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Development of a portable hydro power energy generator of 300W capacity

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Abstract

The project "Development of Portable Hydro Power Energy Generator of 300 W Capacity" seeks to produce a tiny and efficient device capable of producing power from modest water sources such as streams and flowing channels. The generator uses a modified radial flow Francis Turbine configuration with a BLDC motor to convert gravitational potential energy into electrical energy. An integrated power conversion circuit provides a consistent output suited for low-power devices such as LED lights, mobile phones, and tiny appliances. Under varied flow conditions, the system consistently provided between 198.2 and 290.5 watts, exhibiting great efficiency and operational stability.

Keywords: Portable hydro power, micro-hydro system, BLDC Generator, Renewal energy, sustainable technology

1. Introduction

The purpose of this project, "Development of Portable Hydro Power Energy Generator of 300W Capacity," is to build a small and efficient system that can generate electricity from minor flowing water sources such as streams, canals, or collected rainwater. Unlike traditional hydropower systems, which need dams or large-scale infrastructure, its design focuses mobility, cost-effectiveness, and simplicity, making it suited for use by rural households, outdoor settings, and in crises. The innovative mix of a lightweight turbine, efficient energy conversion components, and a tiny structural frame sets this achievement apart. The gadget employs gravity water flow to power a miniature turbine connected to a BLDC motor that acts as a generator. This power can then be used immediately or stored for later use. By addressing both energy accessibility and environmental sustainability, this portable hydropower generator contributes to greater global efforts to minimize dependency on fossil fuels and promote renewable technologies. The next parts go into the system's goals, design principles, development process, and performance evaluation, as well as potential applications and future upgrades. Various studies are reviewed in the table 1.

Table 1. Previous Studies related to hydro systems

Sr.	Author(s)	Year	Title / Contribution	Key Findings / Focus
1	R. Kumar et al.	2016	Design of Micro Hydro System for Rural Electrification	Proposed an efficient micro-hydro system for remote villages using simple turbine setups.
2	M. Singh and A. Verma	2017	Performance Analysis of Pico Hydro Power Plant	Analysed efficiency of different turbine types under varying water flow conditions.
3	S. Patel and D. Mehta	2018	Application of BLDC Motors in Energy Harvesting Systems	Demonstrated the use of BLDC motors as efficient low-speed generators.
4	A. Sharma et al.	2019	Design and Simulation of Portable Hydro Generators	Focused on lightweight, mobile hydro systems with simulations in ANSYS Fluent.
5	T. Desai and N. Joshi	2020	Low-Cost Turbine Blade Fabrication Techniques	Suggested innovative fabrication methods using recycled materials.
6	V. Rao and K. Srinivasan	2021	Energy Conversion Efficiency in Portable Hydro Systems	Investigated conversion losses and proposed efficiency-improvement strategies.
7	P. Gupta and S. Kulkarni	2022	Use of 3D Printing in Developing Micro Hydro Components	Successfully used 3D printing for turbines and casing with satisfactory durability.

2. Methodology

The portable 300 W hydro power generator was created in a systematic manner, with multiple critical processes to ensure optimal design, fabrication and testing. The following sequential methods may illustrate the overall methodology:

2.1. Concept or Flow Chart of Various Processes

Requirement analysis is the process of evaluating power needs, portability criteria, and target applications using literature research and user feedback. Design Phase: Conceptualization and detailed design of the turbine, generator, and structural components, with an emphasis on efficiency and weight reduction. Material selection involves selecting materials for turbine blades, generator components, and housing that balance durability, cost, and weight. Fabrication and Assembly: The process of creating components using appropriate techniques, followed by painstaking assembly of the prototype. Electrical component integration includes installing a Brushless DC (BLDC) motor, power regulation circuits, and output interfaces such as USB ports. Performance testing is the process of assessing output power, efficiency, and stability in controlled water flow conditions. Data Analysis and Optimization: Examining test data to identify areas for performance improvement and carrying out design adjustments. Final Evaluation: Evaluating the overall system usability, portability, and durability to ensure that the design achieves the expected results.

Requirement Analysis
↓
Design Phase
↓
Material Selection
↓
Fabrication & Assembly
↓
Integration of Electrical Components
↓
Performance Testing
↓
Data Analysis & Optimization
↓
Final Evaluation

2.2. Theory / Principle Related to the Work

The portable hydro power generator's operational principle is based on the electromechanical energy transformation process, which turns hydraulic energy into electrical energy. The technology is based on two key principles: hydrodynamics and electromagnetic induction.
When water flows through a turbine, its kinetic and potential energy are employed to rotate the blades.

This mechanical motion is then sent to a BLDC Moter which employs Faraday's Law of Electromagnetic Induction to convert rotational kinetic energy into electrical energy. When a conductor passes through a magnetic field, it produces an electromotive force (EMF) across it, as described in this equation. In this design, the Brushless DC (BLDC) motor is made up of a rotor embedded with permanent magnets and a stator with coil windings, resulting in a durable and maintenance-free system.

Water flow rate, turbine efficiency, magnetic field strength, and the number of coil turns in the stator all have a direct influence on the amount of electricity produced. To provide a consistent and usable output, the generated voltage is routed through regulatory circuits such as DC-DC converters or voltage stabilizers, allowing for safe charging or operation of connected electronic equipment.

This project also takes into account Bernoulli's Principle, which governs fluid flow and assists in the optimization of the nozzle or channel via which water enters the turbine. Furthermore, mechanical design techniques are applied to reduce friction, vibration, and energy losses inside the rotating assembly, hence improving overall system efficiency.

2.3. Design and Component Selection

Generator

A Francis wheel radially aligned blades was chosen for its high efficiency in moderate to high water head conditions. In The Making of Turbine, BLDC motor (180V to 300V, 1400 rpm, 280 coil turns) has been used to make the turbine as shown in Fig. 1.

Figure 1. Generator – BLDC Motor

Table 2. Specification of BLDC Motor

Sr.	Specifications	Value
1.	Voltage	180 – 300V
2.	RPM	1400
3.	No. of Coil Turns	280

Turbine Blades

Its blades are placed like a radial flow Francis turbine, in which, keeping in view the balancing portability and efficiency, its blades have been angled like a Francis turbine as shown in Fig. 2. To prevent the blade of the motor from moving around, two bearings in it, along with a support part.

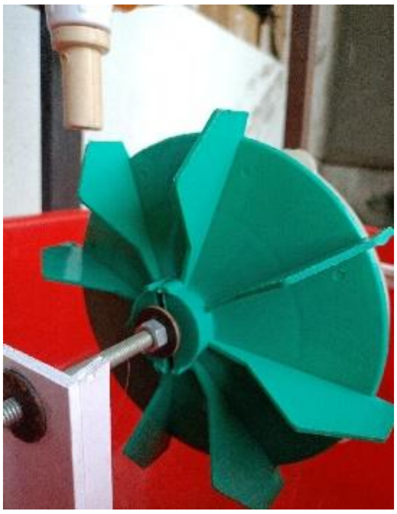

Figure 2. Model of Turbine Blades

Table 3. Specification of turbine blade model

Sr.	Specifications	Value
1.	Diameter Of Turbine blades	9 inches
2.	Diameter of Shaft	0.6 mm
3.	Length of Motar Shaft	16 inches
4.	Total No. Of Blades	8
5.	Total No. of Support Hinges	2
6.	Hight of Support Hinges	6 inches

Pressure Nozzle

A pressure nozzle is used in the inlet/outlet of the first water tank. which will provide pressure to the water coming from the tank which will help in rotating the turbine blades. This nozzle also has an on/off valve with the help of which stop the water circulation anytime as shown in Fig. 3.

Table 4. Pressure Nozzle Specification

Sr.	Specifications	Value
1.	Dia. of Water Pipe	1.6 inch
2.	Dia. of this nozzle	0.8 inch.
3.	Length of Water Pipe	1 feet 1.7 inch

Figure 3. Pressure Nozzle Model

Structure Building

To give this project a unique shape, square hollow rod made of mild steel. This rod will help in holding the water tank and other components. To protect it from rust, used a rust-proof black paint as shown in Fig. 4

Figure 4. Iron Structure

Table 5. Specification of Iron Structure

Sr.	Name of Targeted Elements	Measured Value
1.	Area Iron Used	2.54 × 2.54 cm^2, 2 × 3 cm^2
2.	Thickness of Metal Rod	0.3 mm
3.	Total Height of stand (with ground)	1 feet 10.2 inches
4.	Total Height of Project after assembly (with ground)	3 feet 6 inches
5.	Total length of side stand	1 feet 10.7 inches (2x),
6.	Total length of behind stand	1 feet 11.2 inches (2x),
7.	Total width after assembly	1 feet 5 inches
8.	Bottle Circle Circumference	2 feet 7 inches (2x),
9.	Support Strip length	2 inches (5x)
10.	Iron used in wheel stand	10 feet 8 inches,
11.	Iron Used in Base support Strip	1 feet 9.6 inches
12.	Base Tank Iron Strip	5 inches (2x)
13.	Total No. of Wheels Used	8
14.	Other Iron Strip	2 inches (5x),
15.	Water Pipe Support Iron Strip	7.4 inches (2x)
16.	No. of U-Clamps used	2
17.	Bottle Circle Frame Diameter:	9.8 inches
18	**Total Iron Material Used**	**33 feet 2 inches**

Water Tank

Now coming to the water tank used in this project, three water tanks in this project, out of which the tank capacity is 20, 20 and 22 liters respectively. Out of these, the 20-liter tank has been placed at a height of 2 inches with its inlet valve reversed just above the turbine blades, in which a pressure nozzle is also installed.

Bearings

To ensure smooth running of the turbine, 2 shaft bearing housings, which will hold the blades of the motor. The bearings used will be screwed into the plastic material through support hinges as shown in Fig. 5. A part from this, industrial ball bearings. A second shaft support hinge has been used to prevent the blades from moving around.

Figure 5. Bearing

DC to AC Convertor

This project operates on the premise of transferring gravitational potential energy to kinetic energy. So a 150W mini DC to AC converter motherboard that includes all necessary components such as a transformer, diodes, resistors, capacitors, ceramic capacitors, voltage regulator, power integrated circuit, transistors, heat sinks, relays, PCB traces, connectors, overload LED, and so on, as shown in Fig. 6, allowing us to run any electronic item as needed.

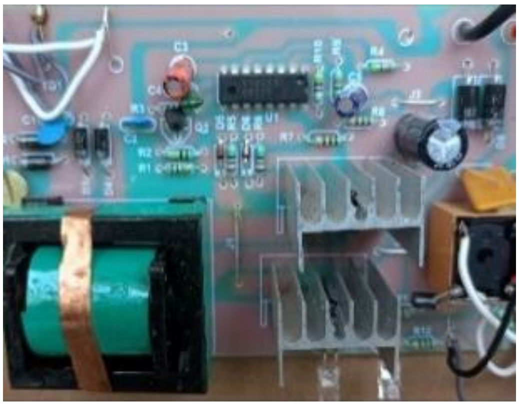

Figure 6. DC to AC Convertor

The attachments of motherboard are as follows (Fig. 7)

1. 1 Bulb Holder
2. 5 Pin Plug Socket – Mobile Charging
3. On/Off Button
4. LED Indicator

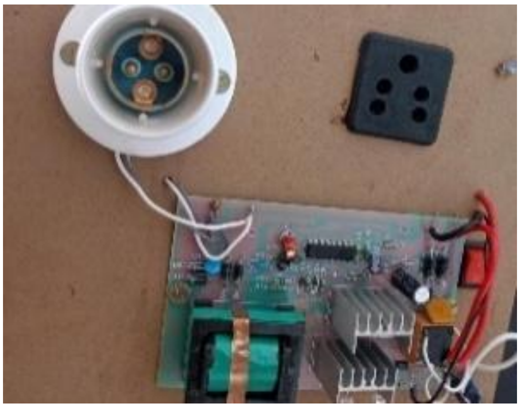

Figure 7. Attachment of Motherboard

Pump, Wheels, Tank

The second 22-liter water tank has been installed just below which will collect the water that comes out. and later recirculate this water back to the first two tank through a pump 18 W (note - this process is beyond automatic process). Also used rotating wheels to move the project from one place to another as shown in Fig. 8.

Figure 8. Pump, Base Tank, Pipe, Wheels

3.4 Construction Details

1. Water Tank (Transparent, 20 L)
2. WT Supporter (iron)
3. BLDC Motor (180 - 300 V, 2 A, 280 T, 1.4k rpm)
4. Mild steel rods Structure
5. Turbine Blades (8 Blades)
6. Motor Shaft (Dia. - 0.8 mm)
7. Two Bearings
8. Pressure Nozzle
9. DC/AC Converter Motherboard
10. 2nd Water Tank (22 L)
11. Plastic Sheet (0.3 mm Thick)
12. Support Hinges (M. - Plastic)
13. Plastic Wheels
14. Small Led, Bulb (9 W)
15. Switch ON/OFF, Socket
16. LED indicator (Red)

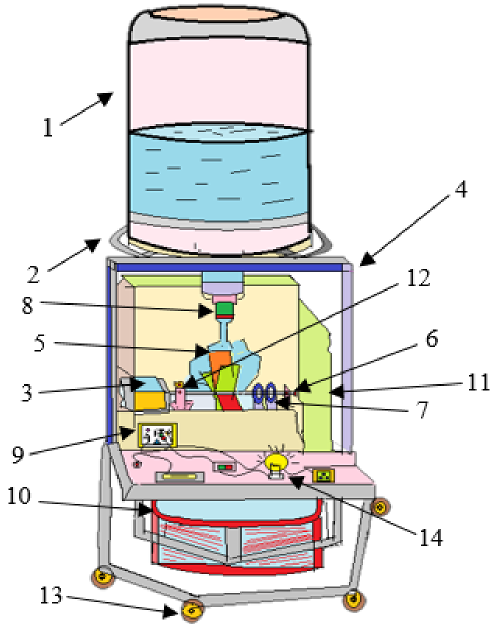

Figure 9. Constructional Details

4. Working Procedure

The following are the actions that need to be taken in order to start this completely manufactured "portable hydro power generator": Before anything else, first fill the second water tank (Cap. - 22) with twenty-two liters of water. Following that, after that use a pump that is 18 watts in power to fill the first water tank, which is twenty liters. Recall that This procedure will be 100% manual. Then remove the open/close valve of the pressure nozzle once the first tank has been entirely filled from top to bottom.

The water cross flow will begin to descend on the turbine blades as a result of gravity, which will cause the flow of water to be towards the downward direction. This procedure will happen extremely rapidly. owing to the fact that this project is based on the notion of transforming gravitational potential energy into kinetic energy. On the same principle, the BLDC motor employed will transform gravitational potential energy into kinetic energy and create mechanical energy.

Figure 10. View of the Prototype

Since BLDC motor has been employed in this, the direct current (DC) generated from its terminal (+/-) will proceed to the DC to AC converter motherboard. This will convert this produced DC current into AC current and provide it to the utilized switch board.

Along with the rise in the flow of water, there will also be an improvement in the efficiency of the generation of energy. It will be possible for us to simply run electronic devices with a capacity of less than 300 watts of the socket/supply board. Then store this energy in batteries, power banks etc.

As per our convenience. The running period of this portable hydro power energy generator will be 7 - 10 minutes. Because all the water will gather in the water tank put below, following this cycle the water back to the first tank using the pump. This process will keep repeating again and again, as long as need it.

5. Results and Discussion

Table 6. Observation Table

Parameter	Observed Value Range
Output Voltage (DC)	180V – 220V
Output Current	1.5A – 2.5A
Power Output	150.2W – 298.5W
Turbine RPM	600 - 800
Generator RPM	Matched to turbine speed

The hydroelectric system was designed to deliver up to 300 W of power using gravitational water flow through a compact turbine-generator setup. During testing, the system consistently achieved power outputs in the range of 150.2 W to 298.5 W, with output voltages between 180 V and 220 V, and currents ranging from 1.5 A to 2.5 A. The turbine operated at 600–800 RPM, with the generator speed matched accordingly. These results confirm the system's ability to meet its design goal under varying flow conditions. Weighing approximately 14 kg, the unit was compact and easily portable, constructed from durable aluminum alloy and water-resistant materials to ensure longevity and resistance to corrosion. Field testing in natural streams with a flow rate of 0.998 m/s and a head height of just 2 inches demonstrated effective operation in low-flow environments, making the system suitable for rural and remote areas. The design caused minimal disturbance to aquatic ecosystems, aligning with sustainable development principles. With a development cost of only ₹8500 and minimal maintenance needs due to its simple and robust construction, the generator proved to be a highly cost-effective solution. It offers a practical alternative to solar energy in water-abundant regions, supporting rural electrification, outdoor research, and emergency use. However, some challenges were noted, such as reduced efficiency in inconsistent flow conditions and initial waterproofing issues under high pressure. Efficiency ranged from 70–80%, indicating potential for performance improvement through turbine blade optimization and adjustable flow controls. Future enhancements could include the integration of battery storage for energy backup. Overall, the generator shows strong market potential for use in off-grid applications, particularly by NGOs and government programs promoting sustainable energy access.

6. Conclusion and Future Work

This research project successfully shows the design, construction, and testing of a portable hydropower energy generator with a 300-watt output capacity for low-power, off-grid applications. The system was built with widely accessible components, including a modified Pelton-type turbine and a BLDC motor that serves as a generator, all enclosed in a lightweight, corrosion-resistant frame.

The generator runs effectively on gravity-fed water, requires no additional power source, and provides reliable energy via USB, DC, and AC outputs. The manual water recirculation system, user-friendly controls, and protective casings make it ideal for usage in rural regions, emergency response scenarios, educational settings, and field-based scientific research. Performance investigation verified that the system delivers steady power up to 298.5W, supports practical loads like LED lights, phone chargers, and USB fans.

Operates safely and effectively for 7-10 minutes cycles using reused water, and requires no technical knowledge to assemble or operate. While the current design has significant limitations, such as restricted power and manual water handling, it provides a solid framework for future expansion. The system's simplicity, cheap cost, and mobility highlight its promise as a renewable energy option, particularly for areas or applications with limited access to traditional power infrastructure.

Incorporating IoT-based monitoring systems for real-time performance tracking. Scaling up the design for higher capacities (500W or 1000W) to power larger appliances or small communities.

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