Hybrid Power Generation Using-Vertical Axis Wind Turbine and Solar Panel

S.Gopalakrishnan[1],R. Sasikumar[2]

PG Students Engineering Design, Gnanamani college of Technology
A.K Samuthiram,Pachal,Namakkal-637018

Abstract: *The rapid diminishing rate of gas and oil is alarming us to think about alternative sources. Renewable energy is a better solution to this problem and technologies of extracting energy from renewable energy sources are being upgraded day by day. Our target was to find out the optimum renewable energy source giving best possible power generation. In our research we analyzed the feasibility of power generation using wind and solar energy. For wind property analysis we have used anemometer and for intensity measurement luxmeter and pyranometer. The aim of the study was to analyze the solar and wind characteristics and selecting a suitable location where both solar and wind energy are strong enough for hybrid power generation and choosing suitable wind turbine for this purpose. We analyzed the beneficiary impact of this hybrid power extraction strategy on our environment and national economy and found that this new technique adaptation can really be useful in off shore islands and high rise buildings of our country. In our research analysis the by using mode analysis factor*

Key words: *solar energy, wind energy, analyzing (velocity & intensity of radiation)*

I. INTRODUCTION:

The combination of wind and solar PV has the advantage that the two sources complement each other because the peak operating times for each system occur at different times of the day and year. The power generation of such a hybrid system is therefore more constant and fluctuates less than each of the two component subsystems. Other solar hybrids include solar-wind systems.

Hybrid power plants combine at least two different energy types. Rather common is the combination of diesel-gensets and renewable energy systems with or without storage. The actual configuration is very site and company specific. It depends on irradiation and wind characteristics as well as on access to financing and the specifications of the existing genets in case of a retrofit.

The advantages of adding battery storage cannot be neglected either. It allows on the one hand side for turning-off the generators during daytime and on the other hand side it can increase the renewable energy penetration considerably. The penetration rate indicates the percentage of renewable energy in the total power system. Cost Of Capital For Renewable Varies Hugely Across EU.

Renewable had a good year in Europe in 2015. Wind grew by 12.8GW and solar PV by 8GW. The wind sector installed more than any other form of power generation (44% of the total) and called it a "record year" for investments (up 40% on 2014). The solar PV industry meanwhile, announced 15% growth after three consecutive years of decline.

II. WIND ENERGY

A. Science of Wind:

Wind is moving air and is caused by differences in air pressure within our atmosphere. Air under high pressure moves towards areas of low pressure. The greater the difference in pressure, the faster the air flows. The energy in the wind spins the turbine blades. They in turn spin a shaft connected to a generator and this makes electricity. The amount of electricity made by a wind turbine generator depends on how hard the wind is blowing.

In the United States, the original heyday of wind was between 1870 and 1930, when thousands of farmers across the country used wind to pump water. Small electric wind turbines were used in rural areas as far back as the 1920s, and prototypes of larger machines were built in the 1940s. When the New Deal brought grid-connected electricity to the countryside, however, windmills lost out.

B. The Wind Resource

The wind resource — how fast it blows, how often, and when — plays a significant role in its power generation cost. The power output from a wind turbine rises as a cube of wind speed. In other words, if wind speed doubles, the power output increases eight times. Therefore, higher-speed winds are more easily and inexpensively captured. Wind speeds in classes three (6.7 – 7.4 meters per second (m/s)) and above are typically needed to economically generate power. Ideally, a wind turbine should be matched to the speed and frequency of the resource to maximize power production.

C. Addressing the Variability of Wind Power:

Dealing with the variability of wind on a large scale is by no means insurmountable for electric utilities. Grid operators must already adjust to constant changes in electricity demand, turning power plants on and off, and varying their output second-by-second as power use rises and falls. Operators always need to keep power plants in reserve to meet unexpected surges or drops in demand, as well as power plant and transmission line outages. As a result, operators do not need to respond to changes in wind output at each wind facility. In addition, the wind is always blowing somewhere, so distributing wind turbines across a broad geographic area helps smooth out the variability of the resource.

D. The future of Wind power:

With increasingly competitive prices, growing environmental concerns, and the call to reduce dependence on foreign energy sources, a strong future for wind power seems certain. The Global Wind Energy Council projects global wind capacity will reach 536,000 MW by 2017, almost double its current size, with growth especially concentrated in the Asia and Europe. Turbines are getting larger and more sophisticated, with land-based turbines now commonly in the 1-2 MW range, and offshore turbines in the 3-5 MW range. The next frontiers for the wind industry are deep-water offshore and land-based systems capable of operating at lower wind speeds. Both technological advances will provide large areas for new development.

III.   SOLAR ENERGY:

On Earth, sunlight is filtered through Earth's atmosphere, and is obvious as daylight when the Sun is above the horizon. When the direct solar radiation is not blocked by clouds, it is experienced as **sunshine**, a combination of bright light and radiant heat. When it is blocked by the clouds or reflects off other objects, it is experienced as diffused light. Direct sunlight has a luminous efficacy of about 93 lumens per watt of radiant flux. This is higher than the efficacy (of source) of most artificial lighting (including fluorescent), which means using sunlight for illumination heats up a room less than using most forms of artificial lighting.
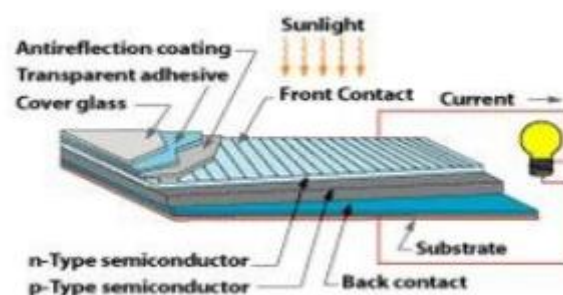
A.   Composition and power:

Solar irradiance spectrum above atmosphere and at surface. Extreme UV and X-rays are produced (at left of wavelength range shown) but comprise very small amounts of the Sun's total output power.

- **Ultraviolet C** or (UVC) range, which spans a range of 100 to 280 nm. The term *ultraviolet* refers to the fact that the radiation is at higher frequency than violet light (and, hence, also invisible to the human eye). Due to absorption by the atmosphere very little reaches Earth's surface. This spectrum of radiation has germicidal properties, and is used in germicidal lamps.

- **Ultraviolet B** or (UVB) range spans 280 to 315 nm. It is also greatly absorbed by the atmosphere, and along with UVC is responsible for the photochemical reaction leading to the production of the ozone layer. It directly damages DNA and causes sunburn, but is also required for vitamin D synthesis in the skin and fur of mammals.

From this solar panel we can produce 35% power in this over all hybrid power system

The operation of solar panels shown in following fig:

A.   *Spectral composition of sunlight at Earth's surface*
The Sun's electromagnetic radiation which is received at the Earth's surface is predominantly light that falls within the range of wavelengths to which the visual systems of the animals that inhabit Earth's surface are sensitive. The Sun may therefore be said to illuminate, which is a measure of the light within a specific sensitivity range. Many animals (including humans) have a sensitivity range of approximately 400–700 nm, and given optimal conditions the absorption and scattering by Earth's atmosphere produces illumination that approximates an equal-energy illuminant for most of this range. The useful range for color vision in humans, for example, is approximately 450–650 nm.

<div align="center">

III . DESING OF HYBRID ENERGY SYSTEM
</div>

For design of the hybrid energy we need to find the following data as follows
a. Data required for solar system
• daily solar radiation(intensity of radiation) according to the time for particular location
b. Data required for wind system
• daily wind velocity according to the time for particular location
• wind power produced by a wind turbine
belowfigure shows the block diagram of the hybrid power generation system using wind and solar power. This blockbdiagram includes following blocks
1.solar panel
2. windtubine
3.charge controller
4.battery bank

1.solar panels
Solar panel is use to convert solar radiation to the electrical energy. The physical of PV cell is very similar to that of the classical diode with a PN junction formed by semiconductor material. When the junction absorbs light, the energy of absorbed photon is transferred to the electron- proton system of the material, creating charge carriers that are separated at the junction. The charge carriers in the junction region create a potential gradient, get accelerated under the electric field, and circulate as current through an external circuit. Solar array or panel is a group of a several modules electrically connected in series parallel combination to generate the required current and voltage. Solar panels are the medium to convert solar power into the electrical power.

2. wind turbine
Wind turbine is that system which extracts energy from wind by rotation of the blades of the wind turbine. Basically wind turbine has two types one is vertical and another is horizontal. in this system we are using vertical axis wind turbine. It's will rotate all the direction. As the wind speed increases power generation is also increases. The power generated from wind is not continuous its fluctuating. For obtain the non-fluctuating power we have to store in battery and then provide it to the load.
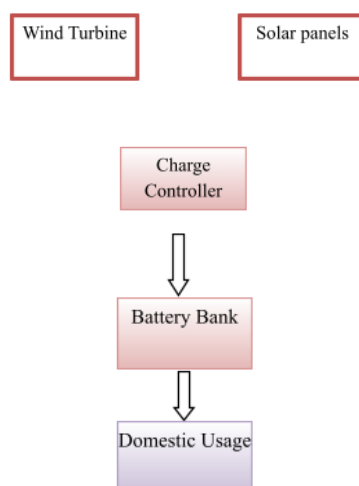
3.charge controller
Charge controller has basic function is that it control the source which is to be active or inactive. it simultaneously charge battery and also gives power to the load . the controller has over charge protection , shoat circuit protection, pole confusion protection and automatic dump load function. Its also the function is that it should vary the power as per the load demand .it add the both power so that the load demand can fulfill. And when power is not generating it should extract power from battery and give it to the load

4.battery bank
We have to choose battery bank size per the load requirement so that it should fulfill the requirement of laod for calculating the battery bank size we need to find following data:
1.find total daily use in watt – hour
2.find total back up time of the battery

for increase in battery bank size we need to control cell in series so that we can get the larger battery bank size

IV. DESCRIPTION OF MEASURING EQUIPMENTS:

A. Description of Anemometer:

An **anemometer** is a device used for measuring wind speed, and is a common weather station instrument. The term is derived from the Greek word *anemos*, which means wind, and is used to describe any wind speed measurement instrument used in meteorology .The first known description of an anemometer given by Leon Battista Alberti in 1450.Some of the simplest anemometer work in exactly this way. They're little more than an electricity generator mounted in a sealed –up metal cylinder with an axle protruding upward from it. On top of the axle , there are several large cups that catch the wind and make the generator spin around.

Why you can't always measure things precisely? A good anemometer will give you a wind speed reading accurate to about +/-0.5m/s(+/-2km/h or +/-1mph),but that's often more accurate than you need .So ,unless you're in a wind tunnel ,where the speed is constant and precise measurements count, any measurements you make is going to be ,at very best, a rough guide to how fast the air is actually moving.

The PMA90 is a digital anemometer .This meter uses conventional angled vane arms with low friction ball bearings and an NTC-Type thermistor for accurate, speedy readings (1/sec).It measures air velocity , Air flow and Temperature. Measures velocity in m/s, Km/H, Ft/Min, MPH and Knots .The PMA90 automatically powers off after 20 minutes to save power.9V battery required.

Features:
- Measures air velocity , Air flow and Temperature- Temperature range:14-140-Degree F-Weight:1.6-Pound including Battery and Probe.
- Air velocity Units- in m/s, Km/H, Ft/Min, MPH and Knots.
- Air velocity accuracy: +//-3-Percent-Sampling rate:1 Reading Per second-Auto power off after 20 minutes.
- Temperature units:-Degree C /-Degree F.
- Air flow units: CMM(Cubic Meters/Min),Cfm(Cubic – Feet/Min)

B.Description of Pyranometer:

A pyranometer is a type of actinometer used to measure broadband solar irradiance on a planar surface and is a sensor that is designed to measure the solar radiation flux density (W/m^2) from a field of view of 180 degrees. The name pyranometer stems from Greek,"pyr - πῦρ" meaning "fire" and "ano - ἄνω" meaning "above, sky".A typical pyranometer does not require any power to operate.

Design of pyranometers

pyranometer properties and functions (1) cable, (3) glass inner dome, (4) thermopile sensor, (5) glass outer dome, (7) humidity indicator with desiccant, (11) connector.

In order to attain the proper directional and spectral characteristics, a pyranometer's main components are:

*   A thermopilesensorwith a black coating. This sensor absorbs all solar radiation, has a flat spectrum covering the 300 to 50,000 nanometer range, and has a near-perfect cosine response.
*   A glass dome. This dome limits the spectral response from 300 to 2,800 nanometers (cutting off the part above 2,800 nm), while preserving the 180 degrees field of view. Another function of the dome is that it shields the thermopile sensor from convection.

The black coating on the thermopile sensor absorbs the solar radiation. This radiation is converted to heat. The heat flows through the sensor to the pyranometer housing. The thermopile sensor generates a voltage output signal that is proportional to the solar radiation.

Usage

Pyranometers are frequently used in meteorology, climatology, solar energy studies and building physics. They can be seen in many meteorological stations (typically installed horizontally) and next to solar panels (typically mounted with the sensor surface in the plane of the panel).

Standardization

Pyranometers are standardized according to the ISO 9060 standard, that is also adopted by the World Meteorological Organization (WMO). This standard discriminates three classes. The best is (confusingly) called "secondary standard" (that is, it has been calibrated by direct comparison with the single Primary Standard instrument), the second best "first class" and the last one "second class.*:*

Product Details:

WACO-206 Solar power meter with 3 ½ Digits LCD and 2000 Display count. Ideal for Measuring Solar Radiation Emitted by Sun

SUITABLE FOR- Meteorology, Light intensity measurement for the car windows, Agriculture application, Solar radiation measurement, Physics and optical laboratories.

Specification:

Display	3 ½ digits LCD display with maximum reading of 2000
Measurement Type	Measuring the solar radiation emitted by the sun
Display Units	W/m^2(Watts per square meter) or BTU
Function	Data hold/Max / Min functions.
Angular accuracy	Cosine corrected Angular Accuracy
Accuracy	Typically within /-10W/m^2[/-3 BTU(ft2*h)]or /-5 ,whichever is greater in sunlight Temperature included error /-0.38 W/m^2/Deg.C[/-0.12 BTU/(ft2*h)Deg.C]deviation from 25 Deg.C

C.Description of Luxmeter
Illuminance

Illuminance is a measure of how much luminous flux is spread over a given area. One can think of luminous flux (measured in lumens) as a measure of the total "amount" of visible light present, and the illuminance as a measure of the intensity of illumination on a surface. One lux is equal to one lumen per square meter.

Relationship between illuminance and irradiance

Like all photometric units, the lux has a corresponding "radiometric" unit. The difference between any photometric unit and its corresponding radiometric unit is that radiometric units are based on physical power, with all wavelengths being weighted equally, while photometric units take into account the fact that the human eye's image-forming visual system is more sensitive to some wavelengths than others, and accordingly every wavelength is given a different weight. The weighting factor is known as the luminosity function.

Specification :

Example lux values	
Clear night, no moon:	.002 lx
Clear night, full moon:	.27-1 lx
Family living room:	50 lx
Sunrise/sunset:	300-500 lx
Overcast day:	1000 lx
Daylight:	10000-25000 lx
Direct sunlight:	32000-130000 lx

Non-SI units of illuminance

The corresponding unit in English and American traditional units is the foot-candle. One foot candle is about 10.764 lux. Since one foot-candle is the illuminance cast on a surface by a one-candela source one foot away, a lux could be thought of as a "metre-candle", although this term is discouraged because it does not conform to SI standards for unit names.

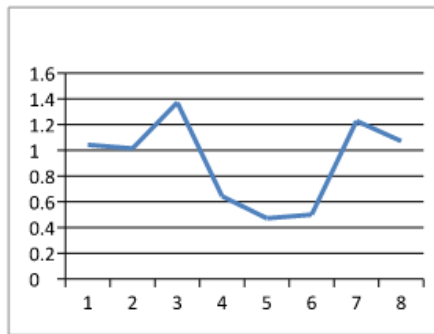## V .FOUR FACTOR ANALYSIS:

A.Instrument location

In order for wind speeds to be comparable from location to location, the effects of the terrain needs to be considered, especially in regard to height. Other considerations are the presence of trees, and both natural canyons and artificial canyons (urban buildings). The standard anemometer height in open rural terrain is 10 meters.

In this project 4 factor analysis { velocity (m/s) , temperature (⁰c), Intensity of radiation (Lux), Electricity (W/m²) will be done by a Anemometer, Lux meter and pyranometer .

From that analyzing various blocks among that we find the best location for production of power by this hybrid power system. Eg. Graphs and tables are shown below:
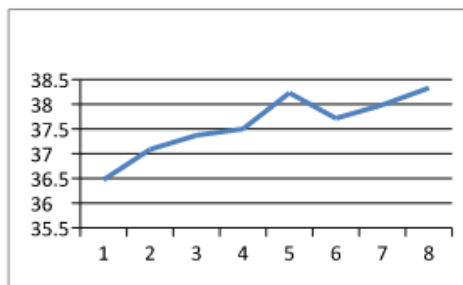
Locations	Velocity (m/s)	Temperature (^{0}c)	Intensity of radiation (Lux) X 100	Electricity (W/m^2)
1	1.042	36.47	807	637.53
2	1.014	37.08	734	579.86
3	1.371	37.37	732.85	579.38
4	0.642	37.5	679.57	536.86
5	0.471	38.22	707	558.53
6	0.5	37.71	687	542.73
7	1.228	37.98	836.71	627.08
8	1.071	38.32	695.14	549.16

B.From that table reading we plot the varies graphs that are follow
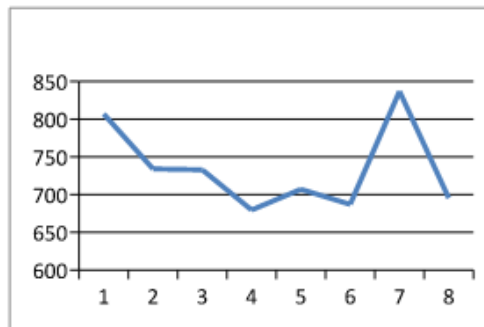*Graph for velocity:*

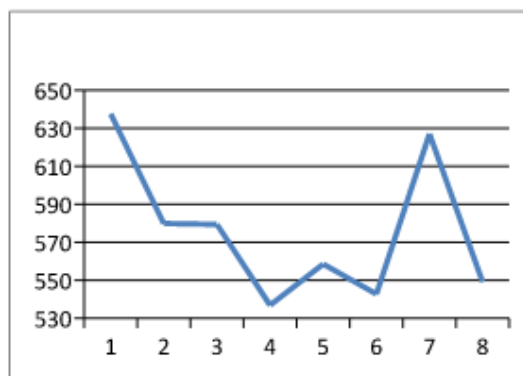This graph will show the velocity reading that mentioned in a above table

Graph for tempreture:

Graph for intensity of radiation:

Graph for electricity:

VI. LOCATION FINDING :

According to the readings and for factor analysis we fix the location for best power production by a this system
First find the frequency for find the maximum and minimum factor
In this system velocity , intensity radiation , electricity should be high, andtemperature factor should be low

A. Calculation:

For finding location we can follow the ranking value method
In this method we provied value for each value according to that rank
For table reading value converted into ranking value on following table
Velocity and intensity of radiation should be value should be high and tempreture should low like wise rank value should provided
Ex : maximum velocity value = 8;Minimum velocity value = 1
Maximum tempreture value = 1; minimum tempreture value = 8
Maximum intensity of radiation value = 1; minimum intensity of radiation value = 8

For table reading value converted into ranking value on following table:

Location	Velocity ranking	Temperature ranking	Intensity of radiation ranking
1	4	6	7
2	5	8	6
3	8	7	5
4	3	5	1
5	1	2	4
6	2	4	2
7	7	3	8
8	8	1	3

For table reading value converted into ranking value on following table
In our project we can generate 65% power by wind turbine
Another 35% power will produced by solar panels
So we have to find the location by following calculation
Location 1 : (4*65)+(7*35)+6 = 511
Location 2: (5*65)+(6*35)+8 =543
Location 3 : (8*65)+(5*35)+7=702
Location 4: (3*65)+(1*35)+5=235
Location 5: (1*65)+(4*35)+2=207
Location 6 : (2*65)+(2*35)+4=204
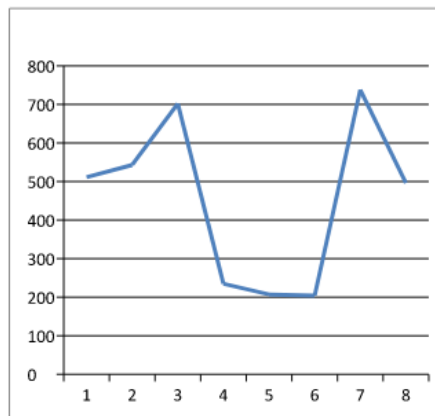Location 7 : (7*65)+(8*35)+3=738
Location 8 : (6*65)+(3*35)+1=496
From this calculation help us to finding the best location for this system to produce high power
For this we can plot graph for this calculation

Ranking value graph shown in follow:

From this calculation we comes to know location 7 is the best location
Like wise we can done for so many location at so many spots

VII.CONCLUSION:

Hybrid power generation system is good and effective solution for power generation than conventional energy resources. It has greater efficiencyIn proposed system, it will overcome the existing system, we can produce up to 1kw electricity. Solar panel will produce the electricity accordingly to the environmental climate. In windmill, the energy will be recovered continuously. The analysing process, helped us to fix in the exact location for producing high electric power. It can provide to remote places where government is unable to reach. So that the power can be utilize where it generated so that it will reduce the transmission losses and cost. Cost reduction can be done by increasing the production of the equipment. People should motivate to use the non conventional energy resources. It is highly safe for the environment as it doesn't produce any emission and harmful waste product like conventional energy resources. It is cost effective solution for generation. it only need initial investment. It has also long life span. Overall it good, reliable and affordable solution for electricity generation.

REFERENCE:

[1]. Ramasubbareddygorla,Rashidsalakon,"Feasibility of wind solar hybrid system for Cleveland",ohio,USA,Smart grid and renewable energy 2011,2,37-44

[2]. MignelToledo ,velazquez,marcelinovega del Carmen,"Design& experimentation of a 1MW horizontal axis wind turbine" journal of power&energy engineering-2014,2,9-16.

[3]. Mingzhizhao,yanlingzhang,"Feasibility analysis of constructing solar power by combining large scale wind farm.Energy and power engineering 2013,5,89-91.

[4]. Ghassan HALASA1, Johnson A. ASUMADU2," Wind-solar hybrid electrical power production to support national grid: case study – Jordan, Energy and Power Engineering, 2009, 72-80

[5]. Kavita Sharma, PrateekHaksar "Designing of Hybrid Power Generation System using Wind Energy- Photovoltaic Solar Energy- Solar Energy with Nanoantenna"Internationa Journal of Engineering Research And Applications(IJERA) Vol. 2, Issue1,Jan-Feb 2012, pp.812-815 .

[6]. Sandeep Kumar, Vijay Kumar Garg, "A Hybrid model of Solar-Wind PowerGeneration System", International Journal of Advanced Research in Electrical,Electronics and Instrumentation Engineering (IJAREEIE), Vol. 2, Issue 8, August 2013, pp.

[7]. Ravi Dwivedi, KshitizUpadhyay, Ankur Kumar SinghandAnant Kumar, "Proposed model for the wind energy harnessing system in trains " International Journal of Applied Engineering and Technology ISSN: 2277-212X , Vol. 1 (1) October-December 2011, pp.119-126. 4107-4016

[8]. "How to build a WIND TURBINE "Axial flux alternator windmill plans 8 foot and 4 foot diameter machines © Hugh Piggott -May 2003.

[9]. S. Ramya, T. Manokaran "Analysis and Design of Multi Input Dc–Dc Converter for Integrated Wind PV Cell Renewable Energy Generated System"- International Journal of Recent Technology and Engineering (IJRTE) ISSN:2277-3878, Volume-1, Issue-5, November 2012.