CHAPTER THREE

3.1 METHODOLOGY

This chapter outlines the procedures used for designing and constructing a solar-enabled rechargeable fan that integrates additional peripheral functions such as LED lighting, USB charging, and a battery status indicator. The system was built to operate efficiently in off-grid conditions by utilizing solar energy as the primary power source and storing excess energy in a rechargeable lithium-ion battery.

The fan control was designed with a speed regulator, allowing users to adjust airflow levels conveniently. A battery charge controller was incorporated to manage safe and efficient battery charging from the solar panel while also protecting the system from overcharging and over-discharging. Each peripheral function was integrated to operate independently but harmoniously, making the entire system compact, user-friendly, and energy-efficient.

3.2 COMPONENT SELECTION

The selection of components for the system was guided by factors such as energy efficiency, reliability, availability, cost-effectiveness, and compatibility with the overall design goals. Each component was carefully chosen to meet the functional requirements of the solar-enabled rechargeable fan and its integrated peripheral outputs.

Table3.1: Summary of the Key Components used and their Respective Functions

COMPONENT	SPECIFICATION	FUNCTION
Solar panel	20W, 18V	Converts solar energy into electrical energy
Rechargeable Battery	7.5V Li-ion, 3700mAh	Stores energy for use when solar input is unavailable
Fan Motor	6V, 0.5A DC	Generates airflow

Voltage Regulator	7809,7812,7818	Controls fan speed by regulating output voltage
Diodes	1N4148	Prevents reverse current and protects sensitive parts
Battery charge controller	12V, 3A max	Regulates voltage and current from solar panel to prevent overcharging/discharging
Voltage regulator	7809, 7812, 7818	Provides fixed voltage outputs (9V, 12V, 18V) for stepwise fan speed control
Rotary switch	3-position	Selects between the three voltage levels supplied by the voltage regulator
Variable resistor	10kΩ potentiometer	Provides continuous fan speed adjustment within selected voltage level
USB Output module	5V, 1A	Supplies a constant 5V for charging mobile devices or powering small gadgets
LED Light	12V DC	Provides lighting as an auxiliary feature during blackout.
Battery status indicator	Digital voltmeter/LED bar	Display real-time battery

		voltage to monitor charge level

3.3 SYSTEM SIMULATION

The designed circuit was simulated using Livewire Pro Version to test for correctness and performance prior to hardware implementation. Simulation helped verify the proper operation of each component, the voltage regulation behavior, and the control logic, ensuring that faults could be corrected before physical construction.

3.3.1 Simulation Objectives

- To observe the switching behavior between the 7809, 7812, and 7818 voltage regulators via the rotary switch.
- To test the response of the variable resistor in regulating the fan motor speed at different voltage levels.
- To monitor the charging process from the solar panel through the battery charge controller into the lithium-ion battery.
- To verify the stability of the USB output and ensure a constant 5V output suitable for charging devices.
- To confirm the functionality of the LED lighting when powered from the battery.
- To observe the real-time response of the battery status indicator as the battery voltage changes during charging and discharging.

3.3.2 Stimulation Outcome

The simulation successfully demonstrated the expected performance of each unit:

- Switching between voltage regulators resulted in clear changes in fan motor speed.
- The variable resistor allowed fine-tuning of the fan speed within each voltage range.

- The battery charge controller responded properly by cutting off the charging line once the simulated battery voltage reached its limit.
- The USB module maintained a stable 5V output.
- The LED lighting remained consistently bright when toggled on.
- The battery voltage indicator tracked voltage fluctuations in real time.

This preliminary validation gave confidence to proceed with the physical construction, knowing the theoretical circuit design was sound.

3.4 ASSEMBLING

In this project work, we are mostly concern about designing and construction of solar enabling rechargeable fan. The main components required to be designed, the solar panel, charge controller, the battery and the coupled fan. It is the solar panel that produced a D.C voltage due to the energy received from the sun, thereby making the battery to charge. The charge controller serves as an interface between the current generated by the module and the battery. Through the help of the charge controller the battery is prevented from over charging the assembling diagram is shown below.

3.5 Block Diagram of the System

The block diagram below represents the functional layout of the solar-enabled rechargeable fan system with integrated peripheral functions. It outlines how the main components interact to achieve power input, energy storage, control, and output functionalities.

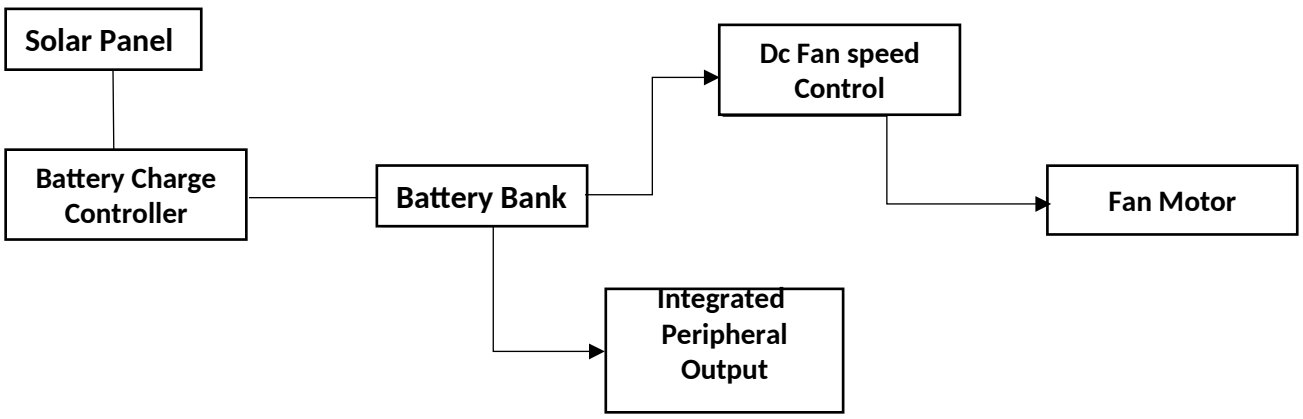

Figure 3.1 Assembling block diagram

3.5.1 Explanation of Flow

- The solar panel charges the battery through the battery charge controller, which regulates current and voltage for safe charging.
- The battery bank stores energy and distributes power to all output units.
- The fan unit receives voltage through a selector switch that lets the user pick between 9V, 12V, or 18V using regulators. A potentiometer allows fine-tuned speed control.
- The USB port, LED lighting, and battery status indicator are powered directly from the battery and controlled through independent switches or circuits.

The design of the system was approached by dividing it into modular functional blocks, each responsible for a specific operation. This modular approach ensured easier troubleshooting, better organization, and improved overall system performance. The major functional sections include:

- Solar Input and Battery Charging Unit
- Battery Bank (Energy Storage)
- Fan Control Unit (Voltage Switch + Speed Regulator)
- Peripheral Output Units (LED Lighting, USB Charging Port, Battery Status Indicator)

3.2.1 Solar Input and Battery Charging Unit

This section involves a solar panel connected to a battery charge controller, which manages the flow of energy into the lithium-ion battery. The charge controller regulates the voltage and current coming from the solar panel to ensure the battery is charged within safe limits. It prevents overcharging, over-discharging, and reverse current flow back into the panel.

3.2.2 Battery Bank

The battery serves as the system's energy reservoir. A 7.4V lithium-ion battery (3700mAh) was selected for its compact size, rechargeability, and suitability for DC applications. The battery supplies power to all system units during operation and stores solar energy for later use when sunlight is unavailable.

3.2.3 Fan Control Unit

This unit is responsible for controlling the speed of the DC fan. It consists of two components working together:

- Voltage Level Switch: A rotary switch selects between three fixed voltage outputs 9V, 12V, and 18V using three separate linear voltage regulators (7809, 7812, and 7818). This provides basic control over fan speed.
- Speed Regulator (Variable Resistor): A potentiometer is used to fine-tune the fan speed within each selected voltage level. This dual control setup allows both stepwise and smooth speed regulation for user comfort.

3.2.4 Peripheral Output Units

Each peripheral function is powered directly from the battery and operates independently of the fan:

- LED Lighting: A 12V DC LED light is connected with its own switch for manual control, providing illumination.
- USB Charging Port: A 5V USB output module is used to charge external devices like phones. It steps down battery voltage to a stable 5V output.
- Battery Status Indicator: A simple LED bar graph or digital voltmeter is connected across the battery terminals to show real-time battery voltage levels, helping users monitor battery health.

- All circuits are protected using diodes, and the outputs are isolated to avoid voltage interference across components.