SOLAR BASED ELECTRIC VEHICLE CHARGING STATION



SONARGOAN UNIVERSITY (SU)

Supervised By
NURUL AMBIA ALAUL
Lecturer
Department of EEE
Sonargaon University (SU)

Submitted By

ABDULLAH AL MUZAHID SHAKIL	ID:EEE2001019143
RAKIB HOSEN	ID:EEE2001019098
MD. RAQIBUL HASAN	ID:EEE2001019138
MD. MOFIJUL ISLAM	ID:EEE1703012146
MEHEDI HASAN	ID:EEE2001019182

Department of Electrical & Electronic Engineering (EEE)
Sonargaon University (SU)
147/I, Panthapath
Dhaka-1215, Bangladesh
Date of Submission: September 2023

Declaration

It is declared hereby that this thesis paper or any part of it has not been submitted to anywhere else for the award of any degree.

....

ABDULLAH AL MUZAHID SHAKIL RAKIB HOSEN

....

MD. RAQIBUL HASAN MD. MOFIJUL ISLAM

……

MEHEDI HASAN

Under Supervision of

.....

NURUL AMBIA ALAUL

Lecturer

Department of EEE

Sonargaon University (SU)

Certification

This is to certify that this project entitled **SOLAR BASED ELECTRIC VEHICLE CHARGING STATION** is done by the following students under my direct supervision. This project work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering, Sonargaon University (SU) in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

Supervisor

.....

NURUL AMBIA ALAUL

Lecturer

Department of Electrical and Electronic Engineer (EEE)

Sonargaon University (SU)

Abstract

In the heart of the "Solar Based EV Charging Station" project lies a groundbreaking initiative for urban sustainability. This fusion of solar, redefines modern urban living. We explore solar charging, uncovering innovation and benefits. Across urban contexts, we assess its environmental, economic, and tech impacts. This compilation highlights the synergy of tech and sustainability, revealing a cleaner, efficient future. Dive into these pages to comprehend its depth and implications, advocating for greener cities. This project signifies our duty to balance innovation, efficiency, and eco-consciousness in urban development and environmental stewardship.

ACKNOWLEDGEMENT

We wish to express our gratitude in the preparation of this report, titled "Renewable EV Charging Station" as part of our practicum program. Firsthand foremost, we extend our appreciation to the university for granting us the opportunity to undertake this practicum. We are especially thankful to our dedicated teacher, **NURUL AMBIA ALAUL**, a lecturer in the Department of Electrical & Electronics Engineering at Sonargaon University (SU), Dhaka. Her unwavering guidance, valuable advice, and deep theoretical knowledge have been indispensable in shaping this project. Our sincere thanks go to our supervisor, whose constant supervision, encouragement, and constructive feedback were pivotal in the successful completion of this project. Her dedication to our progress, including reviewing multiple drafts, greatly contributed to our achievement. Lastly, we acknowledge the support of the Vice-Chancellor of SU, We appreciate everyone who contributed to this report'spreparation.

List of Contents

Title I

Declaration II

Certification III

Abstract IV

Acknowledgement V

Chapter-1 **1-4**

1.1 Introduction

1.2 Objective

1.3 Methodology

1.4 Literature Review

1.5 Background and preliminaries

Chapter-2

5-8

Design and Implementation

2.1 Block Diagram of electric vehicle EV Charging by Solar system

2.1.1 Block Diagram

2.2 Circuit diagram

2.2.1 Working Principle

2.3 List of Component

Chapter-3 **9-16**

Component Description

3.1 Solar Panel System

3.1.1 Photovoltaic cell model

3.1.2 IV Curve for a PV cell

3.2.1 DC Adapter

3.3 Energy Management and Storage

3.4 Electric Vehicle wired Charging

3.5 Buck Converter

3.6 Charge Controller

Chapter-4 **23-26**

Results & Discussions

4.1 Results & Discussions

4.2 Design Architecture

4.3 Features

Chapter-5 **27-29**

CONCLUSION

5.1 Conclusion

5.2 Advantages

5.3 Disadvantages

5.4 Application

Chapter-1

1.1 Introduction

The concept of a "Solar Based EV Charging Station with" marks a significant leap forward in the pursuit of sustainable urban development and cleaner transportation solutions. With the increasing emphasis on environmental conservation and the urgent need to reduce carbon emissions, the integration of renewable energy sources and innovative technologies has become paramount. This project envisions a transformative synergy between electric vehicle (EV) charging infrastructure and energy-efficient street lighting, powered by renewable sources like solar and wind energy.

Simultaneously, the rise of electric vehicles presents a unique opportunity to shift towards cleaner modes of transportation. By combining these two critical aspects - EV charging within a framework of renewable energy sources, this project aims to not only address energy and environmental challenges but also reshape the urban landscape for the better.

The "Solar Based EV Charging Station" project Encompasses advanced technologies such as solar panels, wind turbines, and smart control systems. These elements work in harmony to harness clean and sustainable energy for powering both electric vehicles and street lighting fixtures. The automatic street light feature, responsive to ambient light levels, ensures optimal energy consumption while enhancing the safety and comfort of pedestrians and motorists.

Through this integration of cutting-edge technology, the project aims to set a precedent for urban sustainability, showcasing the possibilities of harnessing renewable resources for multiple applications. As we embark on this journey towards a greener and more efficient urban environment, the "Renewable EV Charging Station " project stands as a beacon of innovation, promising a brighter and cleaner future for our cities.

1.2 Objective

- Integrated Renewable Energy Harvesting
- Efficient Electric Vehicle Charging.
- Battery Management and Optimization.
- Environmental Impact and Sustainability.
- Public Awareness and Education.

1.3 Methodology

1. Planning and Analysis:

- Define objectives and scope.
- Analyze urban mobility and energy requirements.

2. Component Selection and Integration:

- Choose efficient solar panels, Sensor, Powerhouse andgrid supply systems.
- Design an integrated system architecture.

1. Energy Management and Automation:

- Implement algorithms for automated energy distribution.Include predictive energy forecasting.

2. Prototyping, Testing, and Validation:

- Validate performance through real-world trials.

3. Data Collection and Analysis:

- Collect and analyze energy generation and usage data

1.4 Literature Review

The "Solar based Electric Vehicle Charging Station" project resonates within the broader discourse of urban sustainability, where the convergence of renewable energy, technological innovation, and efficient urban infrastructure holds paramount importance. The integration of solar panels, as explored in relevant literature, stands as a pivotal step towards reducing carbon emissions and fostering energy resilience. Notably, the project's solar tracking mechanism aligns with studies highlighting the significance of optimizing solar energy capture throughout the day.

Electric vehicle (EV) charging infrastructure emerges as a critical component in the transition towards cleaner transportation. The project's solar charging technology echoes discussions on enhancing EV adoption through convenient and user-friendly charging options, complementing existing research on urban EV charging solutions. Smart energy management and automation, central to the project's design, find validation in studies emphasizing intelligent systems for demand response, efficient grid integration, and resource optimization. Furthermore, automatic street lighting controls, akin to the project's objectives, have been explored for their potential in enhancing pedestrian safety and reducing energy consumption. The project's innovation is emblematic of contemporary urban sustainability

Aspirations, aligning with a trajectory that intertwines technology, renewable energy and smart urban systems. As it takes strides towards the efficient coexistence of electric mobility and sustainable energy practices, the project effectively contributes to the overarching dialogue on creating more resilient, cleaner, and technologically advanced urban environments.

1.5 Background and preliminaries

The global pursuit of sustainable urban development has prompted innovative solutions to address the challenges of increasing energy demand, environmental degradation, and urbanization. Within this context, the "Renewable EV Charging Station Street Light" project emerges as a dynamic response, fusing renewable energy sources, advanced technology, and efficient infrastructure. Rising urban populations and their associated energy requirements have underscored the urgency of integrating renewable energy intourban landscapes. Solar panels have garnered attention as viable alternatives to conventional energy sources, allowing cities to reduce carbon emissions and

enhance energy security. The project's solar tracking mechanism, aligning with established research, enhances the efficiency of solar energy capture, offering a template for maximizing renewable energy generation. Electric vehicle adoption presents another facet of sustainable urbanization. As the world transitions toward EVs, the project's wireless charging system embodies an innovative approach to promote cleaner mobility. Previous studies emphasize the necessity of convenient and accessible charging infrastructure within urban areas, supporting the project's endeavor to facilitate EV integration seamlessly.

The fusion of smart energy management and automation has been identified as crucial to optimizing resource utilization. The project's integration of predictive algorithms aligns with research advocating for intelligent energy systems that balance supply and demand while ensuring grid stability. In essence, the "Renewable EV Charging Station " project epitomizes the convergence of renewable energy, electric mobility, and smart urban

systems—a synthesis that holds the potential to reshape the urban fabric sustainably. In the following sections, we delve into the project's intricate components, methodologies, and envisioned impact within the realm of Bangladesh's urban development.

Chapter-2

Design and Implementation

2.1 Block Diagram OF Electric Vehicle (EV) Charging by Solar system

In this diagram we can see input and output of our project. Inputs are Sunlight and power. Our output is Wired charging to vehicle charge. As a power source we use solar panel, grid power, rechargeable battery and we used auto cutoff charging control unit for batterycharging.

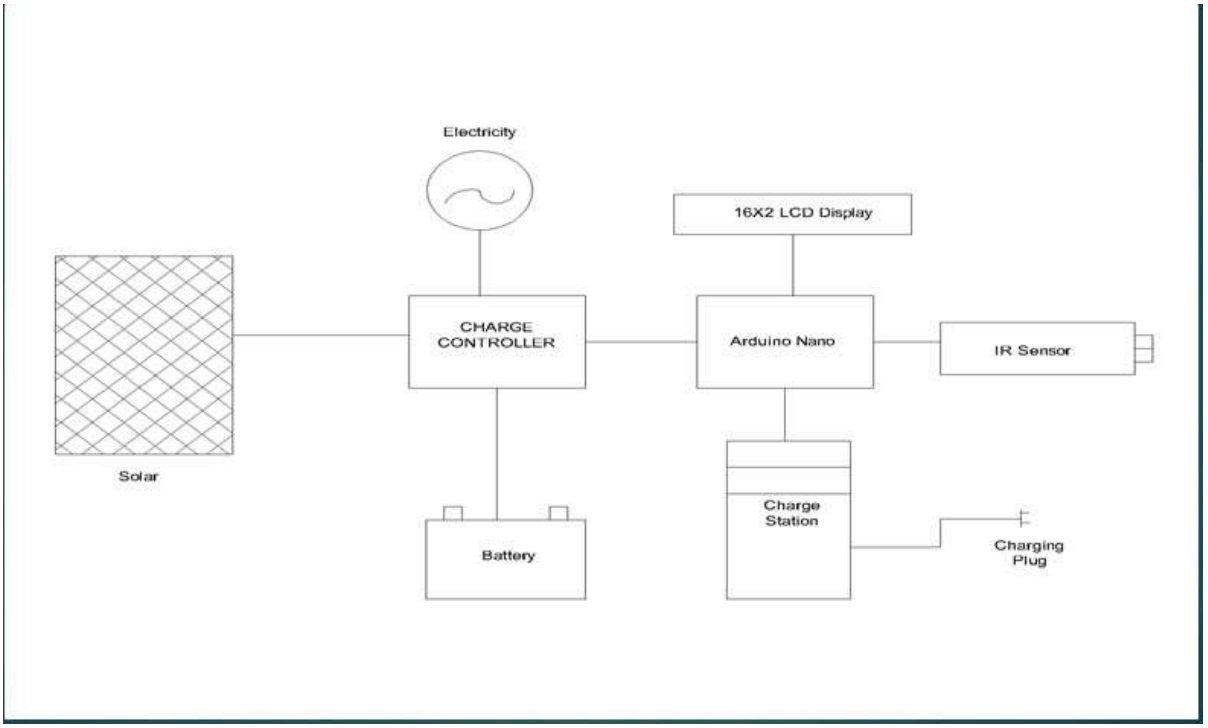


Figure 2.1 Block diagram of Solar Based Electric Vehicle Charging Station

In this diagram we can see input and output of this part. Inputs are Sunlight energy. Our output is recharge the power house and vehicle charging. As a power source we use solar & grid power and reserve source is battery, power supply, Arduino Nano rechargeable battery and we usedrelay module circuit.

2.2 Circuit Diagram

A solar panel give output 19V from sunlight to a buck converter. The buck converter convert 19v to 12V. Then the buck converter sends the 12v output to charge controller. Then the charge controller 12v output is connected to the 12v battery to charge the powerhouse. Another 5v output from the controller connected to Arduino to run the system. Another 5v output from the controller connected with wired vehicle charging cable. We use here a relay for safety purpose. The relay operates from Arduino. A IR sensor connected to Arduino. Which is detect the vehicle and send sends signal to Arduino. A LCD connected to Arduino to show the status of vehicle detection and charging system status.

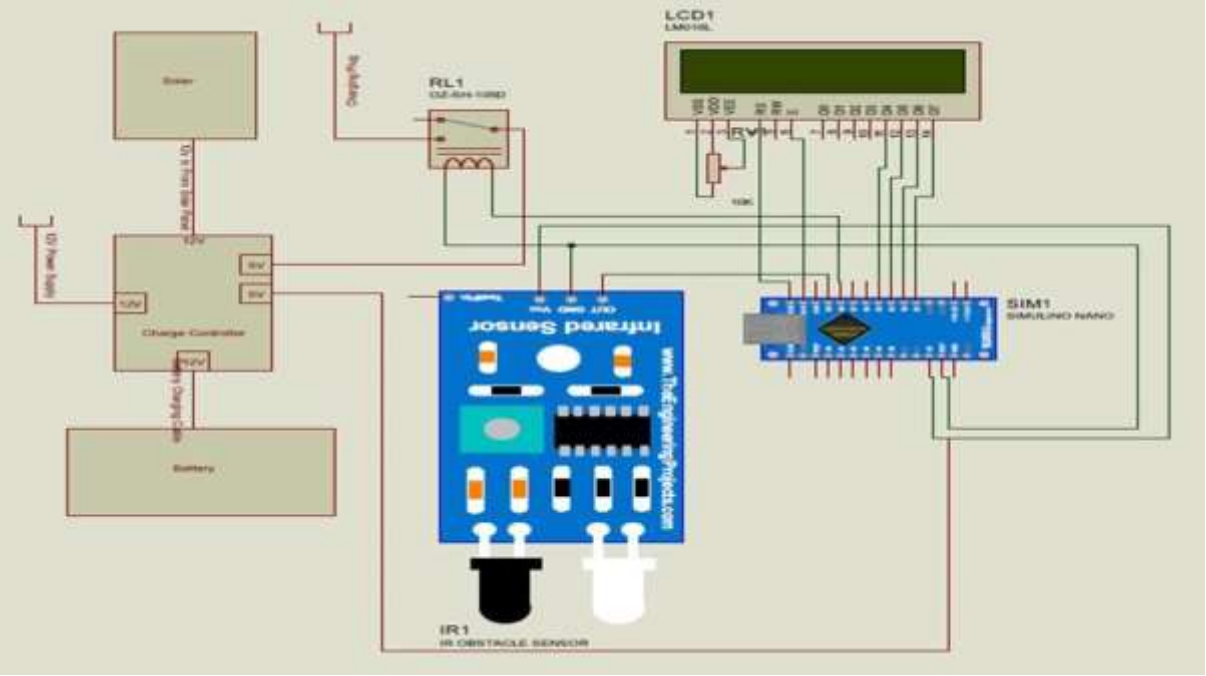


Figure 2. 2 Circuit Diagram of Solar Based Electric Vehicle Charging

2.2.1 Working Principle

The **" SOLAR BASED ELECTRIC VEHICLE CHARGING STATION"** project operates on a comprehensive system that integratesrenewable energy sources and innovative technologies to efficiently provide electric vehicle (EV) charging capabilities.

- **Energy Generation:** A solar panel installed the roof top of the station. Sun light reflect light on the solar panel. Then the solar panel give output 19v.
- **Charging Setup for Internal Powerhouse:** A solar panel give output 19V from sunlight to a buck converter. The buck converter convert 19v to 12V. Then the buck converter sends the 12v output to charge controller. Then the charge controller 12v output is connected to the 12v battery to charge the powerhouse. An extra power supply connected to the controller to charge the powerhouse from grid.
- **Vehicle Detection:** An IR sensor connected to Arduino. Which is detect the vehicle and send sends signal to Arduino. A LCD connected to Arduino to show the status of vehicle detection and charging system status.
- **Vehicle Charging:** When a vehicle enters the station an IR sensor detect the vehicle and sends a signal to Arduino. Then the Arduino sends a signal to operate a relay to ready for charging. Then the charging cable get power for charging. After that when we connect the charging cable to vehicle manually, then the vehicle will charge. After charge full we have to disconnect the charging cable manually. When the vehicle left the station, the IR sensor sends a signal to Arduino. Then the Arduino sends a signal to operate a relay to stop charging. Then the charging cable power cut off automatically.

2.3 List of Components

SL	Name	Quantity
1.	Solar Panel	1
2.	Charge Controller	1
3.	12v Battery	1
4.	Arduino Nano	1
5.	DC Adapter	1
6.	Buck Converter	2
7.	Switch	2
8.	LED Bulb	6
9.	LCD	1
10.	IR Sensor	2
11.	Vero Board	1
12.	Relay	1

Chapter-3

Component Description

3.1 Solar Panel System

Solar panel is mainly designed as a panel which absorbed the sun’s rays and convert light into electricity. Most of the time the most powerful source of light available is the Sun, called Sol by astronomers. It is called photovoltaic which means, basically, "light- electricity."



Figure 3. 1 Solar panel Module

A solar panel is a collection of solar cells. Lots of small solar cells spread over a large area can work together to provide enough power to be useful. Solar power generating systems take advantage of this property to convert sunlight directly into electrical energy. Solar panels also called “solar modules produce direct current (DC), which goes through a power inverter to become alternating current (AC) — electricity that we can use in the home or office or other sectors
.When sunlight hits the semiconductor, an electron springs up and is attracted to the n-type semiconductor. This causes more negative electrons in the n-type semiconductor and more positive electrons in the p-type, thus generating a flow of electricity in a process known as the photovoltaic effect.• The majority of solar modules use wafer-based crystalline silicon cells or thin-film cells based on cadmium telluride or silicon.

3.1.1 Photovoltaic Cell Model

A simplest equivalent circuit of a solar cell is a current source in parallel with a diode. The output of the current source is directly proportional to the solar energy (photons) that hits on the solar cell. During darkness, the solar cell is notan active device; it works as a diode, i.e. A p-n junction. It produces neither a current nor a voltage. The diode determines the IV characteristics of the cell.

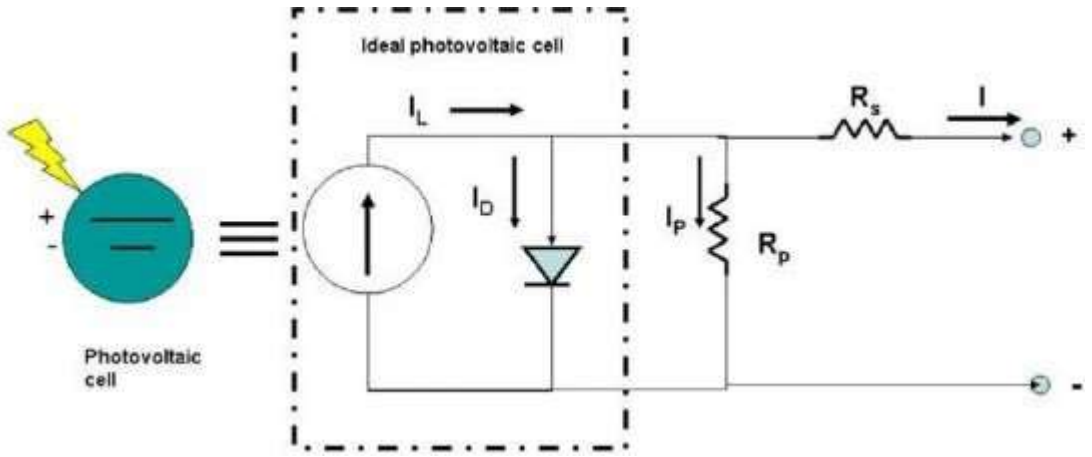


Figure 3.2 Circuit diagram of a PV cell

3.1.2 IV Curve for a PV cell

A general I-V characteristic of the solar cell for a given ambient irradiation 'G' and fixed cell temperature 'T' is shown in Fig 3. For a certain resistive load, the load characteristic is a straight line with slope. Power delivered to the load depends on the value of the resistance only. In some cases, if the R load is very small; the PV cell operates in the M-N region of the IV curve, the PV cell act as a constant current source, which is almost equivalent to a short circuit current. However, if the R load is large, the PV cell operates in the P-S region of the IV curve, the PV cell act as a constant voltage source almost equivalent to the open circuit voltage. A PV cell is characterized by the following fundamental.

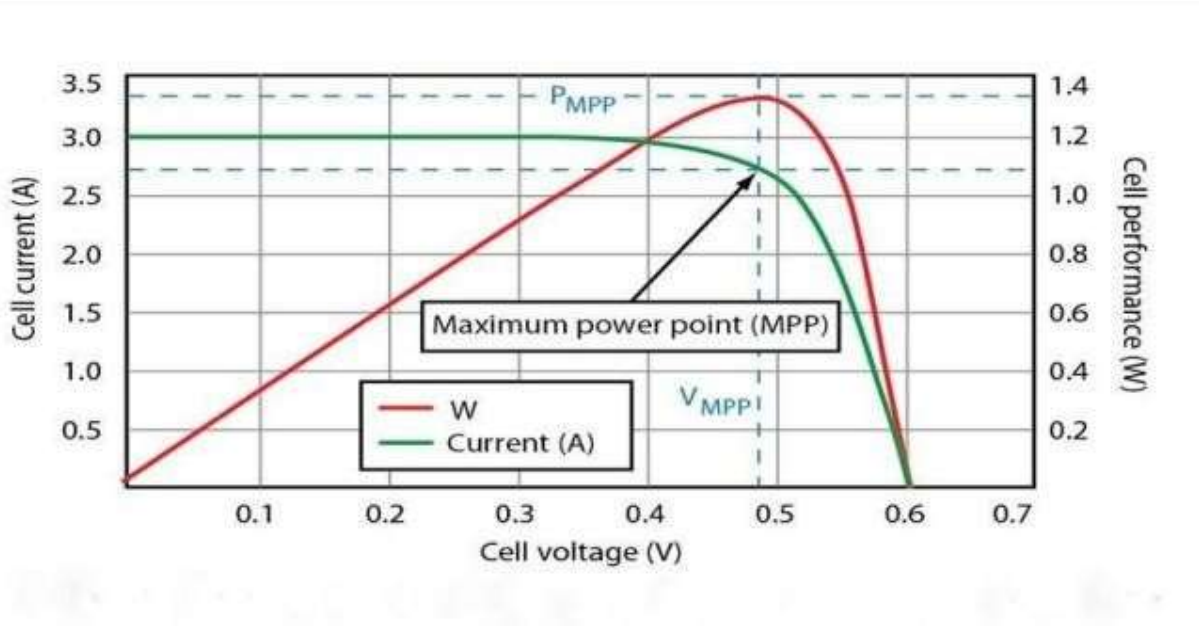


Figure 3.3 I/ V Characteristics of PV cell

- Short circuit current: Isc = Iph (Greatest value of the current generated by a PVcell, which is produced by the short circuit condition: V=0.
- Open circuit voltage is a voltage drop across the diode D when the generated current I=0.It presumes the voltage of the PV cell in the night and it is expressed by (2).
- Maximum power point is the operating point in Fig 2.3, where the power dissipated in the resistive load is maximum. Maximum efficiency is the ratio of the maximum power and the incident solar energy (photons). η=Pmax/Pin=Vmax Imax/AG. Where is the ambient irradiation and A is the PVcell area?
- Fill factor (FF) is the ratio of the maximum power that can be delivered totheload and the theoretical maximum power which is the product of Isc and Voc. FF=Pmax/Voc Isc=Vmax Imax/Voc Isc . FF is a measure of real I-V characteristic which value much be higher than 0.7 for a good PV cell.

3.2 DC Adapter

A 12V DC power supply is an adapter designed to supply precisely 12 Volts of direct current to a device. The voltage supplied must precisely match the requirements of the equipment.



3.3 Energy Management and Storage

12V battery The 12V battery functions as a critical energy repository within the system. It plays a pivotal role in storing excess energy harnessed from solar panels and wind turbines during periods of optimal production. This stored energy serves as a dependable reservoir during times of diminished energy generation, such as overcast skies or minimal wind activity. By releasing the stored energy when needed, the battery ensures a consistent and stable power supply for electric vehicle (EV) charging. This mechanism guarantees uninterrupted functionality, irrespective fluctuations in renewable energy availability. As a linchpin of the energy management strategy, the 12V battery enhances the system's resilience and reinforces its capacity to uphold seamless EV charging and illumination of the streets.



3.4 Charge Controller:

This is charge the main charge control circuit in this project. It's received energy from solar or grid station and supply the energy to battery. It has four output port, one of them five volt, one of them nine volt, two of them twelve volt. From here we get the required rating voltage. This circuit have Short Circuit Protection, High Voltage Protection. Polarity Protection. Output Overvoltage Protection. Thunder protection. Battery percentage Indicator 100%, 75%, 50% & 25%



3.5 Arduino Nano:

The **Arduino Nano** is an open-source breadboard-friendly microcontroller board based on the Microchip ATmega328P microcontroller (MCU) and developed by Arduino.cc and initially released in 2008. It offers the same connectivity and specs of the Arduino Uno board in a smaller form factor.

The Arduino Nano is equipped with 30 male I/O headers, in a DIP-30-like configuration, which can be programmed using the Arduino Software integrated development environment (IDE), which is common to all Arduino boards and running both online and offline. The board can be powered through a type-B mini-USB cable or from a 9 V battery



3.6 Relay:



A power relay module is an electrical switch that is operated by an electromagnet. The electromagnet is activated by a separate low-power signal from a micro controller. When activated, the electromagnet pulls to either open or close an electrical circuit.

5V Relay Module Pin Configuration

The pin configuration of the 5V relay module is shown below. This module includes 6-pins where each pin and its functionality are discussed below. **Normally Open (NO):** This pin is normally open unless we provide a signal to the relay modules signal pin. So, the common contact pin smashes its link through the NC pin to make a connection through the NO pin.

Common Contact: This pin is used to connect through the load that we desire to switch by using the module.

Normally Closed (NC): This NC pin is connected through the COM pin to form a closed circuit. However, this NC connection will break once the relay is switched through providing an active high/low signal toward the signal pin from a microcontroller.

Signal Pin: The signal pin is mainly used for controlling the relay. This pin works in two cases like active low otherwise active high. So, in active low case, the relay activates once we provide an active low signal toward the signal pin, whereas, in an active high case, the relay will trigger once we provide a high signal toward the signal pin. However, these modules generally work on an active high signal which will strengthen the relay coil to make contact with the common terminal with the normally open terminal.

5V VCC: This pin needs 5V DC to work. So 5V DC power supply is provided to this pin.

Ground: This pin connects the GND terminal of the power supply.

3.7 LCD:

"Dot Matrix" is an unique category of LED Displays and also found in LCD and OLED products. The concept of LED Dot Matrix Display is the same as LCD Dot Matrix and OLED Dot Matrix. It is able to show characters, numbers or graphics by light up different pixels (dots) of a Display.



3.8 LED:

Light-emitting diode (LED) is a widely used standard source of light in electrical equipment. It has a wide range of applications ranging from your mobile phone to large advertising billboards. They mostly find applications in devices that show the time and display different types of data.



3.9 IR Sensor:

An infrared sensor (IR sensor) is a radiation-sensitive optoelectronic component with a spectral sensitivity in the infrared wavelength range 780 nm -- 50 µm. IR sensors are now widely used in motion detectors, which are used in building services to switch on lamps or in alarm systems to detect unwelcome guests.



3.10 Vero Board:

Vero board is the original prototyping board. Sometimes referred to as 'stripboard' or 'matrix board' these offer total flexibility for hard wiring discrete components. Manufactured from a copper clad laminate board or Epoxy based substrate, it is offered in both single and double sided formats.



Applications:

Boost converters find applications in a wide range of industries and systems due to their ability to efficiently step up voltage levels. Some common applications include-

Battery-powered devices: many portable electronic devices, such as laptops, smartphones, and digital cameras, require higher voltages than the battery supplies. Boost converters ensure that these devices receive the required voltagelevel.

Led lighting: light-emitting diodes (Leds) often require specific voltage levelsto operate efficiently. Boost converters are used to provide the necessary voltage for led lighting systems.

Photovoltaic systems: solar panels generate variable voltages depending on sunlight intensity. Boost converters are used to increase the solar panel output voltage to charge batteries or feed power into the grid.

Electric vehicles: electric vehicles use boost converters to convert the voltagefrom the battery pack to the required level for various vehicle components, suchas the motor controller.

Power factor correction: boost converters are used for power factor correctionin industrial systems, improving energy efficiency and reducing power consumption.

Energy harvesting: in energy harvesting systems, where energy is captured from ambient sources like vibrations or radio frequency signals, boost converters are employed to step up the harvested energy to usable levels.

Hvac systems: heating, ventilation, and air conditioning (hvac) systems might require higher voltages for certain components. Boost converters help achieve the required voltage levels efficiently.

Auto cutoff 12v solar battery charger



An auto cutoff 12v solar battery charger is a device designed to charge a 12-volt battery using solar panels and to automatically stop the charging process when the battery reaches a certain level of charge. This feature helps prevent overcharging, which can damage the battery and reduce its lifespan.

Operating principle

Solar panel input: the solar charger is connected to a solar panel or a set of solar panels that generate electricity from sunlight.

Battery connection: the charger is also connected to the 12-volt battery that needs to be charged. This could be a lead-acid battery, AGM (absorbent glass mat) battery, gel battery, or other types commonly used in various applications.

Charging process: when sunlight is available, the solar panels generate dc electricity. The charger's electronics convert this dc power to the appropriate voltage and current levels required for charging the 12-volt battery.

Voltage and current monitoring: the charger monitors the battery's voltage and current levels during the charging process. As the battery charges, its voltage gradually increases.

Cutoff threshold: the charger is designed with a predetermined voltage threshold that indicates a fully charged battery. Once the battery's voltage reaches this threshold, the charger's control circuitry recognizes that the battery is fully charged or nearing full charge.

Auto cutoff: when the charger detects that the battery's voltage has reachedthe preset cutoff threshold, it automatically stops the charging process. This prevents overcharging, which can lead to electrolyte loss and other forms of battery damage.

Maintenance mode: some solar battery chargers may transition into a maintenance or trickle charging mode after reaching the cutoff threshold. In this mode, the charger provides a lower level of charge to keep the battery topped up without causing overcharging.

Benefits:

Battery health: prevents overcharging and extends the battery's lifespan by avoiding damage caused by excessive charge levels. - Energy efficiency: ensures that solar energy is used efficiently by halting the charging process when it's not necessary. - User convenience: eliminates the need for manual monitoring and intervention, as the charger automatically manages the charging process.

Applications

Automotive: charging car batteries to maintain their charge during periods of non-use or to recover charge after a deep discharge. Marine: charging batterieson boats and marine vehicles to power onboard equipment.

Rvs and campers: keeping the battery charged in recreational vehicles and campers for lighting and appliance use.

Remote installations: charging batteries in off-grid locations where solar power is the primary energy source.

Home use: providing backup power by charging batteries for use during power outages.

It's important to choose a quality solar battery charger with the appropriate voltage and current ratings for your specific battery type and capacity. This willensure effective charging and protection against overcharging.

Chapter-4

4.1 Results & Discussions

The "**SOLAR BASED ELECTRIC VEHICLE CHARGING STATION** " project has successfully integrated multiple technologies to create an innovative and sustainable solution. The results obtained from the implementation of the various components underscore the project's potential impact on renewable energy utilization, electric vehicle (EV) charging, and energy-efficient street lighting. Renewable Energy Utilization: and a motor, exhibited improved solar energy capture throughout the day. This optimization led to enhanced energy generation and increased the overall efficiency of the solar panel system.
Additionally, the integration of wind turbines and rectifier circuits demonstratedthe feasibility of harnessing wind energy and converting it into usable power, contributing to a diversified renewable energy portfolio.

EV Charging Infrastructure:

The project's dual approach to EV charging, encompassing wired charging and, showcased flexibility and convenience for EV users. The wired charging, supported by voltage and current measurement, yielded rapid charging times.
Meanwhile, the wireless charging system using a transmitter-receiver setup indicated successful energy transfer through resonant coupling, suggesting the potential for efficient EV charging without physical connections. Energy- Efficient Street Lighting: The utilization of piezoelectric technology for street lighting, combined with rectifier and booster circuits, demonstrated effective energy conversion from mechanical vibrations to electrical energy. This innovative approach presents an environmentally friendly solution for urban illumination, reducing dependency on conventional energy sources.





RESULTS AND OUTPUT

4.2 Design Architecture

The **"SOLAR BASED ELECTRIC VEHICLE CHARGING STATION"** project's design architecture integrates solar panels. Renewable energy generatedis efficiently managed, charging a 12V battery via solar and battery chargers.
Electric vehicle charging encompasses wired options. This cohesive design underscores the project's commitment to sustainable mobility, energy efficiency, and technological innovation.

4.3 Program:

```
#include <LiquidCrystal.h>

const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

int IR = 9;
int val=0;
int IR2 = 7;
int sval;


void setup() {

lcd.begin(16, 2);
pinMode(IR, INPUT);
pinMode(IR2, INPUT);




}

void loop() {

lcd.setCursor(0, 0);

val = digitalRead(IR);

if (val == LOW){
  lcd.print("Vehicle Detected");
```

```
  }
  else{
    lcd.print("No Vehicle Found");


  }

  lcd.setCursor(0, 1);

  val = digitalRead(IR);

  if (val == LOW){
    lcd.print("Ready To Charge");



  }
  else{
    lcd.print("Charge Stopped!");

  }

}
  }
```

4.4 Features

- Solar panels ensure consistent renewable energy.
- Vehicle detection system.
- Over charge protection.
- Safety
- Internal Power house storage
- Energy Efficiency.

Application Ideas

- Urban Mobility
- Transformation. Sustainable
- Urban Development. Enhanced
- Public Infrastructure.
- Economic and Environmental Impact

Chapter-5

5.1 Conclusion

The "SOLAR BASED ELECTRIC VEHICLE CHARGING STATION" project stands as a testament to innovation, sustainability, and urban progress. This project represents a remarkable intersection of sustainable technology and modern transportation needs. As we stand at the crossroads of environmental responsibility and the advancement of electric mobility, these innovative stations emerge as beacons of progress. They embody the aspirations of a greener future while addressing the challenges of our times.

By harnessing the power of the sun, these charging stations demonstrate the potential to redefine the way we power our vehicles. They offer a tangible solution to the dual challenges of climate change and the transition to cleaner transportation options. Through the amalgamation of solar panels, cutting-edge electronics like Arduino, and user-friendly interfaces like LCD displays, these stations encapsulate the potential of human ingenuity.

While these stations hold immense promise, it's essential to acknowledge the complexity of their implementation. The variability of weather patterns, the initial investment required, and the need for ongoing maintenance are all considerations that underline the need for meticulous planning and adaptable strategies. However, the pursuit of sustainability often entails overcoming obstacles, and the **Solar Based Charging Station** is a testament to our willingness to innovate in the face of challenges.

As our collective consciousness gravitates towards environmentally conscious choices, the **Solar Based Electric Vehicle Charging Station** aligns with our shared vision of a cleaner, more harmonious world. Its advantages, from reducing carbon emissions to promoting energy independence, serve as strong catalysts for change. Furthermore, these stations contribute not only to the evolution of transportation but also to public awareness, education, and the broader effort to shape a sustainable future for generations to come.

In the grand scheme of our journey towards a planet-friendly future, the **Solar Based Electric Vehicle Charging Station** represents one more step in the right direction. Its implementation, proliferation, and refinement will undoubtedly pave the way for a world where our vehicles are powered by the brilliance of the sun, setting a course towards a future we can all take pride in.

5.2 Advantages

The Solar System Electric Vehicle Charging Station offers numerous advantages that contribute to a more sustainable and efficient transportation ecosystem. Here are some key benefits:

- **Clean and Renewable Energy Source:** The primary advantage is the use of solar energy, a clean and renewable resource. Solar power generation produces minimal environmental impact compared to conventional fossil fuel-based energy sources, reducing greenhouse gas emissions and air pollution.

- **Reduced Carbon Footprint:** By utilizing solar energy for charging, the station significantly reduces the carbon footprint associated with electric vehicle operation. This contributes to combating climate change and improving air quality.

- **Energy Independence:** Solar-powered charging stations generate their own energy, reducing dependence on external power sources. This can lead to increased energy resilience and stability, especially during grid disruptions.

- **Cost Savings:** Over time, solar energy can lead to significant cost savings. Once the initial installation costs are covered, the ongoing operational expenses are lower compared to conventional charging stations powered by grid electricity.

- **Low Operating Costs:** Solar panels have minimal operating and maintenance costs. They require occasional cleaning and inspection, but there are no fuel costs or complex maintenance procedures involved.

- **Infrastructure Flexibility:** Solar charging stations can be deployed in remote areas or places with limited grid access, expanding the reach of electric vehicle charging infrastructure.

- **Public Awareness and Education:** Solar charging stations serve as visible symbols of renewable energy integration. They can educate the public about the potential of solar power and inspire wider adoption of clean energy technologies.

- **Scalability:** Solar charging infrastructure can be easily expanded by adding more solar panels and charging points as demand increases, without significant changes to existing infrastructure.

- **Support for Electric Mobility:** Solar charging stations encourage the adoption of electric vehicles by providing accessible and sustainable charging solutions. This helps accelerate the transition away from internal combustion engine vehicles

- **Eco-Friendly Tourism:** Solar-powered charging stations located in tourist destinations can attract eco-conscious travelers, promoting green tourism while providing essential charging services.

- **Technological Innovation:** The development and deployment of solar charging stations drive innovation in solar panel technology, energy storage, and charging infrastructure, contributing to overall technological advancement.

- **Long-Term Investment:** Solar panels have a long lifespan, typically around 25 to 30 years. This long-term sustainability makes them a valuable investment in the transition to cleaner energy systems.

- **Contribution to Sustainable Development Goals:** Solar-powered EV charging aligns with multiple United Nations Sustainable Development Goals, including affordable and clean energy, climate action, and sustainable cities and communities

5.3 Disadvantages

While Solar System Electric Vehicle Charging Stations offer numerous benefits, there are also certain disadvantages and challenges associated with their implementation. Here are some of the key drawbacks to consider:

- **Weather Dependence:** Solar energy generation is highly dependent on weather conditions, such as sunlight intensity and cloud cover. This variability can lead to inconsistent charging rates, especially on cloudy or rainy days.

- **Limited Nighttime Charging:** Solar panels cannot generate energy at night, which means that nighttime charging relies solely on stored energy from the daytime. Energy storage systems like batteries can mitigate this limitation but may add to the overall cost.

- **Initial Installation Costs:** The upfront costs of installing solar panels, charging infrastructure, and energy storage systems can be relatively high. This can deter some potential adopters and may require longer periods to recoup the investment through cost savings.

- **Space Requirements:** Solar panels require a significant amount of space to generate substantial energy. In urban areas with limited space, finding suitable locations for solar charging stations can be challenging.

THE END