ECONOMY OF HYBRID SOLAR WIND SYSTEM : A CASE STUDY RUTBA CITY

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Abstract – Renewable energy is an alternative solution for power generation in the day today life. Power generation from conventional energy is having a drastic effect to the environment and the ecological life of humans. The energy from renewable sources is abundantly available over the universe. Energy from renewable sources is clean, ecofriendly, efficient, and reliable. Solar and wind are gaining much importance in the present world. The project presented in this paper aims to develop a grid connected hybrid power generation system using solar and wind energy using the Matlab/Simulink software. The model is designed based on the availability of solar irradiance, sunshine hours, temperature, wind speed, wind direction and topography. The hybrid model consists of solar panels, (P&O) MPPT, boost converter, inverter, wind turbine, PMSG generator all connected to a grid. Under different irradiance and temperature conditions the PV model is simulated, and output is observed. The hybrid model is simulated, and the Matlab results are analyzed.

Keywords –Energy, Solar, Wind, Turbine, Hybrid, Desial.

I. INTRODUCTION

In today's world, eco-green energy, or producing energy without affecting the environment, is the main emphasis. Then, we may choose among sustainable energy options including solar, wind, small hydro, biomass, and biofuel. There is a great deal of potential for renewable energy to meet energy demand. However, there are significant drawbacks to using these energy sources, and several studies are being conducted to increase their effectiveness. Because preserving natural resources is the primary goal, systems should be put in place to prevent global warming and carbon emissions. Instead of using coal or other fossil fuels to generate electricity, the nation will save money by switching to renewable sources. It is anticipated that using this renewable resource to produce electricity would lower CO2 emissions [1].

There are several renewable energy sources, as was already said, but wind and solar energy represent the most common. Because wind and sun are well-known sources of energy and are found everywhere, when we speak about renewable energy sources, these are the first things that come to mind. Because of climate change, sunlight throughout the night, the rainy season, and variations in wind speed, single sources of energy like wind and PV are not completely dependable [2].

It needs to determine the amount of solar radiation available in a nation before we can evaluate whether or not it is acceptable for use in a solar application. So, the amount of solar radiation

energy that is received on a certain area of the surface over a specific amount of time is referred to as "insolation" [3]. Irradiance is often measured in terms of (W/m2) or (kWh/(m2•day)) or (hours/day). According to Fig.3, Iraq is one of the nations in this area with the highest levels of solar radiation, indicating that it is an appropriate location for implementing solar technologies [4].

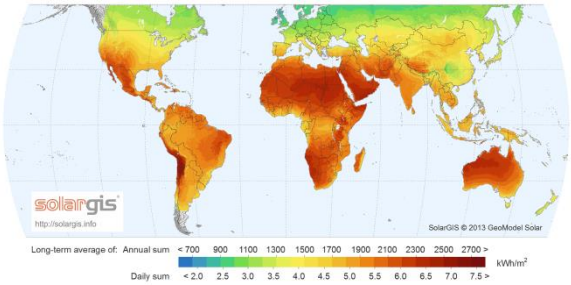

Fig.1 Solar irradiation map.

Due to Iraq's large population, the country's need for power continues to rise. The significance of having access to electricity in Iraq's day-to-day living has reached the point where it is necessary to take precautions against damage to the power grid in the event of faults and to guarantee the greatest possible level of uninterrupted power supply. The power infrastructure in Iraq is struggling with several issues, leading to an inadequate amount of energy being generated. The issues include a low output of energy compared to the actual demand, a dysfunctional power infrastructure, an absence of natural resources necessary for the creation of electricity, and other similar issues [5].

Solar and wind energy have often been employed independently to create electricity; however, both have some losses. These systems were impacted by climate change in the same way that our environment is altered daily. Solar radiation and wind speed variations influence the system's functionality. Any installation costs that would have been necessary for a single system would have been somewhat reduced with this combined hybrid system. Therefore, combining these two will aid each other to overcome losses rather than employing a single system. as when a solar PV system generates power, and a wind turbine system draws energy from a wind source during sunlight hour. Once wind conditions seem to be insufficient to generate electricity, the solar system is going to serve as a backup to meet load demand. Numerous researchers have employed various combinations to increase the reliability of the hybrid wind-solar system for more comfort. They combined wind-solar energy with other sources, such as diesel/wind/PV, wind/diesel, and hybrid diesel/PV systems [6].

II. Literature Review

Everywhere in the planet, energy is used in infinite and tiresome ways. The amount of energy utilized is rising along with the pace at which different development activities are taking place throughout the globe.

Solar energy and wind energy have been integrated in this system in order to generate power from both of the aforementioned sources. Hybrid systems provide a number of benefits over systems that simply use a single source of energy in their operation. Academics have a highly challenging task when tasked with optimizing the system's total energy output while simultaneously minimizing both expenses and reliability [8].

The following will describe both solar energy and wind energy in details along with hybrid system requirement:

A. The Solar Energy Resource

The primary energy source that sustains all living activities on Earth, including plant photosynthesis, the Earth's temperature comfort, the entire biogeochemical process, seems to be the sun. When the electromagnetic radiation from the sun reaches the earth's surface, it would be transformed into different forms of energy and utilized for a variety of things [7].

The two major ways that humans use solar energy are for the production of photoelectricity and thermal conversion. These applications reflect a significant step in resolving the global energy crisis. Given that the world's estimated 2050 energy demand is between 25 and 30 TW, it is evident that only solar energy will be sufficient to meet all demand and rid the world of fossil fuels.

B. The Wind Energy Resource

Air in motion causes wind. An increase in pressure causes the movement of air. Convective circulation is one of the main global forcing mechanisms driving surface winds from the poles toward the equator. The air near the equator is heated by solar radiation, and this low-density heated air is hoisted aloft. Cooler, denser, higher-pressure air traveling from the poles displaces it at the surface. As a result, air tends to flow away from the equator and back toward the poles in the

upper atmosphere close to the equator. Wind energy is easily turned into electrical energy by coupling a wind turbine to an electric generator, which creates rotating motion. The term "aero generator" is sometimes used to describe the generator and wind turbine combo. The comparatively slow speed of the wind rotor must typically be matched to the faster speed of an electric generator using a step-up transmission.

C. Hybrid Power Systems

A hybrid power system is simply one that generates electrical energy from many sources. In contrast to the current system, where outputs from various producing stations were hooked together, here the various energy sources are combined at the point of production, employing two or more fuels for the same devices that, once combined, overcome the shortcomings of each fuel separately.

The following were examples of the many hybrid power systems which are frequently employed:

- A wind-fuel cells hybrid system.
- A solid oxide fuel cell coupled with a micro turbine or gas turbine.
- A hybrid wave-wind system.
- DC hybrid systems with micro grid; wind generator with battery storage and diesel backup generators.

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III. METHODOLOGY

A. Study Area

Rutba is one of Iraqi's most remote islands, located off the coast of Anbar. This area's electrical grid is separate from Anbar, which is supplied by a 20 kV interconnection of diesel power stations.

This system has 15 diesel generating units. The interconnection of generation system in Rutba is shown in Fig.2.

Fig. 2 The power system plant in Rutba city.

this power plant system is running well. Until this time and the total energy generated by this units reached 110 MWh per day in total. The energy produced is equivalent to 25,000 liters of diesel per day. Taking into account the price of diesel fuel 4$/ liter at the time and 2$/liter of lubricate engine. in addition to this, the cost of repair is also too expensive in comparing with the other source of energy. besides, the pollution result from the engine. We know that one million of diesel fuel produce 2.5 ton of co_2.it is leads to increase pollution to environment.

B. Study Area

In this section, we will explain the implementation of one MW hybrid wind-solar system in the west of Iraq by using Matlab program and the data that have received from RETscreen program with energy storage is the system under discussion. A 400-kW grid-connected turbine of wind that employs a battery bank that is coupled to a bidirectional DC-DC converter for energy storage after a PMSG with a generator- and grid-side controller and converter architecture is connected to a bidirectional boost-buck converter. The suggested system architecture is shown in Fig.3, which also shows a 600 kW PV array that is coupled to a boost DC-DC converter and is controlled by a Perturb and Observe (P&O) algorithm block for power point tracking.

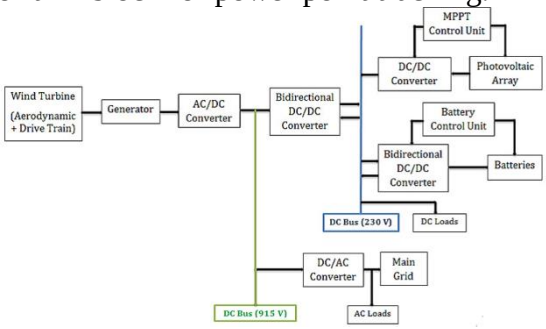

Fig. 3 FESEM micrograph of the fractured surface of as-sprayed YSZ TBC.

1. RETscreen Expert

RETscreen is a management software for environmentally friendly energy sources. Its A complete software platform that allows experts and decision-makers to quickly assess and verify the actual and ongoing energy performance of buildings, industries, and power plants located all over the globe in an intelligent and easy-to-use manner. In addition to this, it helps them to rapidly discover and evaluate the profitability of proposed

initiatives including energy efficacy, sustainable sources, and cogeneration [1].

2. *Installation Of Solar-Wind in Rutba City*

Natural and environmental elements, such as solar radiation, temperature, rainy days, air pressure, humidity, wind speed, and others have a significant impact on the use of renewable energy. The environment must be taken into account in order to maximize the contribution of hybrid plants, particularly wind speed and solar radiation, which are key contributors to the production of electrical energy.by the using data of RETscreen program, the weather conditions of Rutba city are more efficient to build the hybrid of solar-wind station as shown in Table 1.

Table1. Weather condition in Rutba city

	Unit	Climate data location	Facility location	Source
Latitude		33.0	33.0	
Longitude		40.3	40.3	
Climate zone		2B - Hot - Dry		NASA
Elevation	m	637	621	NASA – Map
Heating design temperature	°C	1.7		NASA
Cooling design temperature	°C	36.3		NASA
Earth temperature amplitude	°C	26.1		NASA

Month	Air temperature °C	Relative humidity %	Precipitation mm	Daily solar radiation - horizontal kWh/m²/d	Atmospheric pressure kPa	Wind speed m/s	Earth temperature °C	Heating degree-days 18 °C °C-d	Cooling degree-days 10 °C °C-d
January	6.1	61.0%	11.47	2.66	94.4	4.0	5.7	369	0
February	7.9	54.8%	11.48	3.60	94.3	4.4	7.9	283	0
March	12.2	43.4%	8.06	4.84	94.1	4.3	12.8	180	68
April	18.4	32.8%	6.60	5.97	93.9	4.3	19.6	0	252
May	24.1	25.9%	2.48	7.25	93.8	4.2	26.1	0	437
June	28.2	21.2%	0.30	8.35	93.6	4.6	30.6	0	546
July	30.5	21.3%	0.00	7.93	93.3	4.8	32.8	0	636
August	30.4	21.8%	0.62	7.23	93.4	4.1	32.5	0	632
September	26.9	23.6%	0.30	6.03	93.8	3.5	28.4	0	507
October	21.4	32.3%	5.58	4.24	94.2	3.5	22.0	0	353
November	13.2	48.1%	12.60	2.93	94.4	3.6	13.1	144	96
December	7.6	59.6%	9.30	2.23	94.5	3.8	7.2	322	0
Annual	19.0	37.1%	68.79	5.28	94.0	4.1	20.0	1,298	3,528
Source	NASA	NASA	NASA	NASA	NASA	NASA	NASA	NASA	NASA
Measured at					m	10	0		

IV. RESULTS AND DISCUSSION

A. Estimation of real conditions

It is vital to measure the daily solar radiation intensity and wind speed to ascertain how much weather fluctuations affect the production of solar and wind power stations. It can be clearly seen from data in Fig. 4 that the solar radiation increased gradually with air temperature from 5C° in January until reach to the peak point on July 27.2C° after that is has been decrees to 7C° in December.

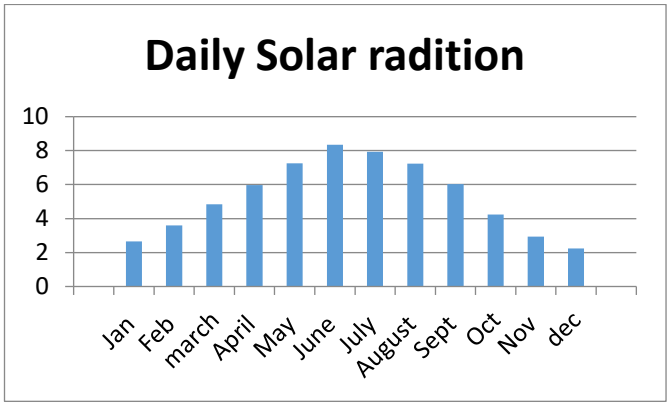

Fig. 4 Solar radiation per month.

Fig. 5 shows the climate data values based on relationship between Air temperature and wind speed, July month records the highest solar radiation, while months July and August record highest wind speeds due to increase the wind speed with reduce the air humidity.

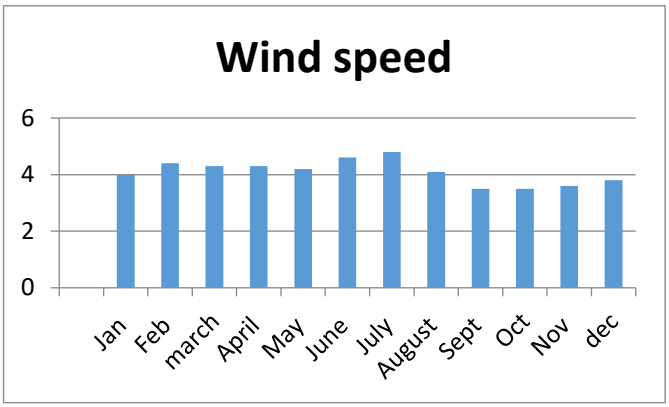

Fig. 5 Wind speed per month.

B. System Performance in Practice

The following equation was used to compute the PV system's hourly energy output:

$$\boldsymbol{kwh = P_{pv}(kw) \times number of\ hours\ of\ day\ light\ (h)}$$

The generated of power produced by the PV system was calculated by modelling it for different monthly average sun irradiation values for the PV system.

The amount of KWh generated by the PV system was then computed using these equations, and the results were noted in Table 2.

Table 2. Average monthly kwh that a PV system produces.

month	Hours of daylight on average	Dayily solar radiation average (kwh/ m^2)	monthly average of solar radiation (w/ m^2)	average monthly kwh that a PV system produces
Jan	4.57	3.89	851	82,260
feb	4.96	4.66	940	89,280
mar	5.18	5.45	1052	93,240
Apr	6.39	5.63	1022	115,020
May	6.7	6.18	922	120,600
Jun	7.06	6.93	982	127,080
Jul	6.95	6.63	954	125,100
Aug	7.03	6.63	943	126,540

Sep	6.58	6.29	956	118,440
Oct	5.91	4.84	819	106,380
Nov	5.11	3.6	705	91,980
Dec	4.47	3.44	670	80,460

Next, the online data for Rutba's monthly average wind speeds from 2018 to 2021 is shown in Table 3. Online meteorological databases show that compared to other months, Rutba's spring season (February to April) has generally higher wind speeds.

Table 3. From 2018 to 2021, the average monthly wind speed in Ramadi, Iraq

Month	2018	2019	2020	2021
Jan	4.5	4.4	4	4.2
feb	4.7	4.8	4.3	4.5
mar	4.2	4.9	3.8	4.8
Apr	4.0	4.2	3.6	3.7
May	5.1	4.7	4.2	4.9
Jun	4.1	5.2	4.5	5.2
Jul	3.8	4.7	4.3	4.8
Aug	3.9	4.6	4.9	4.3
Sep	4.3	4.2	5.1	5.3
Oct	4.8	4.4	4.8	4.8
Nov	5.0	5.5	5.8	5.3
Dec	5.2	5.7	6.1	6.3

This demonstrates unequivocally that a technology for generating wind energy would generate more energy in the spring than in other seasons. The data also reveals that the same month's monthly average wind speed may occasionally change dramatically from year to year. These variances are evidence that there will be significant changes in the wind generator's monthly energy output component of the wind-solar hybrid system.

After obtaining the fluctuations in Rutba's average monthly wind speeds, entry for the output power of the wind generator system throughout 2018 can be found in Table 4.

Table 4. Average monthly wind energy produced in MW.

month	monthly average wind speed (m/sec)	Average monthly wind energy produced in mw
Jan	4.2	100.6
feb	4.5	140
mar	4.8	170
Apr	3.7	45
May	4.9	175
Jun	5.2	195
Jul	4.8	170
Aug	4.3	125
Sep	5.3	195
Oct	4.8	170
Nov	5.3	205
Dec	6.3	290

It was determined that the total MWh generated by wind turbines that are dependent on varying wind speeds is equivalent to the kW of power generated per hour (because, unlike solar irradiation, wind is never completely absent during the day). Thus, the overall kWh generated by the wind-solar hybrid system was calculated.

By contacting ministry of electricity services and requesting the estimated data for one generator in a middle-class neighbourhood of Rutba, average monthly consumption data were acquired to figure out how much this entire amount of kWh can add to the overall amount of MWh consumed by one suburb in Rutba City. The data was collated in Table 5, and it was from this that the amount of energy (MWh) used by the wind-solar system was calculated.

Table 5. contribution of daily kWh production from solar and wind energy

month	Average monthly production of mwh from the wind and solar system	Wind (mw)	Solar (mw)	Rutba city's average monthly mwh consumption for each suburb	Percentage of Wind –solar contribution %
Jan	182.8	100.6	82.2	720	12.59
feb	229.2	140	89.2	700	14
mar	263.2	170	93.2	680	15
Apr	160	45	115	713	17
May	295	175	120	800	16.16
Jun	322	195	127	815	17
Jul	295	170	125	789	17
Aug	251	125	126	770	17.4
Sep	313	195	118	782	16.4
Oct	276	170	106	792	14.5
Nov	296	205	91	805	12.5
Dec	370.4	290	80.4	900	10.3

A column chart below in Figure 6 is used to compare the total monthly kWh produced by the wind-solar hybrid system with the total kWh consumed by the suburbs in Rutbacity.it is cleary seen from data that production of solar wind energy fluctuated during a year.it is reched to peak value in December while the minimum in April .

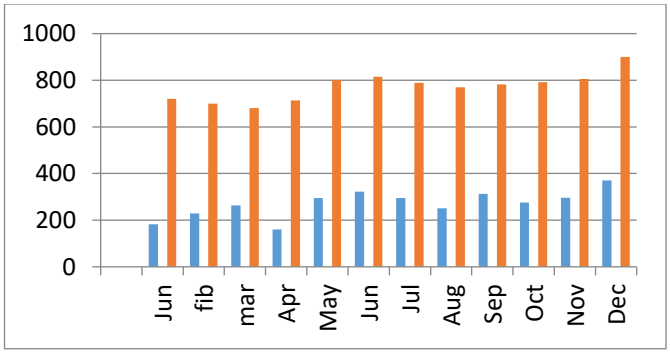

Figure 6: contribution of monthly MWh production from solar and wind energy and monthly consumption in each suburb in Rutba city

V. CONCLUSION

Matlab/Simulink is going to be the primary tool that will be used in the investigation of a hybrid photovoltaic/wind power generating system that will be used in a grid-connected application. The estimation of the solar irradiance and wind speed data in the areas of Rutba was done as a reference to establish the feasibility, and with the availability of energy, it is feasible to propose and construct a model. This was done in the process of proving that it is possible.

The generation of power from a single source of renewable energy is not sufficient to meet the load demands; consequently, a hybrid PV-wind model has been proposed as a means of compensating for the impacts of environmental factors and climate changes of the resources that impact the continuous the operation of electricity generation.

The findings indicate that the output of the system is affected by both the temp and the amount of solar radiation. Although a rise in temp causes a fall in the magnitude of voltage, which in turn leads to a reduction in power, an increase in solar irradiation results in an increase the magnitude of current, which concurrently results in an increase in output power. Wind speed and wind direction are two of the most important parameters that influence the output, and the findings reveal that sinusoidal AC power is generated with only very tiny changes as a consequence of variations in wind speed. The output of the hybrid system is around 1.5 megawatts when taken as a whole. The production of clean energy results from the combination of these two renewable sources for the creation of electricity in order to satisfy the needs.

ACKNOWLEDGMENT

The heading of the Acknowledgment section and the References section must not be numbered.

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