500 respectively. The other wind turbines were less productivity of Net AEP as shown in Table V.

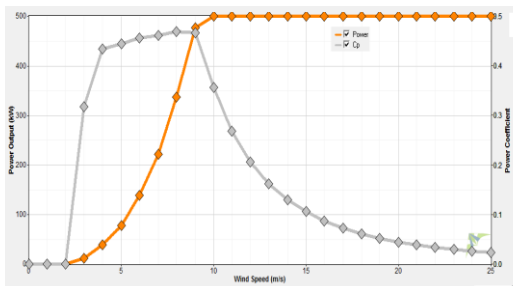

Fig.2 Power curve of (EWT DW54) wind turbine.
Source: http://www.ewtdirecwind.com/UK

TABLE IV. Main characteristics (EWTDW54) wind turbine.

Parameter	Unit	Parameter	Unit
Rotor diameter	54m	Rated wind speed	10m/s
IEC wind class	IIIA	Cut-out wind speed	25m/s,10 min.avg.
	12-24rpm	Survival wind speed	52.5m/s

Nominal output power	500kW	Power output control	Pitch controlled
Hub height	35,40 and 50m	Generator	Synchronous multi-pole
Cut-in wind speed	2.5m/s	Power converter	IGBT-controlled

TABLE V. Selected wind turbine models with wind speed at hub height, Net Power, annual net energy and net capacity factor.

Turbine	Hub Height m	Rated Power(Kw	Hub Height Measured Wind Speed m/s	Speed 50m NASA	Net Power (kW)	Net AEP (kWh/yr)	NCF (%)
Bergey Excel-S	30	10	6.06	-	2.1	18,115	20.68
Eocycle EO 25/12	30	25	6.06	-	6.7	58,701	26.8
Northern Power 100	30	100	6.06	-	21.2	185,678	21.2
Northern Power 100-24	30	100	6.06	-	23.9	209,010	23.86
Northern Power 60-23	30	60	6.06	-	18.8	165,091	31.41
Seaforth AOC 15/50	30	50	6.06	-	15.8	138,597	31.64
Gamesa G58- 0.85 MW	50	850	6.67	5.241	250.2	2,191,918	29.44
Enercon E-33 / 330 kW	50	330	6.67	5.241	94.8	830,134	28.72
EWT DW54-500 (50m)	50	500	6.67	5.241	191.7	1,679,169	38.34
EWT DW54-900 (50m)	50	900	6.67	5.241	237.9	2,084,388	26.44

IX.ECONOMIC RESULTS

The results of the unit cost of electricity that could be generated from used wind turbines were presented in Table VI by using Levelized Cost of Energy (LCOE) and Net Present Value (NPV) Methods. It was found that the wind turbine model EWT DW54-500 could produce electricity at lowest cost value of 0.0618$/KWh and 0.0786$/KWh in both methods and these results are acceptable with the LCOE results [13, 14]. The other model of wind turbines were found as could produce an electrical wind energy with a higher unit cost as compared with EWT DW54-500 model, so, they were not acceptable and excluded.

IX. PREFEASIBILITY RESULTS AND DISCUSSIONS

- The studied site lies in the 3rd class according to IEC classification which means the suitability of AL Shihabi site for wind energy project construction.
- The total initial cost analysis value is $8,565,650 related to (EWT DW54) wind turbine. The required minimum After-tax IRR - equity value was evaluated as 24.7% if the wind turbine models (EWT DW54) were erected.
- The emission analysis worksheet gives the greatest amount of annual net emission reduction (32,613 tCO_2) from the proposed wind farm when using (EWT DW54) wind turbine.
- The financial worksheet provides the following results:-
- The NPV is $11,309,956; this positive value of NPV indicates that the project is feasible for the model of (EWT DW54) at the discount rate (4.85%). the negative value is unacceptable. The result of economic feasibility is illustrated in Fig.3, which summarized the yearly cash flow rate. It describes the cumulative cash flows during the life of the project.
- The benefit –cost ratio was found 4.30 which mean the project is acceptable. The electricity exported to grid 13,703MWh per year at overall wind plant capacity factor of 38.34%. The simple payback period was found 6.1 years and the equity payback 5.0 years.

TABLE VI. Unit cost of electricity from wind farm.

Unit cost of electricity produced from wind energy $/Kwh			
Turbine model	Pr (kw)	LCOE Method	NPV Method
Bergey Excel-S (30m)	10	0.1146667	0.101036
Eocycle EO 25/12 (30m)	25	0.0884647	0.089906
Northern Power 100 ARCTIC (30m)	100	0.1118704	0.099848
Northern Power 100-24 (30m)	100	0.0993822	0.094543
Northern Power 60-23 (30m)	60	0.0754924	0.084395
Seaforth AOC 15/50 50Hz (30m)	50	0.0749362	0.084159
Gamesa G58- 0.85 MW (50m)	850	0.0805509	0.086544
Enercon E-33 / 330 kW (50m)	330	0.0825736	0.087403
EWT DW54-500 (50m)	500	0.0618516	0.078601
EWT DW54-900 (50m)	900	0.0896891	0.090426

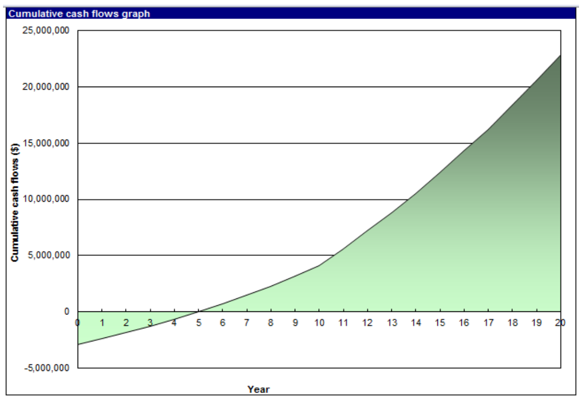

Fig.3 Cumulative cash flow of EWT DW54 wind turbines graph.

X. SENSITIVITY ANALYSIS RESULTS

Sensitivity Analysis worksheet was operated in RETScreen software to test the effect of key financial parameters (initial cost, electricity export rate, debt ratio, debt interest rate, CE production credit rate) on the financial indicators (NPV, IRR and SPB). The key parameters were varied with the base case within values of ±10% and±20%. as shown in the Table VII.

- When the electricity export rate was decreased to -20% of base case, this caused decreasing NPV to 7,414,931$(-34.4%), increasing SPB to 7.6 years (+19.7%) and decreasing IRR to 21.5% (-14.8%). When the electricity export rate varied to +20% causing an increase in the NPV to 15,204,982$ (+25.6%), decrease SPB to5.1 years (-19.6%) and increase IRR 31.1% (+20.5%).
- When debt ratio is varied to -20% of the base case 60%, small increased of NPV value to 11,348,917$(+0.34%), small increased of IRR to 26.3% (+6%) and null decrease of SPB. The impact of increasing the debt ratio to +20% of the base cases was caused in null decreasing of both NPV and IRR, and null increasing of SPB.
- When clean energy (CE) production credit rate was increased by +20% of the base case, then NPV increases to 11,649,387$ (+2.9%), IRR increases to 25.7% (+3.9%) and decreasing of SPB to 5.9 years (-3.3%). The impact of varying the (CE) production credit rate to -20% was made small decreasing for both NPV and IRR values, while small increasing to payback period .
- The increasing of project cost by+20% was caused a reduction in NPV by (-4.57%) and IRR (-9.38%), while increasing SPB by (+6.1%) and vice versa in case of -20%.
- The variation of financial parameters with ±10% of the base case led to same finding procedure results but still less than ±20%.When two key input parameters varied simultaneously as if the initial costs, +10% higher than estimated, and electricity export rate, +20% higher than estimated, IRR was increased to 28.5%.
- When the discount rate was changed below and higher the selected value of 4.85%, as shown in the Table VIII. The change in discount rate effects on the value of NPV and no effect on both of IRR and SPB.
- It was found that the estimated values (base case) of financial parameters were represent as optimum case and adopted in economic evaluation of the project .The energy price is not too high, NPV positive and suitable payback period, Therefore, the results showed suitable wind resources and economic analyses .
- The most financial parameters that affecting the economic indicators were (total initial cost, electricity export rate and discount rate).

TABLE VII. Effect of financial parameters on financial indicators.

Financial parameters	Base case value	Variation from Base case	Changeability of Economic indicators		
			NPV	IRR	SPB
Electricity export rate	100$/MWh	**-20%**	-34.4%	-14.8%	+19.7%
Electricity export rate	100$/MWh	**+20%**	+25.6%	+20.5%	-19.6%
Debt ratio	60%	-20%	+0.34%	+6%	Null decrease
Debt ratio	60%	+20%	Null decrease	Null decrease	Null increasing
(CE) production credit rate	0.021$/kWh	+20%	+2.9%	+3.9%	-3.3%
(CE) production credit rate	0.021$/kWh	-20%	decrease	decrease	increase
Initial cost	8,565,650$	+10%	-4.57%	-9.38%	+6.1%
Initial cost	8,565,650$	-10%	+4.5%	+8.95%	-7%
Initial cost	8,565,650$	+20%	-9.5%	-18.7%	+12.8%
Initial cost	8,565,650$	-20%	+8%	+17.67%	-17.3%

TABLE VIII. Effect of discount rate on financial indicators.

Discount rate value%	NPV $	After-tax IRR - equity IRR %	SPB years
4	12,767,843	24.7	6.1
4.85	11,309,956	24.7	6.1
5	11,071,205	24.7	6.1
6	9,606,478	24.7	6.1
7	8,337,985	24.7	6.1
8	7,236,007	24.7	6.1

XI. RISK ANALYSIS RESULTS

Risk analysis was done to show how much the profitability of the project affected by errors in the values of input parameters. It was found that:

- From Monte Carlo frequency distribution of the financial indicators as shown in the Fig. 4, the minimum within level of confidence was 20.7%, while the maximum within level was 29.6%. A 90% confidence interval indicates that 90% of the 500 financial indicator values will fall within above range. The specified level of risk is 10% of values which will fall outside the confidence interval (e.g. a 90% confidence interval has a 10% level of risk). [12].

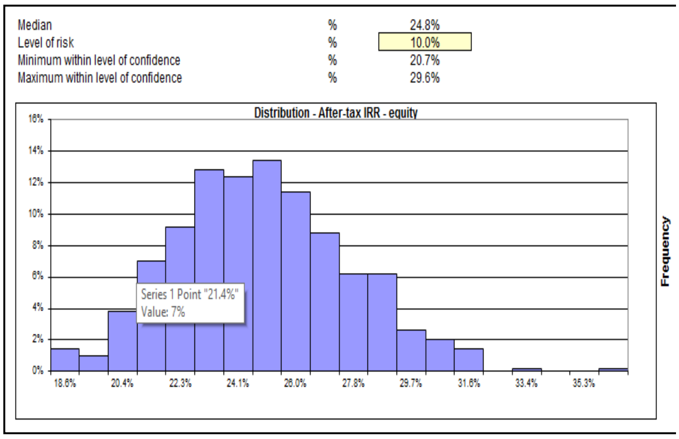

Fig.4 Graph of Monte Carlo frequency distribution the financial indicators.

- The Fig. 4 shows as example, that at 7% of the time of project life, IRR is 21.4±7%. Confidence 29.6% for risk analysis 10%, out of these two limits, the project would be under threat of the risk.

XII. CONCLUSION

The studied site lies in the 3rd class of IEC classification which means the suitability of AL Shihabi site for wind energy project construction.

The feasible model was 10 units of 500kW wind turbines (EWT DW54). The proposed wind farm with an overall wind plant capacity factor of 38.34% can export an electrical power to the grid of value 13,703MWh per year at selling price of 100$/MWh. The unit cost of electricity was found 0.0618 and 0.0786 $/kWh resulted from LCOE and NPV methods respectively. The variation of the unit cost of electricity which were obtained by using LCOE and NPV methods could be interpreted due to the methodology and procedure followed in each of them. Finally, the project is acceptable and feasible.

REFERENCES

[1] " Mistaya Engineering Inc.Windographer", www.windographer.com.

[2] k. thevip.kr, "International Electro technical Commission" (IEC), Website www.iec.ch,2000.

[3] D. L.Elliott, et al. "Wind energy resource atlas of the United States." NASA STI/Recon Technical Report N 87,1987.

[4] T. Stehly, C. Moné, B. Maples, and E. Settle, "Cost of Wind Energy Review", Science Direct, NREL, 2014.

[5] C. Moné, A. Smith, B. Maples, and M. Hand, "Cost of Wind Energy Review", Science Direct, NREL, 2013.

[6] RETScreen International, "Clean energy project analysis RETScreen engineering & cases textbook", 3d edition, 2016.

[7] M.Gilbert Masters, "Renewable and Efficient Electric Power System"s,John Wiley & Sons, Inc. ISBN 0-471-28060-7, 2004.

[8] M. Ragheb, Economics of wind energy. 2017.

[9] R. Gupta, A. Biswas, , "Wind Data Analysis of Silchar (Assam, India) by Rayleigh,s and Weibull Methods", Journal of Mechanical Engineering Research,2, 10-24,2010.

[10] "World Wind Energy Association, Report", 2011, www.wwindea.org.

[11] S. Mathew, "Wind Energy: Fundamentals. Resource Analysis And Economics", Springer, Heidelberg ISBN-10 3-540-30905-5 Springer Berlin Heidelberg New York; Printed in The Netherlands, 2006.

[12] M. Gokçek, MS. Genç, "Evaluation of electricity generation and energy cost of wind energy conversion systems (WECS) in central Turkey". ApplEnerg 86, 2731–2739 ,2009.

[13] M. Gokçek, Erdem, HH.and Bayülken, A., "A techno-economical evaluation for installation of suitable wind energy plants in Western Marmara Turkey". Energ. Explor. Exploit. 25, 407–428 ,2007.

[14] W. Short, D. Packey and T. Holt, "A Manual for the Economic Evaluation of Energy Efficiency and Renewable Energy Technologies", Golden, CO, National Renewable Energy Laboratory , 2013.

[15] N. Blair, , K. Cory, M. Hand, L. Parkhill, B. Speer, T. Stehly, D. Feldman, E. Lantz, C. Augustine, C. Turchi, and P. O'Connor, "Annual Technology" Baseline Golden, CO: National Renewable Energy Laboratory, Report No. NREL/PR-6A20-64077, July 2015.

[16] K .Ali , H. Firas, J. Abdulrazzaq and S. Nmr, "Suitable Wind Turbine Identification Using Capacity Factor and Economic Feasibility", International Journal of Science and Technology Volume 4 No. 8, August, 2015.

[17] G.Leng, A. Monarque, S.Graham, S.Higgins and H. Cleghorn "RETScreen International, Results and Impacts: 1996-2012," Minister of National Resources, Canada, 2004.

[18] O. Baris, O. Serra and T. Mahir, "Feasibility study of wind farms: A case study for Izmir, Turkey", Journal of Wind Engineering and Industrial Aerodynamics, vol. 94, pp.725–743, April 2006.

[19] National Investment Commission Republic of Iraq, investpromo.gov.iq.