SOLAR TREE

A PROJECT REPORT

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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ABSTRACT

Solar energy is a renewable energy source that is derived from the sun's rays. It is a clean and sustainable alternative to traditional fossil fuels and has the potential to help mitigate climate change and reduce greenhouse gas emissions.

One way to harness solar energy is through the use of solar panels or photovoltaic cells, which convert sunlight into electricity. Solar panels are typically installed on rooftops or on the ground, but there is also a growing trend towards integrating them into public spaces in the form of solar trees.

The solar tree has a structure that is designed to resemble a tree, with branches or panels that capture sunlight and convert it into electricity. They can be installed in public spaces such as parks, streets, and parking lots, providing shade while also generating clean energy. The panels are usually arranged in a way that maximizes the amount of sunlight they receive. We have included 6 solar panels which can produce up to 600 watts of energy.

We have implemented the Solar tree that can provide a number of benefits to communities, beyond just generating clean energy. For example, they can serve as charging stations for electric vehicles and mobile devices, and can also provide lighting at night. They can also help to beautify the open space and create a sense of community pride.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER-1
INTRODUCTION

1.1 INTRODUCTION TO SOLAR TREE

A solar tree is an innovative and sustainable way of generating electricity using solar energy. It is a structure that mimics the shape and form of a tree, with branches made up of solar panels that absorb sunlight and convert it into electricity. The solar tree is designed to be visually appealing and can be used in urban areas where space is limited. They offer a unique and eco-friendly solution for generating renewable energy that blends in with the environment.

The solar tree is made up of several components that work together to generate electricity. The trunk and branches of the solar tree are typically made of steel or other durable materials that can withstand the elements. The solar panels are mounted on the branches and are arranged to maximize exposure to sunlight. The solar panels are made up of photovoltaic cells that absorb sunlight and convert it into electricity.

The electricity generated by the solar panels is then stored in a battery system that can be used when there is no sunlight. This battery system is typically connected to the grid or used to power specific applications, such as street lights or electric vehicle charging stations.

Solar trees offer several advantages over traditional sources of energy. First, they are a renewable source of energy that does not rely on finite resources such as fossil fuels. Second, they are eco-friendly and produce no emissions or pollutants. Finally, they can help reduce the carbon footprint of urban areas by reducing the reliance on traditional sources of energy.

In addition to their practical benefits, solar trees can also serve as a statement of the commitment towards renewable energy sources and reducing the impact of climate change. They offer a unique and visually appealing solution for generating clean energy in urban areas and can be customized to match the aesthetics of their surroundings.

Overall, solar trees are an innovative and sustainable solution for generating renewable energy in urban areas. They offer a practical and eco-friendly alternative to traditional sources of energy and can help reduce the carbon footprint of cities and communities.

1.2 OBJECTIVE

One of the primary objectives of solar trees is to generate clean and renewable energy. By harnessing the power of the sun, solar trees can generate electricity without relying on fossil fuels or other non-renewable sources of energy. This helps to reduce greenhouse gas emissions, combat climate change, and promote sustainable development.

Another objective of solar trees is to combine aesthetics with functionality. Solar trees are designed to be visually appealing, and they can add a unique touch to urban landscapes. They can also serve as functional elements, providing shade and shelter, and generating electricity at the same time.

Solar trees can also be used as a tool to raise public awareness about renewable energy and the importance of reducing our carbon footprint. By incorporating solar trees into public spaces, people can see firsthand how solar energy can be used to generate electricity and reduce our dependence on non-renewable sources of energy.

Solar trees can also promote energy independence by providing a reliable source of electricity. By storing energy in batteries, solar trees can provide power during times of low sunlight, such as at night or during cloudy weather. This can help to reduce the reliance on traditional power grids and increase energy independence.

Solar trees can also provide cost savings over time. While the initial installation costs may be higher than traditional sources of energy, the long-term benefits of using solar energy can be significant. By generating clean energy, solar trees can reduce energy costs and provide a return on investment over time.

They can resilience in urban areas. During natural disasters or power outages, solar trees can provide a reliable source of energy, helping to keep essential services running. This can be especially important in areas prone to extreme weather events or other natural disasters.

Generating electricity from solar energy instead of fossil fuels can improve air quality in urban areas. Fossil fuels are a significant source of air pollution, contributing to health issues and environmental problems. Solar trees can help to reduce the reliance on fossil fuels and promote cleaner air and healthier communities.

Overall, the objectives of solar trees are to generate clean energy, combine aesthetics with functionality, raise public awareness about renewable energy, promote energy independence, and provide cost savings over time. By achieving these objectives, solar trees can help to promote sustainable development and reduce the carbon footprint of our communities.

CHAPTER-2
DESIGNING AND FABRICATION

2.1 PROCESS OF BUILDING A SOLAR TREE

The first step in building a solar tree is to design the structure. The design should take into account the location of the solar tree, the desired height and width, and the number and placement of solar panels and LED lights. The design should also consider the weight of the solar panels and LED lights, and the wind and weather conditions in the area.

Once the design is finalized, the next step is to gather the necessary materials. The materials needed for building a solar tree include metal pipes for the trunk and branches, solar panels, LED lights, wiring, and a battery bank. The metal pipes should be strong enough to support the weight of the solar panels and LED lights, and should be rust-resistant to withstand the elements.

The assembly process involves welding the metal pipes together to create the tree structure. The solar panels are then installed on the branches, and the wiring is run from the solar panels to the battery bank. It is important to ensure that the wiring is properly insulated and protected from the elements to avoid any short circuits or damage.

The LED lights are then installed on the branches and wired to the battery bank. The lights can be programmed to turn on and off at specific times using a timer or a light sensor. It is important to choose LED lights that are energy-efficient and can withstand outdoor conditions.

Once the solar tree is fully assembled, it is important to test the system to ensure that everything is working properly. This includes checking the voltage output of the solar panels, testing the LED lights, and making sure that the battery bank is charging and discharging correctly. Any issues or errors should be addressed before the installation.

The final step in building a solar tree is to install it in the desired location. This may involve digging a hole for the base of the tree and securing it with concrete, or attaching the base to a pre-existing concrete foundation. It is important to ensure that the solar tree is securely anchored and will not tip over in strong winds.

It is important to perform regular maintenance on the solar tree to ensure that it continues to function properly. This may include cleaning the solar panels to maximize their efficiency, checking the wiring for damage, and replacing any faulty components. The battery bank should also be checked regularly to ensure that it is holding a charge. Building a solar tree is a complex process that requires careful planning and attention to detail. The design should take into account the location and environment of the solar tree, and the materials used should be strong and durable.

Proper assembly and testing are essential to ensure that the solar tree functions properly, and regular maintenance is necessary to keep it in good condition. However, the benefits of a solar tree are numerous, including reduced energy costs, a smaller carbon footprint, and a unique and attractive addition to any outdoor space.

2.2 MATERIALS USED

2.2.1 Metallic Components:

i) Mild Steel (MS):

Mild steel is a type of carbon steel that is commonly used in various industrial applications due to its unique properties. It is an alloy of iron and carbon, with the carbon content usually ranging between 0.05% to 0.25% by weight. Other elements such as manganese, sulfur, and phosphorus are also added in small amounts to improve certain properties of the material.

One of the most significant advantages of mild steel is its malleability, which refers to its ability to be easily formed or shaped without breaking or cracking. This property makes it a popular choice for use in the construction industry, where it is commonly used to create pipes, tubes, and sheet metal. It is also a popular material for use in the production of automobile bodies, appliances, and machinery.

Another advantage of mild steel is its excellent weldability, which makes it easy to join pieces of mild steel together. It can be welded using a variety of methods, including arc welding, MIG welding, and TIG welding. The welding process of mild steel is relatively simple and straightforward, and it does not require any preheating or post-weld heat treatment.

Mild steel is also known for its corrosion-resistant properties, which make it an ideal material for outdoor applications. It is highly resistant to rust and corrosion, which makes it suitable for use in harsh environments.

When it comes to the mechanical properties of mild steel, it has a relatively low tensile strength compared to other materials. However, it is highly ductile, which means it can be stretched and bent without breaking. Mild steel is also highly machinable, which means it can be easily cut, drilled, and machined into various shapes and sizes.

In terms of cost, mild steel is relatively inexpensive compared to other materials such as stainless steel and aluminum. This makes it an attractive option for many industrial applications where cost is a significant factor.

Therefore, mild steel is a versatile material with excellent properties, making it a popular choice for various industrial applications. Its malleability, weldability, and corrosion-resistant properties make it suitable for use in a wide range of applications in the construction, automotive, and manufacturing industries.

The components that are made up of mild steel are mentioned as below:

- MS square tube
    - Dimensions: 25mm x 25mm
    - Thickness: 1.5mm
    - Length: 42 meters
- MS pipe
    - Thickness: 2mm
    - Inner diameter: 90mm
- MS Base plate:
    - Thickness: 6mm
- MS hinge
    - Quantity: 6 pieces
    - Dimensions: ?
- MS Flange
    - Diameter: 90mm
    - Quantity: 2 pieces
- MS Sheet metal
    - Thickness: 2mm
    - Area: 111.36m^2
- MS Lock
    - Quantity: 4 pieces
- MS Flat bars
    - Length: 4 meters

ii) Base Plate 2 pieces

iii) 14mm Bolt nut 2 pcs

iv) 8mm bolt nuts 12 pcs

v) Hooks 40 pcs

2.2.2 Paint

i) Red Oxide 1 liters

ii) Silver Paint 1 liters

2.3 STRUCTURE OF SOLAR TREE

- **Top view**

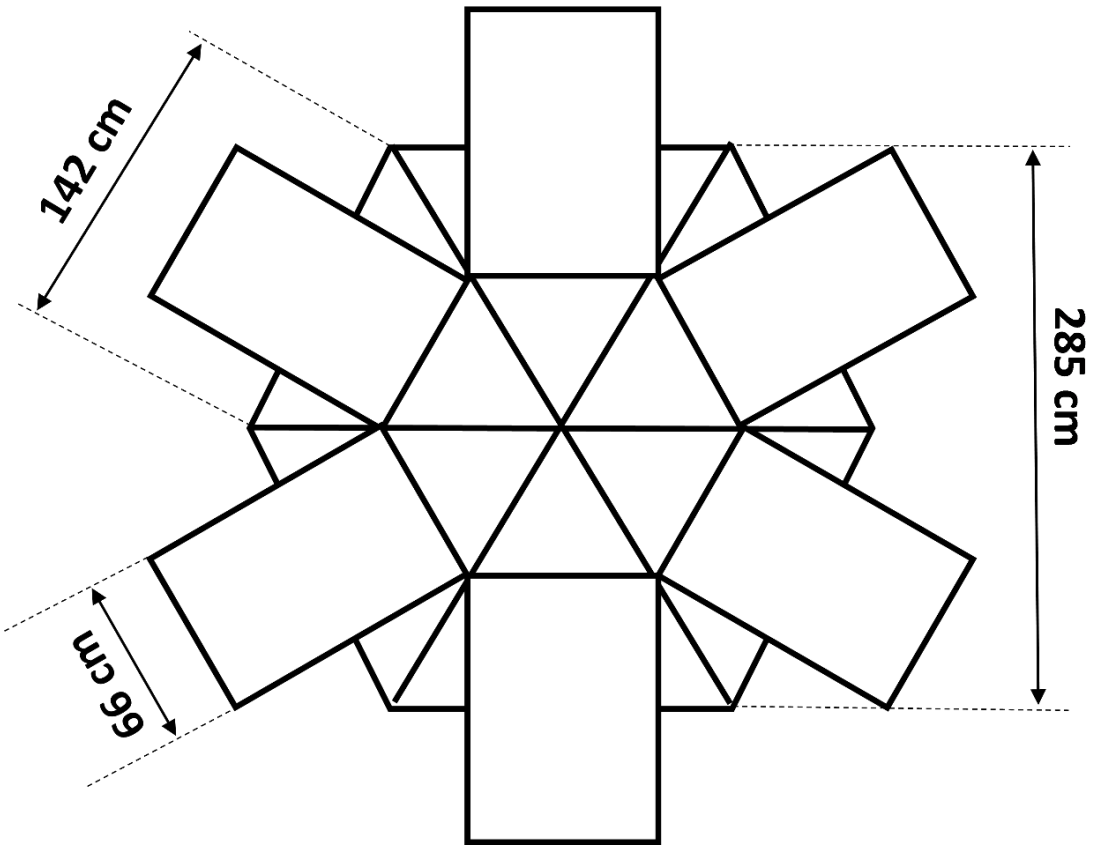

Fig.2.1 Top View

- **Front view**

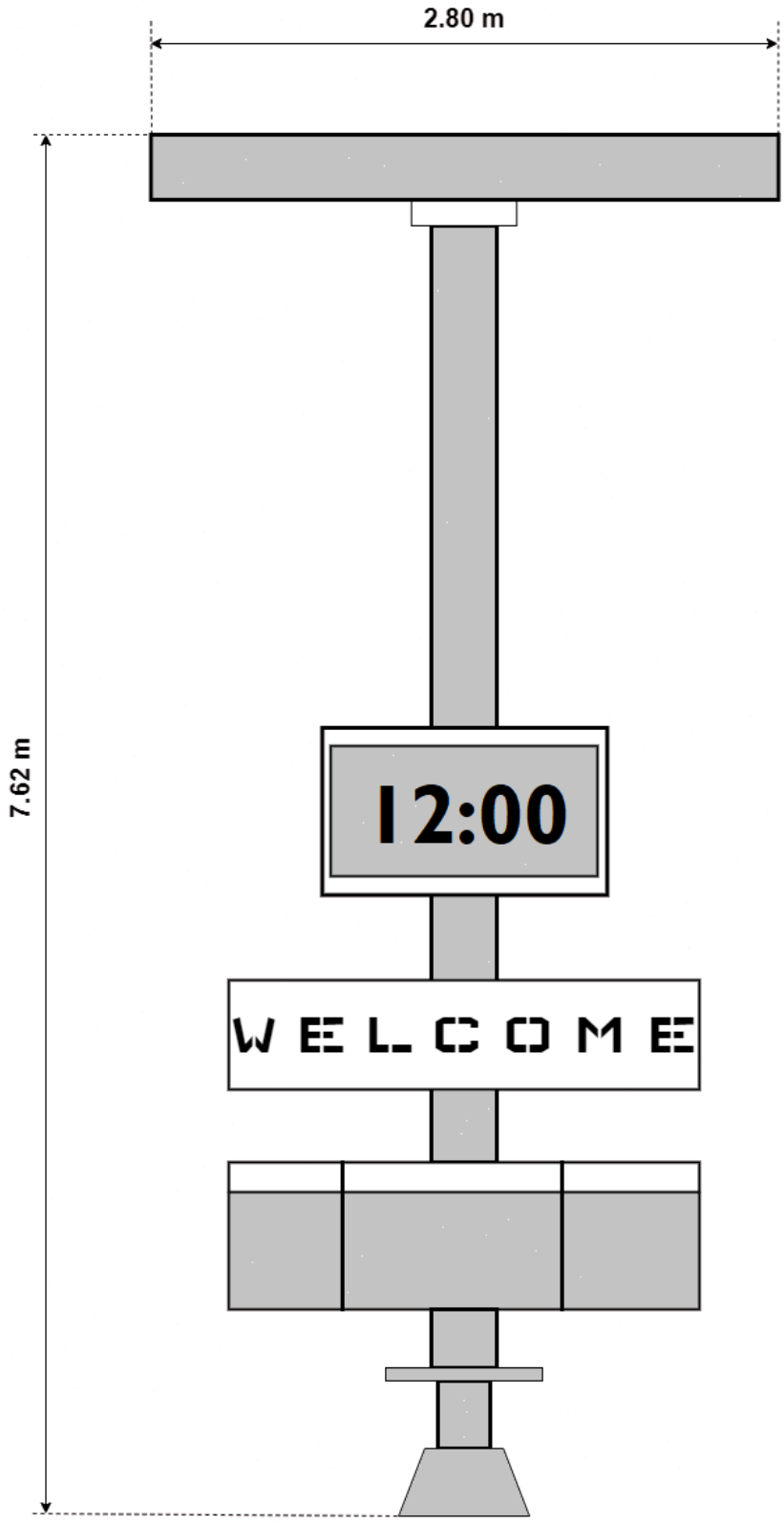

Fig.2.2 Front View

CHAPTER-3

HARDWARE COMPONENTS

3.1 BLOCK DIAGRAM OF SOLAR TREE

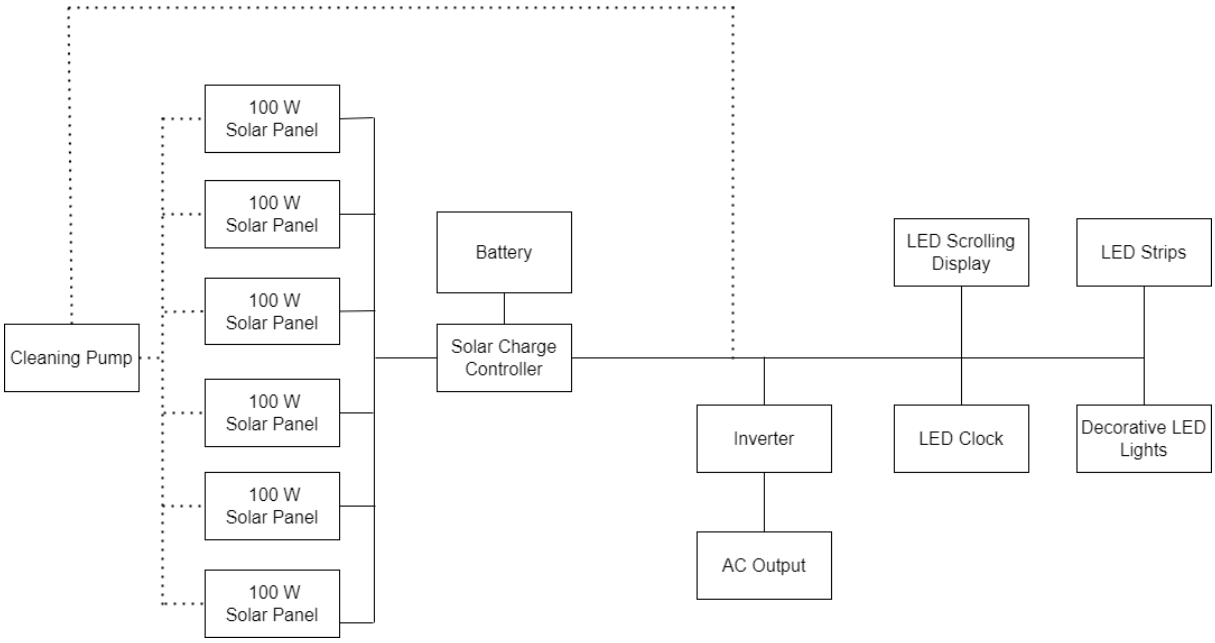

Fig.3.1 Block diagram

Explanation:

The solar panels are mounted at the top of the structure. The outputs of solar panel are connected in parallel and then fed to the solar terminals of the solar charge controller. The battery is connected to the battery terminals of the charge controller. The battery bank stores the electricity for later use and also provides a stable source of power for the system

The output of the solar charge controller acts as the source for different types of loads used in the solar tree. The output of solar charge controller is connected to a common bus bar terminal from which all the loads are connected in parallel.

The battery, charge controller, switches, pump and fuses are kept below the solar tree in a metallic box so that they can withstand the harsh environmental conditions and physical impacts and is easy to access and operate.

The LED Display, LED lights and Clock are placed on the top part of the stem of solar tree so that they are visible outside from a distance. Since they are all already made up of durable materials, they do not need any additional protection.

For power demands in power inaccessible areas and for emergency, we have made a portable inverter that meets all the basic necessities and can be taken anywhere with us. It can be charged by either the supply of the solar tree or by using an external AC to DC adapter.

3.2 ELECTRICAL COMPONENTS

i) Solar Panel:

A solar panel is a device that converts sunlight into electricity through photovoltaic cells. The cells are made of semiconductor material, such as silicon, that generates electricity when exposed to sunlight. The electrical energy produced by the cells is converted into usable power through an inverter.

Solar panels are commonly used in solar energy systems, which are a popular source of renewable energy. They can also be used for portable applications, such as camping and emergency power.

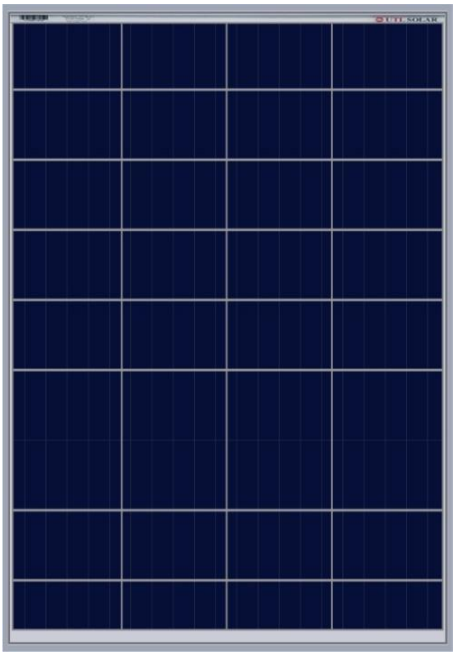

Fig.3.2 Solar Panel

Specifications:

PARTICULARS	DESCRIPTION
Solar Panel Rating	100 Watt
Panel Type	Polycrystalline
Short circuit current	6.3 ampere
Operating voltage at Pmax VMP	17.9 volt
Operating current Imp	5.7 ampere
Open circuit voltage VOC	21.6 volt
Module efficiency	>15 %
Operating temperature	-40 °C to 80 °C
Maximum system voltage	100 V
Power tolerance	0.03
Fill factor	0.77
Standard test condition	Irradiance of 1000 W/m square, spectrum AM 1.5 and cells temperature of 25 °C
Max. series fuse rating	10
No. of Busbar	4BB
No. of cells	36
Cell arrangement	9*4
Module dimension	1006*666*35 mm
Weight	10.5 Kg
Module protection rating	IP65
Frame	Anodized Aluminium Alloy
Front glass	3.2mm Toughened Textured
Cables and connectors	4mm, AWG 1000V/mc4 connectors

i) Solar charge controller:

A solar charge controller is an electronic device used in solar power systems to regulate the voltage and current that is coming from solar panels before it is fed into a battery bank. The primary function of a solar charge controller is to prevent overcharging and over-discharging of batteries, which can cause damage and reduce their lifespan. A solar charge controller is a critical component in a solar power system, as it helps to protect your batteries and ensure that your system operates efficiently and effectively.

Fig.3.3 Solar Charge Controller

There are Two Types of solar charge controllers: PWM (Pulse-Width Modulation) and MPPT (Maximum Power Point Tracking).

- PWM Charge Controllers, which we will be using, are the more basic type and they work by reducing the voltage from the solar panels to match the voltage of the battery bank. Studies are in progress for optimizing the parameters of this, and for understanding the physicochemical phenomena that lead to an improvement of battery life by using PWM management.

- MPPT controllers, on the other hand, use an algorithm to track the maximum power point of the solar panel and adjust the voltage and current accordingly. This results in a more efficient charging process, allowing for faster charging and increased energy output. However, MPPT controllers are typically more expensive than PWM controllers.

Solar charge controllers typically have various features, such as overcharge protection, battery temperature sensing, and load control. Overcharge protection prevents the batteries from being damaged due to excessive charging, while battery temperature sensing ensures that the batteries are charged at the optimal temperature. Load control allows the solar charge controller to manage the power output to connected devices, ensuring that the batteries are not overloaded.

ii) Solar C10 Lead acid Battery

C10 lead-acid battery refers to a type of lead-acid battery that is designed to be discharged over a 10-hour period. The C10 rating is a standard used to measure the discharge capacity of lead-acid batteries. It refers to the rate at which a battery can be discharged over a 10-hour period while maintaining a specific voltage.

Lead-acid batteries are one of the oldest and most widely used types of rechargeable batteries. They are commonly used in applications such as backup power supplies, solar power systems, and automotive batteries. C10 lead-acid

batteries are often used in solar power systems because they are designed to be discharged slowly and can provide reliable power over an extended period.

The capacity of a lead-acid battery is typically measured in ampere-hours (Ah). A C10 lead-acid battery rated at 150Ah can deliver a current of 15 amps over a 10-hour period before the voltage drops below a certain level. The actual capacity of the battery may vary depending on factors such as temperature and the depth of discharge.

Fig.3.4 Solar battery

C10 lead-acid batteries are generally more expensive than other types of lead-acid batteries with shorter discharge times, such as C5 or C20 batteries. However, they are often preferred for applications where a slow and steady discharge rate is required, such as in solar power systems. They also have a longer lifespan than other types of lead-acid batteries, as long as they are properly maintained and charged.

iii) Cleaning Pump:

A diaphragm style water pump that is used to clean solar panels is a compact and powerful pump designed to provide reliable and efficient water pressure for cleaning solar panels. It is specifically designed to be used with a water-fed pole system for cleaning solar panels, which is a common method used in the solar industry.

Fig.3.5 Cleaning Pump

The diaphragm pump is made from durable and high-quality materials, including a corrosion-resistant housing and a stainless-steel diaphragm. It is designed to be compact and easy to install, with a lightweight and portable design that makes it ideal for use in the field. The pump is capable of delivering a consistent flow of water at high pressure, which is essential for effectively cleaning solar panels.

The diaphragm style water pump is typically powered by a 12-volt battery or a solar panel, making it a convenient and environmentally friendly option for cleaning solar panels. It can be used with a variety of water-fed pole systems and cleaning accessories, including brushes and nozzles.

Overall, a diaphragm style water pump is an essential component of a water-fed pole system used for cleaning solar panels. It is designed to be reliable, efficient, and easy to use, providing consistent water pressure and flow for effective cleaning of solar panels.

iv) LED clock:

The clock's design includes a circular LED display with a diameter of 36 inches, which is encased in a durable aluminum frame that is weather-resistant. The LED lights are bright and have a viewing angle of 180 degrees, making it easy to read the time from a distance. The clock has a sleek and modern design that complements any outdoor space.

The clock uses GPS technology via a smartphone to synchronize with the atomic clock, ensuring accurate timekeeping. It can display time in both 12-hour and 24-hour formats. The clock is powered by the battery that is charged by the solar panels on the solar tree.

Fig.3.6 LED Clock Display

Fig.3.7 LED Message Display

The clock is designed to be mounted on a solar tree using a mounting bracket that is made with metallic sheets and cutting tools. The solar tree is a decorative lighting structure that is powered by solar panels, which provide energy to the clock's battery. The installation process is straightforward and can be completed by a professional electrician.

The clock is designed to be low maintenance, with the LED lights having a lifespan of over 50,000 hours. The solar panels on the solar tree should be cleaned regularly to ensure maximum power output.

The large outdoor LED display clock is suitable for various outdoor applications, including parks, sports arenas, and public spaces. It can be used as a timekeeping device for sports events or as a decorative feature in public spaces. The clock's bright LED lights make it easy to read even in direct sunlight, and its durable design ensures long-term use.

The large outdoor LED display is a sustainable and cost-effective option for accurate timekeeping. Its sleek and modern design, along with its functionality, make it suitable for various outdoor applications. The clock's low maintenance requirement makes it an excellent choice for those who want an eco-friendly and reliable outdoor clock.

v) LED Display:

A scrolling LED display board is a type of electronic display board that consists of a series of LED lights arranged in a matrix pattern. It is typically long and narrow, with various sizes available depending on the specific application. The display is designed to be easy to read even in bright sunlight and from a distance, making it ideal for outdoor use.

The display board is controlled by a microprocessor, which can update the display in real-time with the latest information. This allows for the display of important information such as news updates and messages. The display board can also be used for emergency notifications, displaying urgent messages to large crowds in real-time.

The display board is constructed from high-quality materials that can withstand the harsh environmental conditions, including temperature fluctuations and impacts. It is typically encased in a durable housing to protect it from moisture and other environmental factors. The housing can be made from a variety of materials such as metal or plastic, depending on the specific application.

One of the key advantages of a scrolling LED display board is its energy efficiency. The low power consumption and long-lasting LED lights can operate for thousands of hours without needing replacement, making it a cost-effective solution for outdoor advertising and other applications.

The display can be customized to display different font styles, sizes, and colors, as well as different types of animations and graphics. This allows for a high degree of flexibility in terms of the messages that can be displayed. It can also be programmed to display different languages and character sets to accommodate different regions and populations.

The display can be mounted on walls, vehicles, or other structures, depending on the specific application. It can be used in a wide range of settings such as sports stadiums, shopping malls, transportation hubs, and corporate buildings. The versatility and flexibility of a scrolling LED display board make it a popular choice for a variety of applications.

Fig.3.8 LED Scrolling Display

vi) LED Lights:

LED stands for "Light Emitting Diode," which is a semiconductor device that produces light when an electric current passes through it. LEDs are a type of solid-state lighting that is more efficient and longer-lasting than traditional incandescent bulbs. They use less energy and generate less heat, making them an eco-friendlier option. LED technology has advanced significantly in recent years, allowing for the production of high-quality and high-brightness LEDs that can be used for various applications. Here we are using 2 types of LED segments:

- Serial LEDs:

Fig.3.9 Serial LEDs

Serial LED lights, also known as string lights, are a type of decorative lighting that consists of a series of LED lights connected together in a sequence, or "string". They are commonly used for outdoor and indoor decoration, providing a warm and festive atmosphere for various occasions and events.

The LED lights in a string are connected in series, meaning that each LED light is connected to the next in a line, with one end of the string connected to a power source. The lights are typically spaced a few inches apart, allowing for an even distribution of light along the string.

- Strip LEDs:

Fig.3.10 Strip LEDs

LED strip lights are a type of flexible lighting that consist of a series of small LED lights mounted on a thin, flexible circuit board. They are commonly used for decorative and functional lighting in a variety of settings.

The LED lights on the strip are typically low voltage and energy efficient, which allows for long-lasting and cost-effective use. They can be cut to custom lengths to fit specific spaces, and some models can even be bent or shaped to fit curved surfaces.

LED strip lights are easy to install and can be mounted using adhesive tape or clips, making them a convenient and non-invasive solution for lighting.

Fig.3.11 LED Glow

Overall, LED lights offer a low-cost, energy-efficient, and highly customizable solution for a wide range of lighting applications. They are easy to install and offer a range of visual effects and color options, making them a popular choice for both residential and commercial settings.

vii) Fuse and switches:

- **Panel Mount Fuse:**

A fuse is a safety device that is designed to protect an electrical circuit from overloading or short-circuiting. It is a small, replaceable component that is inserted into an electrical circuit and is made of a wire or filament that is designed to melt and break the circuit if too much current flows through it.

Fig.3.12 Fuse

When an electrical circuit experiences a surge of current that is greater than 20 Amperes, the fuse will melt and break the circuit. This prevents damage to the circuit and also reduces the risk of fire or other safety hazards that can result from overheating.

Fuses are necessary because they help to protect electrical equipment, wiring, and other components from damage caused by electrical surges or overloads. They are commonly used in home and industrial electrical systems, as well as in automotive and other types of equipment.

- **Toggle Switches:**

Fig.3.13 Toggle Switches

This is a mini metal body toggle switch. It is actuated by moving a lever back and forth to open or close an electrical circuit. This switch changes its position when actuated and will remain in that position until actuated again.

This switch can be used for controlling the hardware appliances of the solar tree like the LED lights, LED Display, Pump, etc. This switch can withstand high room temperature and is highly durable against outdoor weather conditions, which makes it a great choice for the solar tree.

CHAPTER-4

INVERTER

4.1 INTRODUCTION TO INVERTER

We have made an inverter that's portable and gives you the perfect solution for when you need reliable and efficient power on-the-go. This inverter gives AC power and can drive loads up to 100 watts, which is sufficient enough to power up essential appliances.

With a compact and lightweight design, this inverter is easy to transport and store, and its rechargeable battery means you can use it multiple times without needing access to a power source. The inverter features multiple outlets, so you can power multiple devices at once, and its built-in protection features prevent damage from overloading or overheating.

Whether you need to power your phone, light or other electronic device, our portable inverter provides a convenient and reliable solution. It can be charged by using either an ac adapter outlet or through the output of solar tree.

4.2 SPECIFICATIONS

- Battery capacity: 66.6Wh
- Battery type: Li-ion
- Inverter Output: AC 220V, 100W (max.)
- Charging time: 2.7 Hours
- Charging voltage: 12.3 to 13.0 V DC
- Speakers: 10 watts mid-range
- Audio connectivity: SD card, USB drive, AUX, Bluetooth.
- USB Charger output: DC 5V 2A(max.)
- Maximum Current Discharge: 10A
- Emergency LED power: 8W power LED
- Inbuilt LED battery indicator and Volt amp meter
- Auto cut-off while overheating or overloading
- Overcharge Protection
- Easy to carry

4.3 BLOCK DIAGRAM OF INVERTER

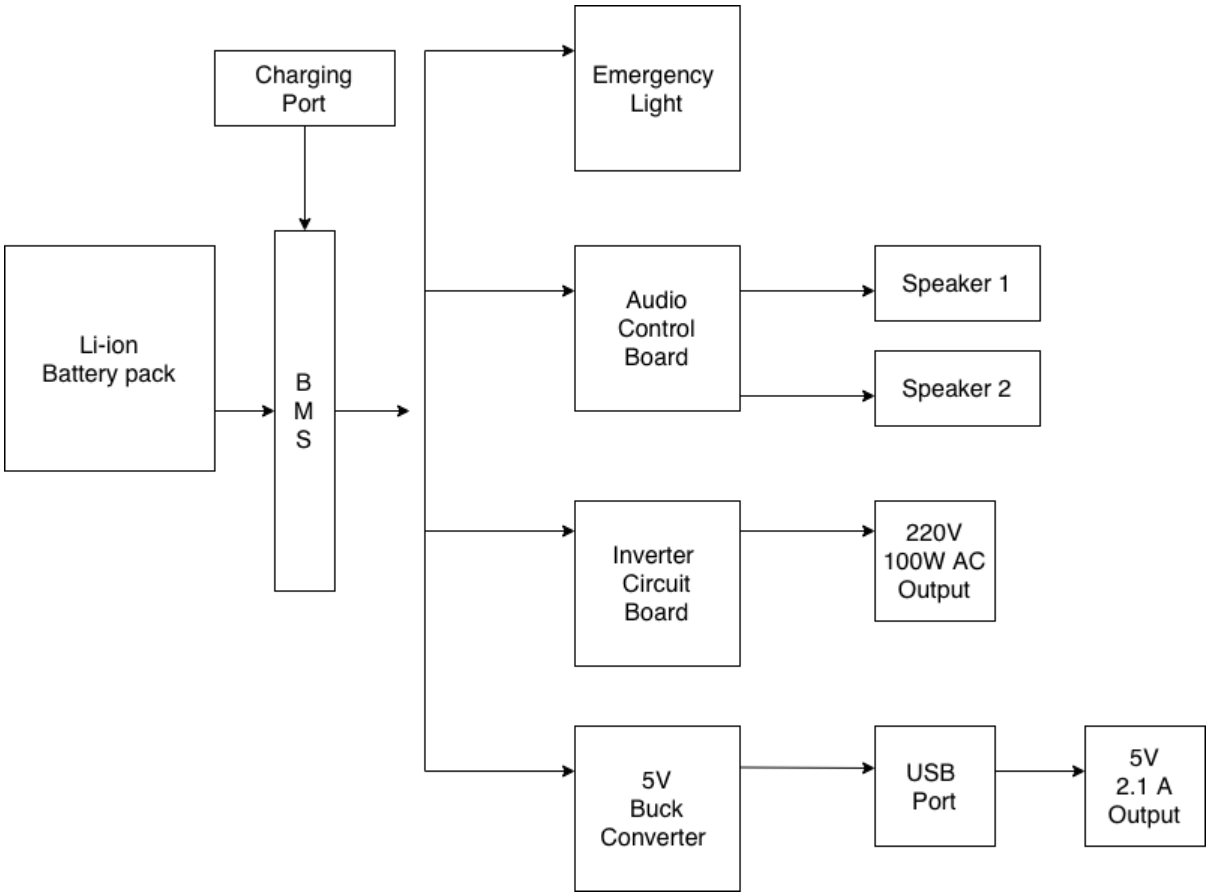

Fig.4.1 Block diagram of inverter

4.4 COMPONENTS OF INVERTER

i) Inverter Circuit Board:

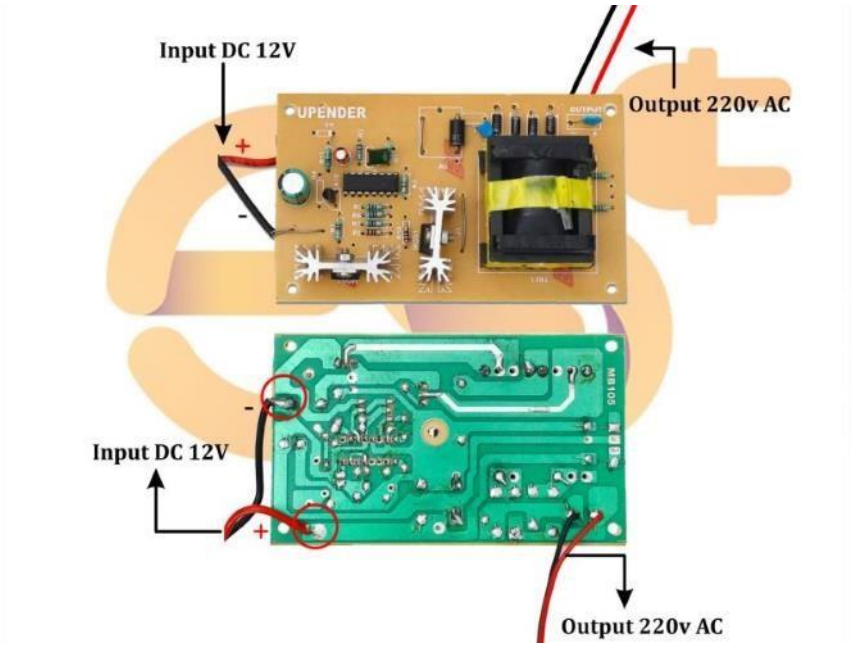

Fig.4.2 Inverter Circuit Board

An inverter circuit is an electronic circuit that is used to convert direct current (DC) to alternating current (AC). Inverters are used in a variety of applications, such as in renewable energy systems like solar power and wind power, as well as in backup power systems and in electric vehicles.

The basic structure of an inverter circuit consists of a DC power source (such as a battery), an inverter module, and an AC load. The inverter module is responsible for converting the DC power from the power source into AC power that can be used by the load.

There are different types of inverter circuits, including the square wave inverter, the modified sine wave inverter, and the pure sine wave inverter. The square wave inverter is the simplest type of inverter and produces a waveform that is similar to a square wave.

Inverter circuits may also include additional components, such as filters to remove noise and harmonics from the output waveform, voltage regulators to maintain a steady output voltage, and protection circuits to prevent damage to the inverter or load in the event of a fault.

ii) Lithium Ion Battery:

Fig.4.3 Li-ion Battery

This is a Li-ion Rechargeable Battery. It is cylindrical in shape. This battery has 7.4Wh power capacity per cell. It is reliable and offers long service life so this battery can be recharged again and again after use.

The outside part of the battery is covered with plastic insulation. But the inner part of the battery is built from high carbon steel which protects the battery from bursting and also protect the battery from overheating at the same time. Due to their low maintenance and low price, these lithium batteries are preferred for this portable inverter.

iii) Battery Management system:

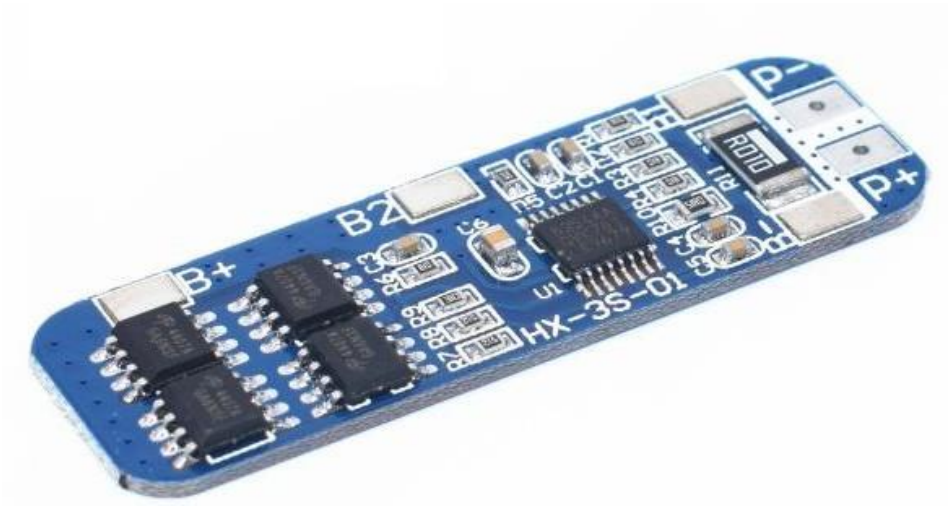

Fig.4.4 Battery Management System

A BMS is an electronic system that manages and protects the battery pack, ensuring that it operates safely and efficiently. The 3S BMS is specifically designed for use with 3-cell Li-ion battery packs, which are commonly used in portable electronic devices such as laptops, tablets, and smartphones.

The 3S BMS is responsible for monitoring and controlling the charging and discharging of the battery pack. It includes a microcontroller unit (MCU) that reads data from sensors to measure the battery's voltage, current, and temperature. Based on this information, the MCU can control the charging and discharging of the battery to prevent overcharging, over-discharging, and overheating.

The 3S BMS typically includes the following components:

1. **Battery protection circuit:** This is the main component of the BMS, responsible for monitoring and controlling the charging and discharging of the battery pack. It includes a protection IC (Integrated Circuit) that controls the charging and discharging, and protects the battery from overcharging, over-discharging, and overcurrent.

2. **Voltage detection circuit:** This circuit monitors the voltage of each cell in the battery pack, and sends this information to the MCU for processing. The voltage detection circuit is essential for ensuring that each cell in the battery is charged and discharged evenly, preventing any cell from becoming overcharged or over-discharged.

3. **Current detection circuit:** This circuit measures the current flowing in and out of the battery pack, and sends this information to the MCU for processing. The current detection circuit is essential for ensuring that the battery pack is not overcharged or over-discharged, and also for monitoring the battery's capacity.

4. **Temperature detection circuit:** This circuit measures the temperature of the battery pack, and sends this information to the MCU for processing. The temperature detection circuit is essential for preventing the battery from overheating, which can cause damage to the battery and create a safety hazard.

5. **Balancing circuit:** This circuit is responsible for equalizing the charge of each cell in the battery pack. It ensures that each cell is charged and discharged evenly, preventing any cell from becoming overcharged or over-discharged.

Overall, the BMS plays a critical role in ensuring the safe and efficient operation of Li-ion battery packs. It protects the battery from overcharging, over-discharging, and overheating, and ensures that each cell is charged and discharged evenly, extending the life of the battery pack.

iv) Speakers:

The 10-watt full-range speaker is a high-quality audio device that offers a full spectrum of sound, delivering crystal-clear audio for your listening pleasure. It is designed with a rugged construction to withstand even the most demanding applications.

The speaker is perfect for use in home theatre systems, car audio systems, and other audio applications.

Fig.4.5 Speaker

The speaker features a polypropylene cone that delivers rich and accurate sound, providing a full range of frequencies from low to high. The cone is designed to resist distortion, providing clear, powerful bass and midrange tones, and crisp high-frequency sounds. The speaker also has a rubber surround that provides a flexible suspension, ensuring the cone moves freely for better sound quality.

The 10-watt full-range speaker has a 4-ohm impedance, making it compatible with a wide range of amplifiers. It also has a frequency response range of 70Hz to 20kHz, which allows it to reproduce a broad range of frequencies, resulting in a well-balanced and natural sound.

The speaker is compact and lightweight, making it easy to install in a variety of applications. It comes with a built-in mounting bracket that allows for easy installation in your desired location.

v) Audio amplifier module:

The audio amplifier module is a compact and versatile audio device that allows you to play high-quality audio from a variety of sources. This module can play MP3 files from USB drives and SD cards, as well as stream music wirelessly from Bluetooth-enabled devices.

Fig.4.6 Audio Amplifier Module

The module has a built-in amplifier that delivers clear and powerful sound, making it ideal for use in home audio systems, car stereos, or portable speakers. The amplifier has a maximum output of 10 watts, which is enough to fill a small room with sound.

The Bluetooth MP3 USB SD card player module has a sleek and modern design with a bright LED display that shows the current playback mode, volume level, and track information. The module also has a built-in equalizer that allows you to adjust the bass and treble to suit your listening preferences.

This module supports a wide range of audio formats, including MP3, WMA, and WAV. It also has a USB port and an SD card slot, allowing you to play music from a variety of sources. Additionally, the module has a 3.5mm audio jack that allows you to connect it to other audio devices.

The Bluetooth MP3 USB SD card player module is easy to install and use, and it comes with a remote control that allows you to control the playback and adjust the volume from a distance. This module is an excellent choice for anyone looking for a versatile and high-quality audio playback solution.

vi) Step down module with USB port:

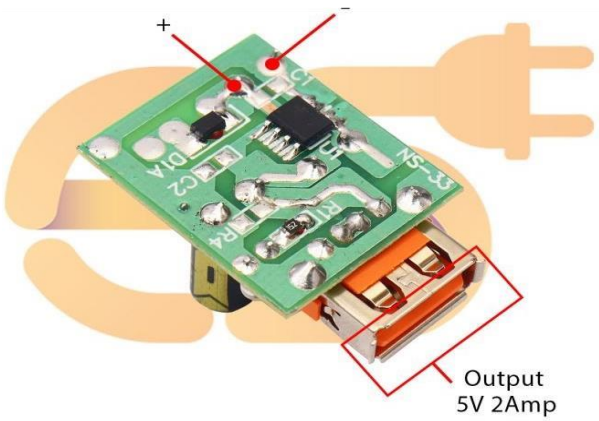

Fig.4.7 Step down module with USB port

A step-down module is a compact and versatile power conversion device that allows you to convert a higher DC voltage into a lower DC voltage suitable for powering various electronic devices. This module can be used to step down voltages from 4.5V to 28V to a stable 5V output, which is ideal for powering USB devices like smartphones, tablets, and other portable electronics.

The step-down module has a compact and durable design, making it ideal for use in a variety of applications. It features a built-in DC-DC converter that ensures high efficiency and low heat dissipation, even when used for extended periods of time. The module has a maximum output current of 3A, which is more than enough to power most USB devices.

The step-down module with USB port also features a built-in over-voltage and over-current protection circuitry that prevents damage to your connected devices in case of any voltage or current fluctuations.

Additionally, the module has a LED indicator that shows the power status and warns you of any issues.

vii) Voltmeter and Ammeter Display Module:

Fig.4.8 Display Module

The voltmeter and ammeter display module is an electronic device designed to measure and display voltage and current levels in a circuit. It consists of two display panels, one for voltage measurement and the other for current measurement, along with associated circuitry to measure and display the readings.

The voltage display panel typically consists of a high-precision digital display that shows the voltage level in volts (V). The current display panel also features a digital display that shows the current level in amperes (A). These two panels are usually placed side by side to allow for easy monitoring of both readings simultaneously.

The module typically requires an external power source, which is usually in the range of 4-30V DC. It can be easily connected to the circuit under test using connecting wires. The module is also designed to provide accurate and reliable measurements over a wide range of voltage and current levels.

The voltmeter and ammeter display module is useful in a wide range of applications, including monitoring the performance of solar panels, batteries, and other electrical devices.

viii) Emergency LED Light:

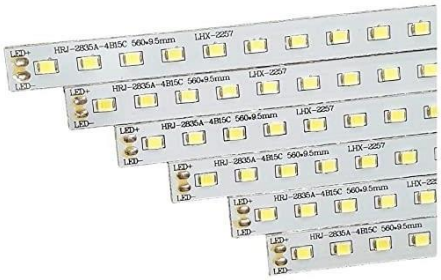

Fig.4.9 LED Light

The Emergency Light in the portable inverter is made of Power LED strips, which are a type of lighting product that consists of a inflexible strip with integrated LED lights. Unlike traditional LED strips, hard power LED strips are designed to be more durable and withstand harsh conditions, making them ideal for outdoor and industrial applications.

The LED chips used in hard power LED strips are of high quality and have a long lifespan of up to 50,000 hours. They are also designed to be energy-efficient, consuming much less power than traditional light sources while providing brighter and more uniform illumination.

The strip itself is made of a strong and durable material, typically polycarbonate, which protects the LED chips from damage and ensures the strip remains stable even when subjected to vibration or other mechanical stress.

Hard power LED strips can be customized to fit different lengths and shapes, making them suitable for a wide variety of applications. They are easy to install and come with aluminium profile and diffuser to secure the strip in place.

ix) LED battery indicator:

Fig.4.10 LED battery indicator

A battery indicator is a compact device that helps you keep track of the battery level of your system. It is designed to work with any 12V lead-acid battery. The indicator is usually mounted on the control panel of the system and provides an instant visual indication of the battery voltage.

The indicator typically consists of a display unit, which shows the battery voltage in real-time, and a wiring harness that connects the indicator to the battery. The display unit is usually a small, rectangular-shaped module with an LED screen that shows the battery voltage in volts and represents visually in bars.

The 12V battery indicator is designed to be easy to install and use. It does not require any additional power source and draws power directly from the battery. Once connected, the indicator will automatically detect the battery voltage and display it on the screen.

4.5 FEATURES OF INVERTER

One of the most significant features of this portable inverter is the emergency flashlight. In emergency situations such as power outages, this feature can provide much-needed light to navigate through dark spaces. The flashlight is usually powered by LED lights, which have a longer lifespan and are energy-efficient. This feature is especially useful for outdoor activities such as camping, where a reliable source of light is essential.

Another essential feature of this device is the USB charging port. This allows the user to charge their devices on the go, such as smartphones, tablets, or cameras. This is especially useful in situations where traditional power sources are not available, such as camping or hiking. The USB charging port usually comes with different power outputs, allowing the user to charge multiple devices simultaneously.

An additional feature of this portable inverter is the inbuilt Bluetooth speaker. This feature allows the user to play music or other audio files wirelessly from their smartphones or other Bluetooth-enabled devices. The inbuilt speaker is usually of high quality and can produce a clear and loud sound. This feature is especially useful for outdoor activities such as camping, where music or audio can add to the overall experience.

One of the most significant benefits of this portable inverter is its portability. The device is usually compact and lightweight, making it easy to carry around. This feature makes it especially useful for outdoor activities such as camping, where traditional power sources may not be available.

In emergency situations such as power outages, natural disasters, or when camping or traveling, the portable inverter can prove to be a valuable resource. The inverter's flashlight can help guide you through dark areas, and the USB charging port can keep your essential devices powered.

Another significant benefit of this device is its versatility. The various features of the device, such as the emergency flashlight, USB charging port, and inbuilt Bluetooth speaker, make it useful in a wide range of situations. This device can be used not only for emergencies but also for recreational activities such as camping, hiking, or outdoor parties.

4.6 CONCLUSION

The convenience of this device cannot be overstated. The ability to charge devices on the go and play music wirelessly provides a level of convenience that traditional power sources cannot match. This device eliminates the need to carry multiple devices such as flashlights, power banks, and Bluetooth speakers, making it a must-have for any outdoor enthusiast.

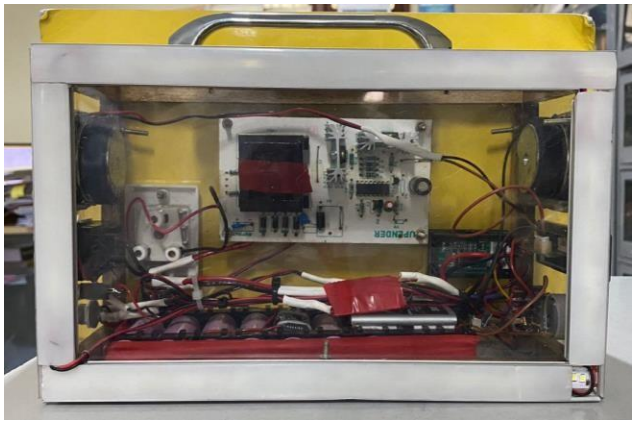

Fig.4.11 Portable inverter (Front view)

Firstly, the controls of the inverter are designed to be intuitive and easy to use. Most models have simple buttons or switches that allow you to turn the inverter on or off, and select the desired function. For example, if you want to use the inbuilt flashlight, you would simply need to flip the switch on the control panel.

Furthermore, this device comes with a LED screen that displays battery level, charging status, and output power. This information is presented in a clear and easy-to-understand way, which helps users to monitor the performance of their inverter and ensure that it is working correctly.

Another aspect of user-friendliness is the design of this portable inverter. It is compact and lightweight, making them easy to carry around and store when not in use. It comes with a built-in handle, which makes it easy to transport them to different locations.

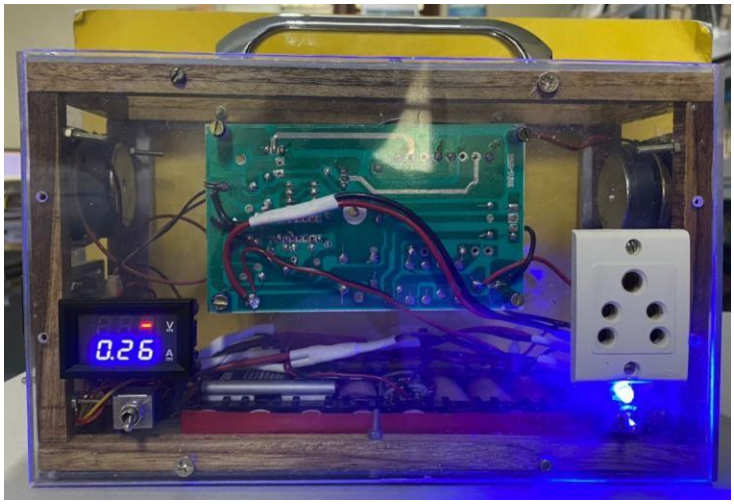

Fig.4.12 Portable inverter (Back view)

In addition, the portable inverter is equipped with safety features that protect the user and their devices. For example, short-circuit protection ensures that the inverter automatically shuts off if a short circuit is detected, preventing damage to the connected devices. Similarly, over-voltage protection and overload protection help to prevent damage to devices and the inverter itself.

The user-friendliness of this portable inverter with additional features such as emergency flashlight, USB charging port, and inbuilt Bluetooth speaker, makes them a convenient and reliable power source for a wide range of applications. They are easy to use, safe, and equipped with features that enhance their functionality and usefulness in various situations.

Fig.4.13 Portable inverter(Light on)

Therefore, the portable inverter with features such as an emergency flashlight, USB charging port, and inbuilt Bluetooth speaker is a game-changer in the world of portable power sources. Its compact size and versatility make it a must-have for outdoor enthusiasts and anyone who values convenience and portability. This device is not only useful in emergency situations but can also provide entertainment while on the go. The future of portable inverters looks bright, and with the continued advancements in technology, we can expect even more innovative features in the years to come.

CHAPTER-5

IMPLEMENTATION OF SOLAR TREE

5.1 PROCESS OF INSTALLATION

Site evaluation is a crucial step in the installation of a solar tree. The first part of site evaluation involves assessing the solar access at the location. This includes analyzing the shading patterns and the amount of solar radiation the site receives. Additionally, a site assessment will consider the soil type, wind patterns, and any potential obstructions that could impact the installation, such as nearby buildings or trees. This information is critical in determining the optimal location for the solar tree and selecting the appropriate foundation.

Once the site has been evaluated and the optimal location has been determined, the foundation installation can begin. The type of foundation required will depend on several factors, including the size of the solar tree and the local soil conditions. In general, solar trees are anchored with a reinforced concrete foundation. The foundation can take several forms, including a single concrete pad or multiple reinforced concrete piers. The foundation must be installed correctly to provide stability and prevent the solar tree from tipping over in high winds.

The pole assembly is the central component of the solar tree, and it supports the solar panels, lighting, and other equipment. The pole assembly is typically made of steel or aluminum, and it is designed to withstand high winds and other environmental factors. The size and shape of the pole assembly will depend on the design of the solar tree and the equipment that will be installed on it. The solar panels are mounted on the pole assembly using special brackets that allow for easy installation and maintenance.

The solar panels are the most critical component of the solar tree, as they are responsible for converting sunlight into electricity. The number and size of the solar panels required will depend on the energy needs of the project and the size of the solar tree. The solar panels are mounted on the pole assembly using specialized brackets, and they are wired together to form a solar array. The solar array is connected to the solar charge converter, which charges the battery at a safety level and discharges current for various loads in a way so that the efficiency of power dissipation is maximum.

Fig.5.1 Solar Panels Structure

The wiring and electronics installation involves connecting the solar panels, inverter, and other components of the solar tree. The wiring must be installed correctly to prevent electrical shorts or other issues. Additionally, the inverter must be connected to a control system that monitors the energy production of the solar tree and manages its energy storage. The control system also allows the LED lights to be turned on and off at specific times, depending on the needs of the project.

Fig.5.2 Electrical Junction Box

Many solar trees are equipped with LED lights, which can be used for a variety of applications, such as illuminating walkways or creating a visual display. The LED lights are typically mounted on the pole assembly and wired to the control system. The LED lights must be installed correctly to ensure that they are functioning correctly and that they do not interfere with the solar panel's energy production.

Once the solar tree has been installed, it must be tested and commissioned to ensure that it is operating correctly. This includes checking the output of the solar panels, verifying that the LED lights are working, and ensuring that the

wiring and electronics are functioning correctly. Any issues that are identified during testing must be addressed before the solar tree can be commissioned.

The ongoing maintenance of a solar tree is critical to ensure that it continues to operate efficiently. This includes regular cleaning of the solar panels to remove dirt and debris, checking the wiring and electronics for damage or wear, and monitoring the energy production of the solar tree to ensure that it is meeting the energy needs of the project.

Additionally, routine inspections of the solar tree should be conducted to identify any signs of damage or wear that could impact its operation or stability. This includes checking the foundation for cracks or shifting, inspecting the pole assembly for signs of corrosion or other damage, and verifying that the wiring and electronics are functioning correctly. Any issues identified during routine inspections should be addressed promptly to prevent further damage and ensure the ongoing operation of the solar tree.

Therefore, it is important to note that the installation process of a solar tree can vary depending on the design of the solar tree and the location where it will be installed.

It is critical to work with experienced professionals who can provide guidance and expertise in the installation and maintenance of a solar tree. By taking a careful approach to the installation and maintenance of a solar tree, colleges and other organizations can benefit from clean, renewable energy while reducing their environmental impact and enhancing their sustainability efforts.

5.2 CIRCUIT DIAGRAM OF SOLAR TREE

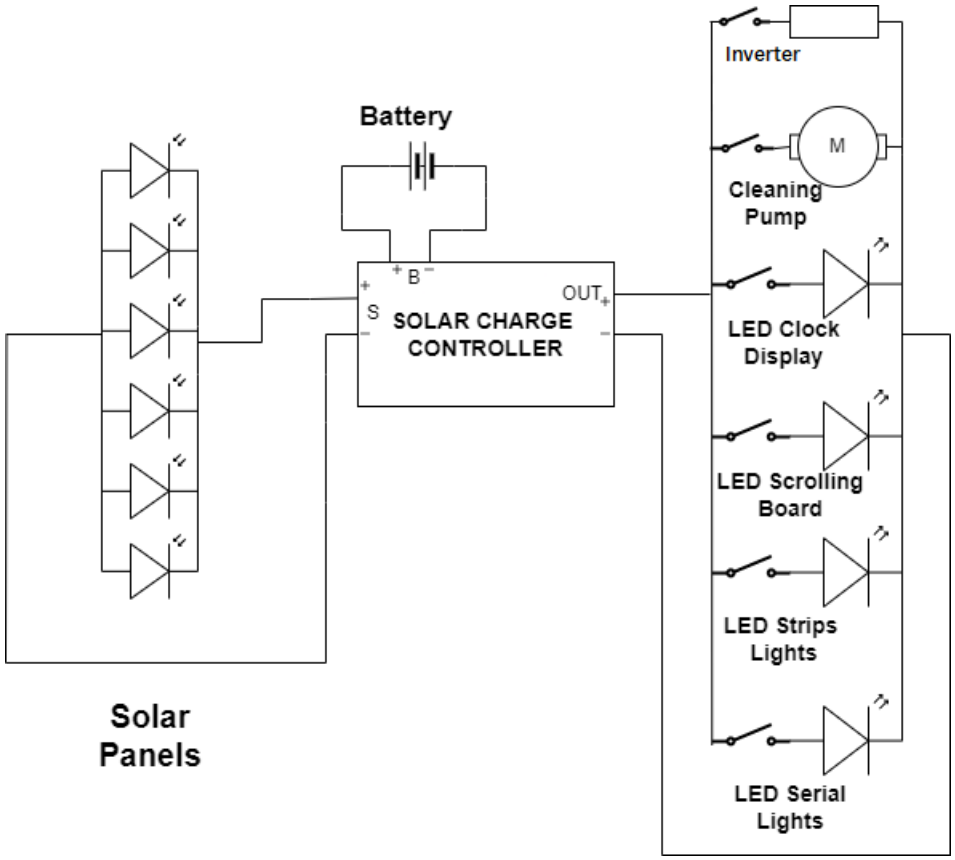

Fig.5.3 Circuit Diagram of Solar Tree

5.3 WORKING OF SOLAR TREE

The solar tree system typically consists of a solar panel array, charge controller, battery bank, inverter, LED lights, and a text display.

The solar panel array is mounted on the top of the pole and consists of multiple solar panels that convert sunlight into electrical energy. The amount of energy produced depends on the size and efficiency of the solar panels, as well as the amount of sunlight available.

The charge controller is a crucial component that regulates the power coming from the solar panels and ensures that the battery bank is not overcharged or undercharged. The controller also manages the power flow between the solar panels, battery bank, and inverter.

The battery bank stores the energy generated by the solar panels during the day and provides power to the LED lights and text display during the night. The size of the battery bank depends on the energy requirements of the LED lights and text display, as well as the number of days of autonomy required.

The DC power from the solar charge controller can be used to power the LED lights and text display. The charge controller must be sized to handle the power requirements of the LED lights and text display.

Fig.5.4 Full View of Solar tree

The LED lights are typically mounted on the pole and controlled by a timer or a smart controller that is programmed to turn them on and off at specific times of the day. The LED lights provide bright and energy-efficient lighting that is ideal for illuminating pathways, public spaces, and other outdoor areas.

The text display is also mounted on the pole and can be used to display messages, announcements, or other information. The text display is typically controlled by a separate timer or smart controller that is programmed to turn it on and off at specific times of the day.

The solar tree system is designed to be a self-contained and self-sufficient source of renewable energy that can provide clean and reliable power. The system is a little complex to install and requires little maintenance, making it an ideal solution for colleges and other organizations looking to reduce their energy costs and improve their sustainability efforts.

CHAPTER-6

CONCLUSION

6.1 ACHIEVED RESULTS

The solar tree can provide a source of clean, renewable energy for the campus. The 6 solar panels on the tree can convert sunlight into electricity, which can be used to power various devices and system inside our campus. This can help reduce the campus's dependence on traditional fossil fuels, which are non-renewable and contribute to greenhouse gas emissions that cause climate change. By generating electricity from the sun, the solar tree can help the college to reduce its carbon footprint and promote sustainable energy practices.

The large text display on the solar tree can be used to communicate important information to the campus community. The display can be programmed to show announcements, upcoming events, emergency alerts, and other relevant information. This can improve communication between the college administration, faculty, staff, and students, and create a more connected campus community. The display can also be updated remotely, making it a convenient way to share information in real-time.

The LED lights on the solar tree can serve practical and aesthetic purposes. The lights can be programmed to turn on and off at specific times, providing lighting for outdoor areas on campus while also conserving energy. This can improve safety and visibility for students and staff who may be on campus early

in the morning or late at night. Additionally, the LED lights can be used to create an attractive and visually appealing space, enhancing the overall aesthetic of the campus and creating a welcoming atmosphere for students and visitors.

Overall, a solar tree can provide multiple benefits for a college campus, including clean energy generation, improved communication, and enhanced aesthetics. It can also serve as a symbol of the college's commitment to sustainability and innovative technology, helping to attract and retain students who are passionate about environmental issues.

6.2 FUTURESCOPE

As cities become more populated, the need for clean energy solutions becomes more pressing. Solar trees offer an elegant and sustainable solution that can be installed in parks, public spaces, and commercial areas. By harnessing the power of the sun, solar trees can provide a source of clean energy that can help to reduce the carbon footprint of cities and improve air quality.

While solar panels are already a highly efficient source of energy, there is always room for improvement. Advances in materials science and technology may lead to solar trees that are even more efficient and cost-effective. For example, researchers are exploring the use of new materials such as perovskite in solar cells, which have the potential to increase efficiency rates to 30% or higher.

The rise of smart cities is opening up new opportunities for solar trees. In the future, solar trees could be equipped with sensors that collect data on weather patterns, energy usage, and air quality. This data could be used to optimize the performance of the solar tree and make it more efficient. Additionally, solar trees could be integrated with other devices and systems in a smart city network, allowing for better energy management and real-time communication.

Solar trees can be used for a wide range of applications beyond just generating electricity. For example, solar trees could be used to power water filtration systems in areas without access to clean water.

They could also be used to charge electric vehicles, provide Wi-Fi hotspots, and power streetlights. With continued investment and research, new and innovative applications of solar trees are likely to emerge.

The potential futurescopes of solar trees are exciting and hold great promise for our transition to a more sustainable and clean energy future. By harnessing the power of the sun, solar trees can help to reduce our dependence on fossil fuels, improve air quality, and create more livable and sustainable communities.

REFERENCES

i. "Solar Trees" Could Light Up Parks and Streets: https://www.nationalgeographic.com/environment/energy/great-energy-challenge/2013/solar-trees-could-light-up-parks-and-streets/

ii. Solar Trees for Shade and Power: https://inhabitat.com/solar-trees-for-shade-and-power/

iii. solar tree charging stations for public spaces: https://inhabitat.com/6-solar-tree-charging-stations-for-public-spaces/

iv. Solar Trees Harvest the Sun in Style: https://www.popularmechanics.com/science/green-tech/a13961/solar-trees-harvest-the-sun-in-style-17353547/

v. The Solar Tree: An Innovative Design for Sustainable Energy: https://www.coolthings.com/solar-tree-sustainable-energy/

vi. Solar trees offer clean energy alternative: https://www.renewableenergyworld.com/2018/07/12/solar-trees-offer-clean-energy-alternative/

vii. All electronic components and guide: http://www.electronicspices.com/

viii. Solar panel ratings and guide: http://www.utlsolar.com/