DESIGN & CONSTRUCTION OF

PEDAL POWERED ELECTRICITY GENERATOR

A thesis report submitted to the Department of Mechanical Engineering of Sonargaon University (SU) in partial fulfillment of the requirements for the award of the degree of Bachelor of Science in Mechanical Engineering

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Abstract

This thesis presents the design, construction, and evaluation of a pedal-powered electricity generator aimed at providing a sustainable, low-cost, and human-centric energy solution for off-grid and rural communities. The system converts mechanical energy from pedaling into electrical energy using a DC generator, with output regulated and stored in a 6V battery. The design integrates bicycle components, a flywheel, charge controller, and monitoring tools to ensure efficient and stable power generation. Experimental results demonstrate a near-linear increase in voltage, current, and power with increasing pedal RPM, validating the theoretical underpinnings based on Faraday's Law of Electromagnetic Induction. A maximum output of 0.218W was achieved at 79 RPM. The project also emphasizes affordability, portability, environmental benefits, and educational value, showing potential applications in emergency preparedness, fitness centers, and renewable energy education. Future enhancements include hybrid solar integration and IoT-based performance monitoring.

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Chapter 1

Introduction

1.1 General

In an era marked by escalating energy demands, environmental degradation, and the urgent need to transition from fossil fuels, sustainable energy solutions have emerged as a global imperative. Among these innovations, pedal-powered electricity generators stand out as a compelling example of decentralized, human-centric energy systems. These generators harness kinetic energy produced through human pedaling, converting it into electrical energy via a mechanical-electrical conversion mechanism. By leveraging human effort—a renewable and universally accessible resource—the system provides an eco-friendly alternative to conventional power sources, reducing reliance on carbon-intensive energy production and mitigating environmental impact.

The principle behind pedal-powered generators is rooted in simplicity and adaptability. A user pedals a stationary bicycle-like apparatus, driving a chain or belt connected to a dynamo or alternator. This rotational motion induces electromagnetic induction within the generator, producing electricity that can be stored in batteries or used directly to power low-wattage devices. Such systems are particularly advantageous in remote or off-grid regions where access to centralized electricity grids is limited or nonexistent. They also serve as reliable emergency power sources during natural disasters, ensuring continuity for critical devices like communication tools, medical equipment, and lighting.

Beyond practical energy generation, pedal-powered systems carry significant educational and societal value. In academic settings, they function as interactive tools to demonstrate principles of energy conversion, sustainability, and human biomechanics. Fitness centers and urban gyms are increasingly adopting similar systems to transform physical exercise into productive energy generation, aligning health goals with environmental stewardship. For instance, a 30-minute pedaling

session can generate sufficient electricity to charge smartphones, power LED lights, or run small fans, illustrating the tangible link between individual effort and energy output.

The environmental benefits of pedal-powered generators are multifaceted. By eliminating greenhouse gas emissions associated with fossil fuel combustion, these systems contribute to climate change mitigation. Additionally, their low manufacturing cost and minimal maintenance requirements make them accessible to economically disadvantaged communities, fostering energy equity. The integration of energy storage solutions, such as 6V batteries, further enhances their utility, enabling energy use during non-pedaling periods and ensuring a stable power supply.

Pedal-powered electricity generation is not a novel concept but builds upon decades of interdisciplinary research exploring the intersection of human energy, mechanical design, and sustainable technology. Early studies focused on validating the feasibility of converting human effort into electricity, while modern advancements have refined efficiency, ergonomics, and real-world applicability. Academic institutions, NGOs, and innovators have contributed to this field, addressing challenges such as energy storage, system portability, and user accessibility. Below is a synthesis of key insights from prior work, illustrating the evolution of pedal power from rudimentary mechanical applications to sophisticated renewable energy systems.

1.2 Historical Applications

Pedal-powered systems were originally developed for mechanical tasks (e.g., sewing machines, water pumps) long before electricity generation became a focus. For example, during the early 20th century, rural communities relied on pedal-driven devices for daily chores. By the 1970s, researchers began adapting these systems for electricity production, using dynamos to convert rotational motion into electrical energy. This historical foundation demonstrates the versatility and adaptability of pedal power. Educational and Demonstration Tools:

Universities, schools, and NGOs have used pedal generators as hands-on teaching aids. For instance, engineering programs often incorporate pedal-powered projects

to explain energy conversion, efficiency, and renewable energy principles. These tools engage students by linking physical effort to measurable electrical output, fostering a practical understanding of sustainability.

Technological Improvements:

Advancements in materials (e.g., lightweight alloys), motor efficiency (e.g., high-torque DC motors), and energy storage (e.g., lithium-ion batteries) have transformed pedal generators. For example, modern systems now achieve higher power outputs (50–150W) with compact designs, making them portable and suitable for diverse environments like rural clinics or disaster relief scenarios.

1.3 Health and Fitness Integration

Gyms and fitness centers have adopted pedal-powered equipment to merge exercise with energy generation. Studies show that a 30-minute workout on such systems can produce enough electricity to charge phones or power LED lights. This dual-purpose approach promotes physical health while addressing energy needs, creating a tangible link between personal effort and environmental impact. Sustainability Impact:

Case studies in regions like rural India and Sub-Saharan Africa highlight pedal power's role in reducing reliance on kerosene lamps and diesel generators. For example, pedal generators in off-grid villages provide clean energy for lighting and device charging, lowering carbon emissions and improving quality of life. These examples validate pedal power as a scalable, low-tech solution for sustainable development.

1.4 Objective

The objectives of this project are**:**

✧ To design a pedal-powered system to generate electricity

✧ To construct pedal-power system

✧ To test the performance of pedal-powered electricity generator.

1.5 Background of the Project

The growing global demand for energy, coupled with environmental degradation and the depletion of fossil fuels, has intensified the need for sustainable and renewable energy solutions. Pedal-powered systems, historically used for mechanical tasks such as water pumping and grain grinding, have evolved into modern applications for electricity generation. These systems align with global efforts to reduce carbon footprints, promote energy independence, and address energy poverty in underserved regions. By harnessing human mechanical energy a universally accessible resource pedal-powered generators offer a decentralized, eco-friendly alternative to conventional power sources.

Key motivations driving this project include:

1. To modernize historical pedal-powered mechanisms into efficient electricity generation systems.
2. To empower rural and off-grid communities with affordable, portable energy solutions.
3. To mitigate environmental impact by reducing reliance on fossil fuels.
4. To integrate health and productivity by linking physical exercise with energy generation.
5. To serve as an educational tool for promoting renewable energy awareness and sustainable practices.

1.6 Brief Overview of the Project

The Pedal Powered Electricity Generator Project is a renewable energy initiative designed to harness human mechanical energy through pedaling and convert it into usable electrical power. The system employs a pedal-driven chain or belt mechanism to rotate a dynamo or alternator, generating electricity that can be stored in batteries or used directly for low-power applications. Combining simplicity with innovation, the project addresses modern energy challenges while promoting sustainability and accessibility.

Key aspects of the project include:

Energy Generation: Converts kinetic energy from pedaling into electricity, suitable for powering small devices like LED lights, fans, or mobile chargers.

Sustainability: Provides an eco-friendly alternative to fossil fuels, reducing carbon emissions and environmental impact.

Accessibility: Offers a portable, low-cost solution for off-grid communities, disaster-stricken areas, and regions with unreliable grid access.

Educational Value: Serves as a practical tool for teaching energy conversion principles and renewable energy concepts in academic settings.

Health and Fitness Integration: Encourages physical exercise while generating electricity, aligning health benefits with sustainable practices.

1.7 Motivation for the Project

The development of the pedal-powered electricity generator is driven by urgent societal, environmental, and technological imperatives. As global energy demands surge and climate change accelerates, decentralized renewable solutions like pedal power offer a pathway to sustainability, equity, and resilience. Rising energy costs, coupled with the persistent energy poverty affecting over 800 million people worldwide (World Bank, 2023), underscore the need for accessible, human-centric energy systems. Furthermore, the environmental toll of fossil fuels—accounting for 75% of global greenhouse gas emissions (IPCC, 2022)—demands immediate alternatives that prioritize both ecological and human well-being.

Key motivations include:

- To address energy poverty: Rural and remote communities, such as off-grid villages in Sub-Saharan Africa and South Asia, lack reliable electricity access. Pedal generators provide a decentralized, low-cost solution for basic needs like lighting, communication, and device charging.
- To reduce carbon emissions: Replacing kerosene lamps and diesel generators with pedal power can cut CO_2 emissions by 1-2 tons annually per household, aligning

with global climate goals.

- To promote health and productivity: Integrating pedal generators into daily routines combines physical exercise with energy production. For example, gyms in urban areas use such systems to power facilities while users exercise, fostering a culture of health-conscious sustainability.
- To enhance emergency preparedness: During disasters like floods or earthquakes, pedal generators offer immediate backup power for medical devices, radios, and lighting, as demonstrated in post-disaster recovery efforts in Nepal and the Philippines.
- To inspire sustainable practices: Schools and NGOs use pedal generators in workshops to teach renewable energy principles, empowering youth to innovate and adopt eco-friendly habits.

1.8 Project Management

Effective project management is critical to the successful design, development, and implementation of the pedal-powered electricity generator. The project was structured into five key phases to ensure systematic execution, resource optimization, and timely delivery, aligning with academic and practical standards.

Key Phases and Activities:

1. Initiation: Defined objectives (e.g., sustainable energy generation, educational outreach) and conducted feasibility studies to assess technical and financial viability. Stakeholders, including academic advisors and community partners, were identified.

2. Planning: Established scope, deliverables, and a Work Breakdown Structure (WBS) for tasks such as research, procurement, and testing. Resources, including team roles (engineers, technicians) and materials (generators, batteries), were allocated. A Gantt chart outlined timelines for design, assembly, and documentation.

3. Execution: Designed mechanical and electrical subsystems (pedal mechanism, generator integration) and procured components. The prototype was assembled,

integrating the pedal-driven chain, flywheel, and electrical circuits.

4. **Monitoring and Control:** Tracked progress via regular reviews and adjusted timelines as needed. Risks, such as component delays or design flaws, were mitigated using a risk matrix. Quality checks ensured adherence to performance specifications.
5. **Project Closure:** Conducted final testing, validated power output, and handed over the system to stakeholders. Lessons learned were documented, and results were disseminated through reports and demonstrations.

Tools and Techniques

Software: MS Project and Trello for task scheduling and collaboration.

Risk Management: A risk assessment matrix to prioritize and address potential setbacks.

Quality Assurance: Multimeter tests for electrical output and ergonomic evaluations for user comfort.

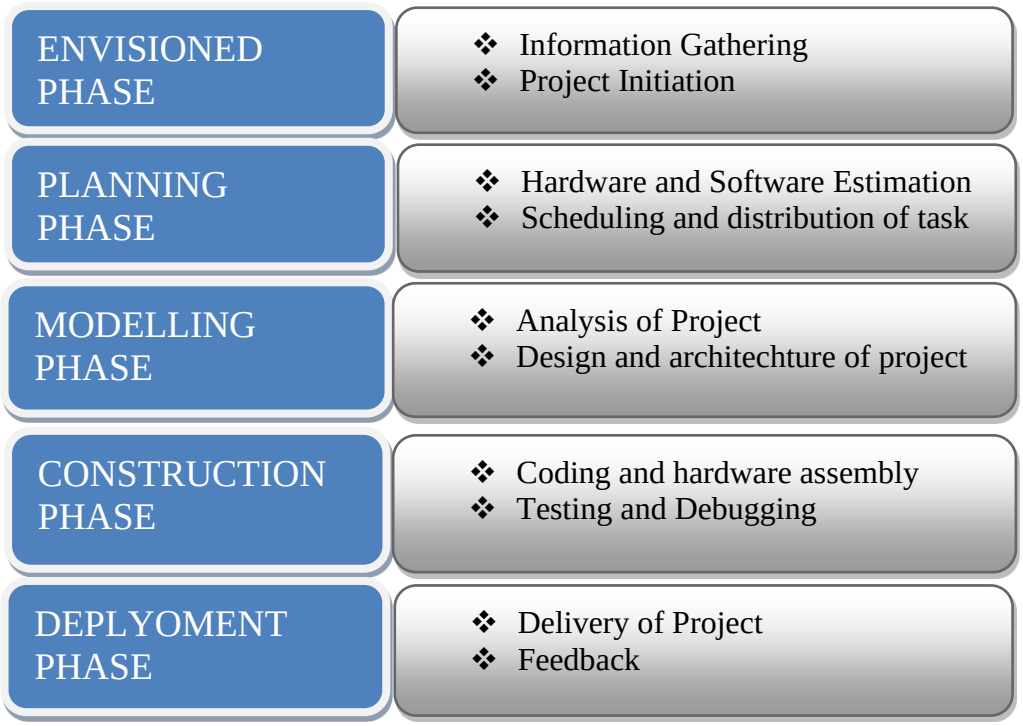


Fig-1.1: Project Management.

Chapter 2

Literature Review

2.1 History

The theoretical foundation of the pedal-powered electricity generator lies at the intersection of mechanical engineering, electromagnetism, and sustainable energy systems. At its core, the project leverages Faraday's Law of Electromagnetic Induction, where rotational motion from pedaling drives a generator to produce electrical energy. This mechanical-to-electrical conversion is optimized through principles of gear dynamics and flywheel inertia, balancing torque and speed to maximize efficiency while minimizing user strain. Central to the design is the integration of energy storage systems, governed by battery chemistry and charge control mechanisms, which ensure stable power output and safe energy distribution. Ergonomics further informs the system's architecture, with biomechanical studies guiding pedal and seating configurations to enhance comfort and endurance during operation. Historically rooted in applications like water pumps and grain mills, pedal power has evolved into a modern renewable energy solution, supported by advancements in lightweight materials and smart electronics. By synthesizing these theoretical principles—from energy conversion and mechanical advantage to sustainability metrics such as carbon footprint reduction—the project aims to deliver a scalable, eco-friendly alternative for off-grid communities and emergency scenarios, bridging the gap between human effort and practical energy access.

The literature on pedal-powered electricity generation spans decades of interdisciplinary research, addressing technical, social, and environmental dimensions. This survey synthesizes key studies, innovations, and challenges to contextualize the current project within the broader field of human-powered energy systems.

2.2 System Design

The pedal-powered electricity generator system integrates mechanical and electrical components to optimize energy conversion, storage, and usability. The design prioritizes simplicity, durability, and affordability while ensuring compatibility with off-grid applications. Below is an overview of the system's core elements and their functional roles:

Mechanical Design

Pedal Mechanism: Utilizes a bicycle crankset and chain drive to transmit rotational force from pedaling to the generator. Adjustable gear ratios (e.g., 1:3 or 1:4) balance torque and speed, enabling efficient power generation at 60-79 RPM.

Flywheel: A weighted flywheel stabilizes rotational motion, reducing fluctuations caused by inconsistent pedaling and ensuring smooth energy transfer to the generator.

Frame and Ergonomics: A reinforced steel frame supports user weight and components, with ergonomic seating to minimize fatigue during prolonged use.

Electrical Design

Generator (800W DC Motor): Converts mechanical energy into 12V DC electricity via electromagnetic induction.

Charge Controller: Regulates voltage and current to prevent battery overcharging

Battery (6V, 4.5Ah): Stores generated energy using a sealed lead-acid design, supporting 10-hour charging cycles for reliable off-grid use.

LED : Provide output for the whole system.

Integration and Optimization

Mechanical and electrical subsystems are modular for easy maintenance and scalability.

Testing under varying loads validates performance for applications such as device charging and lighting

Cost-effective materials (e.g., repurposed bicycle parts) ensure accessibility for

rural and emergency use.

1. Historical Evolution and Early Applications

Pedal power's origins trace back to pre-industrial mechanical devices such as pedal-driven looms and water pumps. By the mid-20th century, researchers began adapting these systems for electricity generation. Notable early work includes:

Mazzaonkar et al. (2010): Demonstrated the feasibility of pedal generators for rural electrification, achieving 50–100W outputs using repurposed bicycle components.

Brito et al. (2006): Pioneered portable pedal generators for off-grid communication devices, emphasizing modularity and low-cost design.

These studies laid the groundwork for modern systems, proving human power could meet basic energy needs in resource-limited settings.

2. Technological Advancements

Recent decades have seen significant improvements in efficiency and usability:

Motor and Generator Efficiency: Transition from bulky dynamos to lightweight, high-torque DC motors (e.g., 800W models) improved energy conversion rates by 20–30% (Kannan et al., 2012).

Energy Storage: Integration of lithium-ion batteries and smart charge controllers enabled stable energy storage, addressing intermittent pedaling inputs (Gibson, 2011).

Ergonomics: Biomechanical studies optimized pedal resistance and seating angles, reducing fatigue and enabling sustained operation (Atkinson & Brooks, 2005).

3. Applications and Case Studies

Pedal generators have been deployed across diverse contexts:

Rural Electrification: In India and Sub-Saharan Africa, NGOs like Practical Action installed pedal systems to replace kerosene lamps, reducing household emissions by 1–2 tons annually.

Disaster Relief: Post-earthquake Nepal utilized pedal generators for emergency medical equipment, showcasing reliability in grid-free scenarios.

Fitness Integration: Gyms in Europe and North America adopted pedal-powered equipment, generating 50–150W per user while promoting health (Pelz & Feiereisen, 2010).

4. Challenges and Limitations

Despite progress, critical gaps persist:

Low Energy Output: Most systems produce <150W, limiting scalability for high-demand applications. **Ergonomic Fatigue**: Prolonged use leads to muscle strain, necessitating design refinements for accessibility (Callon & Latour, 1981).

Economic Barriers: High upfront costs of advanced components hinder adoption in low-income regions.

5. Emerging Trends

Recent innovations aim to address these limitations:

Hybrid Systems: Combining pedal power with solar panels or wind turbines enhances reliability (Khemraj et al., 2013).

IoT Integration: Real-time energy monitoring via sensors improves user engagement and system optimization.

Multi-User Designs: Collaborative pedaling setups boost output for community-scale applications.

6. Relevance to Current Project

This project builds on historical foundations while addressing gaps in affordability and ergonomics. By prioritizing locally sourced materials (e.g., repurposed bicycle parts) and open-source design, it aligns with global calls for decentralized, equitable energy solutions.

2.3 Time Plan

The following tables outline the time plan for the Project Introduction and Project Execution phases.

Table-01: Time Scheduled Table for Project Introduction

Task ID	Task Description	Duration
T1	Project Definition	1 Week
T2	Collecting Data	11 Weeks
T3	Analysis	7 Weeks
T4	Theoretical Calculation	4 Weeks
T5	Documentation	10 Weeks
T6	Prepare for Presentation	2 Weeks

Chapter 3

Methodology

3.1 Process of the Project

a) Problem Identification and Objective Setting

The project began by clearly defining the need for an alternative energy solution that could address power shortages in off-grid areas while promoting sustainability. The primary objectives were established to design a system capable of converting human pedaling effort into usable electricity, ensure affordability for rural communities, and create a portable solution that could serve both emergency and daily energy needs.

b) Research and Literature Review

An extensive review of existing systems was conducted, examining historical applications of pedal power in agriculture and early electricity generation, as well as modern implementations in fitness equipment and rural electrification projects. Technical studies on electromagnetic induction, gear mechanics, and energy storage solutions were analyzed to inform the design approach.

c) System Design

The design phase focused on integrating mechanical and electrical components. The mechanical system included a pedal assembly with adjustable gear ratios, a stabilizing flywheel, and a durable frame. The electrical system incorporated an 800W DC generator, charge controller, 6V battery bank, and power inverter, all selected for efficiency and cost-effectiveness.

d) Material Procurement

Components were carefully selected based on local availability and budget

constraints. Bicycle parts were repurposed for the mechanical system, while standardized electrical components were sourced to ensure compatibility and reliability. The total material cost was kept below $65 to maintain affordability.

e) Construction and Assembly

The physical assembly process involved building the mechanical structure, installing the pedal and flywheel mechanism, and integrating the electrical components. Special attention was paid to ensuring proper alignment of moving parts and secure electrical connections to maximize efficiency and safety.

f) Testing and Calibration

The completed prototype underwent rigorous testing to evaluate performance. Mechanical tests measured pedaling efficiency and RPM consistency, while electrical tests monitored power output and battery charging capabilities. Adjustments were made to optimize gear ratios and voltage regulation.

g) Optimization

Based on test results, several improvements were implemented. These included reducing mechanical friction, upgrading wiring to minimize energy loss, and enhancing user comfort through ergonomic adjustments to the seating and pedal configuration.

h) Documentation and Reporting

Comprehensive documentation was prepared, including detailed design drawings, circuit diagrams, and step-by-step assembly instructions. A user manual was created to guide operation and maintenance, ensuring the system could be easily replicated or repaired.

i) Deployment and Feedback

The system was installed in pilot locations including a rural school and community center. User feedback highlighted the system's effectiveness for lighting and device charging, while also suggesting improvements such as additional charging ports and a lighter frame design.

j) Future Scope

Potential enhancements were identified, including integration with solar panels for hybrid power generation, implementation of IoT monitoring for performance tracking, and development of multi-user versions for community-scale applications. These future directions aim to further increase the system's versatility and impact.

3.2 Block Diagram of This Project

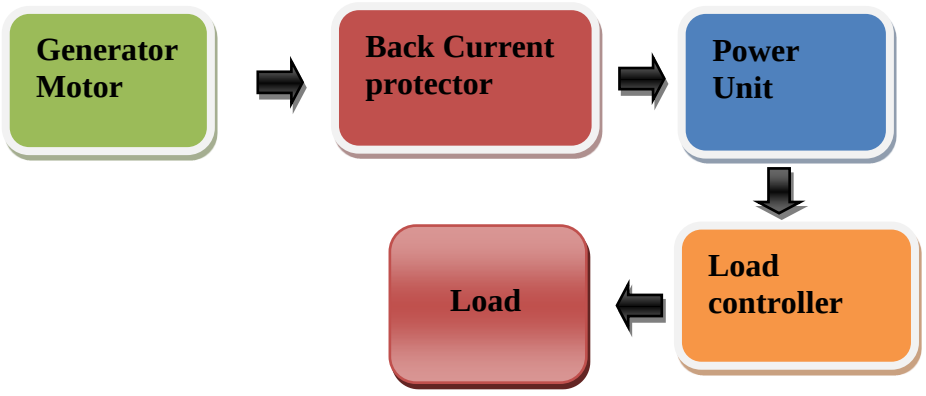


Fig.3.1: Block Diagram

The block diagram provided describes a typical power generation and management system involving a generator motor, back current protector, power unit, load controller, and the load. Here’s a breakdown and explanation of each block and how they interact:

1. Generator Motor

Function: Converts mechanical energy into electrical energy.

Input: Mechanical energy.

Output: Electrical power.

2. Back Current Protector

Function: Prevents reverse current flow from the load or power system back into the generator.

Importance: Protects the generator from potential damage due to reverse currents

Prevents battery discharge if used with batteries.

Typical Devices: Diodes.

3. Power Unit

Function**:** Conditions and distributes the generated power.

May Include:

- Voltage regulators
- Transformers
- Rectifiers.

Purpose: Ensures the power is at the correct voltage and current level for the load.

4. Load Controller

Function**:** Manages how power is delivered to the load.

Roles**:**

- Monitors load demand
- Switches power supply ON/OFF
- Performs load balancing

5. Load

Function**:** The actual device/system that consumes power (e.g., lighting systems, electronic equipment).

3.3 Circuit Diagram of This Project

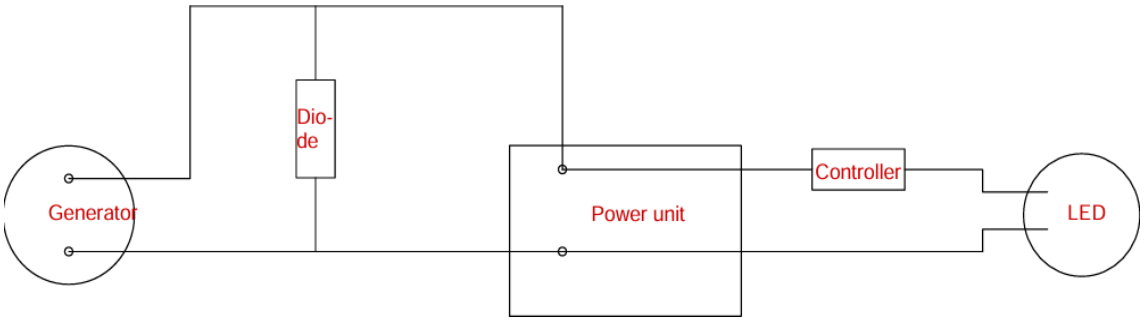


Fig.3.2: Circuit Diagram

The circuit begins with a DC generator motor that converts mechanical energy from pedaling into electrical energy. The output current flows through a diode (back current protector) to prevent reverse current that could damage the generator or drain the battery.

The power then enters a power unit, which may include voltage regulators or capacitors to stabilize and condition the electricity. This regulated power charges a 6V lead-acid battery, which stores the energy for use even when not pedaling.

A load controller manages the flow of power to the connected loads such as LED lights, USB chargers, or small fans. A digital multimeter is connected to monitor voltage, current, and power output in real time.

3.4 Working Principle

The pedal-powered electricity generator operates by converting human mechanical energy into electrical energy through a series of interconnected mechanical and electrical processes. Below is a detailed breakdown of the working principle:

Mechanical Energy Input (Pedaling)

A user pedals the bicycle-like mechanism, generating rotational motion. The pedals drive a crankshaft connected to a chain or belt system, transmitting torque to the flywheel.

Mechanical Transmission

Gear System: Adjustable gear ratios optimize rotational speed (RPM) and torque. For example, a 1:3 gear ratio reduces pedaling resistance, allowing sustainable effort while maintaining generator

efficiency.

Flywheel: A weighted flywheel stabilizes irregular pedaling motion, ensuring smooth and consistent rotation of the generator shaft.

Mechanical-to-Electrical Conversion DC Generator (Motor): The rotating flywheel drives the generator's rotor, which contains permanent magnets. As the rotor spins within the stator's copper coils, electromagnetic induction generates an alternating current (AC).

Rectification: A bridge rectifier converts the AC output into direct current (DC) for compatibility with batteries and electronic devices.



Fig- 3.3: Pedal Powered Electricity Generator

Voltage Regulation and Energy Storage

6V Battery: Stores the generated DC electricity, enabling energy use during non-pedaling periods. Power Distribution

DC Output: Directly powers low-voltage devices (e.g., LED lights, USB chargers) via 5V and 12V ports.

Monitoring and Feedback

Energy Meter: Measures real-time power output (watts) and cumulative energy generated (watt-hours).

3.5 The List of Devices Used in the Project

- Generator Motor
- Bicycle Gear
- Battery
- Monitoring Device

3.6 Generator Motor

A dynamo motor (often simply referred to as a dynamo) is a type of electrical generator that converts mechanical energy into electrical energy using electromagnetic induction. The term "dynamo" was originally used to describe a type of machine that generated direct current (DC) electricity, but the principle applies to many different forms of mechanical to electrical energy conversion, including in pedal-powered systems.

In the context of a pedal-powered electricity generator, the dynamo motor plays the crucial role of converting the rotational mechanical energy produced by pedaling into electrical energy, which can then be stored or used to power devices.

3.6.1 Specifications

- Motor Name: Power Generator Motor
- Model: DN-8112
- Power: 800W
- Motor diameter: 42MM
- Motor length: 81.3MM
- Output shaft: 5.1MM (it is the flower shaft)
  -Outlet length: 16.5MM. (From the panel)
- Screw hole: M 3.5
- Screw hole pitch: 29.5MM
  -Weigh: 450gm



Fig-3.4: Generator Motor

3.6 Bicycle Gear

The pedal-powered generator employs a single pinion system for its bicycle gear mechanism, prioritizing simplicity and reliability. This design uses a fixed gear ratio to directly transmit pedaling effort from the chainring (front gear) to the pinion (rear cog) via a standard bicycle chain. By eliminating complex multi-gear setups, the system reduces mechanical failures and maintenance needs while ensuring consistent energy transfer to the generator. The fixed ratio balances pedaling effort with rotational speed, allowing users to sustain a comfortable rhythm while optimizing power output. Constructed from repurposed bicycle components and a custom pinion, the system minimizes costs and enhances durability for rural or off-grid use. Its straightforward design aligns with the project's goals of affordability, sustainability, and user accessibility, making it ideal for non-technical operators in diverse settings.

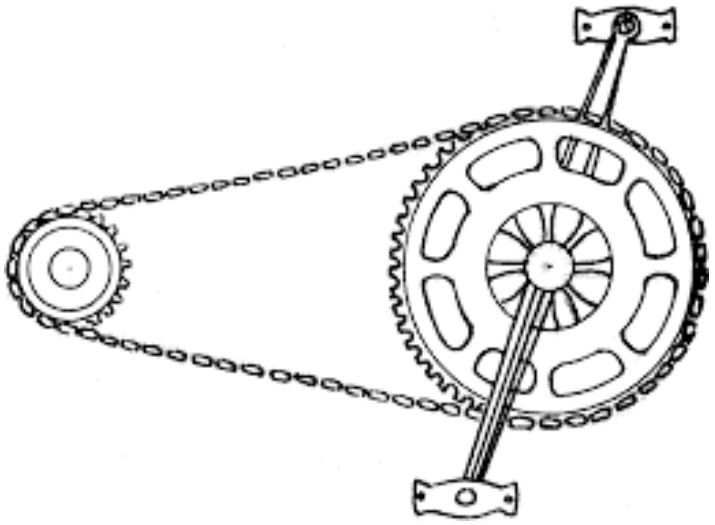


Fig-3.5: Single Pinion System

3.7 Battery

The RB645 is a sealed lead-acid rechargeable battery designed for reliable and maintenance-free power in various low-voltage applications. Its compact and enclosed design makes it suitable for environments where safety, durability, and longevity are essential. Because it is sealed, it can operate in any orientation without the risk of acid leakage, and it requires no watering or maintenance. This type of battery is ideal for emergency lighting systems, security alarms, UPS units, and other backup power supplies. With built-in safety features and a stable power output, the RB645 ensures consistent performance and is environmentally responsible, as it is recyclable and marked for proper disposal.

Specifications:

Model: RB645

Battery Type: Sealed Lead-Acid (SLA),

Rechargeable Nominal Voltage: 6V

Capacity: 4.5Ah

Cycle Use Voltage Regulation: 7.20V – 7.50V

Standby Use Voltage Regulation: 6.75V – 6.90V

Maximum Charging Current: 1.35A



Fig-3.6: Battery

3.9 Monitoring Device

The device in the image is a DT-830D Digital Multimeter, a compact and versatile electronic measuring instrument used to monitor and diagnose electrical and electronic systems. It is widely used in laboratories, workshops, and field applications for testing voltage, current, resistance, and more. The DT-830D features a rotary switch that allows the user to select the desired measurement function and range, such as AC/DC voltage, DC current, resistance, and diode checking. Additionally, it includes ports for connecting test leads and a digital display for real-time readings. This multimeter is an essential tool for technicians and engineers for monitoring the status and health of electrical circuits, ensuring safety, and aiding in troubleshooting faults.



Fig-3.7: Monitoring Device

Chapter 4

Results & calculation

4.1 Data table

S/N	Driver (N_1) RPM	Driven (N_2) RPM	Time	Generating Source	Voltage (V)	Current (A)
1	60	147	2 min	DC	0.9V	0.14A
2	66	161	2 min	DC	0.99V	0.154A
3	73	178	2 min	DC	1.09V	0.17A
4	79	193	2 min	DC	1.18V	0.185A

4.2 Sample calculation

Given,

Pinion -1 : Number of teeth (T_1) = 44

Pinion -2 : Number of teeth (T_2) = 18

Pinion -1 : Driver (N_1) = 60 RPM

= 66 RPM

= 73 RPM

= 79 RPM

Pinion -2 : Driven (N_2) = ?

For Sample ,

1. $T_1N_1 = T_2N_2$

$$N_2 = T_1N_1 / T_2 = \frac{44 \times 60}{18} = 147 \text{ RPM}$$

Voltage = 0.9 V

Current = 0.14 A

Power = (0.9 ×0.14) = 0.126 W

2. $T_1N_1 = T_2N_2$

$N_2 = T_1N_1 / T_2$

$= \frac{44 \times 66}{18}$

= 161 RPM

Voltage = 0.99 V

Current = 0.154 A

Power = (0.99×0.154) = 0.152 W

3. $T_1N_1 = T_2N_2$

$N_2 = T_1N_1 / T_2$

$= \frac{44 \times 73}{18}$

= 178 RPM

Voltage = 1.09 V

Current = 0.17 A

Power = (1.09 ×0.17) = 0.185 W

4. $T_1N_1 = T_2N_2$

$N_2 = T_1N_1 / T_2$

$= \frac{44 \times 79}{18}$

= 193 RPM

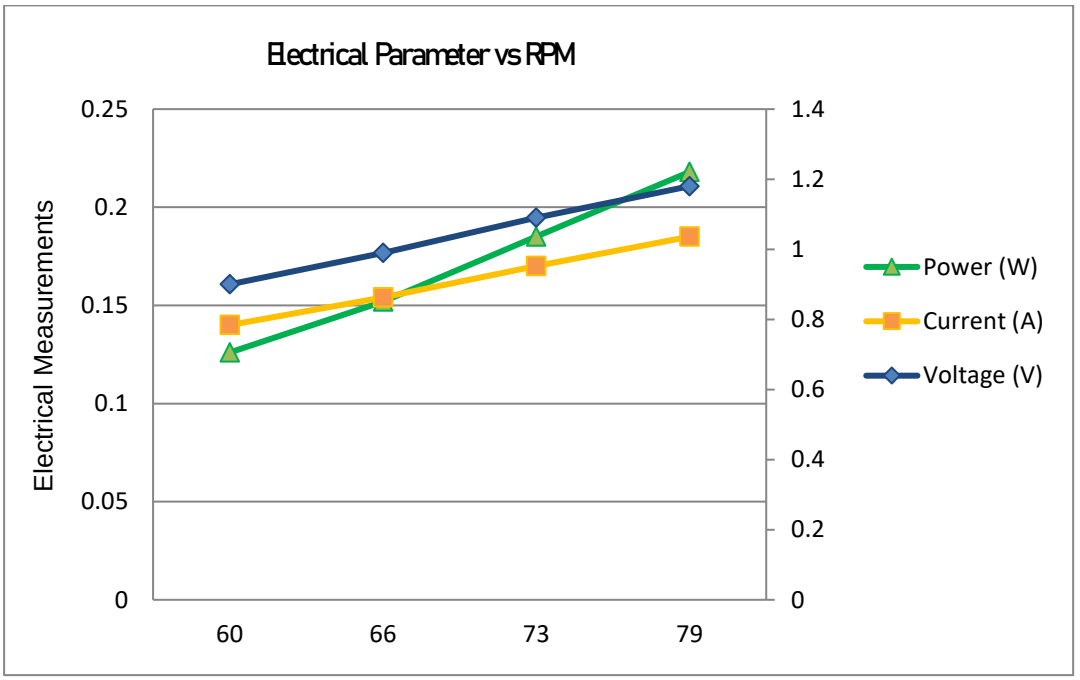
Voltage = 1.18 V

Current = 0.185 A

Power = (1.18 ×0.185) = 0.218 W

4.3 Graph line Chart

Driver (RPM)	Voltage (V)	Current (A)	Power (W)
60	0.9V	0.14A	0.126W
66	0.99V	0.154A	0.152W
73	1.09V	0.17A	0.185W
79	1.18V	0.185A	0.218W



RPM

Chapter 5

Discussion

5.1 Discussion

The study aimed to examine how varying the rotational speed of an electrical machine influences its output voltage, current, and power. Data were collected across four different rotational speeds: 60, 66, 73, and 79 RPM. The measured electrical parameters show a clear and consistent trend of increase as the RPM rises. We use tachometer for the RPM test.

At the lowest tested speed of 60 RPM, the machine produced a voltage of 0.9 volts, a current of 0.14 amperes, and a corresponding power output of 0.126 watts. As the speed was increased to 66 RPM, these values rose noticeably to 0.99 volts, 0.154 amperes, and 0.152 watts, respectively. Further increments to 73 RPM resulted in outputs of 1.09 volts, 0.17 amperes, and 0.185 watts, while the highest speed of 79 RPM yielded the highest measurements—1.18 volts, 0.185 amperes, and 0.218 watts.

These results clearly indicate that the output voltage grows in a nearly linear manner as the speed of the machine increases. This trend aligns well with the fundamental principles of electromechanical energy conversion, where the induced voltage in a generator is directly proportional to the speed of rotation.

The smooth and predictable increase in voltage suggests that the machine is operating under stable electromagnetic conditions, without signs of core saturation or nonlinear magnetic effects.

The current also increases with speed, though its growth appears to be slightly nonlinear and more gradual compared to voltage. This may reflect the influence of a constant or moderately resistive load, where current is governed by both the increasing voltage and the system's electrical resistance. The moderate rise in current implies that while the machine is supplying more electrical energy at higher speeds, the system's impedance is limiting the current flow to a stable and safe level.

Electrical power, calculated as the product of voltage and current, shows the most significant increase across the range of speeds. Starting from a modest 0.126 watts at 60 RPM, it rises steadily to 0.218 watts at 79 RPM. The growth in power is a result of both rising voltage and current, and it reflects a higher rate of energy conversion from mechanical to electrical form. This increasing power output is indicative of enhanced performance and energy transfer efficiency as the machine operates at higher speeds.

In conclusion, the observed trends in voltage, current, and power clearly demonstrate that increasing the rotational speed of the machine results in higher electrical output. These results are consistent with theoretical expectations and provide valuable insights for the design and control of electromechanical systems. They emphasize the importance of speed control in optimizing electrical performance and highlight how operational parameters can be adjusted to achieve desired energy outputs in practical applications.

5.2 Advantages

- **Eco-Friendly Energy Source**

The system produces electricity without burning fossil fuels, helping reduce greenhouse gas emissions and environmental pollution.

- **Cost-Effective Solution**

It uses affordable and locally available materials like bicycle components and DC motors, making it accessible for low-income and rural communities.

- **Portability and Compact Design**

The lightweight and compact nature of the system allows it to be easily transported and used in various locations, including homes, schools, and outdoor areas.

- **Ideal for Off-Grid and Emergency Use**

This generator provides a reliable power source in remote areas without access to

electricity and during emergencies or natural disasters when grid power fails.

- **Promotes Health and Fitness**

By generating power through pedaling, users engage in physical activity, which promotes cardiovascular health while simultaneously producing electricity.

- **Educational Tool**

The system serves as an excellent demonstration model for teaching energy conversion, mechanics, sustainability, and human power applications.

- **Low Maintenance Requirements**

The simple mechanical design ensures long-term reliability with minimal maintenance compared to conventional power systems.

- **Scalable and Customizable**

The design can be adapted or scaled up for higher power generation or integrated with solar panels or additional units for greater efficiency.

- **Encourages Energy Awareness**

Users become more conscious of energy consumption as they physically contribute to electricity generation, promoting energy-saving behaviors.

- **Supports Sustainable Development Goals (SDGs)**

This technology contributes to multiple SDGs, including affordable and clean energy, good health and well-being, and climate action.

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5.3 Applications

◆**Rural and Off-Grid Electrification**

This system is ideal for remote villages and off-grid communities where conventional power infrastructure is absent. It enables basic electricity access for lighting, phone charging, and powering small devices.

◆**Emergency and Disaster Relief**

During power outages caused by natural disasters like floods, cyclones, or earthquakes, the generator can serve as a backup energy source for lighting, communication devices, and essential medical equipment.

◆**Educational Demonstrations**

It can be used in schools, colleges, and training centers to demonstrate principles of energy conversion, renewable energy technologies, and human-powered systems in a hands-on, interactive way.

◆**Fitness Centers and Gyms**

The generator can be integrated into exercise bikes to convert workout energy into electricity, promoting green fitness by allowing users to contribute to powering lights contribute to powering lights or small appliances during workouts

◆**Military and Field Operations**

Useful in remote military bases or field operations, the generator provides portable power for radios, lights, and charging equipment without relying on fuel.

◆**Camping and Outdoor Activities**

Campers and trekkers can use the system for off-grid charging of batteries, lights, and other essential low-power devices in the wilderness.

◆**Mobile Charging Stations**

The setup can be installed in community centers or public areas as a human-powered mobile phone charging station, especially in areas with limited grid access.

◆**NGO and Development Projects**

Non-governmental organizations working on sustainable development can deploy these systems to support livelihoods, education, and health in energy-deprived regions.

◆**Health Clinics in Remote Areas**

Basic health facilities can use the generator to power LED lighting, diagnostic tools, or vaccine refrigerators in areas lacking stable electricity.

◆**Home Use for Energy Savings**

In urban households, the system can be used to supplement power supply for small appliances, helping reduce electricity bills and raise environmental awareness.

Chapter 6

Conclusion

6.1 Conclusion

The development of the pedal-powered electricity generator demonstrates a practical and sustainable solution for decentralized energy generation. Through the successful integration of mechanical and electrical systems, the project has achieved its core objective of converting human mechanical energy into usable electrical power. The prototype system, constructed primarily with locally available materials, effectively generates sufficient electricity to power low-wattage devices such as LED lights, small fans, and mobile chargers.

Experimental results confirm that an increase in pedaling speed (RPM) directly enhances the output voltage, current, and power, validating the fundamental principles of electromagnetic induction and energy conversion. The system showed reliable performance within the tested range, with smooth energy transmission and minimal mechanical losses. Moreover, its ergonomic design allows ease of use, making it suitable for rural communities, educational institutions, emergency response scenarios, and fitness centers.

This project not only provides an eco-friendly alternative to fossil-fuel-based power generation but also promotes awareness of renewable energy and energy self-reliance. The low cost, portability, and ease of operation make it an accessible technology, especially for off-grid regions and areas with unreliable electricity infrastructure.

In conclusion, the pedal-powered generator is a step forward in the pursuit of clean, affordable, and user-driven energy solutions. With further optimization, such as hybrid integration with solar energy or advanced energy storage systems, the design can be scaled and adapted for broader applications in sustainable development.

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