DESIGN AND FABRICATION OF POWER GENERATION USING HYBRID ENERGY SOURCE FOR DOMESTIC APPLICATION

A PROJECT REPORT

Submitted by

SHARANRAJ C 8115U23ME043

in partial fulfilment for the award of the degree

of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

K. RAMAKRISHNAN COLLEGE OF ENGINEERING
(AUTONOMOUS)
SAMAYAPURAM, TRICHY

ANNA UNIVERSITY

CHENNAI 600 025

DEC 2024

I

DESIGN AND FABRICATION OF POWER GENERATION USING HYBRID ENERGY SOURCE FOR DOMESTIC APPLICATION

A PROJECT REPORT

Submitted by

SHARANRAJ C 8115U23ME043

in partial fulfilment for the award of the degree

of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

K. RAMAKRISHNAN COLLEGE OF ENGINEERING
(AUTONOMOUS)
SAMAYAPURAM, TRICHY

ANNA UNIVERSITY
CHENNAI 600 025

DEC 2024

II

DESIGN AND FABRICATION OF POWER GENERATION USING HYBRID ENERGY SOURCE FOR DOMESTIC APPLICATION

MEB1204 UG PROJECT WORK

Submitted by

SHARANRAJ C 8115U23ME043

in partial fulfilment for the award of the degree

of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

Under the Guidance of

Mr.SANTHOSH KUMAR P.C. M.E,

Department of Mechanical Engineering

K.RAMAKRISHNAN COLLEGE OF ENGINEERING

MECHANICAL ENGINEERING

K. RAMAKRISHNAN COLLEGE OF ENGINEERING

(AUTONOMOUS)

Under

ANNA UNIVERSITY, CHENNAI

III

K. RAMAKRISHNAN COLLEGE OF ENGINEERING

(AUTONOMOUS)
Under
ANNA UNIVERSITY, CHENNAI

BONAFIDE CERTIFICATE

Certified that this project report titled **"DESIGN AND FABRICATION OF POWER GENERATION USING HYBRID ENERGY SOURCE FOR DOMESTIC APPLICATION"**is the bonafide work of**,SHARANRAJ C (8115U23ME043),.**who carried out the work under my supervision.

Dr. H. RAMAKRISHNAN,M.E ,Ph.D.,
HEAD OF THE DEPARTMENT
ASSISTANT PROFESSOR,
Department of Mechanical Engineering
K. Ramakrishnan College of
Engineering, (Autonomous)
Samayapuram, Trichy.

Mr. SANTHOSH KUMAR PC
SUPERVISOR
ASSISTANT PROFESSOR,
Department of Mechanical Engineering,
K. Ramakrishnan College of
Engineering, (Autonomous)
Samayapuram, Trichy.

SIGNATURE OF INTERNAL EXAMINER

NAME:

DATE:

SIGNATURE OF EXTERNAL EXAMINER

NAME:

DATE:

K. RAMAKRISHNAN COLLEGE OF ENGINEERING

(AUTONOMOUS)

Under

ANNA UNIVERSITY, CHENNAI

DECLARATION BY THE CANDITATE

I declare that to the best of my knowledge the work reported here in has been composed solely by myself and that it has not been in whole or in part in any previous application for a degree.

Submitted for the project Viva- Voce held at K. Ramakrishnan College of Engineering on _____

SIGNATURE OF THE CANDITATE

ACKNOWLEDGMENT

We thank the almighty god without his blessing it would not have been possible for us to complete this project.

At this moment of having successfully completed our project, we wish to convey our sincere thanks and gratitude to our management of our college and our beloved chairman Dr. K. RAMAKRISHNAN, B.E., Ph.D., who provide all the facilities to us.

We would like to express our sincere thanks to our Executive Director

Dr. S. KUPPUSAMY, M.B.A., Ph.D., for forwarding us to do our project and offering adequate duration in completing our project.

We are also grateful to our Principal Dr. D. SRINIVASAN, Ph.D., for our constructive suggestion and encouragement during our project.

We wish to express our profound thanks to Dr. H. RAMAKRISHNAN, Ph.D., Head of the Mechanical Engineering Department, for providing all necessary facilities for doing this project.

We wholeheartedly and sincerely acknowledgement our deep sense of gratitude and indebtedness to our beloved guide Mr. SANTHOSH KUMAR .PC. M.E.,

Assistant professor, Mechanical Engineering Department, Tiruchirappalli, For his expert guidance and encouragement throughout the duration of the project.

We extend my gratitude to all the staff members of Mechanical Engineering Department, K. RAMAKRISHNAN COLLEGE OF ENGINEERING (AUTONOMOUS) for their kind help and valuable support to complete the project successfully. We would like to thank my parents, and friends who have always been a constant source of support in our project.

ABSTRACT

This project focuses on designing and fabricating a hybrid energy system that combines solar, wind, and hydro energy sources to address the growing energy demand and the depletion of conventional resources. By integrating solar panels, wind turbines, and a micro-hydro turbine, the system ensures continuous power generation. A central control unit manages the energy flow, prioritizing the most efficient source based on real-time availability, while an energy storage system provides an uninterrupted power supply for domestic applications. This hybrid setup offers a reliable, eco-friendly, and cost-effective solution for residential energy needs, promoting sustainability and reducing dependency on non-renewable energy sources. Additionally, it demonstrates the feasibility of decentralized, green energy solutions for domestic use.

Key Words: Hybrid energy system,Renewableenergy,Solar pannel,eco-friendly

TABLE OF CONTENTS

LIST OF THE TABLES

LIST OF FIGURES

CHAPTER- 1

INTRODUCTION

The escalating global energy demand and increasing environmental degradation caused by conventional energy systems have necessitated a shift toward renewable energy sources. Fossil fuels, which have historically been the primary energy source, are rapidly depleting and produce significant greenhouse gas emissions, contributing to climate change. The need for sustainable, eco-friendly, and efficient energy systems is more pressing than ever. In this context, hybrid renewable energy systems, which combine multiple renewable sources, offer a promising solution to meet energy demands sustainably and reliably.

This project focuses on the design and fabrication of a hybrid energy generation system that integrates solar, wind, and hydro energy for domestic applications. Each of these energy sources has its own advantages and limitations. Solar power is a clean and abundant energy source but is restricted to daylight hours and weather conditions. Wind energy, while highly efficient in windy regions, is inconsistent and dependent on atmospheric conditions. Similarly, hydro energy requires continuous water flow, which may not always be available. A hybrid system capitalizes on the complementary nature of these sources, ensuring a more reliable and consistent energy supply.

This hybrid system is designed with domestic energy requirements in mind, aiming to reduce dependency on grid power, lower electricity costs, and contribute to environmental conservation. By leveraging readily available renewable resources, the project demonstrates the feasibility of decentralized energy generation systems, which can play a critical role in achieving energy security and sustainability.

This innovative hybrid energy system demonstrates the potential of decentralized power generation for residential purposes, promoting energy efficiency, sustainability, and reduced dependency on non-renewable resources. By harnessing clean energy sources, the project contributes to a greener and more sustainable future.

The proposed system incorporates a central control unit to monitor and manage the energy flow from different sources, prioritizing the most efficient energy source at any given time. Additionally, an energy storage mechanism is included to store excess power, ensuring uninterrupted supply during periods of low energy generation.

CHAPTER - 2

LITERATUREREVIEW

The concept of hybrid renewable energy systems has gained significant attention in recent years due to the growing need for sustainable energy solutions. Researchers and engineers have extensively explored the integration of multiple renewable energy sources to overcome the limitations of individual systems and ensure continuous power supply. Below is a summary of the key findings and insights from the literature related to hybrid energy systems utilizing solar, wind, and hydro power.

1. Hybrid Energy Systems

- Hybrid energy systems (HES) combine two or more renewable energy sources to enhance efficiency, reliability, and sustainability. These systems often include energy storage units to mitigate intermittency issues associated with renewable sources.
- Studies by **Gupta et al. (2019)** highlight the effectiveness of hybrid systems in balancing energy availability and optimizing resource utilization. Their research demonstrated that hybrid systems could reduce dependency on conventional power grids and significantly lower carbon emissions.

2. Solar Energy in Hybrid Systems

- Solar energy is one of the most widely used renewable sources due to its abundance and scalability. **Sharma et al. (2020)** emphasize the importance of incorporating solar photovoltaic (PV) systems in hybrid setups for consistent energy generation during daylight hours.
- However, the study also noted that solar energy is highly weather-dependent, and hybridization with wind and hydro can address this limitation effectively.

3. Wind Energy in Hybrid Systems

- Wind energy complements solar power due to its potential to generate electricity during the night or cloudy days. **Patel and Kumar (2018)** analyzed wind-solar hybrid systems and found that their combined output could meet residential energy demands efficiently.
- Their research also highlighted the importance of site selection for wind turbines to ensure optimal energy production.

4. Hydro Energy in Hybrid Systems

- Micro-hydro systems have been identified as a reliable renewable energy source, especially in regions with flowing water bodies. **Rao et al. (2021)** explored the integration of hydro energy in hybrid systems and noted its capability to provide stable baseload power.
- The study also emphasized that small-scale hydro systems are ideal for domestic applications, requiring minimal infrastructure and maintenance.

5. Energy Storage and Management

- Effective energy storage and management are critical components of hybrid systems. **Kumar and Singh (2022)** studied battery storage systems in hybrid configurations, highlighting their role in ensuring uninterrupted power supply during low-generation periods.
- Advanced energy management systems (EMS) were identified as crucial for optimizing energy flow between sources, storage, and load.

6. Hybrid Systems for Domestic Applications

- Research by **Ali et al. (2020)** demonstrates the feasibility of hybrid systems for domestic applications, with findings showing significant reductions in electricity costs and grid dependency.
- The study also pointed out that hybrid systems are particularly beneficial in remote or off-grid areas, where conventional power supply infrastructure is unavailable or unreliable.

CHAPTER – 3

PROBLEM IDENTIFICATION

The increasing global energy demand, coupled with the environmental degradation caused by conventional energy sources, highlights the urgent need for sustainable and reliable power generation methods. However, several challenges persist in achieving this goal, particularly in the context of renewable energy systems:

1. Dependence on Conventional Energy Sources

- Over-reliance on fossil fuels for energy generation leads to environmental issues such as greenhouse gas emissions, global warming, and air pollution.
- The finite nature of fossil fuels raises concerns about long-term energy security and availability.

2. Intermittency of Renewable Energy Sources

- **Solar energy** generation is limited to daylight hours and affected by weather conditions like cloud cover and rain.
- **Wind energy** depends on wind speed and direction, which are often inconsistent and unpredictable.
- **Hydro energy** relies on the continuous flow of water, which may not always be available due to seasonal changes or limited water resources.

3. Unreliable Power Supply

- Standalone renewable energy systems often struggle to meet continuous power demands, especially during periods of low energy generation from a single source.
- This intermittency results in dependency on backup systems or grid power, reducing the system's reliability.

CHAPTER- 4

OBJECTIVES

The primary objective of this project is to design and fabricate a hybrid energy generation system that integrates solar, wind, and hydro energy sources, addressing the challenges of sustainable and reliable energy supply for domestic applications. By leveraging renewable resources, the system aims to reduce reliance on conventional fossil fuels, thereby minimizing environmental impacts and promoting eco-friendly power generation. This project seeks to overcome the limitations of individual renewable energy sources, such as the dependency of solar energy on sunlight, the variability of wind energy, and the seasonal fluctuations in hydro energy availability. By integrating these sources, the hybrid system ensures a consistent and uninterrupted power supply, regardless of weather or environmental conditions.

The proposed system includes an advanced energy management unit that optimizes the usage of available energy sources, prioritizing the most efficient one at any given time. To further enhance reliability, the system incorporates energy storage solutions to retain excess power generated during peak conditions, making it available for use during periods of low or no energy generation. The project also aims to design the system in a cost-effective manner, ensuring its affordability and feasibility for domestic use, especially in areas where access to grid power is limited or non-existent.

Beyond providing energy for residential needs, the project seeks to promote sustainability by showcasing the practicality and benefits of hybrid renewable energy systems. It aims to contribute to the global effort toward reducing carbon emissions, enhancing energy security, and addressing the energy demands of the future. Furthermore, by demonstrating the scalability and adaptability of the system, the project aims to inspire the adoption of similar solutions in larger applications, fostering a greener and more energy-efficient society. Ultimately, this project aspires to set a benchmark for decentralized, renewable energy solutions that combine innovation, efficiency, and environmental responsibility.

CHAPTER – 5

SELCTIONOFMATERIALS

MILDSTEEL:

The hybrid energy system involves multiple components like solar panels, wind turbines, and micro-hydro turbines, which need to be mounted on stable frames or structures. Mild steel provides a strong and rigid framework to support these components, ensuring their proper positioning and alignment for efficient energy generation.

Fig5.1 Mild steel

SOLAR PANNEL:

Solar panels play a central role in the hybrid energy system by converting sunlight into electrical energy, providing a clean and renewable source of power for domestic applications. In the context of this project, the integration of solar panels alongside wind and hydro energy sources ensures a continuous and reliable power supply while minimizing environmental impact. Below are the key reasons for using solar panels in the hybrid energy system.

Fig5.2 solar pannel

DYNAMO:

In the context of the hybrid energy system, **dynamo** plays a vital role in converting mechanical energy into electrical energy, primarily used in the **wind and hydro** components of the system. A dynamo is a type of **electrical generator** that produces direct current (DC) electricity from mechanical motion, and it can be effectively integrated into the wind and hydro turbines. Below are the key uses and benefits of incorporating a dynamo in this hybrid energy system.

Fig5.3Dynamo

WIND BLADES:

In the hybrid energy system, **wind blades** play a critical role in harnessing the kinetic energy of the wind and converting it into mechanical energy, which is then transformed into electrical power via the dynamo or generator. Wind blades are a fundamental component of the **wind turbine**, which is one of the three primary energy sources in the hybrid system, alongside solar and hydro power. Below are the key uses and benefits of integrating wind blades into the hybrid energy system.

Fig 5.4 windblade

WIRE:

Wires are an essential component in any electrical system, including the hybrid energy system that integrates solar, wind, and hydro power sources. They are used to **connect various components** of the system, facilitate energy transmission, and ensure the efficient flow of electricity. Below are the key roles and benefits of using wires in this hybrid energy project

CHAPTER–6

MODELING AND DESIGN

The modeling and design of a hybrid energy system involving solar, wind, and hydro power require an integrated approach to efficiently combine these renewable energy sources and optimize their performance. The goal is to design a system that can provide continuous, reliable, and sustainable energy for domestic applications while considering factors such as efficiency, cost, and environmental impact. Below is a breakdown of the modeling and design process:

1. System Components and Layout Design

The hybrid energy system consists of several key components, each designed to work in synergy:

- **Solar Panels**: These are used to convert sunlight into electrical power. The number of panels and their placement is based on available sunlight in the location.
- **Wind Turbine (Wind Blades)**: Wind energy is harnessed by the wind turbine blades, which convert the kinetic energy of wind into mechanical power. This is then converted into electrical energy using a dynamo or generator.
- **Hydro Turbine (Micro-Hydro)**: The hydro component involves the use of a small turbine driven by flowing water. This provides a stable and continuous energy source, especially when wind and solar energy are not available.

2. Modeling of Hybrid System Components

Solar Energy Modeling:

- **Solar Irradiance**: The solar energy generation depends on the average **solar irradiance** (in W/m^2) at the location, which varies by time of day, weather, and geographical location. Modeling tools can simulate solar radiation patterns for a specific area.
- **Panel Efficiency**: The **efficiency** of the solar panels, typically between 15% and 20%, affects how much of the sunlight is converted into usable electrical energy.
- **Panel Array Size**: The number of panels is determined based on the required energy consumption and local solar irradiance data.

- **Wind Energy Modeling:**
- **Wind Speed Data**: Wind power generation depends on the wind speed at the location, which varies by season and time of day. The optimal wind turbine blade design is selected based on the average wind speed (typically measured in meters per second).
- **Turbine Performance Curve:** A performance curve for the wind turbine is used, which maps wind speed to the mechanical power produced by the blades.
- **Efficiency:** The efficiency of the turbine is influenced by factors like blade design, wind direction, and turbulence.

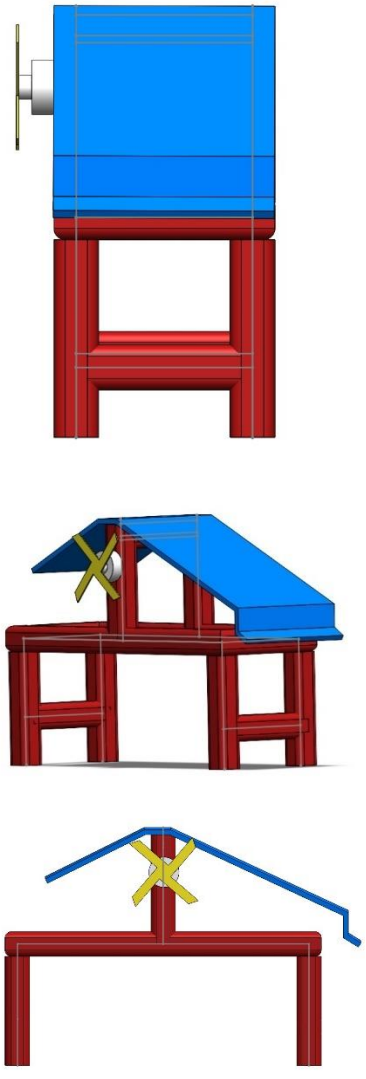
Hydro Energy Modeling:

- **Flow Rate**: The hydro system depends on the **flow rate** of water, measured in cubic meters per second (m^3/s). The amount of power generated is proportional to the water flow rate and the **height of the water column** (head).
- **Turbine Design**: The turbine design is optimized based on the flow rate and head, ensuring maximum energy extraction from the available water source.
- **Energy Generation**: The power output is modeled based on the formula: $P=\rho \cdot g \cdot h \cdot Q$ $P=\rho \cdot g \cdot h \cdot Q$
  where P P is the power output, ρ ρ is the density of water, g g is the gravitational constant, h h is the head (height), and Q Q is the flow rate.

4. Design Considerations

- **System Sizing**: The system must be sized to meet the household's energy needs while accounting for fluctuations in the availability of each energy source. The design takes into consideration the **load demand** (daily energy consumption) and the average output from solar, wind, and hydro sources.
- **Energy Losses**: Losses from **wiring, conversion (DC to AC), and storage** must be modeled to ensure that the system is as efficient as possible.
- **Cost Considerations**: The design must also account for the **initial investment** (solar panels, wind turbine, hydro turbine, battery storage, etc.) and the **maintenance costs** to ensure the project remains affordable.
- **Environmental Impact**: The materials used for the system components must be chosen to minimize the environmental impact.

ASSEMBLY DIAGRAM:



CHAPTER – 7

DESIGN CALCULATION

1. Solar Panel Sizing

Calculate the total power required from solar panels:

$$\text{Solar Panel Capacity (W)} = \frac{\text{Daily Energy Demand (Wh)}}{\text{Peak Sun Hours (h)} \times \text{Panel Efficiency} \times \text{System Loss Factor}}$$

2. Wind Turbine Sizing

Calculate the energy contribution from wind turbines:

Pwind=0.5·ρ·A·v3·η*P*wind=0.5·*ρ*·*A*·*v*3·*η*

Where:

- P*P*wind: Power output (W)
- ρ*ρ*: Air density (1.225 kg/m31.225kg/m3)
- A*A*: Swept area of blades (πr2*π**r*2)
- v*v*: Wind speed (m/s)
- η*η*: Efficiency of the turbine system (0.4−0.50.4−0.5)

3. Hydro Turbine Sizing

Calculate the power generated from hydro energy:

Phydro=ρ·g·h·Q·η*P*hydro=*ρ*·*g*·*h*·*Q*·*η*

Where:

- *ρρ: Water density (1000 kg/m31000kg/m3)*
- *gg: Gravitational acceleration (9.81 m/s29.81m/s2)*
- *hh: Head (height of water fall, m)*
- *QQ: Flow rate (m3/sm3/s)*
- *ηη: Efficiency (0.7−0.80.7−0.8)*

CHAPTER 8

WORKINGPRINCIPLE

The hybrid energy system integrates **solar, wind, and hydro power sources** to generate electricity for domestic applications. These energy sources work in tandem to ensure a continuous, reliable power supply, even when one or more sources are unavailable. Here's a detailed explanation of its working principle:

1. Energy Generation

Solar Power Generation:

- Solar panels are made of **photovoltaic (PV) cells** that convert sunlight into direct current (DC) electricity.
- When sunlight falls on the PV cells, the **photoelectric effect** generates electrical energy.
- The generated DC electricity is sent to a **charge controller** to regulate the output and prevent overcharging of the battery.

Wind Power Generation:

- The **wind turbine blades** capture the kinetic energy of the wind and convert it into mechanical energy.
- This mechanical energy drives a **dynamo or generator**, producing DC electricity.
- The output is regulated by the charge controller before being sent to the battery for storage or directly to the load.

Hydro Power Generation:

- Flowing water is directed through a **hydro turbine**, which converts the potential energy of water (due to its height and flow) into mechanical energy.
- A generator attached to the turbine converts the mechanical energy into DC electricity.
- The generated electricity is stored in the battery or sent to the inverter for immediate use.

CHAPTER -9

FABRICATED MODEL

Fig9.1Fabricated model

CHAPTER–10

COST ESTIMATION

BILL OF MATRIAL

S.NO	DESCRIPTION OF PARTS	MATERIALS	NO.OFF
1.	FRAME	M.S	1
2.	DYNAMO	ELEC	3
3.	PVC PIPE	PVC	1
4.	SOLAR PANNEL		1
5.	CUTTING WHEEL	ABRASIVE	2
6.	RED-OXIDE		1

COST ESTIMATION

S.NO	MATERIAL	COST
1.	MILD STEEL	Rs.500/-
2.	DYNAMO	Rs.240/-
3.	CUTTING WHEEL	Rs.90/-
4.	RED-OXIDE	Rs.160/-
5.	SOLR PANNEL	Rs.500/-
6.	WIND BLADE	Rs.30/-
7.	MISILANIOUS	Rs.500/-

TOTAL: Rs.2020/-

CHAPTER-12

CONCLUSION

The hybrid energy system combining solar, wind, and hydro power provides a reliable, sustainable, and cost-effective solution for domestic energy needs. By integrating renewable sources with energy storage and smart management, it ensures continuous power supply while reducing dependency on non-renewable energy and minimizing environmental impact. This project highlights the potential of hybrid systems as an efficient and eco-friendly alternative for sustainable development.

REFERENCES

1. "Renewable Energy Systems: The Earthscan Expert Guide to Renewable Energy Technologies for Home and Business" by David Thorpe.
2. K. Ramakrishnan College of Engineering Library

   Check for books on renewable energy systems in the engineering section for hands-on guidance.
3. **Design and Optimization of Hybrid Renewable Energy Systems**
   - Author: S. Rehman, L.M. Al-Hadhrami, M.M. Alam.
   - Journal: Renewable and Sustainable Energy Reviews, Elsevier.