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Sustainable Dual-Purpose Water Pump and Generator Using a Reused Bike Engine

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Abstract

The unreliable electrical supply and costs of running independent pumps and power generation systems may limit their use for water pumping in rural areas. This paper outlines the development of a multi-functional system involving the reuse of a 97.2 cc motorcycle engine for both water pumping and electricity generation. Both a self-priming centrifugal pump and a 24V 40A DC generator were attached to the reused engine using a chain-sprocket drive. The design of the multi-functional system was based on calculations of engine power and generator output, as well as testing of water delivery rate and electric power. The experiment was conducted at an engine speed of 3000 rpm, with a calculated engine power of about 2.5 kW. With these test parameters, the pump was able to deliver up to 70 L/min, while the generator could produce 22-24V with a current of 40A, corresponding to a maximum calculated electrical output of 960 W. The results indicate that the used motorcycle engine is capable of offering both hydraulic and electric services through a combined system. This configuration has been proposed as an approach for use in rural areas where an efficient and reliable energy conversion system is required. Further investigation would include the quantification of fuel use, hydraulic efficiency, transmission efficiency, electrical efficiency, and emissions under varying operating conditions.

Keywords: Dual-Purpose System, Water Pumping, DC Generation, Reused Motorcycle Engine, Centrifugal Pump, Rural Applications.

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1. Introduction

Access to reliable energy sources and water pumping are essential for productivity in agriculture and for domestic purposes. Energy is used in pumping, and the energy requirement for irrigation is dependent on pumping head, discharge rate, equipment efficiency, and pump operation. Some researchers have investigated the relationship between water and energy in small-scale irrigation and energy considerations related to pumping technologies [1], [2]. There have also been techno-economic evaluations of pumping using diesel, electricity, and renewable energy [3]. Solar powered pumping systems have been considered a viable option due to their ability to cut the cost of reliance on grid power and fuel-driven systems [4], [5]. Solar-powered pumping systems, however, are subject to solar presence, and storage and backup arrangements and proper system sizing. For rural residents who already have access to abandoned or under-utilized mechanical parts, utilization of such parts is yet another alternative.

This research focuses on a compact, dual-purpose setup whereby the same reused motorcycle engine is used for pumping water through a centrifugal pump and powering a direct current generator. The idea is that this would reduce the need for different prime movers and utilize an otherwise unused motorcycle engine. Thus, the system meets two rural needs through one source of mechanical energy [6], [10]. In addition to reducing the number of prime movers, the integrated configuration provides an opportunity to coordinate water delivery with small-scale electrical demand. The same engine would thus be used based on the priority of the application, where the shaft power is shared between pumping and power generation. This is especially applicable in decentralized systems where space and maintenance facilities are limited [1], [6], [11].

The significant contribution of this research is the application and practical usage of a used 97.2 cc motorcycle engine coupled with a centrifugal pump and a DC generator through a chain-sprocket drive system. This research differs from previous studies, which considered only electrically driven or solar-driven pumps, since this system involves both hydraulics and electrical energy production from the same reused mechanical power source [7], [8], [10].

1.1 Objectives

- To design and fabricate a dual-purpose system powered by a reused motorcycle engine.

- To achieve simultaneous water pumping and electrical power generation.
- To utilize readily available mechanical components and reduce system cost.
- To demonstrate practical operation suitable for rural agricultural and domestic applications.
- To evaluate the reported water discharge and electrical output under practical test conditions.

2. Energy Efficiency in Pumping Systems

The efficiency of pumping systems is especially sensitive to issues like equipment choice, operating point, control scheme, and system losses. Studies on centrifugal pumping systems stress the significance of wisely choosing components, appropriate system sizing, and control of the operating point [7]. Modern studies have shown the need for experimental observation and optimization in pumping systems to achieve energy efficiency gains [8], [9]. For agricultural purposes, the interplay between water and energy use is viewed in terms of the water-energy-food nexus. Sawant et al. provided a methodology to measure the relationships between crops, irrigation water, and energy in small-scale irrigation systems in India [1]. Water-energy-carbon metrics for evaluating agricultural groundwater pumping systems have been introduced in the field [2]. These research efforts further support the necessity of proper pumping technology in terms of size and energy usage.

Solar-powered pumping is one of the most important methods for remote agricultural purposes [4], [5]. Its performance can depend on variations in resource availability and electrical power conditioning or energy storage needs. There are still research works dealing with the performance evaluation of such systems [10], [11]. The current research takes an alternative approach in that a repurposed internal combustion engine is used as the main source of power and two different uses are derived from one mechanical source of energy. It appears from the literature review that there is a necessity to analyze the performance of pumping systems not only based on the performance in pumping water, but also based on energy consumption, operating costs, and sustainability [3], [6]. This system can contribute to this research topic in terms of repurposing and multi-functionality. More research is needed to test energy and environmental performance.

The maintainability of the proposed configuration is one more significant aspect. Utilization of the motorbike engine provides an opportunity to consider readily accessible mechanical and serviceable components during the maintenance process. Moreover, it should be emphasized that correct alignment, chain tensioning, lubrication, and loading are necessary for reliable functioning owing to the combined loading of the pump and generator. These useful aspects, along with the energy and efficiency issues discussed above, complement previous research [7, 8].

3. Proposed System and Methodology

The design includes a 97.2 cc engine from a used motorcycle as the main source of energy. Transmission of mechanical energy is achieved using a chain and sprocket assembly to a self-priming centrifugal water pump and a 24-volt, 40 ampere DC generator. The entire assembly is mounted on a mild steel structure. The engine converts chemical energy into mechanical energy in the form of shaft power while the transmission delivers the mechanical energy to the hydraulic and electrical systems [7], [11], as illustrated in Figure 1.

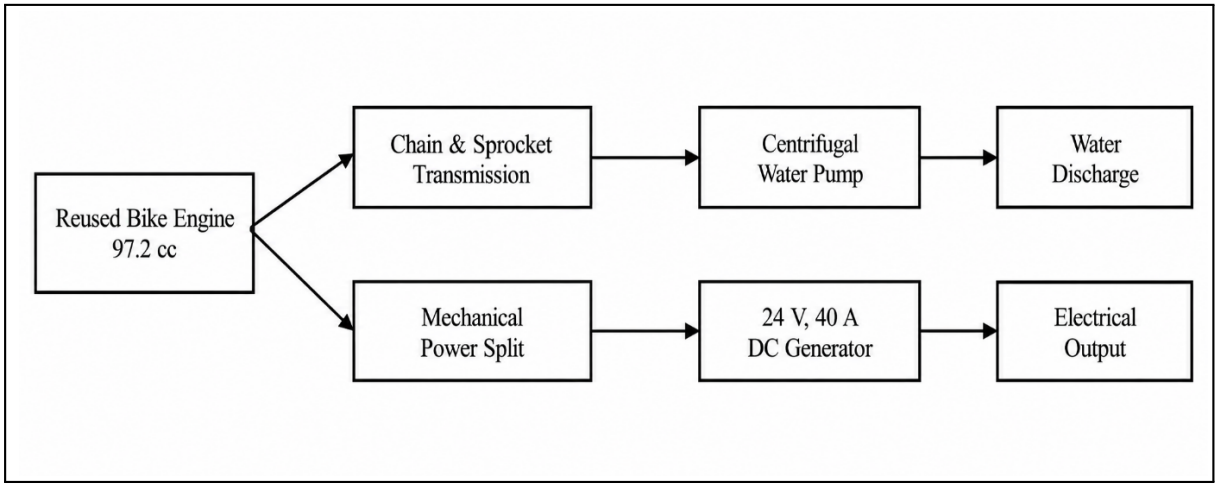


Figure 1. Proposed dual-purpose system architecture.

3.1 System Components

The system consists of modified engine, centrifugal water pump, DC generator, mechanical transmission, and frame. The 97.2 cc motorcycle engine acts as a primary source of energy generating the necessary mechanical energy for driving the electrical and pumping devices. The drive mechanism is directly linked with the self-priming centrifugal water pump,

supplying the flow of water. Based on the operating conditions, the chosen pump has a discharge rate of between 40 and 70 L/min.

The 24 V, 40 A DC generator with an output capacity of up to 960 W is included for the conversion of some of the produced mechanical energy into electrical energy. A chain and sprocket drive system is employed for power transfer from the engine to the driven components. A Mild steel frame is used to mount the entire system and align the engine, pump, and generator. Table 1 contains the basic elements and their primary functions.

Table 1. Major components of the proposed system.

Component	**Specification**	**Function**	**Remarks**
Motorcycle engine	97.2 cc	Prime mover	Reused engine
Water pump	Self-priming centrifugal	Water pumping	Reported discharge 40–70 L/min
DC generator	24 V, 40 A	Electrical generation	Maximum rated output 960 W
Transmission	Chain and sprocket	Power transmission	Connects engine to driven units
Frame	Mild steel	Structural support	Supports engine, pump and generator

3.2 Working Principle

The engine is started and operated at the reported test speed of 3000 rpm. The engine's shaft acts as the mechanical input for the chain-and-sprocket transmission. The transmitted mechanical energy drives both the centrifugal pump and the DC generator. The centrifugal pump generates water discharge, whereas the generator acts as an energy converter, converting some of the mechanical input energy into electrical energy. Since both subsystems get their energy from the same source, the total engine power must be shared between hydraulic, electrical, and mechanical losses [7]. The arrangement is intended to operate as a compact multifunctional unit. The water-pumping subsystem could be used for irrigation purposes or household water transportation, and the electric subsystem for supplying various DC devices

depending on the generator parameters and load requirements.

During operation, the two driven units must be considered connected loads rather than separate machines. An increased electrical load may lead to higher mechanical load on the engine, and an increased hydraulic load will influence the engine rpm and power generation capacity. Therefore, proper engine functioning and load sharing are crucial to ensure efficient operation of both circuits [7], [8], [9], as illustrated in Figure 2.

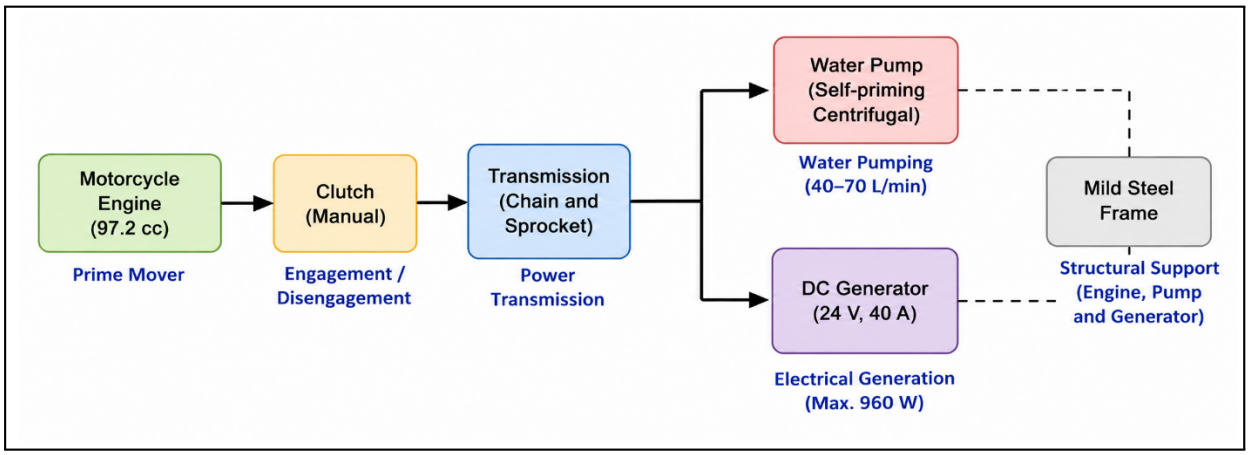


Figure 2. Experimental workflow for the proposed methodology

3.3 Design Calculations

The design calculations were carried out to determine the available power from the engine shaft and the electricity generated by the DC generator. The available mechanical power is allocated between the pumping and electrical-generation branches through the chain and sprocket drive.

3.3.1 Engine Shaft Power: The engine shaft power was estimated using,

$$P_{eng} = \frac{2\pi NT}{60} \tag{1}$$

where N is engine speed (rpm) and T is torque (N•m). For $N = 3000 rpm$ and $T = 8.05\ N \cdot m$.

$$P_{eng} = \frac{2\pi(3000)(8.05)}{60} = 2530.6\ W \approx 2.53\ kW \tag{2}$$

Thus, the estimated engine shaft power at the reported operating condition is approximately 2.5 kW.

3.3.2 Generator Electrical Output: The generator electrical output was calculated from,

$$P_{el} = VI \tag{3}$$

Using the reported maximum values of $V = 24\ V$ and $I = 40\ A$.

$$P_{el} = 24 \times 40 = 960\ W \tag{4}$$

Therefore, the maximum electrical output obtained is 960 W. This is the output achieved from the measured values of voltage and current and cannot be regarded as generator efficiency.

3.3.3 Hydraulic Output: The hydraulic power can theoretically be determined from,

$$P_h = \rho g Q H \tag{5}$$

where Q is discharge and H is total dynamic head. The reported maximum discharge of 70 L/min corresponds to approximately 0.001167 m^3/s. However, because simultaneous measurements of discharge, head, and pump shaft power were not available, hydraulic power and pump efficiency were not independently calculated. The reported pump values of 40-70 L/min, head up to 50 m, and 60-70% efficiency are therefore retained as reported performance specifications.

3.3.4 Power Distribution: The common-prime-mover arrangement can be represented by,

$$P_{\text{eng}} = P_{\text{pump}} + P_{\text{gen},m} + P_{\text{loss}} \tag{6}$$

where P_{pump} is pump shaft power, $P_{\text{gen,m}}$ is generator mechanical input, and P_{loss} represents transmission and other mechanical losses.

3.4 Experimental Procedure

The simulated unit was subjected to practical operations. The engine speed was kept constant at around 3000 rpm, as per the report. Water discharge was observed from the pumping branch, and the voltage and current of the generator were measured on the electrical branch.

The reported observations were a water discharge of 70 L/min, a voltage of 22-24 V, and a current of 40 A. The electrical power produced was calculated based on the maximum voltage and current.

Further tests need to be performed at different engine speeds and under varying hydraulic and electrical loads to achieve a better understanding of the system. The performance characteristics would be able to describe the system by considering input and output pressures, discharge, fuel consumption, generator voltage, generator current, engine speed, and environmental parameters.

4. Results and Discussion

The practical test verified the simultaneous functioning of the pump and generator. Stable engine rotation was achieved in the range of 3000 rpm. The water pumping branch provided a 70 L/min flow rate, whereas the electric branch provided 22–24 V and 40 A. According to the maximum data, the power output in the electric branch is 960 W [8], [10]. These results indicate the potential of the integrated configuration to provide simultaneous hydraulic and electrical outputs. However, the electrical output represents a calculation based on the reported maximum voltage and current rather than an independently measured efficiency. The reported performance results are summarized in Table 2, and the corresponding maximum values are illustrated in Figure 3.

Table 2. Reported design and experimental performance

Parameter	**Reported result**	**Interpretation**
Engine speed	3000 rpm	Reported stable operating condition
Engine power	≈2.5 kW	Calculated from reported speed and torque
Water discharge	40–70 L/min; up to 70 L/min	Hydraulic output
Pump head	Up to 50 m	Reported pump capability
Pump efficiency	60–70%	Reported range; not independently recalculated

Generator voltage	22–24 V	Observed electrical output range
Generator current	Up to 40 A	Observed maximum current
Generator power	Up to 960 W	Calculated as V × I at 24 V, 40 A

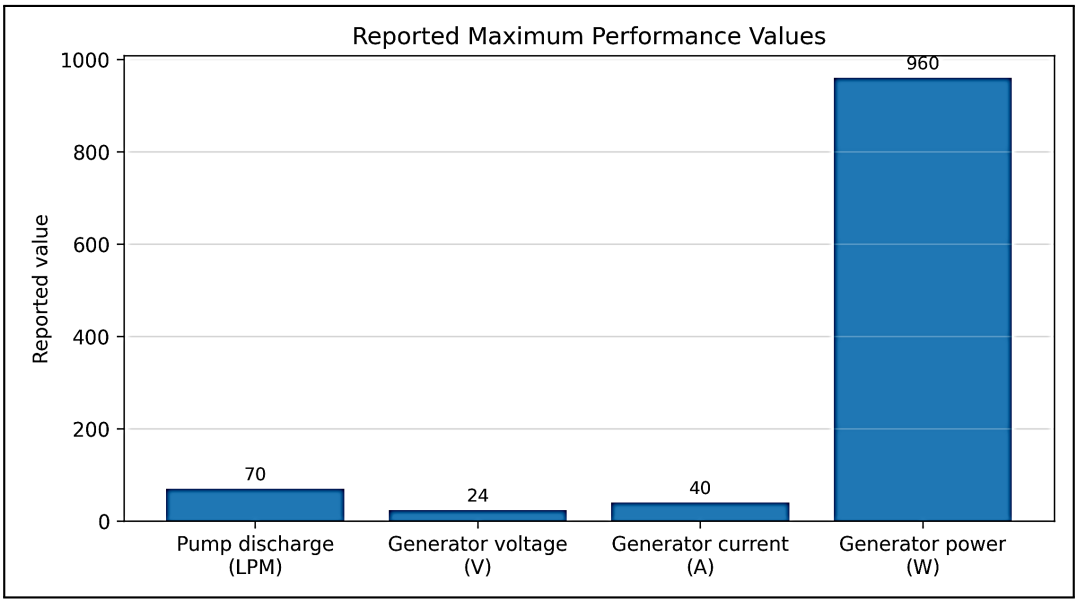


Figure 3. Reported maximum performance values.

4.1 Hydraulic Performance

The reported water discharge reached 70 L/min. This corresponds to approximately 4.2 m³/h, calculated from Q = 70 × 60/1000. The actual hydraulic power in relation to an operating state is determined by the flow rate, total head, water density, and acceleration due to gravity. Due to the lack of information about the total head value at the operating state of 70 liters per minute, hydraulic power and efficiency cannot be independently determined [7], [8]. The specified pump range of 40–70 L/min shows that the system will have sufficient capacity to deliver water through the system. For actual irrigation use, the choice of operating point must be made considering discharge and head needed as opposed to maximum discharge only. Energy saving in pumping systems is dependent on operating point and energy efficiency [7], [8], [9].

4.2 Electrical Performance

The generator was found to generate a voltage between 22-24V and an optimum current of 40A. At the optimal voltage and current figures, the electric power generated is 960W. The electric branch can thus be seen as the additional output of the system as the engine simultaneously powers the water pump. This value of 960W would thus be the maximum calculated power of electrical generation from the reported voltage and current and not the electrical efficiency.Future experiments should record voltage, current, engine speed and load continuously so that electrical power and efficiency can be plotted as functions of operating condition.

4.3 Energy Utilization and Sustainability

The key sustainable aspect of the proposed mechanism is the reuse of components. A motorcycle engine, which is basically worthless in terms of its original use, is repurposed into a prime mover that serves two purposes. This mechanism may lead to an unnecessary need for two prime movers and could make the servicing of machines easier where mechanical parts and rudimentary engine services are available [1], [3], [6]. Sustainability cannot be viewed only through the lens of component reusability. The complete evaluation should encompass fuel use, specific fuel consumption, emissions from exhaust gas, life cycle effects, useful hydraulic energy, and useful electrical energy. Contemporary research on irrigation stresses the importance of examining all four indicators together [1], [2], [3], [6].

4.4 Comparison with Conventional Pumping Arrangements

The proposed method was analyzed against solar photovoltaic and diesel-driven systems using the technoeconomic analysis provided in [3] and solar pumping systems described in [4]. The analysis will consider hydraulic efficiency, electric performance, cost factors, and environmental aspects. As illustrated in Table 3, the proposed configuration provides the capability to deliver pumping and electricity generation together, whereas in traditional designs irrigation needs have been the main objective. The irrigation scenarios presented in [3] provide an excellent foundation for determining the possible time of water delivery by the proposed system on continuous operations.

The comparative assessment highlights the different operational trade-offs among the

three configurations. Solar pumping reduces dependence on conventional fuels but remains sensitive to solar availability and system sizing. Diesel pumping provides operational flexibility but incurs fuel consumption and direct combustion emissions. The proposed arrangement offers an alternative where both water delivery and supplementary DC electricity are required.

Table 3. Comparison of conventional and proposed pumping systems.

Parameter	**Solar PV pump [3,4]**	**Diesel pump [3]**	**Proposed system**
Energy source	Solar photovoltaic energy	Diesel fuel	Reused 97.2 cc motorcycle engine
Water discharge	Not specified	Not specified	40–70 L/min
Electrical output	Depends on PV array and pump configuration	Separate generator required for electrical output	22–24 V DC; maximum calculated output 960 W
Crop-water requirement considered	500 m^3 (rice), 383 m^3 (strawberries), and 600 m^3 (mustard) [3]	500 m^3 (rice), 383 m^3 (strawberries), and 600 m^3 (mustard) [3]	At 70 L/min: approximately 119.05 h, 91.19 h, and 142.86 h, respectively
Operating cost and emissions	Lower operating costs and reduced CO_2 emissions reported relative to conventional alternatives [3,4]; exact comparable values unavailable	Fuel dependent cost and direct combustion emissions; exact comparable values unavailable	Fuel consumption, operating cost, and emissions not measured

5. Advantages And Limitations

The key benefits of the proposed system are its multifunctionality, reusability of an already available engine, compact mechanical integration, reduction in equipment needs,

and applicability in regions where the electric power grid may be unstable. The system also demonstrates a practical circular-engineering concept by extending the useful life of an automotive component [3], [4], [6]. The main drawbacks of the current research include the small amount of data used for the experiments and lack of energy, fuel, emission, and uncertainty assessments. The findings provided in this paper have been obtained through practical observation and basic calculations, but not through full performance map analysis. Moreover, the output voltage and current of the generator are 24 V and 40 A correspondingly; thus, the suitability of the generator to certain loads needs to be checked [7], [10, [11].

6. Conclusion

Design and experimental demonstration of a system for pumping water and generating electricity with a recycled 97.2 cc motorcycle engine were made. The engine was used as a common driving machine for a self-priming centrifugal pump and a 24 V, 40 A DC generator via a chain-and-sprocket drive. In the given test conditions, the engine ran at about 3000 rpm with a power output of about 2.5 kW. The pump could deliver 70 L/min, while the generator supplied 22-24 V with 40 A which corresponds to a power output of 960 W. The obtained results prove that the suggested configuration can generate two useful outputs from one recycled mechanical power source. Future research can incorporate multi-point performance tests, measurement of fuel consumption, hydraulic head, transmission losses, generator efficiency tests, emissions and techno-economic analysis. Integration of renewable energy and battery storage is another area of study that could enhance flexibility and eliminate reliance on fossil fuels.

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