

# Design of Solar Powered Bin to Trap Floating Waste in Water

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**Abstract -** Water pollution caused by floating waste such as plastic bottles, polythene bags, leaves, and other debris has become a serious environmental issue in ponds, lakes, and small water bodies. Traditional cleaning methods mainly depend on manual labor or fuel-powered machines, which are time-consuming, costly, and inefficient for continuous operation. To address this problem, a solar powered waste collection system is proposed.

The system uses renewable solar energy to power a DC motor which drives a slider crank mechanism that helps collect floating waste from the water surface and move it into a storage bin. The entire system is mounted on a floating platform so that it can operate efficiently in ponds and lakes. The use of solar energy makes the system environmentally friendly and suitable for remote areas where electricity supply is limited.

The proposed design focuses on simplicity, low cost, and ease of maintenance. The study includes system design, component selection, CAD modeling, and fabrication considerations. The results indicate that the solar powered waste collection bin can effectively reduce floating waste from water surfaces and contribute to better water quality and environmental protection.

**Keywords:** Solar Energy, Floating Waste Collection, Water Pollution Control, Slider crank Mechanism, Renewable Energy, Waste Management.

## 1. INTRODUCTION

The project of solar powered bin uses automated, floating “bins” to collect trash and debris from marinas, ports, and other water bodies, with the goal of reducing ocean plastic pollution by targeting collection at the source. These bins function by pumping polluted water through the bin, filtering out floating litter into a catch-bag, and returning clean water to the small rivers and ports. Founded by surfers, concerned about pollution, the solar-powered, low-maintenance devices aim to offer a sustainable, cost-effective method of cleaning waterways and raising environmental awareness, with many units deployed globally to collect significant amounts of waste.

The system helps in preventing plastic waste from spreading further into oceans and harming marine life. The use of solar energy makes the system environmentally friendly and reduces dependence on conventional electricity sources. Such innovative solutions contribute to cleaner water bodies and support global efforts toward environmental protection. The project also encourages communities to adopt sustainable technologies for waste management and pollution control.

## 2. LITERATURE REVIEW

A literature review of solar-powered floating waste collection systems highlights their effectiveness in capturing floating debris, including microplastics, while also identifying key design challenges and environmental considerations. Research has focused on

improving system efficiency, sustainability, and monitoring capabilities to address water pollution in controlled environments such as marinas and harbors. Studies indicate that floating waste collectors are capable of capturing and removing debris efficiently, and it has been reported that a single unit can collect up to 10-15 Kg per day.

These systems are most effective in calm and semi-controlled environments such as marinas, docks, and yacht clubs, where natural water currents help direct debris towards the collection unit. Researchers have also emphasized the importance of sustainability and circular economy approaches, where collected plastic waste is recycled into new products, reducing environmental impact and dependence on fossil resources (Ocean Conservancy, 2020; UNEP, 2021).

Filtration improvement is another important research area. Studies have explored the use of efficient filter materials, including natural fibers and synthetic media, to enhance the capture of microplastics and separate oil from water. These advancements improve the overall purification efficiency of the system (Cordier et al., 2021).

In addition, the integration of smart technologies such as the Internet of Things (IoT) has enabled real-time monitoring of system performance. Parameters such as waste levels, water quality (pH and temperature), and device location can be tracked using sensors and GPS, improving operational efficiency and reducing manual effort.

Environmental impact has also been studied in detail. While these systems are effective in collecting floating waste, some studies have reported that small marine organisms may occasionally be captured. However, most of these organisms are released later, suggesting limited long-term ecological impact. This highlights the need for improved design to minimize harm to aquatic life (Lebreton et al., 2018).

### 3. SYSTEM DESIGN

The system design of the mechanism is discussed below.

#### 3.1 Design Objectives

The main objectives of the proposed system are:

- To design an efficient mechanism for collecting floating waste from water surfaces.
- To utilize solar energy as the primary power source.
- To reduce human effort required for cleaning ponds and lakes.
- To design a stable floating platform for water operation.
- To develop a low cost and environmentally friendly waste collection system.

#### 3.2 Major Components

**Solar Panel :-** The solar panel is the main source of energy for the system. It converts sunlight into electrical energy using photovoltaic (PV) cells. These cells absorb solar radiation and generate direct current (DC) electricity.

The electricity produced by the solar panel is used to power the DC motor and charge the battery through a charge controller. By using solar energy, the system becomes environmentally friendly and does not require external electrical supply. This makes the waste collection system suitable for remote locations such as ponds, lakes, and water bodies.



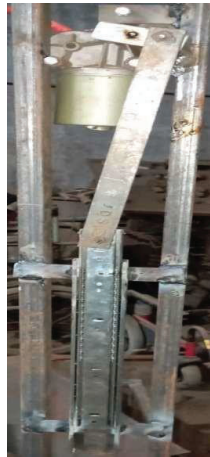
**DC Motor :-** The DC motor is responsible for providing the mechanical motion required for the operation of the waste collection mechanism. It converts electrical energy stored in the battery into rotational mechanical energy. When the motor rotates, it drives the slider

mechanism connected to the waste collection tray. The continuous rotation of the motor helps move the tray back and forth to collect floating waste efficiently. DC motors are widely used in such systems because they are simple, efficient, and easy to control.



**Slider Mechanism :-** The slider mechanism is used to convert the rotary motion of the motor into linear motion. This mechanism consists of components such as a crank, connecting rod, and sliding element.

When the motor rotates the crank, the connecting rod transfers the motion to the slider, causing it to move in a straight line. This linear movement helps push or pull the waste collection tray, allowing it to gather floating waste from the water surface and move it toward the storage bin.



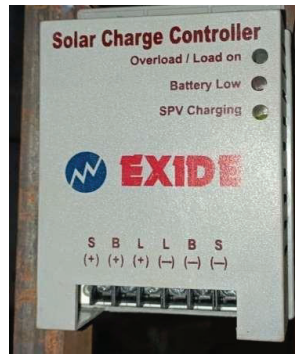
**Mild Steel Frame Structure :-** The mild steel frame structure acts as the main supporting body of the system. It provides strength, stability, and durability to hold all the components such as the solar panel, motor, slider mechanism, and waste collection tray.

Mild steel is commonly used because it has good strength, is easy to fabricate, and is cost-effective. The frame is designed to withstand environmental conditions such as moisture and water exposure near ponds or lakes. A properly designed frame ensures that all components remain aligned and function efficiently during operation.



**Solar Charge Controller:-** The solar charge controller is an important electronic component that regulates the voltage and current coming from the solar panel to the battery. Its main function is to protect the battery from overcharging and over-discharging.

It ensures that the battery receives a stable and controlled amount of electrical energy for safe charging. The charge controller also improves battery life and system efficiency. In this project, it manages the power flow between the solar panel, battery, and DC motor to ensure reliable operation of the waste collection system.



#### 4. DESIGN CALCULATION

##### 4.1 Given Data

- Volume of bucket = 8 L = 0.008 m<sup>3</sup>
- Radius of bucket (r) = 0.12 m (12 cm)
- Density of water (ρ) = 1000 kg/m<sup>3</sup>
- Acceleration due to gravity (g) = 9.81 m/s<sup>2</sup>

##### 4.2 Design (Size) Calculation

The volume of a cylinder is given by:

$$V = \pi r^2 h$$

Solving for height (h):

$$h = \frac{V}{\pi r^2}$$

$$h = \frac{0.008}{\pi(0.12)^2} = 0.17684 \text{ m} \approx 17.68 \text{ cm}$$

Therefore:

- Height of bucket = 17.68 cm
- Bottom area:

$$A = \pi r^2 = \pi(0.12)^2 = 0.04524 \text{ m}^2$$

Volume check:

$$V = A \times h = 0.04524 \times 0.17684 \approx 0.008$$

##### m<sup>3</sup> 4.3 Hydrostatic Force Calculations

Useful Relations

- Pressure at depth:

$$p = \rho gh$$

##### 1. Horizontal Hydrostatic Force on Cylindrical Side

Projected area of cylindrical surface:

$$A_p = h \times 2r = 0.17684 \times (2 \times 0.12) = 0.042441 \text{ m}^2$$

Force:

$$\begin{aligned} F_h &= \rho g h \times A_p \\ F_h &= 1000 \times 9.81 \times 0.088419 \times 0.042441 \\ F_h &\approx 36.8 \text{ N} \end{aligned}$$

**Result:** Horizontal force = **36.8 N (acting outward)**

## 2. Pressure at Bottom

$$p = \rho g h = 1000 \times 9.81 \times 0.17684 = 1734.79 \text{ Pa}$$

## 3. Vertical Force on Bottom

$$\begin{aligned} F_v &= p \times A \\ F_v &= 1734.79 \times 0.04524 \approx 78.5 \text{ N} \end{aligned}$$

## 4. Weight of Water

$$\begin{aligned} m &= \rho V = 1000 \times 0.008 = 8 \text{ kg} \\ W &= mg = 8 \times 9.81 = 78.48 \text{ N} \end{aligned}$$

## Result Verification

- Vertical force on bottom = **78.5 N**
- Weight of water = **78.48 N**

**Both values are approximately equal**, confirming that the hydrostatic force at the bottom balances the weight of water.

### 4.4 solar plate capacity calculation

- Motor power = **250 W**
- Operating time = **2 hours**
- Sunshine (charging time) = **6 hours**

## Total Energy Requirement

$$\text{Energy} = \text{Power} \times \text{Time} = 250 \times 2 = 500 \text{ Wh}$$

## Solar Panel Rating

$$\text{Panel Power} = \frac{500}{6} \approx 80 \text{ W}$$

## Final Result

- Required solar panel = **80 W**
- Horizontal force = **36.8 N**
- Vertical force = **78.5 N**

## 4.5 CAD Model and Layout

The proposed system is designed using CAD software to visualize the structure and arrangement of components. The CAD model includes the floating platform, solar panel mounting structure, slider mechanism, motor placement, and waste collection bin.



The following figures show different views of the CAD model of the solar powered waste collection system designed for trapping floating waste:-

- **Front View**

This view shows the front side of the solar powered bin model. It clearly displays the solar panel mounted on the top and the vertical support structure connected to the base.

- **Side View**

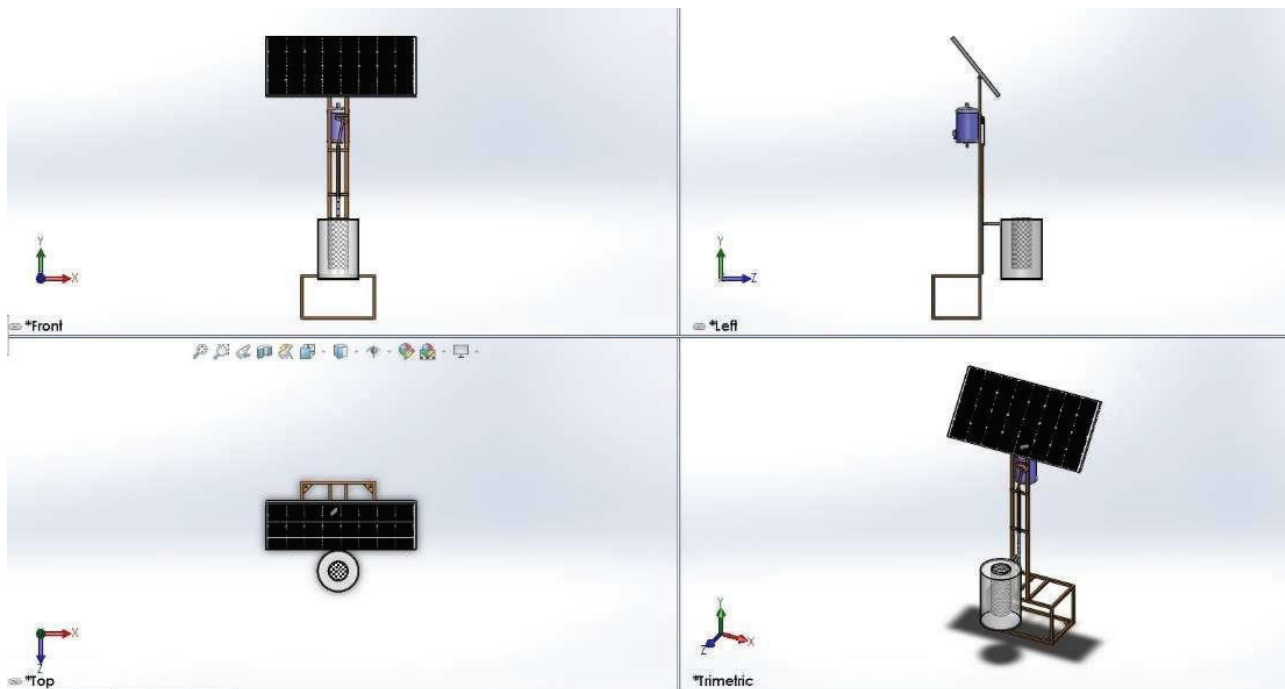
This view represents the side profile of the model. It shows the inclination of the solar panel and the placement of the cylindrical bin and wiring connection.

- **Top View**

This view shows the top layout of the solar panel and frame structure. It helps to understand the positioning and alignment of the solar panel in the system.

- **Isometric View**

This view provides the complete 3D representation of the model. It shows all components together such as the solar panel, mild steel frame structure, base support, and bin assembly.



## 5. CONCLUSION

The design and fabrication of a solar powered bin for trapping floating waste provides an effective and sustainable solution for cleaning water bodies. The use of a slider mechanism allows efficient movement for collecting floating debris while the solar panel supplies renewable energy for operation.

The developed prototype demonstrates that the system can successfully collect floating plastics and waste materials from water surfaces. With further improvements and scaling, this system can be implemented in lakes, ponds, and rivers to help reduce water pollution and protect aquatic ecosystems.

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