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Design and Fabrication of Hybrid Power Generation System by using Solar and Wind Energy

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Abstract:
Nowadays, mostly electricity generation is based on Thermal Power Stations. Thermal Power Stations are consuming more fuel and their availability is decreasing drastically. Due to combustion of fuel, the Exhaust gases from the Thermal Power Plant causes the Ozone as well as pollutes the environment. To overcome the insufficiency of fuel and environmental pollution due to the exhaust emission it is necessary for us to the use the Renewable Energy Sources for a better future. Generally the constructing the Solar or Wind Power Plants requires huge area. This necessitates us to build a Hybrid System using Wind and Solar Energy. We are depending on power from Renewable and Non- Renewable energy sources but mostly on non renewable energy sources. But as far as there is a steep increase in population and leak in availability of fuel it is not safe to depend on Non-Renewable energy resources. Hence, our Hybrid Power Generation System will be one of the solutions for this worldwide energy resource crisis.

I. INTRODUCTION

INDIA is the third most electricity producing country in the world. The Indian Electricity Board every year releases an annual report. On 30 NOV 2018 IEB released a report in that 346.62 GW power produced by Renewable and Non-Renewable Power Plants. In that 66.40% of power produced by Non-Renewable Power Plants i.e. Coal Power Plant, Diesel Power Plant, Nuclear Power Plant and 33.60% of power produced by Renewable Power Plants i.e. Solar Power Station, Wind Power Station, Hydro Electric Power Station. Each and every hour, the electricity produced in India 1303.49 TWH but our consumption level per hour 1486.50 TWH every hour they need to buy an 183.01TWH. There is a Shortage in Electricity due to increase in Population and Electronics devices. We couldn't resist the usage of electronics devices. As per Indian Electricity Board report, each and every day the Diesel Power Plants are consuming the fuel 36, 60,000 Barrels per day or 58, 19, 40,000 Liters per day. Non-Renewable power plant one day lose all the resources of fuel and it will be ending up with shutdown of all the Thermal Power Plants as an Engineer we should have a preplan and overcome this issue. The Thermal Power Plants have generated 170million tones of fly ash of which only 50-60% have been, utilized. Currently, about a billion tone of this toxic ash, a by-product, lies in dumps, polluting land, air and water. It is estimated that by 2021-2022, the sector will produce 300 million tones of fly ash ever year.

Generally the power plants takes lot of space for construction, in a country like India because of rapid increase in population it is not possible. To overcome this problem we have to design a special type of power station known as Hybrid Power Station to reduce the space occupied by the conventional power station.

II. PROBLEM IDENTIFICATION

The insufficiency of fuel and environmental pollution due to combustion of fuel the Exhaust Gases from the Thermal Power Plant causes depletion of the Ozone as well as pollutes the Environment. Generally the area consumption for building Solar or Wind Power Plants is Huge. We are depending on two or more Power Sources of Renewable and Non-Renewable. We are depending on both the renewable as well as Non-Renewable Power sources. But as far as there is a steep increase in Population it is not safe to depend only on Non-Renewable resources.

All our Thermal Power Plants (Coal Power Plant, Diesel Power Plant, Nuclear Power Plant) running with Non-Renewable resources either Diesel or Coal or Chemicals. One day we will lose all the Resources of Fuel that time we will be ending up with shutdown of Thermal Power Plants. Each and every hour there is a Shortage in Electricity due to Population and the Consumption of Electronic Devices are increasing our day-to-day life. We couldn't resist the consumption of Electronics. The Thermal Power Plants have generated 170 million tones of fly ash of which only 50-60% have been, utilized. Currently, about a billion tone of this toxic ash a by-product, lies in dumps, polluting land, air and water. It is estimated that by 2021-2022, the sector will produce 300 million tones of fly ash ever year.

III. SOLUTIONS

To overcome the insufficiency of fuel and Environmental Pollution due to the Exhaust and Emission it is necessary for us to use the Renewable Power Sources for a better future. This necessitates us to build a Hybrid Power Generation System by using Solar and Wind Energy. Hence our Hybrid Power Generation System will be one of the solutions for this worldwide energy resource crisis.

Table.1. Comparison of Thermal and Wind Power Plant

Power Plant	Input	Output
Wind	1MW	(17*X) MW
Thermal	1MW	(11*X) MW

IV. EXISTING SYSTEMS

Figure.1. Existing systems

These are the different types of Hybrid Power Generation system used in nowadays in difference with this our Hybrid Power Station will produce more energy with less space consumption.

V. METHOLOGY

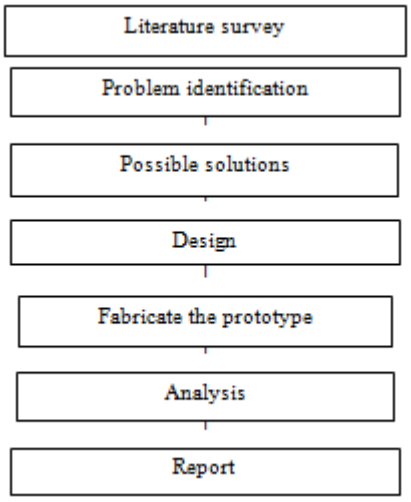

Table.2. Prototype Stem Design Specification

Parts	Dimensions
Upper Stem Size	1180mm of Circumference
Down Stem Size	1800mm of Circumference
Overall height	1650mm
Height of the Stem with mounting of Wind generator setup	134mm
Height of the Stem without mounting of Wind generator setup	120mm
North and South Side Angle	90°
East and West Side Angle	90°

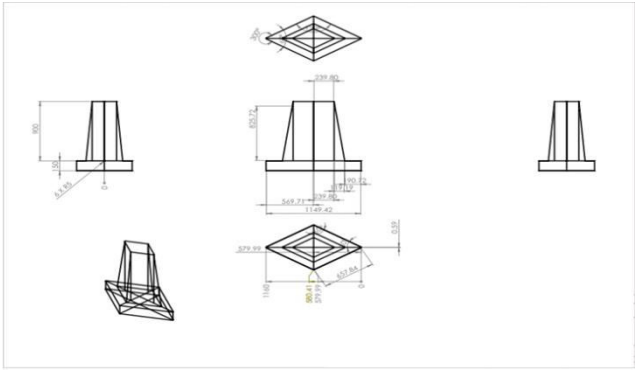

Figure. 2. Diagram Of Stem Design

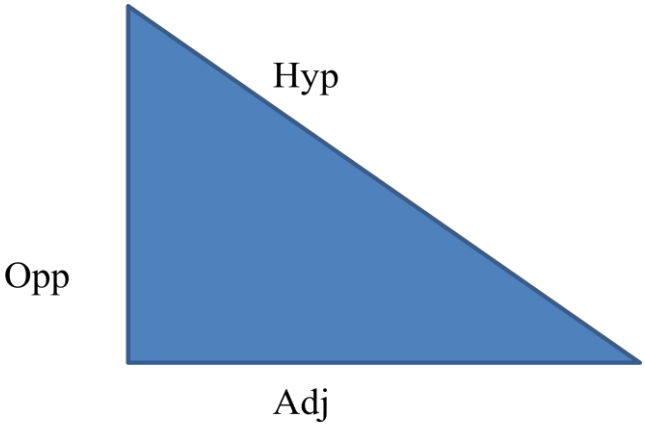

Figure.3. Trignometry Triangle

In this Trigonometry Condition is used as to be calculating the distance between the corners.

Table.3. Big Scale Design Specification

Parts	Dimensions
Upper Stem Size	(4-6 Meter) Circumference
Down Stem Size	(5-6 Times of Upper Stem Circumference)
Height of the Stem	(90-120 Feet) Based on the Pressure and Land
North and South Side Angle	(60°-90°) Based on Height of the Stem and Stem Pressure
East and West Side Angle	(90°-120°) Based on Height of the Stem and Stem Pressure
Window Distance For Each Side	Every 10 Feet
Window Size	30*100 cm

THEORITICAL MAXIMUM EFFICIENCY

$$P = \frac{1}{2} * \rho * A * V^3$$

Where,

ρ = Air Density
A = Swept Area
V = Air Velocity

We know that BET'Z LIMIT (Cp= O.593) that is mentioned as Theoretical Efficiency = 59.3%

PROPULSION

Wind Velocity of Relative = Velocity of – Velocity of
Wind Blade

PRACTICAL EFFICIENCY

TIP SPEED RATIO

$\lambda = \Omega R / V w$

Where,

λ = Tip Speed Ratio R = Radius

Ω = Rotational Velocity (rad/s) V w = Wind Velocity

PRACTICAL MECHANICAL EFFICIENCY Vs YEARS

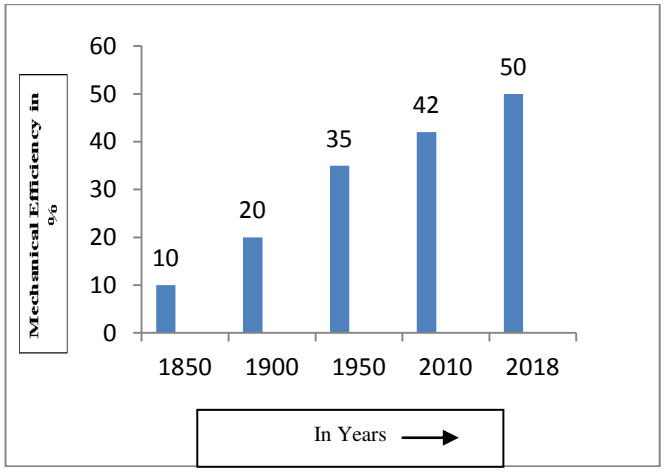

Figure.4. Practical Mechanical Efficiency Vs Years

(2MW) WIND PROPELLER SPECIFICATION

ROTOR

Diameter - 90m
Swept Area - 6362m²
Rotational Speed - 9-19 rpm
Direction of Rotation - Clockwise from front
Weight (Including HUB) - 36T
Top Head Weight - 106T

BLADES

Quantity - 3
Length - 44m
Aerofoil - Delft University and FFA-W3
Material - Pre Impregnated Epoxy Glass Fiber + Carbon Fiber
Mass - 5800 KG

GEARBOX

Type - 1 Planetary Stage, 2 Helical Stages
Ratio - 1:100
Cooling - Oil Pump with Oil Cooler
Oil Heater - 2.2KW

(2MW) GENERATOR

Type - Doubly Fed Machine
Voltage - 690 V (AC)
Frequency - 50 HZ
Stator Current - 1500 A at 690 V

SOLAR PANEL

Type - Mono-crystalline
Power Range - 300W- 340W
Tolerance - 0-3%
Dimension for each plate - 1950*980*40mm
Weight of each plate - 25KG
Max. System Voltage - 1000 V (DC)
Max. Series Fuse - 15 A
Max. Wind Load - 2400 N/m²
Max. Snow Load - 5400 N/m²

BRAKE

Cut off Speed~80 KM/ HR

TRANSFORMER

Type - Step-up Transformer

LIMITATIONS IN THE DESIGN

- Our design should consume less area.
- There should be an air ventilation window in every 10 feet in the stem depends on the developed pressure.
- We should consider this while designing the solar panel area.
- As mentioned above there are many limitations. We have designed the system which overcomes all the limitations.
-

VI. FABRICATION AND WORKING

FABRICATION

The above mentioned dimensions were established and the output has given to controller kit for stabilized usage of generated power.

WORKING

The designed Hybrid System is a combination of both Solar and Wind power resources which is a Renewable energy source. Depends on the angle of exposure of Solar panel to the sun (solar power energy), the power generated in erratic manner, which will be stabilized using controller. Whereas, the wind power generation will generate wherever there is the required amount of wind rotates the propeller. Thus Renewable Energy source was used to demolish the insufficiency of Non-Renewable energy Source due to Population.

BASE FRAME

FULL FRAME

Figure.5. Working

VII. RESULT

ANALYSING PICTURES

Analyzing the solar panels efficiency

Analyzing the wind-mill efficiency

Figure.6. Analysing Pictures

ANALYSING CONCLUSION

After fabricating we have to do analyze our project**.** The Obtained Results were tabulated the values are following tables.

OPEN CIRCUIT OUTPUT VOLTAGE FOR SOLAR

Table.4. Open circuit output voltage reading on (12/02/ 20 19) a.n.

	Time	Temp	1	2	3	4	5	6	7	8
Unit	Hr	°C	V	V	(V)	(V)	(V)	(V)	(V)	(V)
	01:40	30	19.8	19.8	20.4	20.8	19.1	19.2	19.2	19.2
	02:00	32	19.4	19.4	20.2	20.2	19.4	19.6	19.3	19.3
	02:20	32	19.2	19.1	20.1	20.1	19.5	19.3	19.0	19.0
	02:40	34	19.1	19.2	20.2	20.1	19.5	19.3	19.0	19.0
	03:00	34	19.0	19.1	20.1	19.7	19.7	19.3	19.1	19.2
	03:20	35	19.1	19.1	20.1	20.1	19.8	19.6	19.0	19.1

In this reading taken from every 20mintues by using Multi-meter and tabulated.

Table.5. Open circuit output voltage reading on (13/02 / 20 19) f.n.

	Time	Temp	1	2	3	4	5	6	7	8
Unit	Hr	°C	V	V	(V)	(V)	(V)	(V)	(V)	(V)
	09:50	20	21.0	21.0	19.9	19.9	20.2	19.8	20.7	20.6
	10:20	26	20.8	20.8	19.9	19.8	20.0	19.8	20.4	20.1
	10:50	29	20.8	20.8	19.9	19.9	20.0	19.8	20.1	20.1
	11:20	29	20.5	20.5	19.9	20.0	19.9	19.6	19.8	19.6
	11:50	30	20.4	20.4	20.2	20.1	19.8	19.5	19.8	19.5
	12:20	30	20.4	20.4	20.1	20.1	19.8	19.6	19.7	19.3

In this reading taken from every half-an –hour by using Multi-meter and tabulated.

Table.6. Open circuit output voltage reading on (13/02/20 19) a.n.

	Time	Temp	1	2	3	4	5	6	7	8
Unit	Hr	°C	V	V	(V)	(V)	(V)	(V)	(V)	(V)
	01:40	32	19.6	19.9	20.4	20.2	19.6	19.4	19.4	19.0
	02:10	32	19.4	19.5	20.7	20.8	19.7	19.8	19.8	19.1
	02:40	33	19.5	19.4	20.4	20.1	19.8	19.6	19.3	19.0
	03:10	34	19.3	19.3	20.4	20.3	19.8	20.0	19.1	18.9
	03:40	34	19.2	19.2	20.4	20.4	19.8	20.1	19.0	18.7

In this reading taken from every half-an –hour by using Multi-meter and tabulated.

Table.7. Voltage Vs Rpm

RPM	Voltage (V)
523	0.23
1040	0.56
1560	1.00
2030	1.60

By using Taco-meter and Multi-meter to take various reading and tabulated Our proposed solution delivers the best result.

Table.8. Cost Estimation for Prototype

	Specification	Quantity	Price (R.s)
Generator	5V	1	1000
Solar Panel	12V/10W	8	5360
DC Controller Kit	12V/ 20A	1	1500
Battery	12V	1	780
Frame Material	Iron-Steel	25kg	1460
Wire	Copper	12m	363
Propeller, Hub	Plastic	1	150
Propeller shaft, Bushes	Stainless Steel	1	170
Bolt, Nut, Vassar	Steel	1	200
Hanger	Steel	1	20
Generator Clamp	Plastic	1	50
Coupler	Steel	1	100
Total Material Cost			**11,153**

TOTAL COST

TOTAL COST = TOTAL +TRAVEL + OVERHEAD
MATERIAL ALLOWANCE COST
COST

TOTAL COST = 11,153+370+310= RS.11, 833/-

TOTAL COST = RS.11, 833/-

PROTOTYPE PHOTOGRAPHY

Figure.7. Prototype Photography

VIII. CONCLUSION

Our proposed solution delivers the best result, which produces the power based on Renewable energy by using Solar and Wind Enenrgy. It facilitates the electricity board of India to overcome the insufficiency due to the Non-Renewable eneregy source.

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