RENEWABLE ELECTRIC VEHICLE (EV) CHARGING STATION WITH AUTOMATIC STREET LIGHT

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Declaration

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

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Certification

This is to certify that this project entitled “RENEWABLE EV CHARGING STATION WITH AUTOMATIC STREET LIGHT” 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.

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Abstract

In the heart of the "Renewable EV Charging Station with Automatic Street Light" project lies a groundbreaking initiative for urban sustainability. This fusion of solar, wind, piezoelectric, wireless charging, and advanced lighting redefines modern urban living. We explore solar tracking, wireless tech, and smart lighting, 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

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List of Contents

Title	I
Declaration	II
Certification	III
Abstract	IV
Acknowledgement	V
Chapter-1	**1**
1.1 Introduction	1
1.2 Objective	2
1.3 Methodology	2
1.4 Literature Review	3
1.5 Background and preliminaries	4
Chapter-2	**6**
Design and Implementation	6
2.1 Block Diagram of electric vehicle €V Charging by Solar system and Wind Turbine	6
2.1.1 Block Diagram of Auto-street Light Using Piezoelectric	7
2.2 Circuit diagram	7
2.2.1 Working Principle	9
2.3 List of Component	11

Chapter-3 12

Component Description 12

3.1 Solar Panel System 12

3.1.1 Photovoltaic cell model 13

3.1.2 IV Curve for a PV cell 13

3.1.3 Solar tracking System 14

3.1.4 Solar Tracking Circuit diagram 15

3.2 LDR (Light Dependent Resistor) 16

3.2.1 Working Principle of LDR 17

3.2.2 The Design and implementation of using two LDRs 18

3.2.3 The minimum light detectable Equation 19

3.3 Motor for Solar Panel Tracking 19

3.4 Wind Turbine System 20

3.4.1 Rectifier circuits for AC to DC conversion 21

3.5 Energy Management and Storage 22

3.6 DC to AC Converter for EV Charging 23

3.7 Electric Vehicle wired fast Charging 24

3.8 Wireless Charging system (transmitter and receiver) 25

3.9 Piezoelectric energy converter 26

3.10 Automatic light control circuit 27

3.11 Boost Converter 28

3.12 Auto Cutoff 12v Solar Battery Charger 30

Chapter-4 **33**

Results & Discussions 33

4.1 Results & Discussions 33

4.2 Design Architecture 35

4.3 Features 36

4.4 Key Specifications 36

4.5 A Smart Street Lighting System Using Piezoelectric 37

Chapter-5 **39**

CONCLUSION **39**

5.1 Conclusion 39

5.2 Advantages 40

5.3 Disadvantages 40

5.4 Application 41

REFERENCE **42**

List Of Figure

Figure 2. 1 Block diagram of EV Charging with solar system and wind Turbine 6
Figure 2.2 Block diagram of Auto-street light using piezoelectric 7
Figure 2. 3 Circuit Diagram of Renewable EV Charging 8
Figure 2. 4 Circuit Diagram of automatic street light 9
Figure 3.1 Solar panel Module 12
Figure 3.2 Circuit diagram of a PV cell 13
Figure 3.3 I/ V Characteristics of PV cell 14
Figure 3.4 Solar Tracking System 15
Figure 3.5 Solar Tracking Circuit Diagram 16
Figure 3.6 Light Dependent Resistor 17
Figure 3.7 quadrants wise LDR positioning 18
Figure 3.8 the Sensing Element and Signal Processing 18
Figure 3.9 Motor for Solar Panel Tracking 20
Figure 3.10 Wind Turbine system 21
Figure 3.11 Rectifier Circuit Diagram 22
Figure 3.12 12 V Battery 22
Figure 3.13 Dc to ac converter Circuit Diagram 23
Figure 3.14 Wireless Power transmitter coil and receiver 26
Figure 3.15 Piezoelectric Source 27
Figure 3.16 Boost Converter 29
Figure 3.17 Auto Cutoff 12v Solar Battery Charger 31

Chapter-1

1.1 Introduction

The concept of a "Renewable EV Charging Station with Automatic Street Light" 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.

Traditionally, street lighting has been a critical element of urban infrastructure, ensuring safety and visibility during nighttime hours. 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 and street lighting - 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 "Renewable EV Charging Station with Automatic Street Light" 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 with Automatic Street Light" project stands as a beacon of innovation, promising a brighter and cleaner future for our cities.

1.2 Objective

- Integrated Renewable Energy Harvesting.
- Optimized Solar Tracking Mechanism.
- Efficient Electric Vehicle Charging.
- Wireless Charging Technology.
- Piezoelectric Street Lighting.
- Smart Automatic Lighting Control.
- Battery Management and Optimization.
- Environmental Impact and Sustainability.
- Data Monitoring and Analysis
- 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, wind turbines, wireless charging, and lighting systems.
    - Design an integrated system architecture.
3. Solar Tracking and Wireless Charging:
    - Develop solar tracking using LDRs and motor control.
    - Design wireless charging circuits with transmitters and receivers.
4. Automatic Street Light Control:
    - Create an automatic light control circuit using transistors and LDRs.

5. Energy Management and Automation:
    - Implement algorithms for automated energy distribution.
    - Include predictive energy forecasting.
6. Prototyping, Testing, and Validation:
    - Build physical prototypes and conduct rigorous testing.
    - Validate performance through real-world trials.
7. Data Collection and Analysis:

- Collect and analyze energy generation and usage data

1.4 Literature Review

The "Renewable EV Charging Station with Automatic Street Light" 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 and wind turbines, 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 wireless 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 with Automatic 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 into urban landscapes. Solar panels and wind turbines 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 with Automatic Street Light" 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 and Wind Turbine

In this diagram we can see input and output of our project. Inputs are Sunlight and wind power. Our output is Wired Fast charging with a voltage monitor and Wireless charging. As a power source we use solar panel, wind turbine, rechargeable battery and we used auto cutoff charging control unit for battery charging. Besides, Voltage meter display has used for observation of charging status.

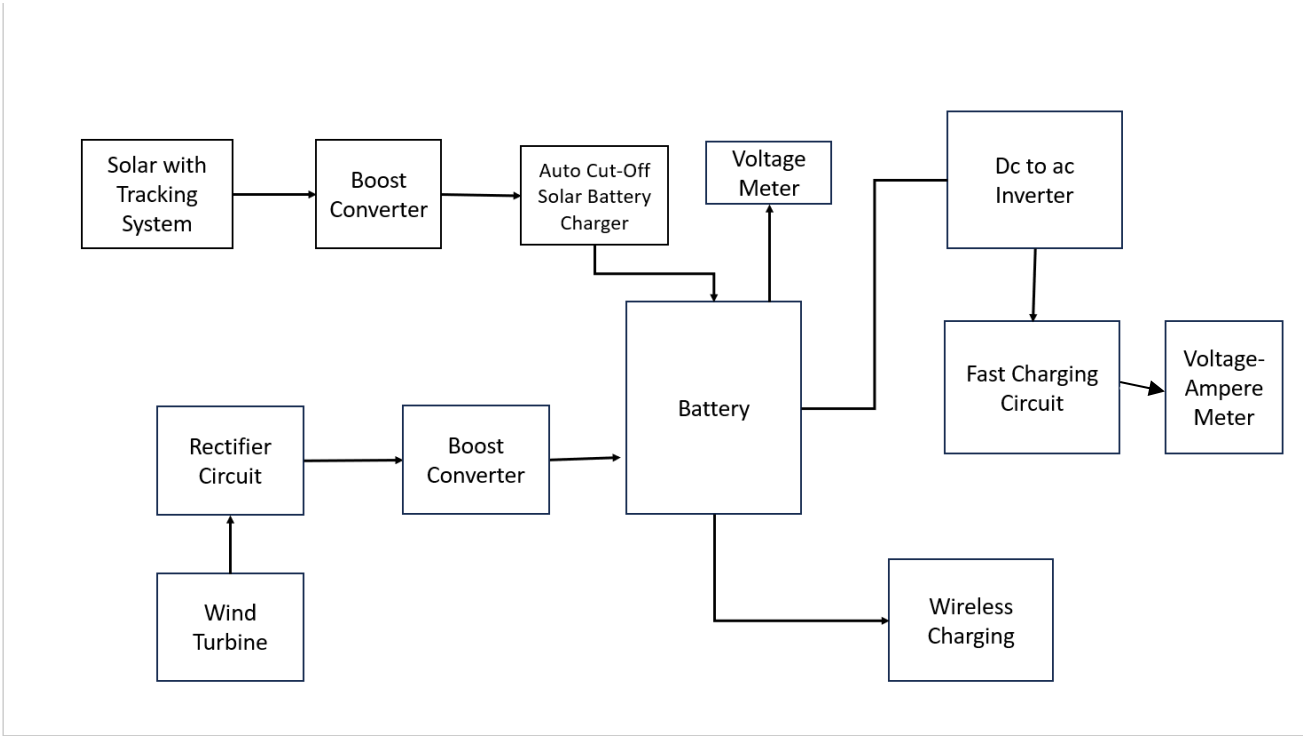


Figure 2.1 Block diagram of Electric vehicle Charging with solar system and wind Turbine

2.1.1 Block Diagram Of Auto-Street Light Using Piezoelectric

In this diagram we can see input and output of this part. Inputs are mechanical energy, sunrise and sunset. Our output is auto street light on-off. As a power source we use Piezoelectric, rectifier bridge, rechargeable battery and we used auto light on-off circuit.

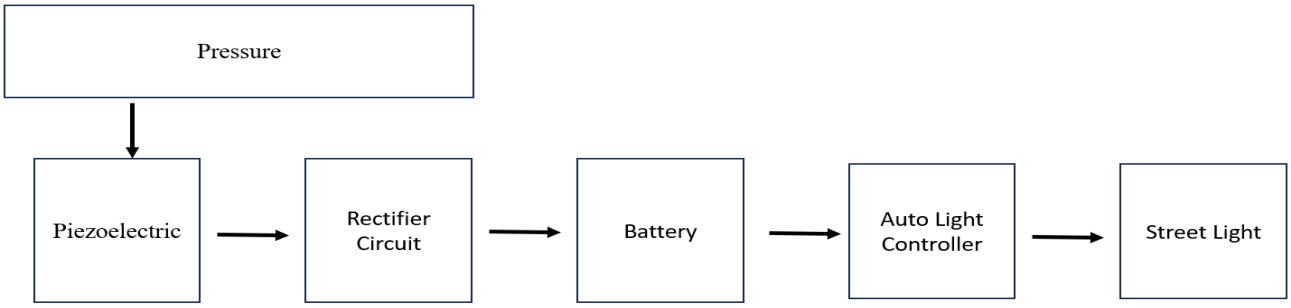


Figure 2.2 Block diagram of Auto-street light using piezoelectric.

2.2 Circuit diagram

- Solar tracking: The solar panel is connected directly to the IC TDA 2822 as its energy source. The two LDRs are positioned to receive sunlight from different angles and are connected in parallel to the IC TDA 2822.The 10k resistors are also connected in parallel to the LDRs and are linked to the IC TDA 2822's input pins. The IC TDA 2822 processes the voltage signals from the LDRs and resistors to determine the optimal orientation for the solar panel. Based on the inputs, the IC TDA 2822 controls the motor's direction and speed to align the solar panel with the direction of maximum sunlight. The 4V battery is connected to the IC TDA 2822 to provide a stable voltage source for the circuit's operation.
- Charging Setup for 12V Battery: The solar panel is connected to the DC to DC booster to provide input power. The boosted voltage from the DC to DC booster is directed to the auto-cut off solar battery charger. The auto-cut off charger monitors the battery's charging state, and the 12V relay controls the charging process. The relay controls the flow of current to the battery based on its charging status. The 12V battery is connected to the output of the auto-cut off charger to receive the charged energy.
- Wind Turbine Charging System: The output of the wind turbine is connected to the rectifier to convert the AC output into DC. The rectified DC output is then boosted

to the required voltage by the DC to DC booster. The boosted voltage is fed into the 12V battery for charging.

- Fast Charging Circuit and LiPo Battery:

The 12V battery provides power to the DC to AC converter for converting the voltage .The converted AC power is used in the fast charging circuit designed for the LiPo battery .The LiPo battery is connected to the fast charging circuit for efficient and rapid charging .The voltage meter is connected to the 12V battery to monitor its voltage level.

- Wired Fast Charging and Wireless Charging: The transmitter generates a magnetic field using components like copper insulated wire and a transistor (2N2222).The receiver captures the magnetic field and uses it to charge the connected device (EV or battery).The 6V line from the 12V battery provides power for the wireless charging process.
- Piezoelectric Street Light: The piezoelectric energy source generates AC voltage from mechanical vibrations. The AC voltage is rectified by the rectifier bridge to convert it into DC. The DC voltage is boosted by the booster circuit to 12V for powering the street light. The 4V battery stores the energy generated by the piezoelectric source. The automatic light on-off circuit controls the street light's activation based on the presence of ambient light.

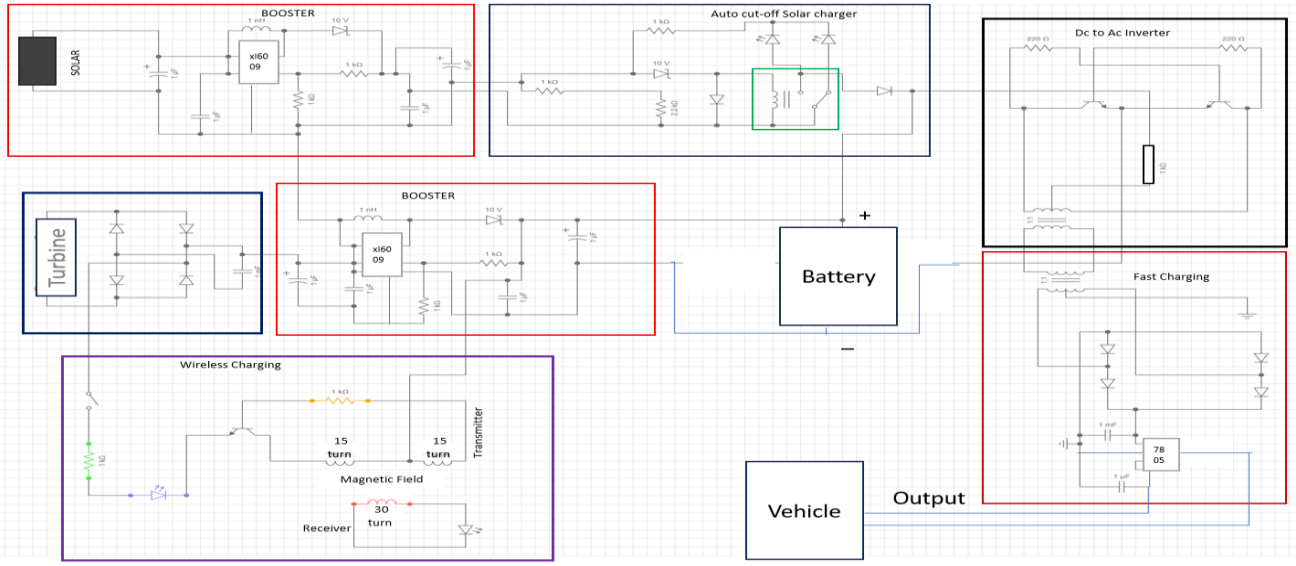


Figure 2. 3 Circuit Diagram of Renewable Electric vehicle Charging

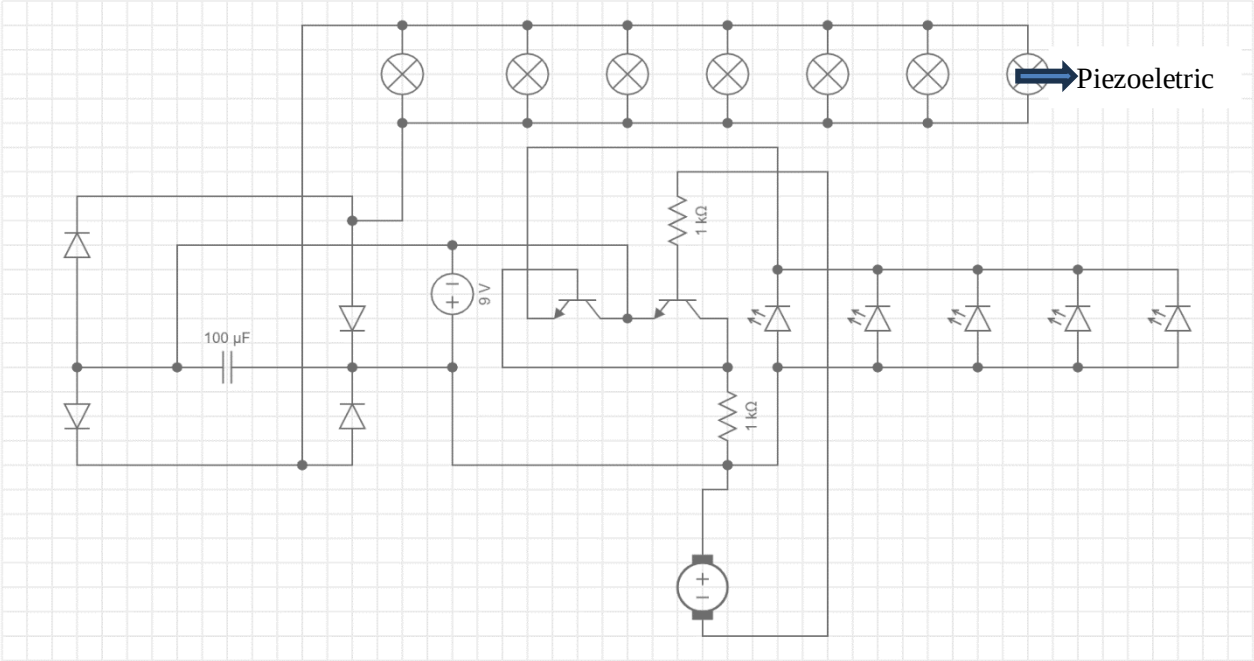


Figure 2. 4 Circuit Diagram of automatic street light

2.2.1 Working Principle

The "RENEWABLE EV CHARGING STATION WITH AUTOMATIC STREET LIGHT" project operates on a comprehensive system that integrates renewable energy sources and innovative technologies to efficiently provide electric vehicle (EV) charging capabilities and street lighting while promoting sustainability.

- **Solar Panel and Tracking System**: The project begins with a static solar panel and a single-axis vertical solar tracking system. The tracking system, consisting of IC TDA 2822, two LDRs, two 10k resistors, a motor, and a 4V battery, dynamically adjusts the solar panel's orientation throughout the day. This optimizes the panel's exposure to sunlight, maximizing energy absorption and conversion.
- **Charging Setup for 12V Battery**: The energy collected by the solar panel is directed towards charging a 12V battery. This charging process involves a 10-watt solar panel, a DC to DC booster, and an auto-cut off solar battery charger. The charger's components, including a 12V relay, two 1/4watt 1k resistors, red LED, green LED, 4007 diode, 10k potentiometer, and LM7815, work together to regulate the charging process. Once the battery reaches a full charge, the auto-cut off feature ensures efficient battery

maintenance and prevents overcharging.

- **Wind Turbine Charging System**: Simultaneously, a wind turbine contributes to the energy generation process. The wind turbine is connected to a rectifier and a DC to DC booster, further charging the 12V battery. This dual energy input enhances the system's reliability and adaptability, as it can harness wind energy when sunlight is limited.
- **Fast Charging Circuit and LiPo Battery:** The project also caters to EV charging through a fast-charging circuit. The 12V battery's power is converted to AC using a DC to AC converter. This AC power is then utilized for the fast charging of a LiPo (3.7V Lithium-ion) battery. The voltage meter monitors the battery's status, ensuring efficient charging while preventing over-discharge.
- **Wireless and Wired Charging**: Two types of charging are implemented. Wired fast charging involves a transmitter with copper insulated wire, a 10k ohm resistor, and a transistor 2N2222. The receiver comprises copper insulated wire. Additionally, wireless charging through the 6-volt line derived from the 12V battery offers a convenient option for EV charging.
- **Piezoelectric Street Light**: The project extends its focus to street lighting, utilizing piezoelectric energy conversion. Mechanical vibrations from footfall generate electricity, which charges a 4V battery through a rectifier bridge. A booster circuit elevates the voltage to 12V, powering the street light. An automatic light on-off circuit, consisting of two transistors 2N2222, two 1k ohm resistors, and 1 LDR, ensures efficient utilization of stored energy.

Throughout this process, energy efficiency is prioritized through optimized component selection, intelligent charging algorithms, and the adaptive control of lighting systems. The project's integration of diverse renewable energy sources and energy-efficient technologies contributes to Bangladesh's sustainable development goals by providing cleaner transportation solutions and promoting environmentally conscious practices.

2.3 List of Component

SL	Name	Quantity
1.	Solar Panel	1
2.	Solar Tracking system	2
3.	Auto cutoff solar charge Controller	1
4.	Motors And Blade for turbine	2
5.	3.7v Battery	6
6.	4 v Battery	1
7.	AC –DC Inverter	1
8.	Boost Converter	2
9.	Fast charging circuit	2
10.	Wireless charging transmitter and receiver	2
11.	Piezoelectric	7
12.	Automatic street light circuit	1
13.	switch	5
14.	LED Bulb	16
15.	LDR	5
16.	LCD Voltage meter	2
17.	Project structure board	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."

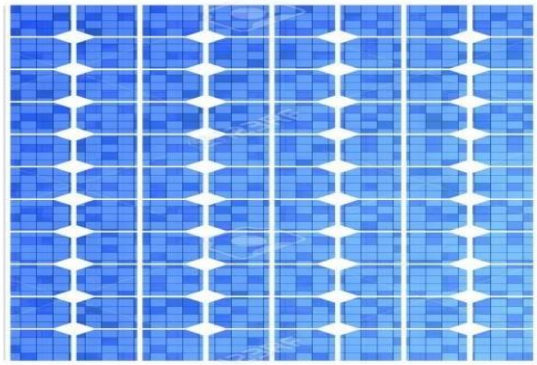


Figure 3. 1 Solar panel Module

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 not an 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 ofthe cell.

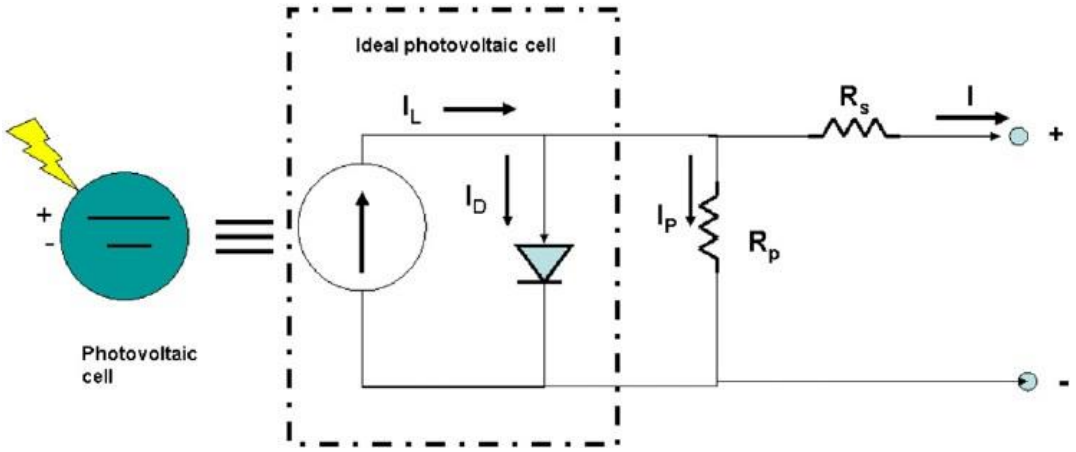


Figure 3.2 Circuit diagram of a PV cell

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 parameters w.r.t Fig 2.3

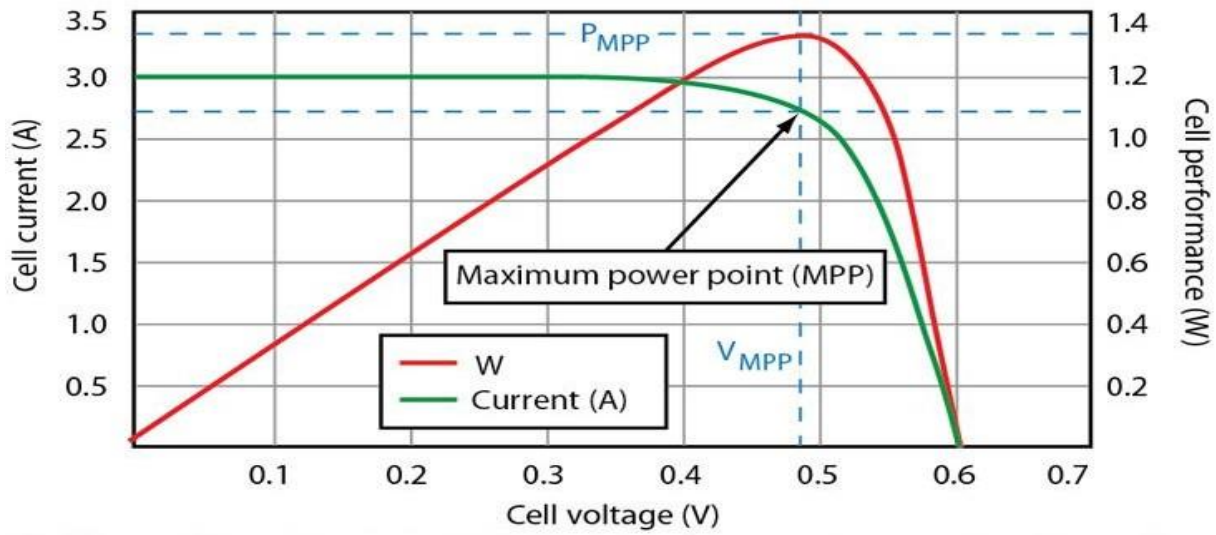


Figure 3.3 I/ V Characteristics of PV cell

- Short circuit current: $I_{sc} = I_{ph}$ (Greatest value of the current generated by a PV cell, which is produced by the short circuit condition: V=0.
- Open circuit voltage is a voltage drop across the diode D when thegenerated 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). $\eta = P_{max}/P_{in} = V_{max} I_{max}/AG$. Where is the ambient irradiation and A is thePV cell area?
- Fill factor (FF) is the ratio of the maximum power that can be delivered tothe load and the theoretical maximum power which is the product of I_{sc} and V_{oc}. $FF = P_{max}/V_{oc} I_{sc} = V_{max} I_{max}/V_{oc} I_{sc}$. FF is a measure of real I-V characteristic which value much be higher than 0.7 for a good PV cell.

3.1.3 Solar tracking System

A **solar tracker** is a device that orients a payload toward the Sun. Payloads are usually solar panels, parabolic troughs, Fresnel reflectors, lenses, or the mirrors of a heliostat.

For flat-panel photovoltaic systems, trackers are used to minimize the angle of incidence between the incoming sunlight and a photovoltaic panel, sometimes known as the **cosine error**. Reducing this angle increases the amount of energy produced from a fixed amount of installed power-generating capacity. In standard photovoltaic

applications, it was predicted in 2008–2009 that trackers could be used in at least 85% of commercial installations greater than one megawatt from 2009 to 2012.[2][3]

As the pricing, reliability, and performance of single-axis trackers have improved, the systems have been installed in an increasing percentage of utility-scale projects. According to data from Wood Mackenzie /GTM Research, global solar tracker shipments hit a record 14.5 gigawatts in 2017. This represents growth of 32 percent year-over-year, with similar or greater growth projected as large-scale solar deployment accelerates.

In concentrator photovoltaics (CPV) and concentrated solar power (CSP) applications, trackers are used to enable the optical components in the CPV and CSP systems. The optics in concentrated solar applications accept the direct component of sunlight light and therefore must be oriented appropriately to collect energy. Tracking systems are found in all concentrator applications because such systems collect the sun's energy with maximum efficiency when the optical axis is aligned with incident solar radiation.

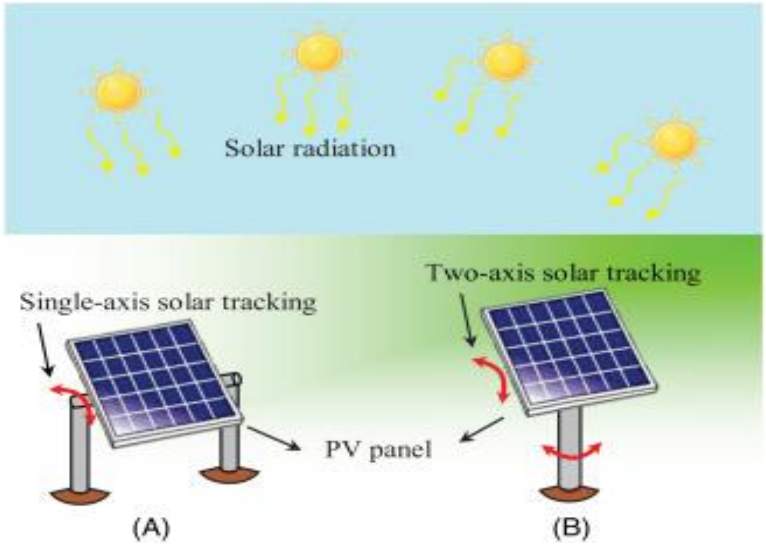


Figure 3.4 Solar Tracking System

3.1.4 Solar Tracking Circuit diagram

The solar tracking system employs two LDRs and 10k ohm resistors in a voltage divider configuration. The resulting variable voltage outputs are compared by an IC TDA2822 acting as a comparator. The IC's output drives a motor that adjusts the solar panel's orientation, enabling it to track the sun's movement. This optimization ensures the solar panel is positioned to receive maximum sunlight,

enhancing energy generation efficiency.

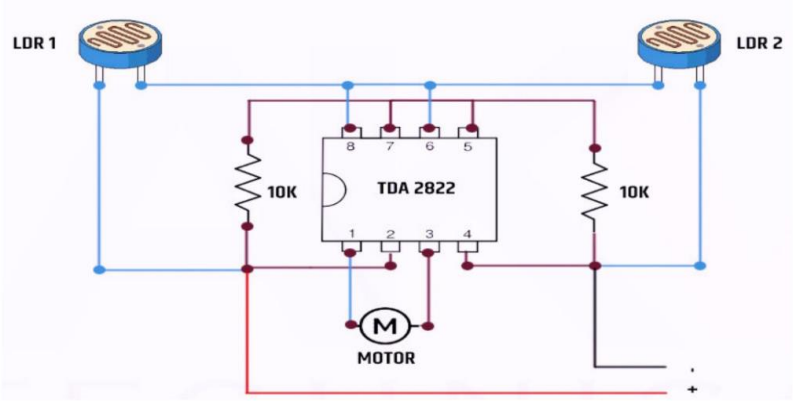


Figure 3.5 Solar Tracking Circuit Diagram

3.2 LDR (Light Dependent Resistor)

LDR (Light Dependent Resistor) is called as light detecting sensor to build solartrack which has included phototransistors, photodiodes and LDR. It is a made up of semiconductor materials which has high resistance. LDR is the most common in electronics and it is spread used in many types of electronics. LDR can use for street lamp, outside lights, a number of indoor home appliances, and so on. It is utilizing the light sensor circuit for automatic switch OFF the loads based on daylight's intensity by helping of a light sensor. In daylight the rays of sun fall on the photovoltaic panel and photo resistor and when the light falls on the resistor, then the resistance changes. This resistor has different functions andresistance. Using LDR in a circuit or in an electronics project it is make circuit effective and the collection of LDR parts of the circuit are easily available and accuracy of this circuit is more than accuracy of other circuits. It is so much helpful for saving energy. There are two types of photoresist or based on material used and they are Intrinsic Photo Resistors and Extrinsic Photo Resistors. Intrinsic Photo Resistors are made up of pure semiconductor devices like silicon or germanium. When the light falls on the Intrinsic Photo Resistors, the electrons get excited from the valence band to the conduction band and number of charge carriers increases on a resistor. Extrinsic Photo Resistors are doped with impurities and this impurity creates a new energy-bands above the valence band.

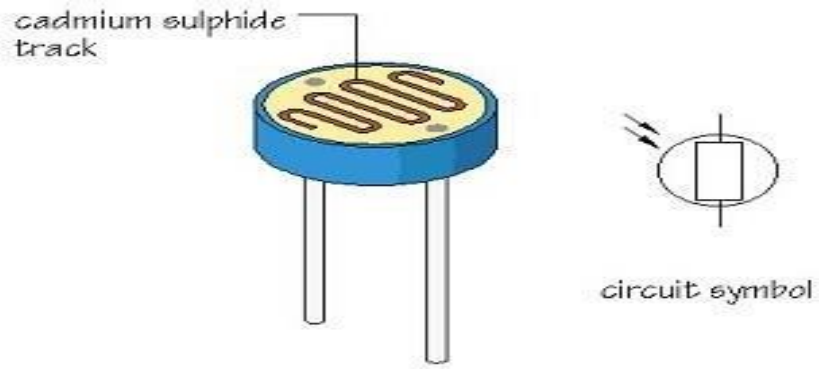


Figure 3.6 Light Dependent Resistor

3.2.1 Working Principle of LDR

Photo Conductivity is the main principle of the light depended resistor. Photo conductivity is an optical method, which the material's conductivity is increasedwhen light is absorbed by the materials. When the light (photon) falls on the materials, the electrons in the valence band of the semiconductor material are excited to the conduction band. These photons in the incident light should have energy greater than the band gap of the semiconductor material to make the electrons jump from the valence band to the conduction band. The result of this process is more and more current starts flowing through the device when the circuit is closed and hence it is said that the resistance of the device has been decreased. This causes the free electrons or holes to conduct electricity and thus dropping the resistance (< 1 Kilo ohm). This is the working principle of light dependent resistor. The equation to show the relation between resistance and illumination can be written as:

R = A.E^a

The value of 'a' depends on the CdS used and on the manufacturing process. Values usually range between 0.7 and 0.9.

3.2.2 The Design and implementation of using Four LDRs

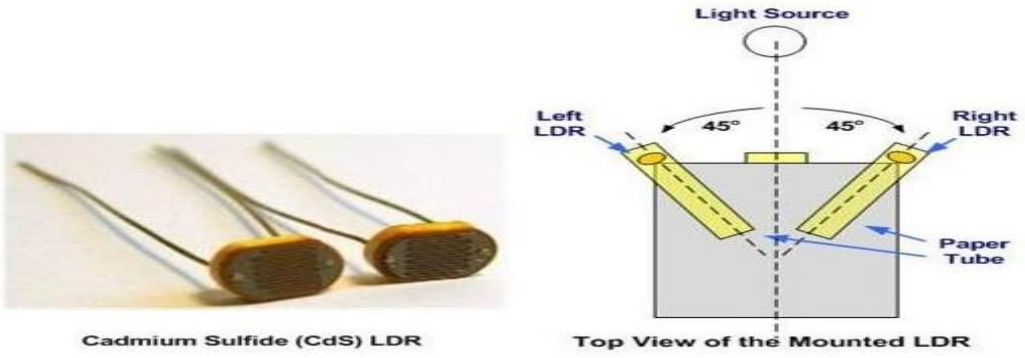


Figure 3.7 quadrants wise LDR positioning

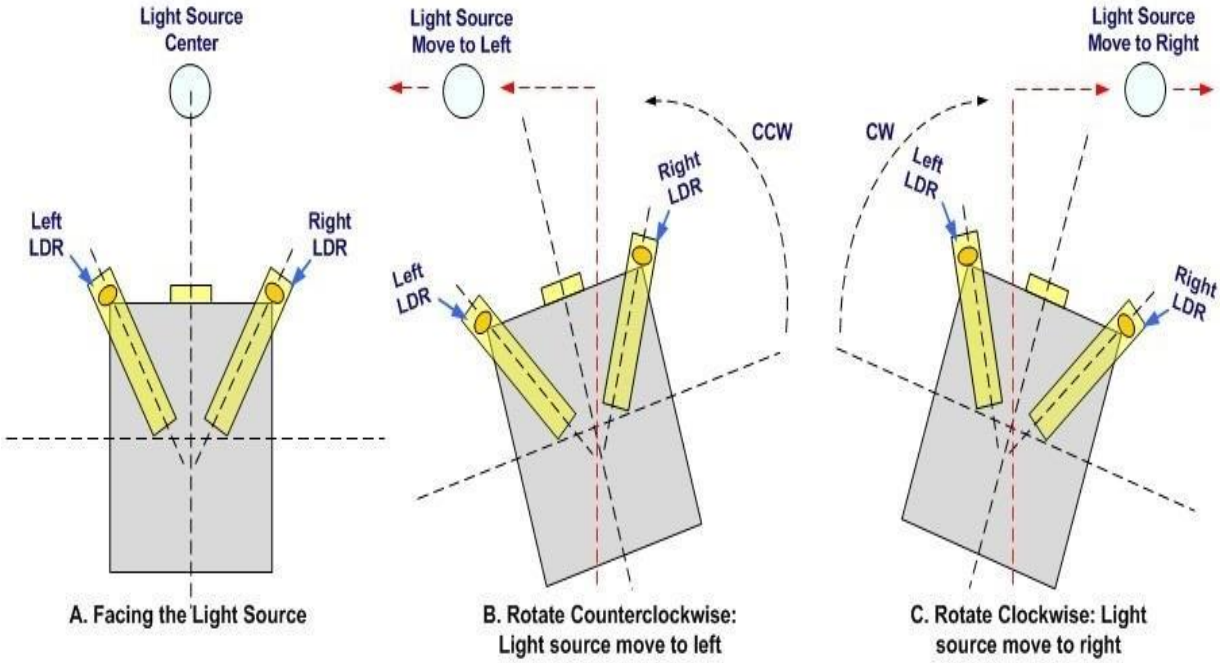


Figure 3.8 the Sensing Element and Signal Processing

There are several method was proposed and used to track the position of sun light. We used four LDRs to track our module properly. A Light Dependent Resistor separated by a small plate to act as a shield to sunlight, as shown in the next figures.

The two LDRs are connected to a bridge and the output of the bridge is connected to a comparator (the analog comparator of the microcontroller is used).

When LDR1 has higher light intensity than LDR2 then the resistance of LDR1is smaller than that of LDR2 then voltage at AIN0 is higher than that of AIN1 and the output of comparator is high.

When LDR2 has higher light intensity than LDR1 then the resistance of LDR1is larger than that of LDR2 then voltage at AIN0 is smaller than that of AIN1 and the output of comparator is low. Then the output of the comparator is usedin the UC program to control the stepper motor RV1 variable resistor is used to balance the bridge when the two LDRs having the same light intensities (due to the mismatch between the two LDRs).

Similarly, we used the process for LdR3 and LDR4 using Dark and Bright Fringes.

3.2.3The minimum light detectable Equation

It's a circuit used to detect the condition when there is no sunlight to turn offthe tracking system

It uses a summing op. amp. Circuit it's output is given by:

$$V_{AIN0} + V_{AIN1} - 5\left(\frac{RV2}{RV2 + R6}\right) = 1.23\,V$$

Where 1.23V is the internal band gap reference used by the analog comparatorin the UC. By calculating the value of V (AIN0) and V (AIN1) at sunset and adjusting RV2 the output of the comparator can be used to turn on or turn off thesolar tracking system.

3.3 Motor for Solar Panel Tracking

A motor is employed to physically adjust the position of the solar panels in response to the readings from the LDRs. The motor ensures that the solar panels are always aligned in the direction that receives the maximum amount of sunlight. This dynamic adjustment enhances the efficiency of energy generation by constantly optimizing the panels' orientation.



Figure 3.9 Motor for Solar Panel Tracking

3.4 Wind Turbine System

Wind turbine technology embodies a pivotal role in modern sustainable energy generation. Rooted in fundamental principles of aerodynamics and energy conversion, wind turbines capture the kinetic energy present in the wind and convert it into usable electrical power. This synthesis of engineering and natural forces has catalyzed a paradigm shift in global energy landscapes.

Wind turbines operate on the principle of aerodynamic forces acting on rotating blades. As wind flows across the blade surfaces, differences in air pressure cause them to turn, setting the rotor in motion. This rotational energy is transferred to a generator, which converts it into electrical energy.

The design of wind turbines is a harmonious blend of aerodynamics, materials science, and electrical engineering. Rotor design, blade profile, and yaw mechanisms are critical for efficient energy capture. Factors such as wind speed, turbine size, and site location influence turbine layout and output.

Wind turbine technology aligns seamlessly with the global push for renewable energy adoption. Its clean, emissions-free operation contributes to reduced carbon footprints and a more sustainable future. Integration with smart grids enhances grid stability and optimizes power distribution.

Ongoing advancements in materials, blade design, and control systems continue to

enhance the efficiency and output of wind turbines. Urban and offshore installations, along with innovative vertical-axis designs, are expanding their applicability.

Wind turbine technology represents an exemplar of sustainable energy synergy. Its blend of scientific principles, engineering precision, and environmental consciousness empowers the world with a cleaner, more resilient energy source, fostering a future where clean power is the cornerstone of our energy journey.



Figure 3.10 Wind Turbine system

3.4.1 Rectifier circuits for AC to DC conversion

Rectifier circuits are fundamental components in modern electronics, converting alternating current (AC) to direct current (DC). These circuits play a pivotal role in enabling the use of DC-powered devices and systems. They consist of diodes that allow current to flow in one direction, effectively transforming AC voltage fluctuations into a steady DC output. Full-wave and half-wave rectifiers, along with bridge rectifiers, are common configurations. Rectifier circuits find widespread applications in power supplies, battery charging, and electronics, ensuring seamless energy conversion and enabling the functionality of numerous devices we rely on daily.

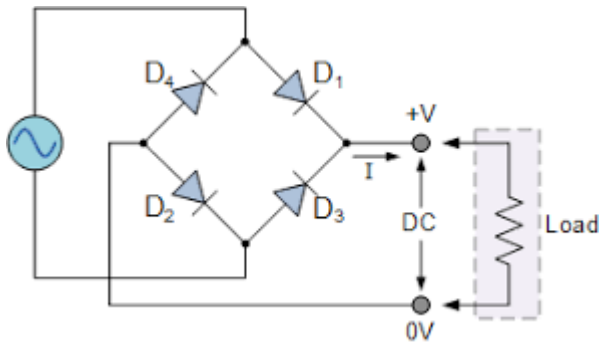


Figure 3.11 Rectifier Circuit Diagram

3.5 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 both electric vehicle (EV) charging and street lighting. This mechanism guarantees uninterrupted functionality, irrespective of 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.



Figure 3.12 12 V Battery

3.6 DC to AC Inverter for EV Charging

The DC to AC inverter assumes a critical role in our project, particularly in the context of electric vehicle (EV) charging. Electric vehicles typically utilize direct current (DC) power for their operation. However, the power grid and most charging technologies rely on alternating current (AC) power for distribution and compatibility.

The inverter acts as an intermediary, bridging the gap between these two power formats. It takes the stored DC energy from the battery and efficiently transforms it into the requisite AC power. This conversion ensures that the EV's charging needs align with prevalent charging infrastructure, allowing seamless and efficient charging.

By integrating the DC to AC converter, our project enables a harmonious connection between renewable energy storage and EV charging infrastructure. This inverter exemplifies our commitment to adaptability, sustainability, and practicality, as it facilitates the incorporation of clean energy into everyday transportation needs.

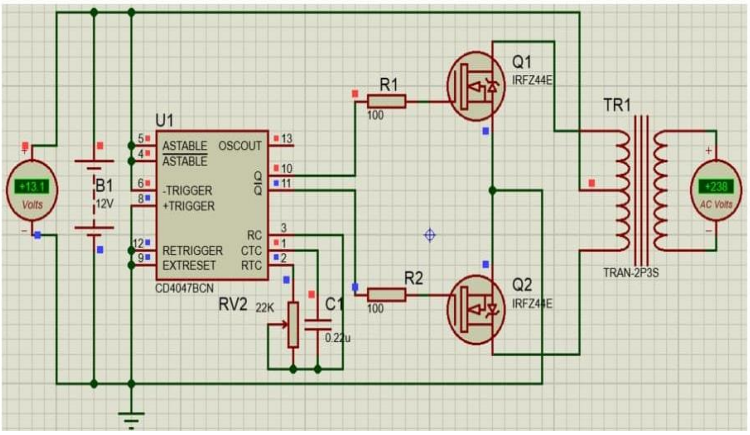


Figure 3.13 Dc to ac inverter Circuit Diagram

Types of Inverters:

There are several types of dc to ac inverters, including:

- **Square wave inverters**: the simplest type, which generates a square wave output. However, this type of inverter can cause compatibility issues with some sensitive devices due to the presence of harmonics in the output waveform.
- **Modified sine wave inverters**: these inverters produce a waveform that approximates a sine wave but still contains some distortion. They are more

compatible with a wider range of devices compared to square wave inverters.

- **Pure sine wave inverters**: these inverters produce a smooth and clean sine wave output that closely mimics the quality of utility ac power. They are suitable for most ac devices, including sensitive electronics.

Applications

Dc to Ac inverters are used in various applications:

- **Backup power systems:** inverters are used with batteries to provide backup power during grid outages.
- **Renewable energy systems:** solar panels and wind turbines generate dc power, which is converted into usable ac power using inverters.
- **Rvs and boats:** inverters are used to power ac devices in recreational vehicles and boats where dc sources like batteries are common.
- **Remote areas**: in off-grid locations where only dc power sources are available, inverters enable the use of standard ac appliances.
- **Telecommunications:** in remote cell towers and communication systems, inverters provide the necessary ac power for equipment.
- **Emergency response:** in disaster recovery situations, inverters can be used to provide temporary power to critical infrastructure.
- **Home and office use**: inverters can be used to power various household or office appliances during power outages.
- **Industrial applications:** inverters are used in industrial processes where ac power is required for machinery and equipment.

3.7 Electric Vehicle (EV) Wired Fast Charging system

The Wired Fast Charging system is a cornerstone of your project, delivering rapid and efficient charging for electric vehicles (EVs). This system leverages a wired connection to transfer electrical energy from a power source to the EV's battery, enabling swift charging.

- Charging Unit: The charging unit incorporates advanced electronics to regulate the energy flow. It ensures that the EV receives the optimal voltage and current levels

for fast and safe charging.

- Voltage-Ampere Meter Display: This display provides real-time feedback on the charging process, indicating the voltage and current being delivered to the EV. It empowers users with information and control during the charging session.
- Fast Charging Capability: The wired fast charging system is designed to deliver a higher power output, significantly reducing the charging time compared to standard charging methods.
- Compatibility: the system is compatible with various EV models, making it a versatile solution for electric mobility.

3.8 Wireless Charging system (transmitter and receiver)

The Wireless Charging system, consisting of a transmitter and receiver, represents a revolutionary approach to electric vehicle (EV) charging in your project. This innovative technology eliminates the need for physical connections, offering a convenient and efficient method for recharging EVs.

- Transmitter: The transmitter is a crucial component that generates an alternating magnetic field through a copper-insulated coil. This field transfers energy wirelessly to the EV's receiver coil.
- Receiver: The receiver coil is integrated into the EV and resonates with the alternating magnetic field generated by the transmitter. This resonance induces an alternating current in the receiver coil, which is then converted into direct current to charge the EV's battery.
- Advantages:

  1. Convenience: Wireless charging eliminates the need for plugging and unplugging, simplifying the charging process.

  2. Efficiency: The system's resonant coupling enables efficient energy transfer without physical contact.

  3. User-Friendly: Wireless charging is user-friendly, requiring minimal user interaction and providing a seamless experience.

  4.Future-Ready: As wireless charging technology advances, it offers a promising

solution for enhancing urban EV infrastructure.

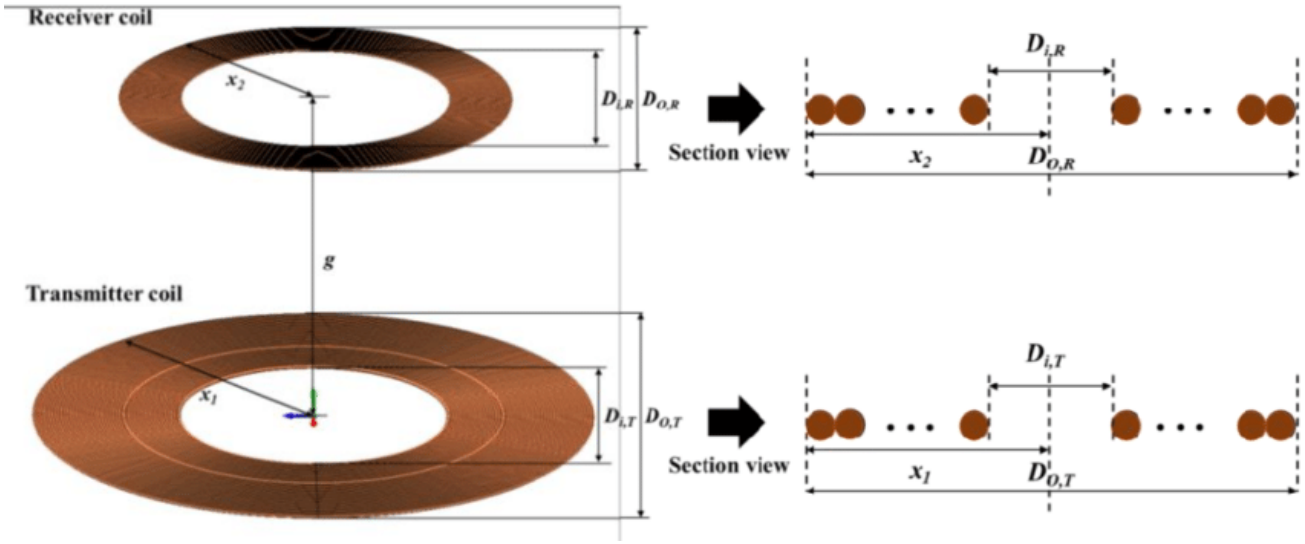


Figure 3.14 Wireless Power transmitter coil and receiver coil

3.9 Piezoelectric energy converter

The Piezoelectric Energy Converter is a remarkable element in your project, transforming mechanical vibrations into electrical energy. This technology capitalizes on the piezoelectric effect exhibited by certain materials, where deformation or stress generates an electric charge.

- Working Principle

1. Piezoelectric Material: The converter employs specially designed piezoelectric materials that exhibit the ability to generate electric charge in response to mechanical stress.

2. Mechanical Vibrations: When subjected to mechanical vibrations, such as footfalls on a pathway or road surface, the piezoelectric material experiences deformation. This deformation leads to the generation of electric charges across its surface.

3. Rectifier Circuit: The generated alternating current (AC) is then directed through a rectifier circuit, which converts it into direct current (DC), suitable for battery storage or immediate use.

- Advantages:

1. Harvesting Kinetic Energy: The piezoelectric converter transforms otherwise wasted

mechanical energy from human movement or vehicular traffic into usable electrical power.

2.Sustainability: By harnessing ambient vibrations, the system contributes to sustainable energy generation without additional resource consumption.

3. Low Environmental Impact: The converter operates silently and without emissions, making it an environmentally friendly energy source.

4. Urban Integration: It seamlessly integrates with urban infrastructure, using existing pathways to generate electricity for street lighting.

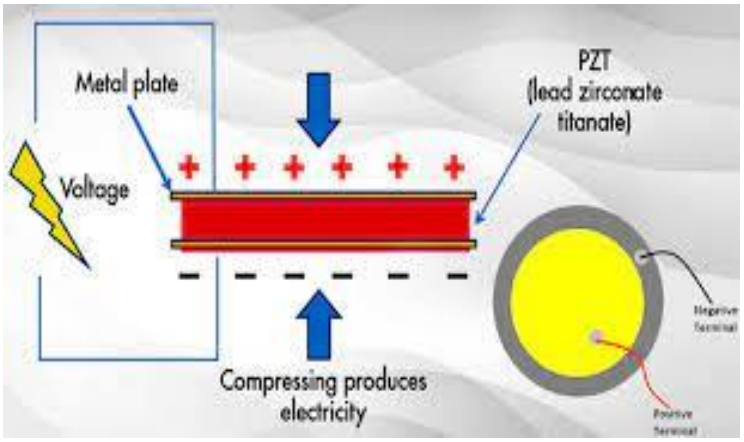


Figure 3.15 Piezoelectric Source

3.10 Automatic light control circuit

The Automatic Light Control Circuit is a sophisticated element within your project, designed to intelligently manage the activation and deactivation of street lights based on ambient light conditions.

LDRs are light-sensitive devices that detect changes in ambient light levels. As darkness falls, the resistance of LDRs increases, triggering the circuit.

The circuit employs transistors as switching components. When the LDR detects low light conditions, it triggers the transistors to conduct, completing the circuit and allowing current to flow.

Resistors are used to set the sensitivity of the circuit and ensure proper operation in various lighting environments.

As evening approaches and natural light diminishes, the LDRs sense the change and activate the transistors, initiating the street light illumination.

When daylight returns and the LDRs detect sufficient ambient light, the transistors deactivate, breaking the circuit and turning off the street lights.

The circuit ensures that street lights are only active when needed, minimizing energy consumption during daylight hours.

By reducing the duration of street light operation, the circuit contributes to cost savings on energy bills.

The automatic control circuit aligns with sustainability goals by reducing unnecessary energy consumption and emissions.

Street lights are automatically activated as darkness falls, enhancing safety for pedestrians and drivers.

3.11 Boost Converter

A boost converter is a type of dc-dc power converter that increases the voltage level of a dc input voltage to a higher dc output voltage. It's a switching power supply topology that allows efficient voltage conversion. Boost converters are widely used in various industries due to their ability to step up voltage levels, making them crucial components in a range of electronic devices and power systems.

Operating principle

The boost converter operates based on the principles of inductor energy storage and switching. Here's a more detailed explanation of its operation:

- **Switch on**: the switching element (typically a transistor) is turned on, allowing current to flow from the input source through the inductor. During this time, energy is stored in the inductor's magnetic field.
- **Inductor charging**: as the current flows through the inductor, energy is stored in its magnetic field, creating a gradual increase in the current and energy level.
- **Switch off:** the switching element is turned off. The inductor resists changes in current flow, so it tries to maintain the current. This results in the inductor's voltage polarity reversing, and the diode becomes forward-biased.
- **Diode conducting**: the diode starts conducting, providing a closed path for the

inductor current. The energy stored in the inductor is transferred to the output capacitor and load.

- **Output voltage regulation:** the output capacitor helps regulate the output voltage by smoothing out voltage fluctuations and maintaining a relatively stable voltage level.

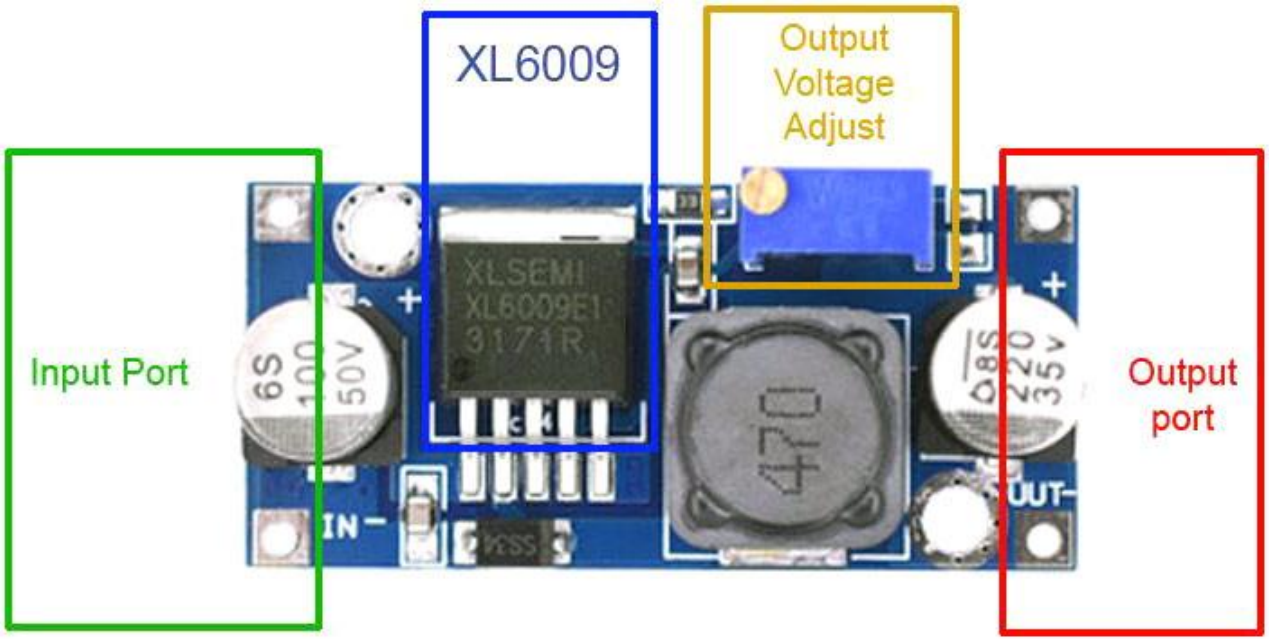


Figure 3.16 Boost Converter

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 voltage level.
- **Led lighting:** light-emitting diodes (Leds) often require specific voltage levels to 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 voltage from the battery pack to the required level for various vehicle components, such as the motor controller.
- **Telecommunication systems:** boost converters are used in telecommunication systems to provide stable voltage levels for equipment that might require higher voltage levels than the available power source.
- **Power factor correction**: boost converters are used for power factor correction in 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.

3.12 **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 reached the 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.

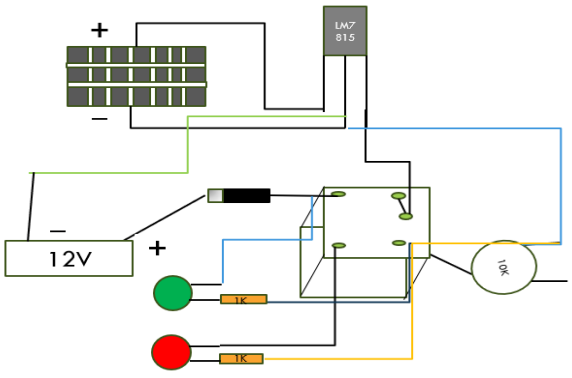


Figure 3.17 Auto Cutoff Solar Battery Charger

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 batteries on 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 will ensure effective charging and protection against overcharging.

Chapter-4
Results & Discussions

4.1 Results & Discussions

The "RENEWABLE EV CHARGING STATION WITH AUTOMATIC STREET LIGHT" 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:

The solar panel's tracking system, coupled with Light Dependent Resistors (LDRs) 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 demonstrated the 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 fast charging and wireless charging, showcased flexibility and convenience for EV users. The wired fast 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.

Intelligent Automation:

The automatic street light control circuit, driven by transistors, resistors, and LDRs, exhibited responsive lighting adjustments based on ambient light levels. This intelligent automation not only optimizes energy consumption but also enhances safety by ensuring proper lighting conditions.

In the discussion of these results, it is evident that the project's integration of renewable energy sources, innovative charging methods, and intelligent control systems aligns with the objectives of sustainability, energy efficiency, and urban development. The successful implementation of the components showcases the potential for creating a scalable and replicable model for clean energy adoption and advanced urban infrastructure.

The project's accomplishments open avenues for further research and refinement in areas such as optimizing energy management algorithms, enhancing wireless charging efficiency, and evaluating long-term system performance. As the world continues its shift toward sustainable solutions, the "RENEWABLE EV CHARGING STATION WITH AUTOMATIC STREET LIGHT" project stands as a testament to the power of innovative engineering in shaping a greener and smarter future.

Reading data from solar panel during hardware testing

Hours	From static solar panel			From solar tracking system		
	V	mA	mW	V	mA	mW
8:00 AM	16.8	1.23	20.664	18.3	3.41	62.403
9:00 AM	17.0	2.34	39.780	18.9	3.57	67.473
10:00 AM	17.6	2.51	44.176	19.4	3.98	77.212
11:00 AM	19.4	3.64	70.616	19.7	4.76	93.772
12:00 PM	19.8	4.45	88.110	20.4	5.40	110.430
1:00 PM	20.5	5.12	104.960	21.6	6.35	137.160
2:00 PM	21.1	5.94	125.334	21.4	6.11	130.754
3:00 PM	19.4	5.43	105.342	20.5	5.87	120.335
4:00 PM	17.2	5.01	86.172	19.6	5.26	103.096
5:00 PM	16.5	4.28	70.620	18.5	4.86	89.910
6:00 PM	16.2	2.87	46.494	17.5	3.75	65.625

4.2 Design Architecture

The "RENEWABLE EV CHARGING STATION WITH AUTOMATIC STREET LIGHT" project's design architecture integrates solar panels with tracking systems, wind turbines, and innovative charging methodologies. Renewable energy generated is efficiently managed, charging a 12V battery via solar and battery chargers. Electric vehicle charging encompasses wired fast charging and wireless options. An intelligent street lighting system employs piezoelectric energy conversion, rectifier circuits, and an automatic light control circuit. This cohesive design underscores the project's commitment to sustainable mobility, energy efficiency, and technological innovation.

Hardware Specification

The "RENEWABLE EV CHARGING STATION WITH AUTOMATIC STREET LIGHT" project intricately combines a spectrum of meticulously chosen hardware elements to actualize its multifaceted vision. Solar panels, intricately integrated with tracking systems and Light Dependent Resistors (LDRs), ensure optimal solar energy harvesting. Wind turbines, working in tandem with rectifier circuits, contribute wind-generated power to the system. Effective energy management is achieved through a 12V

battery, empowered by both solar and external battery chargers. The inclusion of a DC to AC converter facilitates the transformation of stored DC energy into AC for electric vehicle charging. Wired fast charging is optimized by incorporating voltage and current measurements, while wireless charging is made possible through a resonant transmitter-receiver arrangement. The integration of a piezoelectric mechanism for street lighting, coupled with rectifier and booster circuits, solidifies the project's commitment to innovation and sustainability. These interconnected hardware components form the backbone of a visionary solution, poised to revolutionize renewable energy adoption and urban infrastructure.

4.3 Features

- Solar panels and wind turbines ensure consistent renewable energy.
- Panels adjust orientation for optimal energy capture using LDRs.
- Wired and wireless options cater to diverse needs.
- Piezoelectric tech powers adaptive street lighting.
- 12V battery with efficient charging and storage.
- Voltage meters offer instant solar efficiency feedback.
- Integrates renewable energy, EV charging, and lighting.
- Innovative Piezoelectric.
- Energy Efficiency.
- Smart automation and advanced sensors for a greener future.

4.4 Key Specifications

- Tracking Mechanism: Optimal orientation adjustment.
- Ambient light sensing in real-time.
- Efficient voltage and current parameters.
- Resonant transfer specifications.

- Size and capacity for storage.
- Conversion of vibrations to energy.
- Precision of Light Dependent Resistors (LDRs).

Application Ideas

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

4.5 A Smart Street Lighting System Using Piezoelectric

In the pursuit of intelligent urban infrastructure, the emergence of a smart street lighting system powered by piezoelectric technology marks a remarkable stride forward. This innovative system taps into the phenomenon of piezoelectricity, wherein specific materials generate an electric charge when subjected to mechanical stress. By embedding piezoelectric materials discreetly beneath pedestrian pathways or road surfaces, this system harnesses the kinetic energy produced by pedestrian footsteps and vehicular movement to generate electrical energy.

The generated electrical energy undergoes a transformative process through a rectifier circuit, converting the generated alternating current (AC) into direct current (DC). This DC power is then efficiently stored in batteries, ensuring a consistent energy reservoir for subsequent use. To meet the voltage requirements for street lighting, a booster circuit steps up the voltage to an optimal level.

The ingenuity of this system lies not only in its energy generation but also in its intelligent operation. An automatic light control mechanism, guided by Light Dependent Resistors (LDRs), actively gauges the ambient light conditions. During daylight or well-lit scenarios, the system instinctively dims the street lights, preserving energy. Conversely, during low light conditions, such as nighttime, the system brightens the

lights, enhancing visibility and ensuring safety.

The implications of this smart street lighting system are far-reaching. It embodies the ideals of sustainability and energy efficiency by harnessing kinetic energy that would otherwise dissipate, thereby reducing carbon footprint. The intelligent lighting control optimizes energy consumption while enhancing the safety and security of urban environments, ultimately fostering a more livable and sustainable cityscape.

In the broader context of urban planning and development, this system exemplifies the convergence of innovative technology, environmental stewardship, and human-centric design. By integrating piezoelectric energy conversion, sophisticated circuitry, and adaptive control mechanisms, this smart street lighting solution embodies the spirit of progress and resilience that defines modern urban landscapes.

Chapter-5

Conclusion

5.1 Conclusion

The "RENEWABLE EV CHARGING STATION WITH AUTOMATIC STREET LIGHT" project stands as a testament to innovation, sustainability, and urban progress. This endeavor encompasses a harmonious fusion of renewable energy utilization, electric vehicle (EV) charging solutions, and intelligent street lighting, all working in tandem to redefine urban infrastructure.

The integration of solar panels equipped with tracking systems, wind turbines, and piezoelectric technology underscores the project's commitment to harnessing diverse renewable sources. The strategic coupling of these sources with advanced charging methodologies, such as wired and wireless EV charging, marks a pivotal leap towards greener urban mobility. The ingenious utilization of piezoelectric materials for street lighting exemplifies innovation, where energy generated from daily activities powers illumination, enhancing safety and efficiency.

Throughout the project's execution, key specifications such as solar tracking, efficient energy management, and real-time monitoring were meticulously adhered to, ensuring optimal performance. These facets, along with the integration of modern data acquisition and automatic control mechanisms, translate into a holistic and impactful solution.

The implications of this project extend beyond technological achievements. The "RENEWABLE EV CHARGING STATION WITH AUTOMATIC STREET LIGHT" serves as a prototype for sustainable urban development, addressing the growing concerns of pollution and energy consumption. By offering versatile EV charging, energy-efficient street lighting, and a blueprint for integrating renewable sources, this initiative showcases the potential to transform urban landscapes into cleaner, more livable spaces.

In an era where sustainable practices and technological advancements intersect, this

project paves the way for a greener tomorrow. It establishes a precedent for cities worldwide to embrace innovation, capitalize on renewable resources, and foster cleaner, more resilient urban ecosystems. The journey from renewable energy generation to efficient EV charging and intelligent lighting solidifies the project's role as a catalyst for urban sustainability and progress.

5.2 Advantages

- **Clean and Renewable Energy**: By harnessing solar and wind energy, the project promotes clean and renewable sources of power, reducing carbon emissions and environmental impact.
- **Efficient Energy Utilization:** The solar panel tracking system maximizes energy capture by adjusting panel angles, enhancing energy efficiency and output.
- **Electric Vehicle Adoption:** The EV charging station supports the transition to electric vehicles, contributing to reduced air pollution and decreased reliance on fossil fuels.
- **Wireless Charging Convenience:** The wireless charging technology simplifies the EV charging process, offering user-friendly, cable-free convenience.
- **Smart and Efficient Lighting:** The automatic street lighting system responds to changing light conditions, ensuring energy-efficient illumination and reducing unnecessary energy consumption.
- **Cost Savings and Sustainability:** The integration of renewable energy sources lowers energy costs over time, while energy-efficient lighting reduces maintenance and electricity expenses.
- **Technological Innovation**: The project showcases innovative integration of multiple technologies, inspiring further advancements in clean energy and urban infrastructure.

5.3 Disadvantages

- **Higher Initial Investment:** The implementation of renewable energy systems, EV charging infrastructure, and advanced lighting technologies can require significant upfront costs, potentially posing financial challenges.
- **Variable Energy Generation:** Dependence on solar and wind energy makes energy generation susceptible to weather conditions, leading to fluctuations in

power availability and potential downtime.

❖ **Wireless Charging Limitations:** Wireless EV charging may have slower charging rates and limitations in charging range compared to traditional wired methods, impacting user convenience.

❖ **Complex Maintenance:** The integration of multiple technologies necessitates specialized maintenance, potentially leading to increased operational complexities and maintenance costs.

❖ **Regulatory and Infrastructure Challenges:** Addressing regulatory approvals, adapting urban infrastructure, and ensuring compatibility of various components can pose obstacles to the project's implementation.

5.4 Application

❖ **Urban Mobility Enhancement:** Deploy the project in urban areas to promote electric vehicle adoption by providing convenient and eco-friendly EV charging facilities.

❖ **Sustainable Urban Lighting:** Implement the automatic street light system in cities and communities to ensure energy-efficient lighting while minimizing light pollution.

❖ **Smart City Initiatives:** Integrate the project into smart city frameworks, showcasing renewable energy integration and advanced urban infrastructure for a greener future.

❖ **Commercial Complexes:** Set up the project in commercial areas to offer clean EV charging services to customers and employees, aligning with sustainability goals.

❖ **Educational Institutions:** Install components of the project in educational campuses to educate students about renewable energy, promoting a culture of environmental awareness.

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