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Feasibility Study of Mini Hydel Power Plant

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Abstract: This research paper presents a practical implementation and analysis of a small-scale hydroelectric generation plant designed for an educational institution. The project utilizes rooftop rainwater harvesting, a vertical Kaplan turbine, and solar-assisted pumping to generate renewable energy. Detailed design parameters, turbine selection, prototype testing, annual energy output, and economic analysis are discussed. The model serves not only as a viable green energy solution but also as a demonstrative educational tool.
Keywords: Hydropower, Kaplan Turbine, Micro-Hydro, Renewable Energy, Sustainable Campus, Rainwater Harvesting.

I. INTRODUCTION

Small-scale hydropower harnesses renewable energy from flowing water, offering efficient, environment-friendly electricity. In this project, a compact hydropower system using rooftop rainwater is developed for an academic institution. The combination of civil, mechanical, and electrical disciplines aims to reduce dependency on grid power while promoting sustainable development.

II. LITERATURE REVIEW

Relevant literature highlights global progress in distributed generation, Kaplan turbine optimization, feasibility of urban hydro systems, and integration of hybrid renewable energy sources. These studies underline the viability of small hydropower in rural as well as institutional urban contexts.

III. METHODOLOGY

1) Site Selection: College rooftop with adequate rainwater collection potential
2) Discharge Measurement: 249.84 L/min (0.004164 m³/s
3) Head: 13 meter
4) Power Output Calculation: 424.83 W theoretical, 297.38 W actual (after generator efficiency
5) Turbine Design: Vertical Kaplan type, 30 mm runner, 10 mm shaft, 5 blade
6) Component Design: Includes intake, penstock (50 mm dia.), forebay, draft tube, and generato
7) Prototype Development: 3D printed components, tested on-site

Fig.no.1. Calculation of head with the help of the total station.

Fig.no.2. Taking the staff reading help of total station

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Fig.no.3. Selection of water tank location

Fig.no.4. Selection of turbine location

In India, the classification of small, mini and micro schemes has been done by the Central Electricity Authority (CEA) based on total station capacity as well as unit rating Indian standard code IS: 12800 (Part-111)-1991 defines small hydro up to 15MW station capacity.

Table-I. Classification of Mini Hydro Schemes Depending on Capacity

Type of scheme	Station capacity (KW)	Unit rating (KW)
Small hydro	25000	1001-5000
Mini hydro	2001-25000	101-1000
Micro hydro	1001-2000	100
Pico hydro	10-100	-

Mini hydro plants are also classified according to the "Head" or the vertical distance through which the water is made to impact the turbines. The usual classifications are given below.

Table-II. Classifications of Mini Hydro Schemes Depending on the Available Head

Ultra-low head	Below 30 meters
Medium head	30 to 75 meters
High head	Above 75 meters

IV. COMPONENTS OF PROTOTYPES HYDROELECTRIC MODEL

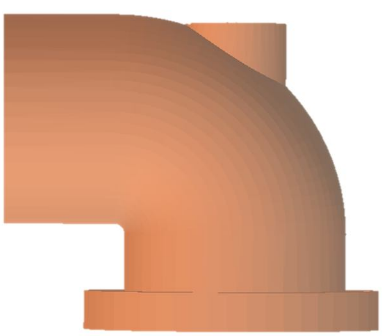

Fig.no.5. Elbow Casing

Fig.no.6. Shaft

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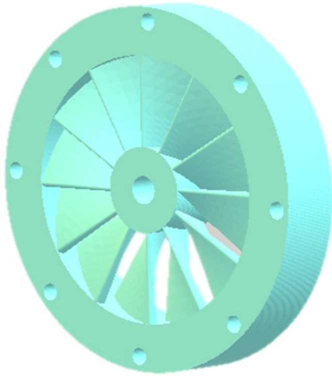

Fig.no.7. Wicket

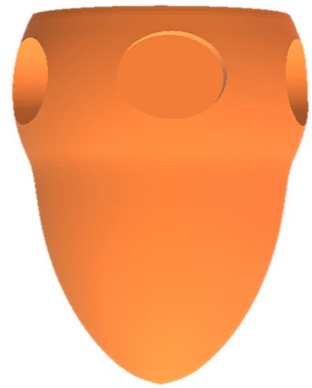

Fig.no.8. Runner

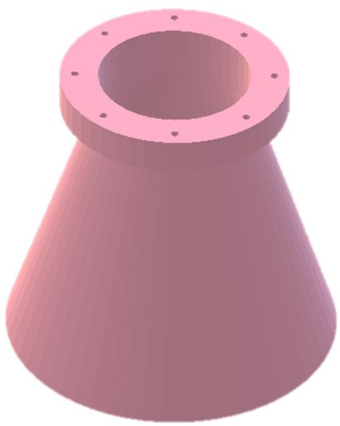

Fig.no.9. Draft tube.

Fig.no.10. Blade.

V. SYSTEM DESIGN AND CALCULATIONS

- Intake Area: 0.01388 m^2 (velocity limited to 0.3 m/s)
- Penstock Flow: Velocity = 2.12 m/s, Head loss = 0.18 m
- Generator Matching: PMDC motor or bicycle dynamo (70% efficiency)
- Annual Energy Output: 1085.44 kWh/year (10 hr daily use)
- Freeboard/Safety: 20% water depth allowance, 1.3 bar pressure rated pipes

VI. RESULTS AND DISCUSSION

- System classified as micro-hydro (<1 kW)
- Annual savings potential in grid dependency
- Educational benefits through real-time demonstration
- Prototype performance validated through testing

VII. ECONOMIC ANALYSIS

- Total Estimated Cost: ~Rs. 11,500 – 12,000
- O&M Cost: Rs. 500–700 annually
- Cost per kWh (5 years): Rs. 2.67/kWh

VIII. CONCLUSION

The implementation of a small hydroelectric power system within a college campus demonstrates both technical feasibility and cost-effectiveness. It aligns with sustainable development goals and offers a scalable model for educational and remote area applications.

IX. ACKNOWLEDGMENTS

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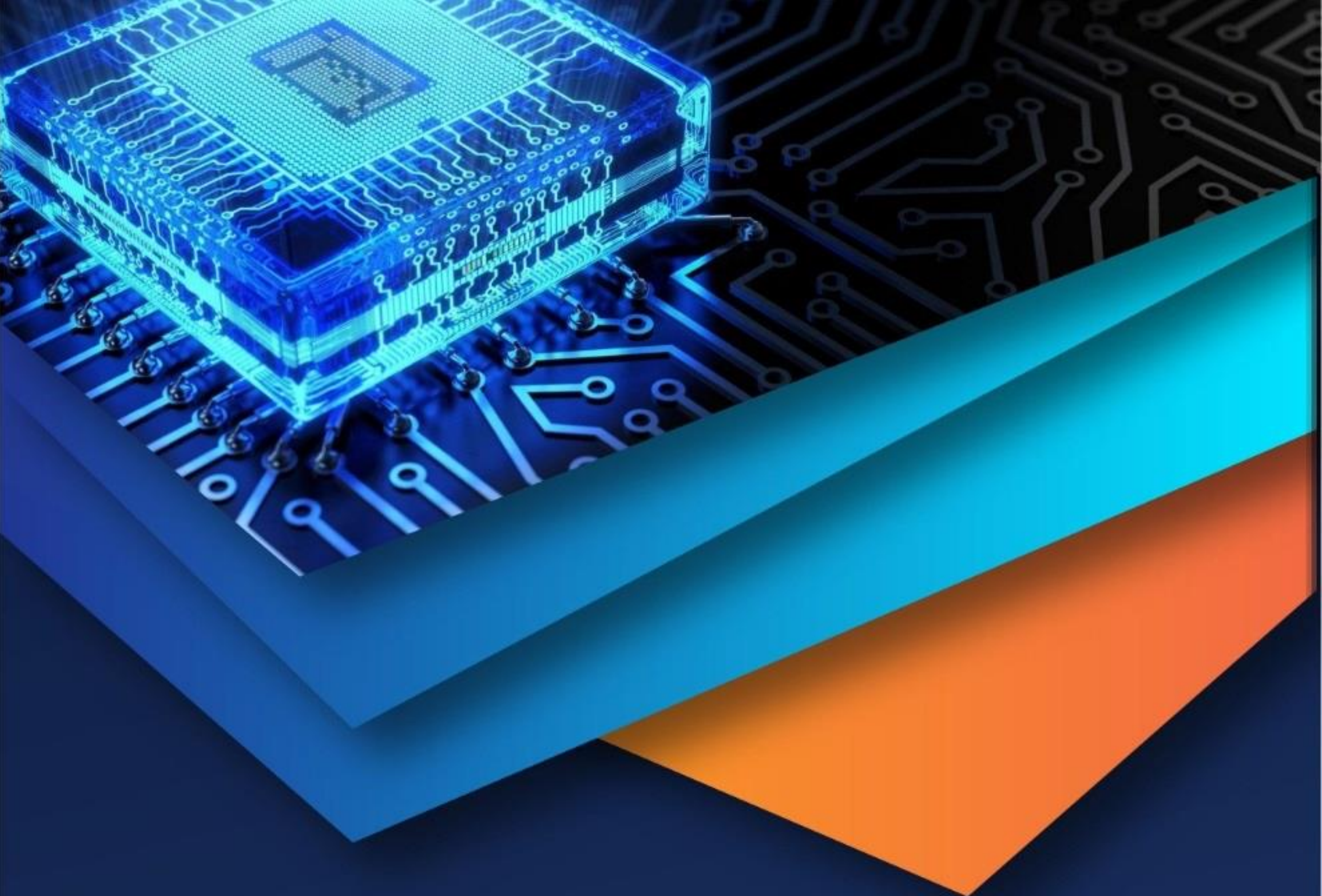

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