Chapter One

1.0 Introduction

1.1 Background and Motivation

The global shift towards cleaner energy has sparked growing interest in harnessing renewable sources, with solar energy emerging as a leading option. In many areas, grid electricity remains unreliable, causing frequent power cuts that disrupt daily activities. At the same time, environmental concerns tied to fossil fuels highlight the need for greener, more sustainable solutions.

Solar photovoltaic (PV) systems present a promising alternative by converting the sun's energy in an abundant and renewable resource into electricity. However, standalone solar setups can face challenges due to unpredictable weather and limitations in battery storage capacity. Integrating solar systems with grid or backup power through hybrid systems helps overcome these challenges, offering both reliability and flexibility.

The aim of this project is to develop a **2 kVA hybrid solar powered inverter system** that can support residential or small commercial loads. By combining solar energy with grid backup, the system ensures a steady, eco-friendly power supply while reducing dependence on conventional energy sources. The project also serves as a practical example of solar system design and implementation, fostering a better understanding of hybrid power solutions.

1.2 Problem Statement

Many homes and small businesses experience frequent power outages due to unstable grid systems, leading to disruptions in daily routines and possible damage to sensitive equipment. While generators are often used as a backup, they pose environmental concerns and involve significant fuel and maintenance costs.

Solar PV systems offer a renewable energy alternative, but when used alone, they can struggle to meet energy demands during low sunlight or nighttime hours. Therefore, a more versatile solution is needed one that combines solar power with grid electricity or a generator backup to provide consistent, reliable power.

The purpose of this project is to design and build a **2 kVA hybrid solar powered inverter system** that ensures continuous, clean, and stable electricity for household or small office use. The system must maximize solar energy usage, automatically switch between power sources when necessary, and deliver a dependable AC output to meet user requirements.

1.3 Objectives

The specific objectives of the project are to:

1. design a 2 kVA hybrid solar power system that integrates solar, grid, and battery power sources.
2. select and size appropriate system components, including solar panels, batteries, MPPT charge controller, and inverter.
3. ensure seamless switching between solar power and grid backup for uninterrupted

electricity supply.

4. construct and assemble the system with proper wiring, safety features, and testing.
5. evaluate the performance of the system in terms of efficiency, reliability, and load handling capability.
6. provide a practical demonstration of a clean, sustainable, and cost-effective energy solution for small-scale applications.

1.4 Scope of Work

The scope of work are:

- **Design**: Develop a comprehensive design for a 2 kVA hybrid solar power system, including system architecture, sizing calculations, and component selection.
- **Component Selection**: Identify and procure key system components, including solar panels, MPPT charge controller, inverter, batteries, and protection devices.
- **Construction**: Assemble the system, incorporating proper wiring, mounting, and safety features.
- **Integration**: Configure the hybrid inverter to manage power from solar panels, grid, and battery sources, ensuring seamless transitions and optimal energy use.
- **Testing and Evaluation**: Conduct tests to verify system performance, including load handling, solar power prioritization, battery charging/discharging, and reliability under various conditions.

- **Documentation**: Prepare a detailed report documenting system design, implementation, testing results, and any challenges encountered during the project.
- **Demonstration**: Present the fully operational system as a proof-of-concept for reliable, renewable power for residential or small commercial use.