e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:04/Issue:04/April-2022 Impact Factor- 6.752 www.irjmets.com

DESIGN AND DEVELOPMENT OF HYBRID POWER GENERATION SYSTEM

Pranay V. Wadhai*1, Prof. D.R. Rangari*2

*1Undergraduate Scholars, Department Of Mechanical Engineering, Shri Shankarprasad Angnihotri College Of Engineering, Wardha, Maharashtra, India.

*2Assistant Professor, Department Of Mechanical Engineering, Shri Shankarprasad Angnihotri College Of Engineering, Wardha, Maharashtra, India.

ABSTRACT

Vertical axis wind turbine that converts highways into renewable energy sources using city dynamics. It will generate energy using wind generated by vehicles as well as natural winds. This turbine uses the wind pressure generated by fast moving vehicles on the road like large trucks and buses which helps to rotate its blades. It is designed with vertical long blades so that it will use maximum wind energy. The turbine takes up less space on the ground and is easier to handle and can be easily assembled and disassembled making it more durable. A solar panel is also fixed at the top of the turbine for power generation. This paper discusses the design of the axial flow permanent magnet synchronous generator that converts mechanical energy from the blade into an electrical output of about 20KW.

Keywords: Turbine, Power, Renewable Energy, Highway Intermediate, Power Generation, Vertical Axis, Wind Turbine.

I. INTRODUCTION

In daily life, the demand for electricity is much higher than the production of electrical energy. A big problem since natural resources are going to run out one day. Fossil fuels play a major role in the formation of global warming, greenhouse gases, etc. At present, 68 per cent of the electricity generated by thermal power projects and the remaining 22 per cent is from hydropower projects, nuclear power projects, gas power plants and fuel is depleted in one day as we have observed fossils. Solar and wind are both renewable free energy sources.. The solar energy available starts the day and the wind energy is maximized on the highway due to the speed of the vehicle.

The motivation of this project has led to a global trend towards clean energy. The main objective behind this project is to design a vertical axis wind turbine that effectively utilizes the wind energy generated by the speed of the vehicle on the highway. Therefore, maximum wind energy can be extracted by vertical axis wind turbines as compared to horizontal axis wind turbines. We have designed a modified vertical axis wind turbine that is more efficient than the old design. We try to get less vibration at the gear moment. This turbine works in all environmental conditions and even in cyclones. This design of the blade enables the turbine to rotate clockwise and counterclockwise. Solar plates are arranged in such a way that they divert vehicle air to the turbine for efficient use of vehicle air. The solar system generates electrical energy through the sun's radiation during the day and at night we can use the electrical energy generated from the vehicle's headlights for street lights, toll gates, etc.

A combination of various renewable energy sources, such as wind turbines and PV systems, is known as a hybrid power system. As mentioned earlier, wind-solar hybrid systems can provide stable community-level electricity services, including residential electrification. This dissertation focuses on the combination of wind, solar and energy storage systems for sustainable energy generation. Wind turbine output power varies with different wind speeds and solar energy also varies according to the hourly, daily and seasonal variation of solar radiation. Thus, a proper controller-converter system as well as a battery module (energy storage bank) can be integrated with the wind turbine and PV system to ensure that the system will operate in all conditions.

In the proposed system, when the wind speed is sufficient, the wind turbine can meet some of the AC load demand. When there is enough energy from the sun, part of the DC load demand can be supplied through wind turbines and PV-array systems. Whenever there is an excess supply from the system, the energy storage bank stores energy from wind turbines and PV arrays which will be supplied to DC loads when there is insufficient supply from the wind solar system. Also, when there is insufficient wind and the PV system requires more

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:04/Issue:04/April-2022 Impact Factor- 6.752 www.irjmets.com

energy for DC load and the battery is fully charged, the PV system has the ability to send its energy to the grid.Figure 1.1 shows a schematic description of the wind-solar hybrid system used in this dissertation, where the power generated from various sources reaches the consumption area when the power electronic equipment is integrated with PV and wind turbine modules. In the second, control the total energy flow and increase the efficiency of the whole system

II. METHODOLOGY

Fabrication of vertical axis wind turbine (Savonius Model Vertical Axis Wind Turbine) consists of different parts which are needed to be fabricated as parts of main assembly. The VAWT to be fabricated has the following parts.

- Blades- fabrication of blade consists of GI blades, steel pipes, MS flat, GI sheet circular cross section base.
- Housing- fabrication of Housing consists of triangular metal disc, pillow block bearing MS pipe and metal rods.
- Lower triangular metal disc- fabrication of lower triangular metal disc consists of MS flat welded in upper side threaded pipe coupling and in lower side rigidly fix with MS Pipe for supporting base frame and turbine shaft.
- Upper triangular metal disc –Fabrication of upper triangular metal disc consist of MS flat welding in triangular shape and drill hole both three side for insert bolt in Ms pipe.
- Base- The purpose of base fabrication is to provide strong support to the turbine. So there is flexibility in the design according to the supporting power.
- Adjustable model – The project is easily assembled and dissembled, Easy installation and easy to transport from one place to other.

In addition to the parts mentioned above, some materials and components are required between the main assembly of a vertical axis wind turbine, such as triangular metal discs, GI metal straps, and threaded pipes, nuts and bolts for fastening and pillow block bearings.

III. PROPOSED SYSTEM HARDWARE AND ARCHITECTURE

1. Savonius Model Vertical Axis Wind Turbine : The vertical axis wind turbine is used to convert the kinetic energy into mechanical energy. The light weight blade materials (GI sheet) are used for making the vertical axis wind turbine. The height of blade is 1.39 meter and width of blade is 0.2032 meter. The entire turbine is assembled with a collar and a blade that is fitted with a nut bolt. The blades are bent by the shaft of the turbine attached to the shaft of the generator at an angle of 300 angles to obtain the directionless motion of the turbine. The Savonius model was invented by the Finnish engineer Siegard Savonius and is illustrated in the figure.

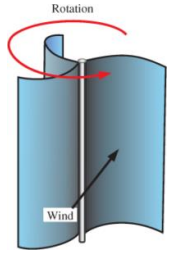

Fig 1: Savonius Model Vertical Axis Wind Turbine

2. Generator: DC motor is a electrical motors which converts direct current (DC) electrical energy into mechanical work. The most common types depend on the forces created by the magnetic field. Almost all types of DC motors have some internal mechanism, either electromechanical or electronic, to change the direction of current in the parts of the motor from time to time. A DC motor is a motor that converts direct current into mechanical work. It operates on the principle of Lorentz's law, which states that "a conductor of electric current carried in a magnetic and electric field experiences a force". And that force is the Lorentz force. Although motor gives 7000RPM at 12V but motor runs smoothly from 4V to 12V and gives wide range of RPM 1.1rpm-7000rpm, and Operating Voltage: 6~20Vdc. (Nominal voltage 12Volt dc) ,No Load Speed: 7000 RPM @ 12Volt . Rated current: 1.2A @ 12V. Stall Torque: 79Ncm @ 14.4V.Series DC Motor is high quality low cost DC motor.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:04/Issue:04/April-2022 Impact Factor- 6.752 www.irjmets.com

Fig 2: Generator

3. Solar panel: The cells in the module will be wired in series or parallel to generate the specified voltage. The so-called 12 volt panel can produce about 16 volts in full sunlight to charge a 12 volt battery. Here we use solar panels from Loom Solar Company. Mechanical features made from high efficiency crystalline silicon solar cells. Cells capsulated in low iron, high transmission, rigid glass using UV stable ethylene vinyl acetate (EVA) sheet. The premium quality back sheet protects the module from environmental conditions. Framed laminate with strong anodized aluminum profile with fit junction box.

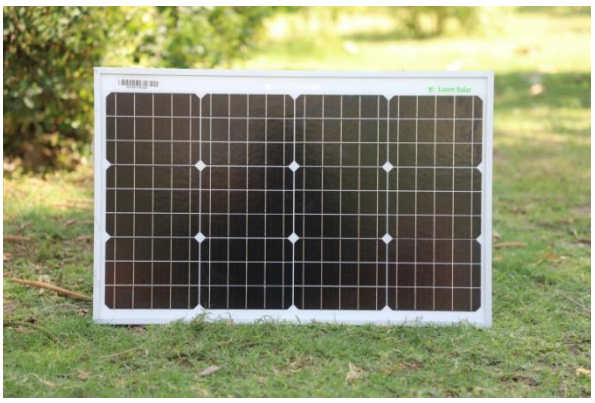

Fig 3: Solar panel

4. Solar Charge Controller: A charge controller or charge regulator is basically a voltage and / or current regulator that prevents the battery from overcharging. It controls the voltage and current flowing from the solar panel to the battery. Most "12 volt" panels emit about 16 to 20 volts, so if there is no regulation the batteries will be damaged by overcharging. Most batteries require about 14 to 14.5 volts to fully charge. Not always, but usually. Normally, a charge controller with small maintenance or trickle charge panels like 1 to 5-watt panels is not required. A general rule of thumb is that if the panel holds about 2 watts or less for every 50 battery amp-hours, you don't need it. Charge controls come in all sizes, shapes, features and price ranges. They range from small 10 amp (Exide) controls to 10 to 20 amp Exide controller. Often, if more than 30 amps of current is required, two or more 10 to 20 amps units are wired in parallel. The most common controls used for all battery-based systems range from 4 to 30 amps, but some newer controls.

5. Lead Acid Battery: The electrical energy produced by the system must be either fully utilized or stored. Not all energy produced by the system can be fully utilized at all times. So save it instead of wasting it. Electrical batteries are the most relevant, low cost, most efficient storage of electrical energy in the form of chemical reactions. Therefore, battery is preferred. The energy generated from the proposed project needs to be stored. So, two batteries are required. Attached to a wind turbine will require a 120AmpH battery, which will be suitable for filling the storage capacity to its full value. The second battery is 80AmpH which is preferred for storing solar energy. However, battery capacity may vary depending on the application storage and demand.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:04/Issue:04/April-2022 Impact Factor- 6.752 www.irjmets.com

Fig 4: Battery

6. Frame design: Mild steel flat is welded at its triangular shape. Two such plates are made. One of the plates is drilled and one of the plates is welded with pipe coupling. Mild steel pipe is traded on one side and nut is welded on the other side. Whereas the mild steel pipe is welded at other end of frame.

7. Main shaft: Main turbine shaft is held at both end in pillow block bearings for respective main shafts and they are bolted to the base frame..

8. Base frame: Base frame comprises of the base MI pipe, MI flat, nuts & bolts , motor plate , pillow block bearing, and main turbine shaft. These are support members that hold the assembly together. Easy installation and easy to transport from one place to other.

9. Bearing housings: The input and output bearing housings hold the pillow block bearings for respective main shafts and they are bolted to the base frame.

IV. WORKING

Vehicles running on the highway can be of all types such as small or heavy vehicles. When a vehicle travels on both sides of a highway divider, the speed of the vehicle produces a certain amount of compressed air. This compressed air hits the blades of the vertical axis wind turbine and the turbine rotates. The shaft of the vertical axis wind turbine is connected to the generator with the help of coupling and motor adaptor. The generated electricity is an DCl quantity; the output of the generator is stored in the battery. In addition to the vertical axis wind turbine installed solar system, the function of the solar system not only generates electricity but also provides a constant flow of air to the blades of the vertical axis wind turbine. The position of the solar plates is tilted at an angle of 45 degrees. A solar cell or photovoltaic cell is an electrical device that converts the energy of light into direct electricity under the photovoltaic effect, which is a physical and chemical phenomenon. It is a photoelectric cell, defined as a device whose electrical parameters, such as current, voltage or resistance, are subject to changes in light. The generated electricity is stored in the battery.. The stored energy is used for street lighting and for domestic purposes.

Fig 5: Working Model

V. RESULT & DISCUSSION

1. Calculation for wind power plant:

When wind turbine start to rotate, Number of revolutions obtained = 7000rpm

Average output Voltage = 12 V

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:04/Issue:04/April-2022 Impact Factor- 6.752 www.irjmets.com

Average output current = 2 Amp

Total power generation When wind turbine start to rotate, Number of revolutions obtained = 7000

electricity generated = 12 V, 2 Amp

∴ For 7000 revolution = 12 V x 2 Amp = 24W

∴ In 1 hour = 24x 60 = 1440 watt

Consider that in a day, turbine is operated for 12 hours

∴ Power generated in a day = 1440 x 12 = 17280 watt = 17.28 KW.

2. Calculation for solar power plant:

The maximum power of the solar panel is = 30W

Rated voltages=12 V

Rated current=1.68 A

Open Circuit: 22.1 VDC

Therefore, generation can be obtained from solar power plant is 30W solar panel can create 1.6 amps per hour..

How do you convert VDC to watts?

The formula is (A)*(V) = (W).

1.6*30=48 W

So for say you receive 6 hours of sunlight daily for your 30-watt solar panel then the total power (W) generation for this solar panel would be 48*6= 288 watt daily. Overall, output obtained from these project is 17.568 KW

VI. CONCLUSION

This system is environmentally friendly. We are using an integrated energy source for our project consisting of a solar system and vertical axis wind turbine system which is a good and effective solution for generating power. Keep Wind power even in ideal seating conditions. It is hoped that they will be manufactured using high-strength, low-weight materials for deployment in more developed nations and settings, or reusable materials and local skills in less developed countries. It is ideal to design an involuntary wind turbine in the middle of the highway to generate wind power. Generating electricity and will continue to power the load. Renewable energy sources such as solar and wind energy are used for power generation. Our work and results so far are very encouraging and reinforce the belief that vertical axis wind energy conversion systems can potentially contribute to the creation of practical and clean renewability. Heavy vehicle transport takes advantage of more wind opportunities. With the idea of putting it on the highway median, it will enable street lights and / or commercial use. In many cities, highways are a fast way to travel to different places and because of the need for constant lighting; it becomes an efficient way to generate electricity.

VII. REFERENCES

[1] https://www.omnicalculator.com/ecology/wind-turbine (Patil1, 2018)

[2] Castillo, J. (2011). SMALL-SCALE VERTICAL AXIS WIND TURBINE DESIGN.

[3] J. L., T. L., S. R., & T. M. (2018). Vertical Axis Wind Turbine for Remote Power Generation. Retrieved fromVertical_Axis_Wind_Turbine_for_Remote_Power_Generation.pdf: https://web.wpi.edu/Pubs/E-project/Available/E-project-042518-112236/unrestricted/Vertical_Axis_Wind_Turbine_for_Remote_Power_Generation.pdf

[4] L. P., & C. D. (2014, may). http://ethesis.nitrkl.ac.in/6322/1/110EE0236-12.pdf. Retrieved from: http://ethesis.nitrkl.ac.in/6322/1/110EE0236-12.pdf:http://ethesis.nitrkl.ac.in/6322/1/110EE0236-12.pdf

[5] P. N., P. N., P. S., & P. R. (2017). Design and Analysis of Savonius Vertical Axis Wind Turbine. IJSRD - International Journal for Scientific Research & Development , 5 (05), 111-112.

[6] Patil1, S. S. (2018). HYBRID POWER GENERATION (SOLAR AND WIND ENERGY). IJARIIE-ISSN(O)-2395-4396 , 2 (2), 232-239.

[7] Shabbir, M., Muhammad, O. S., Muhammad, s., & Taqi, A. (2010). Wind & Solar Renewable Energy. researchgate , 1, 6-40.

[8] Elmnifi, M. (2019). HYBRID POWER GENERATION BY USING SOLAR AND WIND ENERGY HYBRID POWER. researchgate, 1, 4-35.

[9] P.Karthikeyan1, P.Dineshkumar2, R.Gokul3, & G.Tamilvanan4. (2019). Design and Development of ENLIL Turbine For Highways Electrification. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering , 8 (3), 804-811.

[10] Prof.K.Subhas. (2021). Solar & Wind Electrical Systems . Retrieved from Solar & Wind Electrical Systems:https://mrcet.com/downloads/digital_notes/EEE/31082020/IV-I%20SOLAR%20&%20WIND%20ELECTRICAL%20SYSTEMS%20DIGITAL%20NOTES%201.pdf

[11] Shahzad, U. (2016). A Quantitative Comparison of Wind and Solar Energy. Durreesamin Journal , 2 (1), 1-7.

[12] P. S., G. P., P. G., & M. F. (2018). Power Generation on Highway by using Vertical Axis Wind Turbine & Solar System. International Research Journal of Engineering and Technology(IRJET) , 05 (03), 2133-2136.

[13] A. L., T. B., & A. K. (2020). Control and Management Solar-Wind-Storage Hybrid System. Artificial Intelligence and Renewables Towards an Energy Transition , 174.

[14] A. P., A. A., S. S., & S. K. (2014).

[15] http://www.kscst.iisc.ernet.in/spp/37_series/spp37s/synopsis_exhibition/171_37S0033.pdf. Retrievedfrom:http://www.kscst.iisc.ernet.in/spp/37_series/spp37s/synopsis_exhibition/171_37S0033.pdf: http://www.kscst.iisc.ernet.in/spp/37_series/spp37s/synopsis_exhibition/171_37S0033.pdf

[16] H. M., VASANGOUDA, M. C., & P. M.

[17] (n.d.).

[18] http://www.kscst.iisc.ernet.in/spp/41_series/40S_awarded_&_selected_projs_further_devpt/40S_BE_0250.pdf.Retrievedfrom:http://www.kscst.iisc.ernet.in/spp/41_series/40S_awarded_&_selected_projs_further_devpt/40S_BE_0250.pdf:https://greencoast.org/solar-battery-charging-basics/.(n.d.). Retrieved from https://greencoast.org/: https://greencoast.org/solar-battery-charging-basics/

[19] https://sunwatts.com/battery-charge-controllers/. (n.d.). Retrieved from sunwatts.com:

[20] https://sunwatts.com/battery-charge-controllers/

[21] https://uesgeneraltrade.blogspot.com/. (n.d.). Retrieved from https://uesgeneraltrade.blogspot.com/: https://uesgeneraltrade.blogspot.com/

[22] https://wattsupwiththat.com/2013/06/29/getting-energy-from-the-energy-store/. (n.d.). Retrievedfrom

[23] https://wattsupwiththat.com/2013/06/29/getting-energy-from-the-energy-store/: https://wattsupwiththat.com/2013/06/29/getting-energy-from-the-energy-store/

[24] https://www.dss.gov.au/our-responsibilities/women/publications-articles/economic-independence/the-leadership-challenge-women-in-management?HTML. (n.d.). Retrieved from:

[25] https://www.dss.gov.au/our-responsibilities/women/publications-articles/economic-independence/the-leadership-challenge-women-in-management?HTML:

[26] https://www.dss.gov.au/our-responsibilities/women/publications-articles/economic-independence/the-leadership-challenge-women-in-management?HTML

[27] https://www.indiamart.com/proddetail/goldi-green-24v-polycrystalline-solar-pv-module-21074482091.html. (n.d.). Retrieved from https://www.indiamart.com/proddetail/goldi-green-24v-polycrystalline-solar-pv-module-21074482091.html:https://www.indiamart.com/proddetail/goldi-green-24v-polycrystalline-solar-pv-module-21074482091.html

[28] https://www.solar-electric.com/learning-center/solar-charge-controller-basics.html/.(n.d.).Retrieved fromhttps://www.solar-electric.com/learning-center/solar-charge-controller-basics.html/: https://www.solar-electric.com/learning-center/solar-charge-controller-basics.html/

[29] K. A., P. V., D. S., & D. D. (2017). Design, Development and Cost Estimation of a. International Journal of Engineering Research & Technology (IJERT) , 6 (11), 51-53.

[30] N. S., M. Y., P. P., & P. N. (2017). Power Generation using Maglev Windmill. International Journal for Scientific Research & Development , 4 (12), 39-41.

[31] Nimgade, S. D., & Sheikh, H. (2021). Control and Simulation of A Standalone Solar Photo-Voltaic Hybrid

System. INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) , 10 (8), 278-282.

[32] O. U., I. S., W. P., & G. P. (2018). Spherical Shaped Vertical Axis Wind Turbine. International Research Journal of Engineering and Technology (IRJET) , 5 (6), 2236-2238.

[33] P. P., A. P., & A. S. (2016). Solar-Wind Hybrid Energy Generation System. International Journal of Engineering Research and General Science , 4 (2), 546-549.

[34] P.Karthikeyan, P.Dineshkumar, R.Gokul, & G.Tamilvanan. (2019). Design and Development of ENLIL TurbineFor Highways Electrification. InternationalJournal of A dvancedResearch in Electrical, Electronics and Instrumentation Engineering, 8 (3), 804-810.

[35] V. .., K, D. .., .P, C. .., P, A. .., & V, M. .. (2017). Highway Power Generation using Low Cost Vertical Axis WindTurbine [VAWT. International Journal of Engineering Science and Computing , 7 (5), 12008-12010.