Smart Charging System for Electric Vehicles

A Project Report submitted in partial fulfilment of the requirement
for the Award of degree of

BACHELOR OF TECHNOLOGY

in

(ELECTRICAL AND ELECTRONICS ENGINEERING)

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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

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CERTIFICATE

This is to certify that the main project report entitled “Solar Charging Station with Maximum Radiance Tracking using PV cells “that is being submitted by I. Eswara Manikanta (16345A0220), M. Ganesh (16341A0262), Ch. Sharone Raj (16345A0210), Saadique Mehboob (15341A0283) during the year 2018-19 has beencarried out in partial fulfillment of the requirements for the award of Bachelor of Technology in ELECTRICAL & ELECTRONICS ENGINEERING of the GMR Institute of Technology. An Autonomous Institute Affiliated to JNTUK, KAKINADA, is a record of bonafide work carried out by them under my guidance & supervision. The results embodied in this report have not been submitted to any other University or Institute for award of any degree.

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ABSTRACT

In this fast-growing world, technology plays a major role in developing the human civilizations. One of the recent inventions that changed the face of the world is SOLAR ENERGY. Now -a- days all the appliances, vehicles, offices are using solar energy to power them. As the charging of the electric vehicles is not enough for long distances, solar charging stations plays a key role to charge the electric vehicles. As this is a eco-friendly way of charging. In this project, a small prototype of solar powered charging station will be designed so that devices can be charged outdoors and in an environmentally friendly way.

This system converts solar energy to electricity and stores it in a battery bank. An microcontroller prevents the batteries from being overcharged and prevents the system from being used when the batteries need charging. An SOC (State Of Charge) is used to indicate the percentage of charge. Based on the charging level in the SOC, the load points will automatically turn on and off. Two small PV cells (5V) are placed on the panel, which helpsin rotating the panel to the direction having more radiation. These PV cells are attached to theArduino Uno.

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LIST OF ABBREVATIONS

EV	–	Electric Vehicle
ECS	–	Electronic Charging Station
EVSE	–	Electric Vehicle Supply Equipment
CARB	–	California Air Resource Board
PV	–	Photo Voltaic
IDE	–	Integrated Development Equipment
LED	–	Light Emitting Diode
CSSB	–	Charging Station Storage Battery
SOC	–	State Of Charge

1. INTRODUCTION

Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaics, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis. It is an important source of renewable energy and its technologies are broadly characterized as either passivesolar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentratedsolar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favourable thermal mass or light- dispersing properties, and designing spaces that naturally circulate air. The large magnitude ofsolar energy available makes it a highly appealing source of electricity. The potential solar energy that could be used by humans differs from the amount of solar energy present near thesurface of the planet because factors such as geography, time variation, cloud cover, and the land available to humans limit the amount of solar energy that we can acquire.

1.1 Literature survey

[1] M. Alsomali, Member, IEEE and Ali T. Al-Awami, Member, IEEE ***"Charging Strategy for Electric Vehicles using Solar Energy"*** Published in 2017 Saudi Arabia Smart Grid on 12-14 Dec. 2017.

"In this paper they designed and evaluated a charging algorithm that will prioritize EVs and fill faster than others. This approach can be utilized by private business organizations to categorize and lower the fees for charging, making EVs more attractive economically".

[2] Driss Oulad-abbou, Said Doubabi, Ahmed Rachid ***"Solar Charging Station for Electric Vehicles"*** IEEE, Published in 3rd International Renewable and Sustainable Energy Conference (IRSEC) on 10-13 Dec. 2015.

"In this paper they have stated that, for taking into account, environmental and cost considerations, using renewable energy sources such as solar energy is preferable to charge the electric vehicles. Moreover, sustainable energy is a key source to meet reduction of carbon emissions. On the contrary, standard vehicles are a big source of pollution, which makes the use of electric vehicles (EVs) a promising solution."

[3] Fred Chiou, Ph. D., Member, IEEE ***"Solar Energy for Electric Vehicles"*** Published in 2015 IEEE Conference on Technologies for Sustainability (Sus Tech).

"In this paper they have designed a pilot project, Solar Charging Station. This paper gives an idea on how to charge an electric bike and electric motorcycle experimentally."

[4] Duy C. Huynh, Member, IEEE and Matthew W. Dunnigan, Member, IEEE *"Development and Comparison of an Improved Incremental Conductance Algorithm for Tracking the MPP of a Solar PV Panel"* **Published in IEEE Transactions on sustainable energy 2015.**

"In this paper the strategy proposed is the control combination between the solar tracker (ST) and MPP tracker (MPPT) that can be greatly improve the generated electricity from solar PV systems. This paper also proposes an improved incremental conductance (InC) algorithm for enhancing the speed of the MPP tracking of a solar PV panel under various atmospheric conditions as well as guaranteeing that the operating point always moves towards the MPP using this proposed algorithm."

[5] Ali Chikh, IEEE, and AmbrishChandra, Fellow, IEEE *"An Optimal Maximum Power Point Tracking Algorithm for PV Systems With Climatic Parameters estimation"* **Published in IEEE TRANSACTIONS ON SUSTAINABLE ENERGY, VOL. 6, NO. 2, APRIL 2015.**

"This paper presents a maximum power point tracking (MPPT) method for photovoltaic (PV) systems with reduced hardware setup. The proposed MPPT technique helps to reduce the hardware setup using only one voltage sensor, while increases the array power efficiency and MPPT response time."

[6] Manisha Pipattanasomporn, Senior Member, IEEE, Murt Kuzlu, Member, IEEE, and Saifur Rahman, Fellow, IEEE ***"An Algorithm for Intelligent Home Enegry Management and Demand Response Analysis"*** Published in IEEE TRANSACTIONS ON SMART GRID 2012.

"This paper presents an intelligent HEM algorithm for managing high power consumption household appliances with simulation for demand response (DR) analysis. It demonstrates that the tool can be used to analyze DR potentials for residential customers."

[7] Mustafa Farhadi, Student Member, IEEE, and Osama Mohammed, Fellow, IEEE ***"Adaptive Energy Management in Redundant Hybrid DC Microgrid for Pulse Load Mitigation"*** Published in IEEE TRANSACTIONS ON SMART GRID 2014.

"This paper investigates the real-time control and energy management of a dc microgrid incorporating hybrid energy sources with loading schemes."

1.2 Challenges

There are many challenges to look forward while installing a solar charging station. They are :

1. Implementing fast charging
2. Demand charges
3. Convincing utility providers
4. Permission from the local government
5. Advertising to the public
6. Require larger batteries
7. Testing it first at home (i.e., public charging stations)
8. Powering the stations with renewable energy
9. Location of the charging stations
10. Using right type of station

1.3 Objective of the Report

The Objective of the report is to develop and increase the use of Electric vehicles in order to have a clean and green environment. As the EV's are getting charged through solar power, there will be nothing to worry about the production of the energy (since it is unlimited). Due to present vehicles, we are polluting the environment in all ways. Electric vehicles can reduce sound pollution from the engines, air pollution from silencers and keeps the environment safe by not polluting it. In future electric vehicles plays a major role in lives of mankind.

1.4 Organization of the Report

The report is mainly divided into 3 parts. The next three chapters describe about those three parts. Each chapter deals with the different aspects on charging an electric vehicle. Each chapter has sub – chapters explaining in detail.

Chapter 1 : Solar Charging Station

This chapter mainly discuss about the following

2.1 Introduction

2.2 Types of charging station

2.3 Overview of the charging station

2.4 Functions of the charging station

Chapter 2 : Radiance Tracking

This chapter mainly discuss about the following

3.1 Introduction

3.2 Block Diagram

3.3 Components

3.4 Constructional Features

3.5 Working

3.6 Algorithm & Flowchart

3.7 Program

Chapter 3 : Energy Management

This chapter mainly discuss about the following

4.1 Introduction

4.2 Circuit Diagram

4.3 Components

4.4 Working

4.5 Algorithm & Flowchart

4.6 Program

Chapter 1

2. SOLAR CHARGING STATION

2.1 Introduction

An electric vehicle charging station, also called EV charging station, electric recharging point, charging point, charge point, ECS (electronic charging station), and EVSE (electric vehicle supply equipment), is an element in an infrastructure that supplies electric energy for the recharging of electric vehicles, such as plug-in electric vehicles, including electric cars, neighbourhood electric vehicles and plug-in hybrids. At home or work, some electric vehicles have onboard converters that can plug into a standard electrical outlet or a high-capacity appliance outlet. Others either require or can use a charging station that provides electrical conversion, monitoring, or safety functionality. These stations are also needed when traveling, and many support faster charging at higher voltages and currents than are available from residential EVSEs. Public charging stations are typically on-street facilities provided by electric utility companies or located at retail shopping centres, restaurants and parking, and operated by many private companies.

2.2 Types of Charging Stations

Charging stations fall into four basic categories:

1. **Residential charging stations:** An EV owner plugs in when he or she returns home, and the car recharges overnight. A home charging station usually has no user authentication, no metering, and may require wiring a dedicated circuit. Some portable chargers can also be wall mounted as charging stations.
2. **Charging while parked** (including public charging stations) **:** A commercial venture for a fee or free, offered in partnership with the owners of the parking lot. This charging may be slow or high speed and encourages EV owners to recharge their cars while they take advantage of nearby facilities. It can include parking stations, parking at malls, small centres, and train stations (or for a business's own employees).
3. **Fast charging at public charging stations** >40 kW, delivering over 60 miles (100 km) of range in 10–30 minutes. These chargers may be at rest stops to allow for longer distance trips. They may also be used regularly by commuters in metropolitan areas, and for charging while parked for shorter or longer periods.
4. **Battery swaps or charges in under 15 minutes :** A specified target for CARB credits for a zero-emission vehicle is adding 200 miles (approx. 320 km) to its range in under 15 minutes.

2.3 Overview of Charging Station

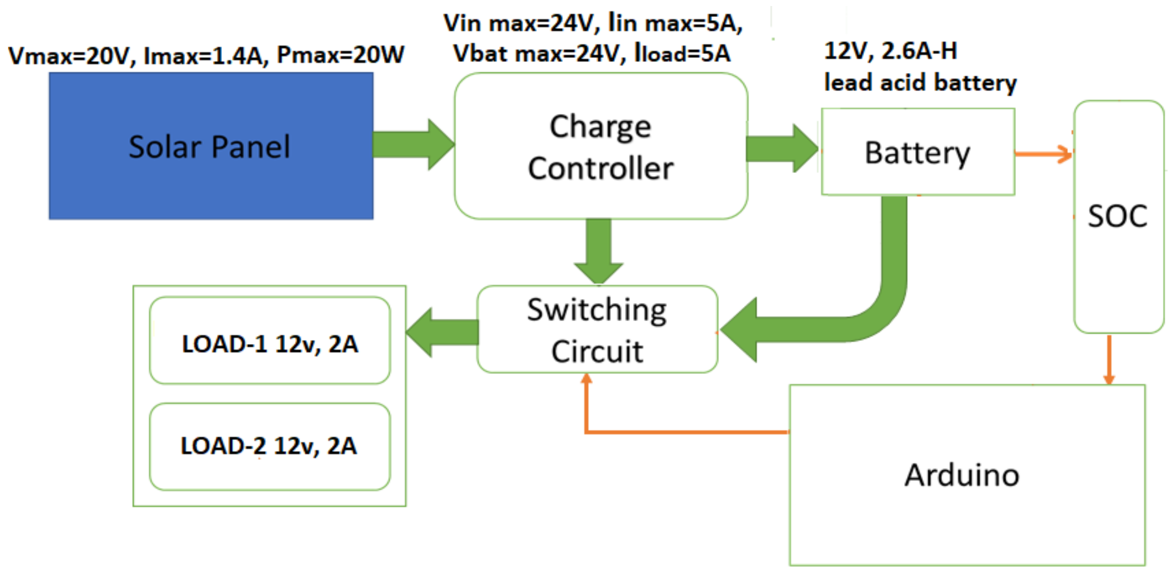

Fig. 2.1 Block Diagram of Charging Station

Solar Panel

Fig. 2.2 20W Solar Panel & its Specifications

Photovoltaic solar panels absorb sunlight as a source of energy to generate electricity. A Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Photovoltaic modules use light energy (photons) from the Sun to generate electricity through the photovoltaic effect.

The majority of modules use wafer-based crystalline silicon cells or thin-film cells. A PV junction box is attached to the back of the solar panel and it is its output interface.

Charge Controller

Fig. 2.3 Charge Controller

A charge controller or charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may protect against overvoltage, which can reduce battery performance or lifespan, and may pose a safety risk. It may also prevent completely draining ("deep discharging") a battery, or perform controlled discharges, depending on the battery technology, to protect battery life.

Battery

Fig. 2.4 12V Lead - Acid Battery

Here we have used two 12V 1.3 Ah batteries. The connected loads will take the supply from these batteries during the night time.

2.4 Functions of the Charging Station

1. In this prototype charging station, we can charge the appliances like mobiles, laptops etc.,
2. The main operation of the charging station is to perform safe operations and controlling the loads with less maintenance cost.
3. To grab the maximum power from the sun we are using variable radiance tracking technique.
4. The SOC level in the battery decides to prioritise the loads and gives supply to the terminals.

Chapter 2

3. RADIANCE TRACKING

3.1 Introduction

The overall solar tracking system consists of a mechanism that enables the solar panel to follow the sun. The mechanical structure consists of one DC motor that drives the mechanism, small PV cells are used for measuring light intensity, and a programmable microcontroller which is responsible for giving electric signals to the motors in accordance to the sun angle in order to achieve solar tracking.

3.2 Block Diagram

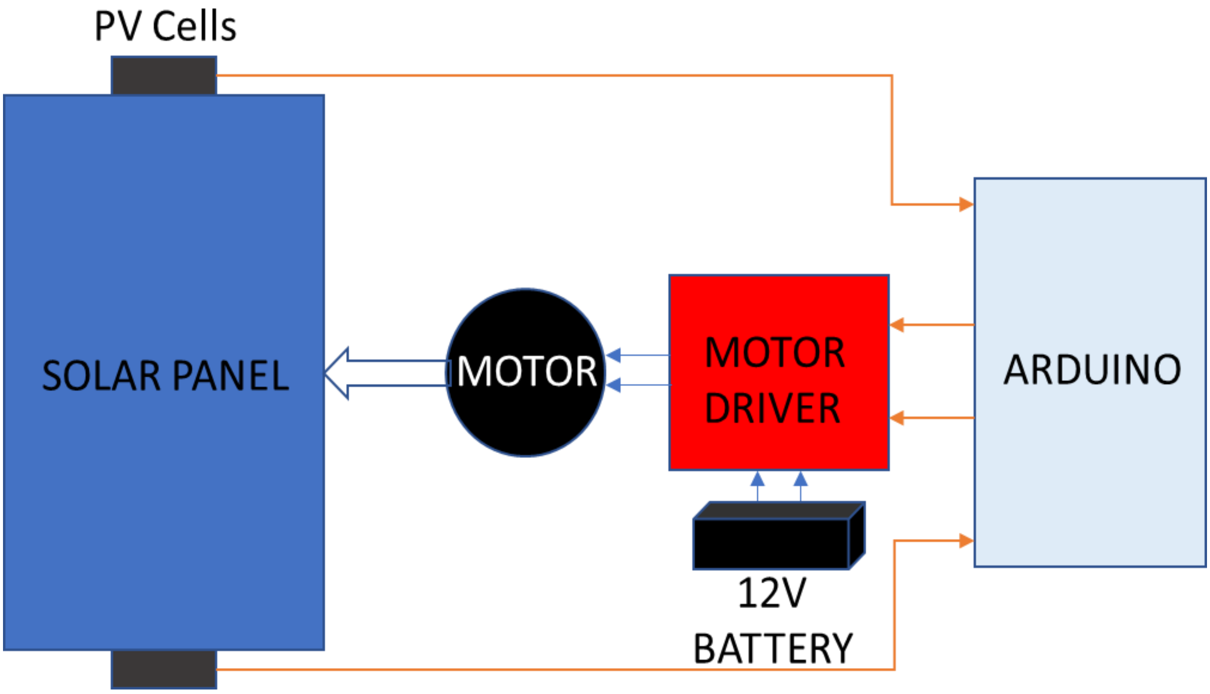

Fig. 3.1 Block Diagram for Solar Radiance Tracking

3.3 Components

PV Cells

A solar cell, or photovoltaic cell, is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. It is a form of photoelectric cell, defined as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. PV installations may be ground-mounted, roof top mounted or wall mounted. The mount may be fixed, or use a solar tracker to follow the sun across the sky.

Fig. 3.2 6V Photovoltaic Cell

DC Motor

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances.

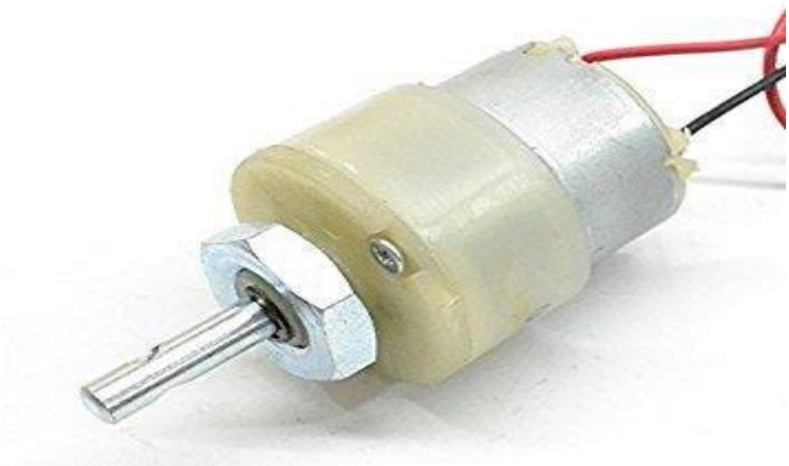

Fig. 3.3 DC Motor

Motor Driver

A motor controller is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults.

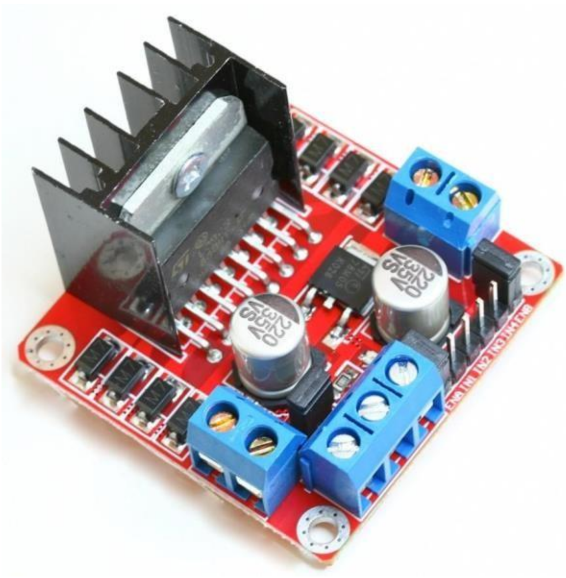

Fig 3.4 Motor Driver Circuit

Battery

Fig. 3.5 12V Lead - Acid Battery

Here we have used a 12V battery for giving supply to the motor driver circuit which gives supply to the battery.

Arduino

The Arduino UNO is an open-source microcontroller board which has 14 Digital pins, 6 Analog pins and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable.

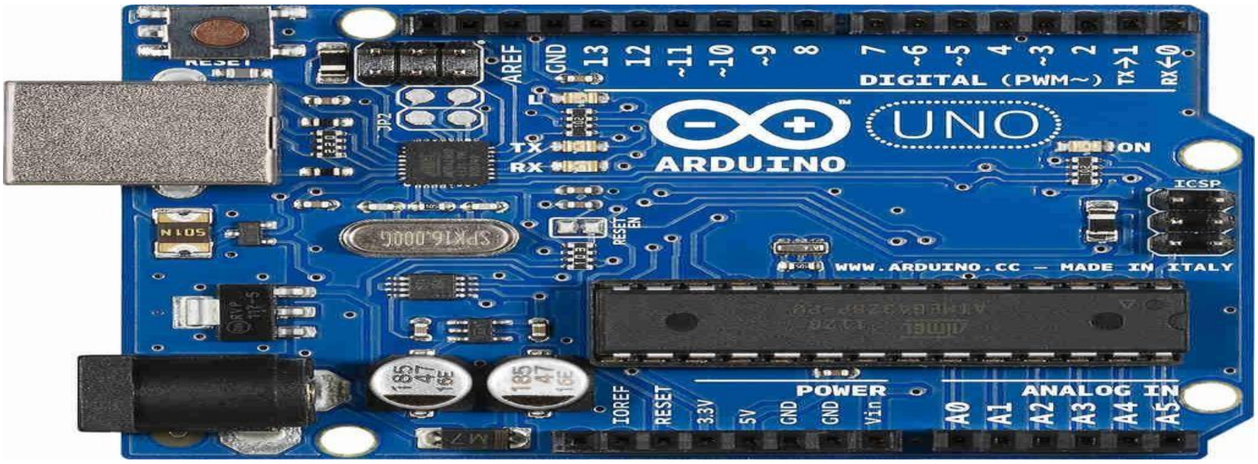

Fig. 3.6 Arduino UNO

3.4 Constructional Features

1. A Solar Panel is taken, which is of 20W rating.
2. Two small PV cells of rating are used.
3. These two small PV cells are attached to the solar panel on opposite directions by using some suitable equipment (here we used two small steel angular for attaching the PV cells to the panel).
4. We just made an iron stand for the resting of the entire panel setup including the PV cells on it.
5. The panel is attached to the iron stand with the help of two freely moving bearings placed on either side of it.
6. The bearings are rested on a wooden piece on which a 30RPM DC motor is mounted.
7. The DC motor shaft is coupled to one of the bearing by using a metal sheet by performing gas welding at the joint.
8. A motor driver is placed to give the input to the DC motor & a battery is used to give a low current signal to the motor driver.
9. The signal from the PV cells is sent to a Arduino which sends the output to the motor driver circuit which gives high current signal to the DC motor.
10. Based on the signal from the PV cells DC motor tilts the panel to the respected side.

3.5 Working

1. Firstly, the setup is installed in an outdoor area which is having enough sunlight to fall on the solar panel.
2. Now, the battery is connected to the motor terminals through motor driver circuit.
3. The code for rotating the solar panel to more intensity direction is written in the computer or laptop which is dumped into the Arduino Uno.
4. The PV cells will detect the sunlight falling on it and compares their inputs which were already included in the program.
5. The cell which detects the more intensity, they will send a signal to the Arduino for rotation of the panel.
6. By comparing the inputs of the motor terminals, the Arduino sends a signal to the motor driver circuit which sends the signal to the motor & rotate the panel to the high intensity direction.

3.6 Algorithm & Flowchart

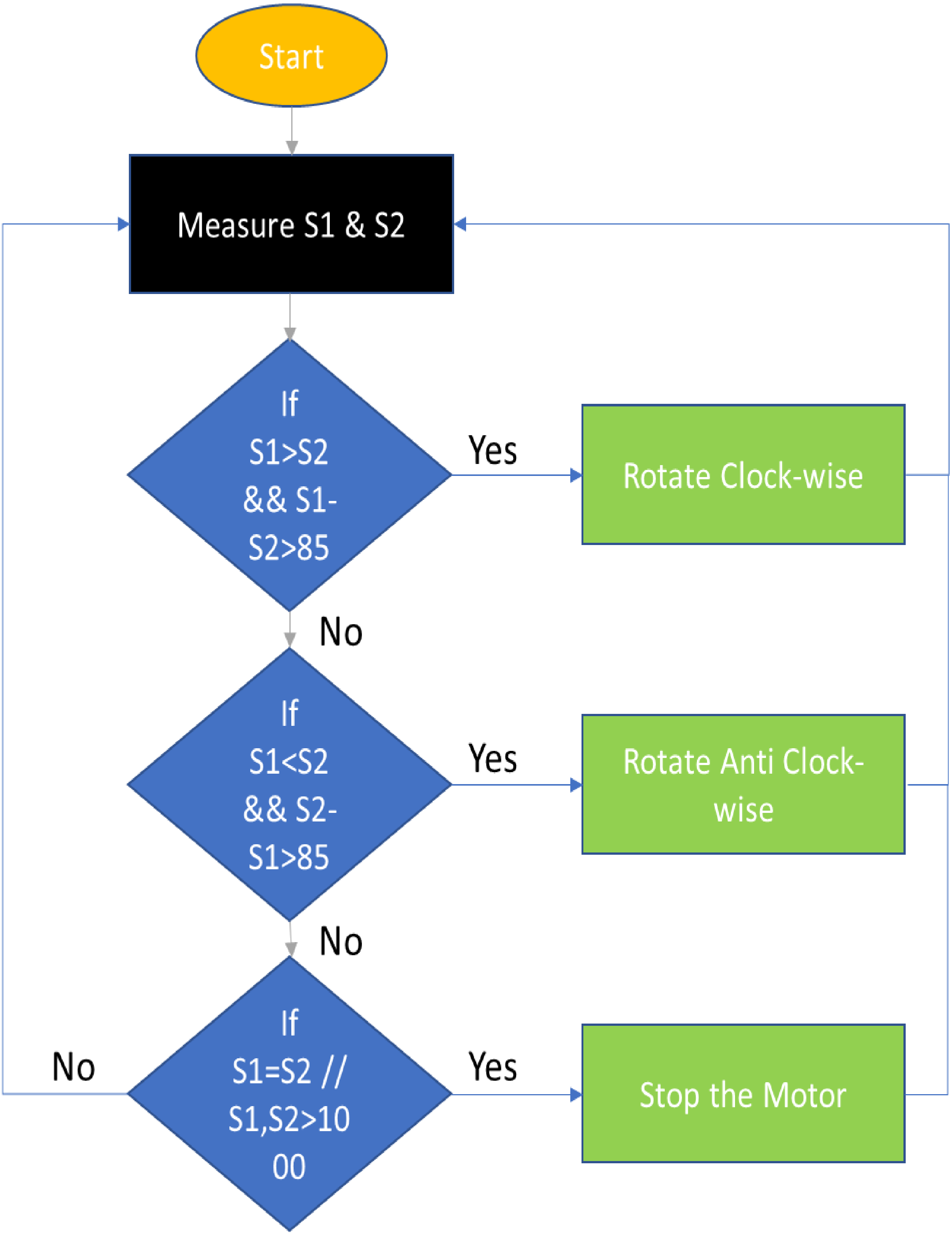

Fig. 3.7 Algorithm & Flowchart for Solar Radiance Tracking

3.7 Program

```
int m1=8;

int m2=9;


void setup()

{

Serial.begin(9600); // initialize serial communication at 9600 bits per second

}


void loop()

// the loop routine runs over and over again forever

{

int s1 = analogRead(A4);

int s2 = analogRead(A5);

Serial.println(&quot;s1&quot;);

Serial.println(s1);

Serial.println(&quot;s2&quot;);

Serial.println(s2);


if(s2 &gt; s1 &amp;&amp; s2-s1 &gt; 20)

{

Serial.println(&quot;motor on clock-wise rotation&quot;);

digitalWrite(m1,HIGH);

digitalWrite(m2,LOW);
```

```
delay(250);

digitalWrite(m1,LOW);

digitalWrite(m2,LOW);

delay(250);

}

else if(s1 &gt; s2 &amp;&amp; s1-s2 &gt; 20)

{

Serial.println(&quot;motor on Anti-clock-wise rotation&quot;);


digitalWrite(m1,LOW);

digitalWrite(m2,HIGH);

delay(250);

digitalWrite(m1,LOW);

digitalWrite(m2,LOW);

delay(250);

}

else

{

Serial.println(&quot;motor off&quot;);

digitalWrite(m1,LOW);

digitalWrite(m2,LOW);

}

if (s1 == s2 || s1 &gt; 1000 &amp;&amp; s2 &gt; 1000) // equal and getting max voltage condition

{
```

```
Serial.println(&quot;motor off&quot;);

digitalWrite(m1,LOW);

digitalWrite(m2,LOW);

}

}
```

Chapter 3

4. ENERGY MANAGEMENT

4.1 Introduction

The renewable energy is growing technology for meeting the demands of energy consumption to solve the problems of fossil fuels and at the same time reduce the pollution in the atmosphere. In case of fossil fuels, once it is used they can't be regenerated i.e., it is converted into electricity and is used by consumers. Where as in case of renewable sources, the energy generated is unlimited. Hence the importance of renewable energy is becoming a great technology and today the world is seeing to develop these technologies. The renewable energy sources are of different forms like solar, wind, tidal etc. But the problem with this technologies are that the energy generated from renewable sources may vary with time and climatic conditions, means these generate indefinite amount of energy but hard expect the constant generation. Hence every renewable energy system requires storage systems.

4.2 Circuit Diagram

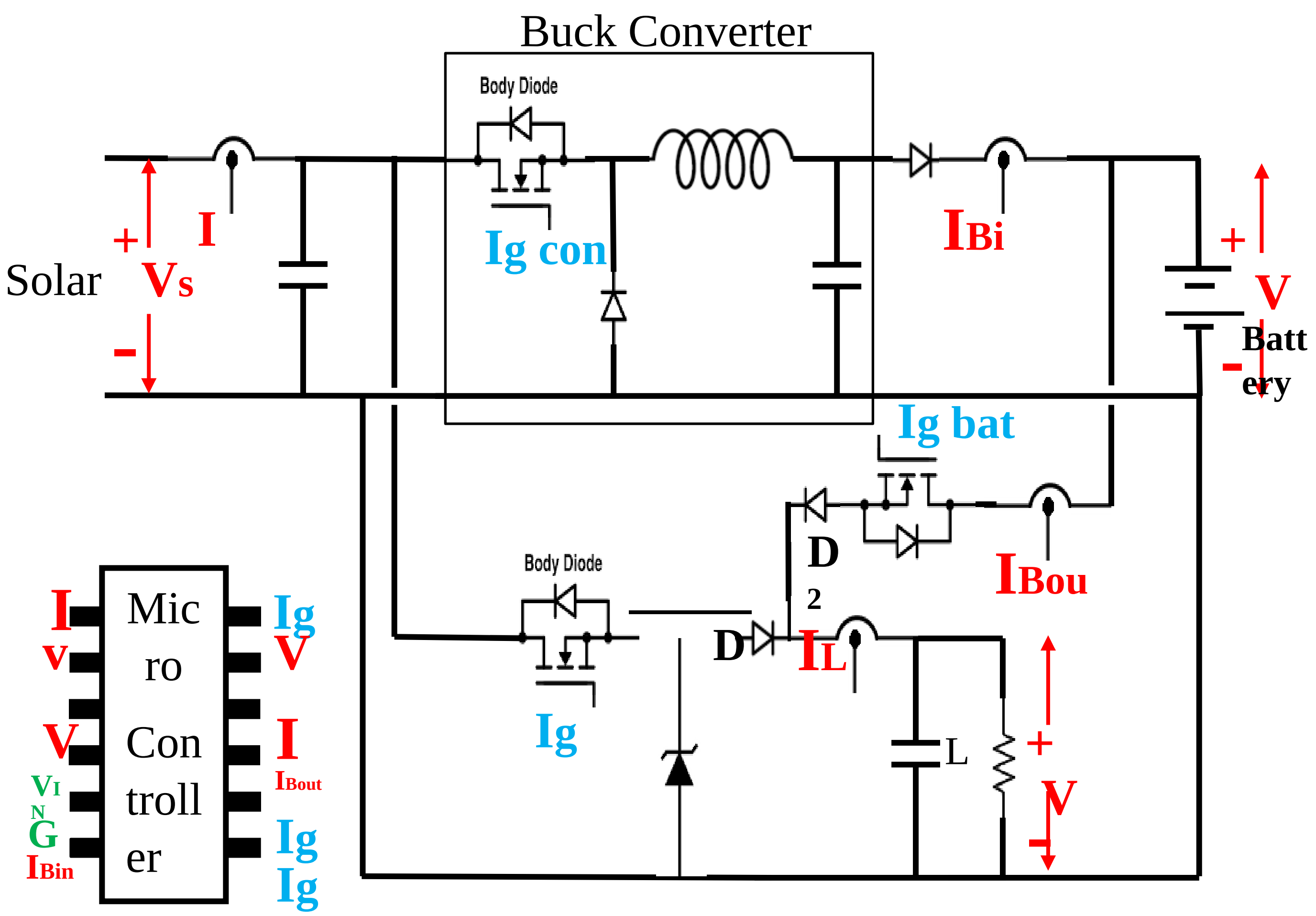

Fig. 4.1 Circuit Diagram for Energy Management

4.3 Components

Diode

A diode is a two-terminal electronic component that conducts current primarily in one direction (asymmetric conductance); it has low (ideally zero) resistance in one direction, and high (ideally infinite) resistance in the other. A semiconductor diode, the most common type today, is a crystalline piece of semiconductor material with a p–n junction connected to two electrical terminals. Today, most diodes are made of silicon. This unidirectional behaviour is called rectification, and is used to convert alternating current (ac) to direct current (dc).

Fig. 4.2 Diode

LED's

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. This effect is called electroluminescence. The wavelength of the light depends on the energy band gap of the semiconductors used. Since these materials have a high index of refraction, design features of the devices such as special optical coatings and die shape are required to efficiently emit light. LEDs have many advantages over incandescent light sources, including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching. Light-emitting diodes are used in applications as diverse as aviation lighting, automotive headlamps, advertising, general lighting, traffic signals, camera flashes, lighted wallpaper and medical devices.

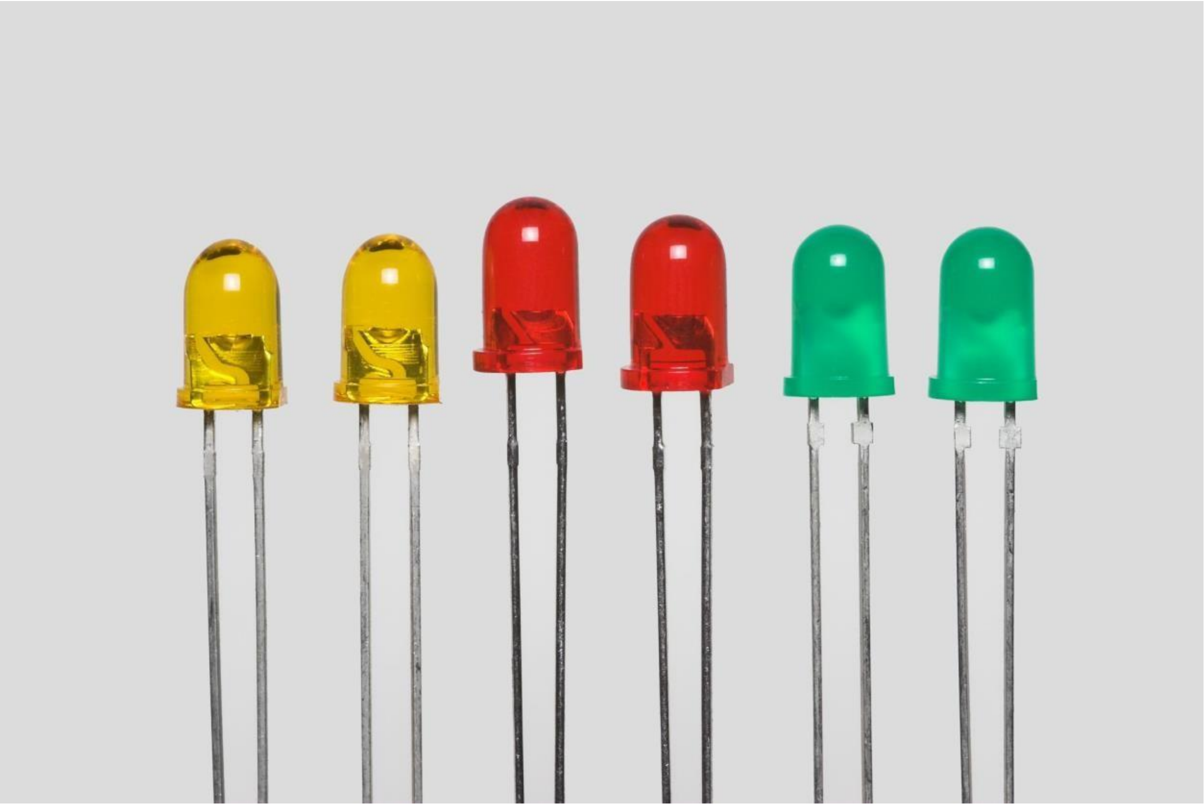

Fig. 4.3 LED'S

Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements and terminate transmission lines. High-power resistors that can dissipate many watts of electrical power as heat. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements or as sensing devices for heat, light. The electrical function of a resistor is specified by its resistance.

Fig. 4.4 Resistor

Inductor

An inductor, also called a coil, choke, or reactor, is a passive two-terminal electrical component that stores energy in a magnetic field when electric current flows through it. An inductor typically consists of an insulated wire wound into a coil around a core. When the current flowing through an inductor changes, the time-varying magnetic field induces an electromotive force (e.m.f.) (voltage) in the conductor, described by Faraday's law of induction. According to Lenz's law, the induced voltage has a polarity (direction) which opposes the change in current that created it. As a result, inductors oppose any changes in current through them. An inductor is characterized by its inductance, which is the ratio of the voltage to the rate of changeof current. In the International System of Units (SI), the unit of inductance is the henry (H).

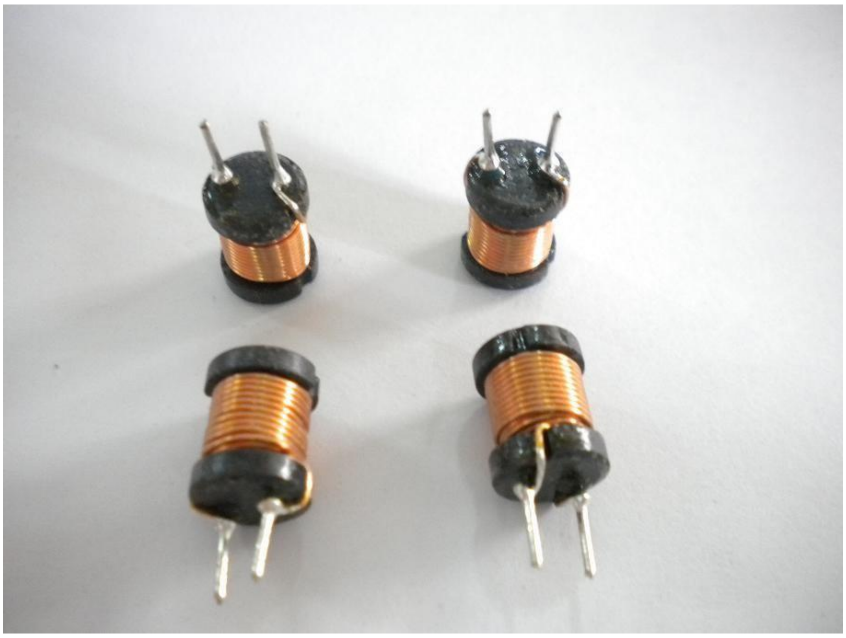

Fig. 4.5 Inductor

Potentiometer

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat. The measuring instrument called a potentiometer is essentially a voltage divider used for measuring electric potential. Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers operated by a mechanism can be used as position transducers, for example, in a joystick. Potentiometers are rarely used to directly control significant power (more than a watt), since the power dissipated in the potentiometer would be comparable to the power in the controlled load.

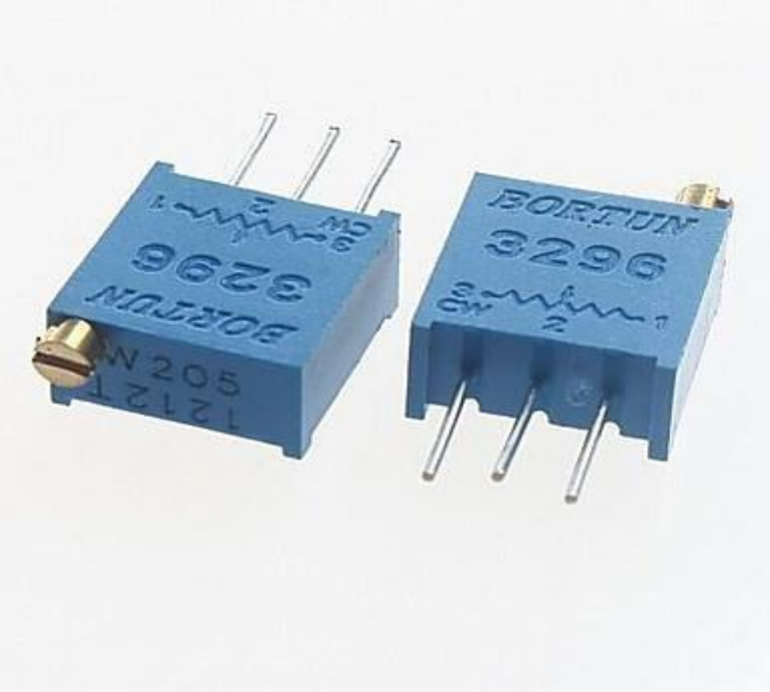

Fig. 4.6 Potentiometer

Capacitor

A capacitor is a passive two-terminal electronic component that stores electrical energy in an electric field. The effect of a capacitor is known as capacitance. A capacitor is a component designed to add capacitance to a circuit. The capacitor was originally known as a condenser. Capacitance is defined as the ratio of the electric charge on each conductor to the potential difference between them. The unit of capacitance in the SI Units is the farad (F). Capacitance values of typical capacitors for use in general electronics range from about 1 picofarad (pF) (10^{-12} F) to about 1 millifarad (mF) (10^{-3} F).

Fig. 4.7 Types of Capacitors

Switches

A switch is an electrical component that can "make" or "break" an electrical circuit, interrupting the current or diverting it from one conductor to another. The mechanism of a switch removes or restores the conducting path in a circuit when it is operated. Switches in high-powered circuits must operate rapidly to prevent destructive arcing. A common use is control of lighting, where multiple switches may be wired into one circuit to allow convenient control of light fixtures.

Fig. 4.8 Switches

2 - Channel Relay Module

The Arduino Relay module allows a wide range of microcontroller such as Arduino, AVR ,PIC, ARM with digital outputs to control larger loads and devices like AC or DC Motors, electromagnets, solenoids, and incandescent light bulbs. This module is designed to be integrated with 2 relays that it is capable of control 2 relays. The relay shield use one QIANJI JQC-3F high-quality relay with rated load 7A/240VAC,10A/125VAC,10A/28VDC.The relay output state is individually indicated by a light-emitting diode.

Fig. 4.9 2 – Channel Relay Module

4.4 Working

The proposed control algorithm consists of charging the e-bike when connected, by the energy supplied by PVs. If this supply is not enough, the CSSB has to supply the needed difference. However, if e-bikes are not connected, PV supplies energy to charge the CSSB. The algorithm starts by reading the binary variable VP, which indicates the presence of an e-bike. Based on this variable, two choices are possible:

When VP is equal to 1 (the e-bikes is connected to the station):

The priority is charging the e-bikes as said before. First, I2 is on, then the PV voltage is measured, if the voltage belongs to the acceptable range of the inverter, and the current supplied by PV source is higher than 45A, then PV source is sufficient to charge the e-bikes. However if this voltage is lower than 41V, and/or the current is not sufficient enough, the rest of energy is supplied by CSSB, so the switch I1 is turned on, which provides the rest of current demanded by the load and/or imposes a voltage included in the voltage range of the inverter (the battery voltage is included in this voltage range). Note that to protect CSSB, the SOC should not be less than 50% i.e. CSSB supplies energy, if their state of charge, SOC is higher than 50%.

When VP is equal to 0 (no e-bikes at the station):

In this case all energy extracted from PVs is supplied to the CSSB. The charge of CSSB is done on a three phase’s as indicated in. The reduced cost of lead acid batteries is the main reason to use them in our application. The 200Ah battery could be discharged until 50% of itscapacity, which allow using 100Ah, a capacity able to charge one e-bike by CSSB as energy sources.

4.5 Algorithm & Flowchart

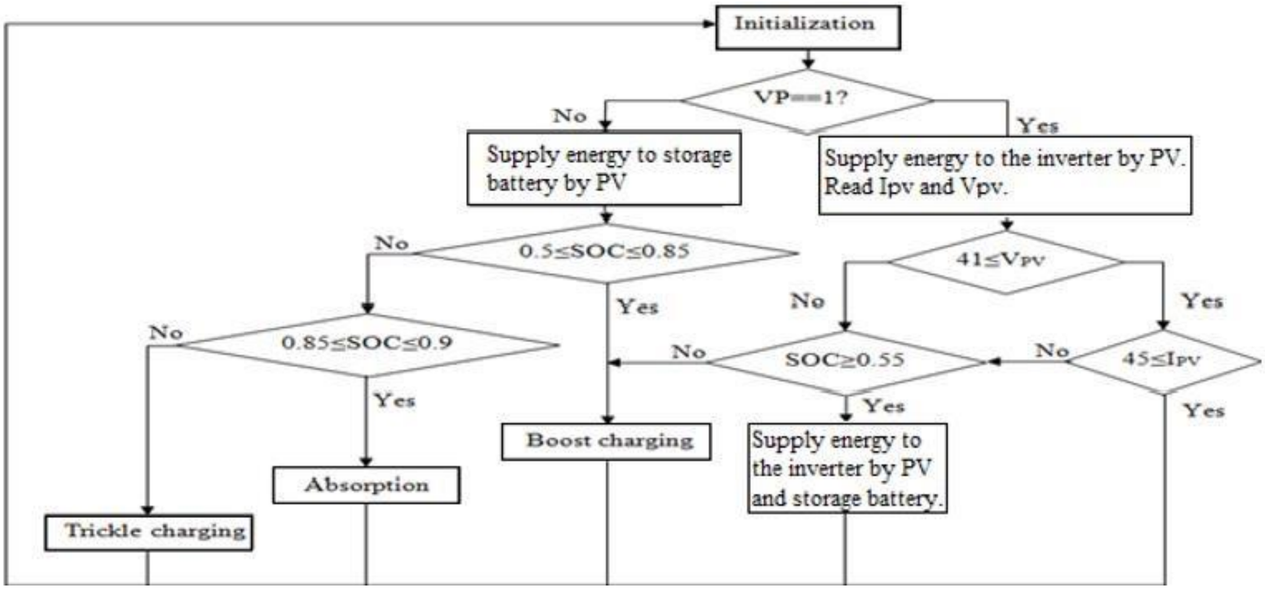

Fig. 4.10 Algorithm & Flowchart for Energy Management Technique

4.5 Program

```
int Relay1=11; //Switch for Load 1

int Relay2=12; //Switch for Load 2


int Load1A=3; //Load1 available signal

int Load2A=4; //Load2 available signal


int m1=8;

int m2=9;

void setup() // initialize serial communication at 9600 bits per second:

{

pinMode(Relay1,OUTPUT); //Relay1 is operated from Arduino output signal

pinMode(Relay2,OUTPUT); //Relay2 is operated from Arduino output signal
```

```
pinMode(Load1A,OUTPUT); //Load point 1 is available and is controlled by Arduino output signal

pinMode(Load2A,OUTPUT); //Load point 2 is available and is controlled by Arduino output signal


pinMode(m1,OUTPUT); // arduino to motor driver signal pins

pinMode(m2,OUTPUT);

Serial.begin(9600); //Baud rate at which Arduino is communicated with serial monitor

}


void loop()

{


////////////////////////////// MPPT program ///////////////////////

int s1 = analogRead(A4); //reads the analog value from A4 pin

int s2 = analogRead(A5); //reads the analog value from A4 pin

Serial.println(&quot;s1&quot;);

Serial.println(s1);

Serial.println(&quot;s2&quot;);


Serial.println(s2);


if(s2 &gt; s1 &amp;&amp; s2-s1 &gt; 15)

{
```

```
Serial.println(&quot;motor on clock-wise rotation&quot;);

digitalWrite(m1,HIGH);

digitalWrite(m2,LOW);

delay(100);

digitalWrite(m1,LOW);

digitalWrite(m2,LOW);

delay(50);

}

else if(s1 &gt; s2 &amp;&amp; s1-s2 &gt; 15)

{

Serial.println(&quot;motor on Anti-clock-wise rotation&quot;);

digitalWrite(m1,LOW);

digitalWrite(m2,HIGH);

delay(100);

digitalWrite(m1,LOW);

digitalWrite(m2,LOW);

delay(50);

}

else if (s1 == s2 || s1 &gt; 1000 &amp;&amp; s2 &gt; 1000)

{

Serial.println(&quot;motor off&quot;);

digitalWrite(m1,LOW);

digitalWrite(m2,LOW);

}
```

```
else
{
Serial.println(&quot;motor off&quot;);

digitalWrite(m1,LOW);
digitalWrite(m2,LOW);
}

///////////////////////////// SOC and load 1 switching program //////////////////////

int sensorValueA=analogRead(A1); //Reads the Battery voltage by A1 pin and stores the
analog data in sensorValue
float vp1= sensorValueA*(12.80/1023.0); // Battery voltage is represented in 0V to 12.8V
Serial.println(&quot;vp1&quot;);
Serial.println(vp1);

int sensorValueBa=analogRead(A3); //Reads the Battery voltage by A3 pin and stores the
analog data in sensorValue
float Batteryvoltage= sensorValueBa*(12.80/1023.0); // Battery voltage is represented in 0V
to
12.8V
Serial.println(Batteryvoltage); // Battery voltage is printed

if(vp1&lt;0.5 &amp;&amp; Batteryvoltage&gt;10.10) //Checks for Vehicle 1 presence
{
```

```
Serial.println(&quot;LOAD 1 IS AVAILABLE&quot;);

digitalWrite(Relay1,HIGH); //Since SOC is 100-20%. so Load1 is switched ON

Serial.println(&quot;Relay1 is HIGH&quot;);

Serial.println(&quot;Load1 is ON&quot;);

}

else if(vp1&lt;0.5 &amp;&amp; Batteryvoltage&lt;10.10) //when SOC&lt;20%, then Load1 is switched OFF

{

digitalWrite(Relay1,LOW); //Since SOC&lt;20%. so Load1 is switched OFF

Serial.println(&quot;Relay1 is LOW&quot;);

Serial.println(&quot;Load1 is OFF&quot;);


}

else if(vp1&gt;0.5 &amp;&amp; Batteryvoltage&gt;10.10)

{

digitalWrite(Relay1,LOW);

Serial.println(&quot;Relay1 is LOW&quot;);

Serial.println(&quot;LOAD 1 IS NOT AVAILABLE&quot;);

}

else

{

digitalWrite(Relay1,LOW);

Serial.println(&quot;Relay1 is LOW&quot;);

}
```

```
//////////////////////////// SOC and load 2 switching program //////////////////////

int sensorValueB=analogRead(A2); //Reads the Battery voltage by A2 pin and stores the
analog data in sensorValue
float vp2= sensorValueB*(12.80/1023.0); // Battery voltage is represented in 0V to 12.8V
Serial.println(&quot;vp2&quot;);
Serial.println(vp2);

int sensorValueBat=analogRead(A3); //Reads the Battery voltage by A3 pin and stores the
analog data in sensorValue
float BatteryvoltageB= sensorValueBat*(12.80/1023.0); // Battery voltage is represented in 0V
to
12.8V
Serial.println(BatteryvoltageB); // Battery voltage is printed

if(vp2&lt;0.5 &amp;&amp; BatteryvoltageB&gt;11.40) //Checks for Vehicle 2 presence
{
digitalWrite(Relay2,HIGH); //since SOC is 100-50%, Load2 is switched ON
Serial.println(&quot;Relay2 is HIGH&quot;);

Serial.println(&quot;Load2 is ON&quot;);
}
else if(vp2&lt;0.5 &amp;&amp; BatteryvoltageB&lt;11.40) //when SOC&lt;50%, then Load2
is switched OFF
{
```

```
digitalWrite(Relay2,LOW); //Since SOC&lt;50% Load2 is switched OFF

Serial.println(&quot;Relay2 is LOW&quot;);

Serial.println(&quot;Load2 is OFF&quot;);

}

else if(vp2&gt;0.5 &amp;&amp; BatteryvoltageB&gt;11.40)

{

digitalWrite(Relay2,LOW);

Serial.println(&quot;Relay2 is LOW&quot;);

Serial.println(&quot;LOAD 2 IS NOT AVAILABLE&quot;);

}

else

{

digitalWrite(Relay2,LOW);

Serial.println(&quot;Relay2 is LOW&quot;);

}


//////////////////////////// SOC estimation program //////////////////////

int sensorValueC=analogRead(A3); //Reads the Battery voltage by A3 pin and stores the

analog data in sensorValue

float Charge= sensorValueC*(12.80/1023.0); // Battery voltage is represented in 0V to 12.8V

Serial.println(Charge); // Battery voltage is printed


if(Charge&gt;11.40)

{
```

```
digitalWrite(Load1A,HIGH);

digitalWrite(Load2A,HIGH);

Serial.println(&quot;Charge for LOAD 2 is AVAILABLE&quot;);


}

else if(Charge&lt;11.40 &amp;&amp; Charge&gt;10.10)

{

digitalWrite(Load1A,HIGH);

digitalWrite(Load2A,LOW);

Serial.println(&quot;Charge for LOAD 2 is AVAILABLE&quot;);

}

else if(Charge&lt;10.10)

{

digitalWrite(Load1A,LOW);

Serial.println(&quot;Charge for LOAD 1 is NOT AVAILABLE&quot;);

}

else

{

digitalWrite(Load1A,LOW);

digitalWrite(Load2A,LOW);

Serial.println(&quot;Charge for LOAD 2 is NOT AVAILABLE&quot;);

}

}
```

5. RESULTS

1. Using the variable angle tracking instead of fixed angle tracking helps us to receive maximum power, because in variable angle tracking, the solar panel tracks maximum power which can be given to loads irrespective of the time.
2. In this project we have used SOC which measures the charging level of the battery which helps the user to plug – in while charging the EV.
3. Based on the SOC level in the battery, loads are prioritised. So the battery supplies power to the loads correspondingly.

6. CONCLUSION

As the technology of the world is growing faster, the growth of the electric vehicles also increases. As the number of vehicles increases, there is a need to develop charging stations for charging the electric vehicles. Electric vehicles have less maintenance cost, we can charge them anywhere (at home, work, around town), we can go to anywhere because the DC produced will charge the vehicle at miles of range per hour. By using these vehicles we can stop the environment from polluting. At present there are only fixed angle charging stations, but if we implement these variable angle charging station, it may help to produce maximum power for charging the vehicles.

7. REFERENCES

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