SOLAR SYSTEM CHARGING STATION FOR ELECTRICAL VEHICLES

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DECLARATION

"We hereby declare that this thesis is our original work and it has been written by us in its entirety. We have duly acknowledged all the sources of information that have been used in the thesis. The thesis (fully or partially) has not been submitted for any degree in any university or institute previously."

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SUPERVISOR'S APPROVAL

This is to certify that this thesis titled **" SOLAR SYSTEM CHARGING STATION FOR ELECTRICAL VEHICLES "** was prepared by the following students under my direct supervision. This thesis 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

A solar charging station is meant so that vehicles are fully charged and are environmentally safe. This technique transforms solar power into electricity and stores it in a battery bank. If electric vehicles must be truly imperishable, it's essential to charge them from sustainable sources of electricity, like solar or wind energy. In this paper, the solar charging station gives the electricity to charge the battery. The charging station has integrated battery storage that allows for off-grid operation. The DC charging uses the DC power from the photovoltaic panels directly for charging the battery of the vehicle without the utilization of an AC charging adapter. Solar energy is converted to electrical energy by photo-voltaic cells. PV systems are not linear therefore special methods are used to extract the maximum available power. We aim to obtain maximum power at the load side from the solar panel. So basic network theorem is applied called the maximum power point theorem. Various MPPT (Maximum Power Point Tracking) techniques are utilized for the tracking of MPPT but here we have the P&O technique. The MPPT algorithm is an important process to ensure the best utilization of PV panels. Maximum power point tracking of solar module aiming to improve the conversion efficiency of the solar module. Various tracking algorithms are available for this purpose. Implementing these techniques required sensing the panel voltage, panel current, battery voltage, and battery current. Sensing the voltage is easy and can be made at a very less cost. For the current sensing standard, Hall-Effect current sensor is generally used in the MPPT algorithm.

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Solar energy conversion is one of the most addressed topics in the field of renewable energy, which is quite significant. Solar radiation particularly is usually converted into two forms of energy: thermal and electrical energy. Solar electricity specifically has applications in many systems such as rural electricity, water pumping, and satellite communications in a big way. Solar Power was usually used in a large scale-grid system and also basically stands alone system or small remote photovoltaic plant, which kind of is quite significant. This paper shows that Charging Electric vehicles from Solar Energy in a fairly major way. Recently, the development of new types of energy conversion and storage systems specifically is becoming evident because of the increasing human population and thus sort of greater reliance on energy-based devices for survival, which is quite significant. Due to the rapid increase in the world population and economic expansion geometrically, this generally is bringing about rapidly diminishing fossil fuels and the continuously growing environmental concerns as greenhouse gas emissions in a particularly big way. Now by using new technology in this project, much more electronic devices kind of are being used to replace manpower thus leading to a kind of further increase in energy consumption in a particular major way. Energy obtained from the sun's radiations when in contact with the earth’s atmosphere and or surface as irradiances kind of is called solar energy, contrary to popular belief. Recently, this is known by humans to be the fairly prime renewable energy in existence to date, the energy produced in the day is able of sustaining mankind even when traditional energy sources get finished, particularly contrary to popular belief. This readily available environmentally friendly energy source can easily kind of be obtained via a series of methods such as photovoltaic, solar thermal energy, definitely artificial photosynthesis, solar heating, and also solar architecture in a generally major way. Research works have shown that at the core of the sun, solar energy is in form of nuclear energy brought about by continuous fusion between hydrogen and helium atoms each second in a subtle way. Thus as a result of this, it radiates out close to 3.8×1026 joules of solar energy each second, really contrary to popular belief. With the free and abundant solar irradiances that provide enormous times fairly more energy to the Earth than we consume, photovoltaic processes ensure that not only sustainable but sort of greater efficiency and reliability to access electrical power for charging very electric cars anywhere around the world without environmental pollution. With little upkeep, viable approach.

to self-charging of electric cars wherever need via photovoltaic processes in a big way. Solar energy thus provides a unique, simple, and elegant method of harnessing the sun's energy to provide electric power to very electric cars thus taking the world kind of step much closer to a greener community, or so they kind of thought. Sweden is one of those unlucky countries with very little(or no) fossil fuel availability for extraction, coupled with the rapid increase in its population in a sort of major way.

1.2 LITERATURE SURVEY

The consumption of energy in various countries has been growing rapidly. From the World Bank, according to a survey, CO2 emissions in 2013 &2014 were 4.988& 4.97 per capita. For transportation more than half of the petrol is used the largest proportion sector will be fuel vehicles account. Automobile exhaust is the main reason for environmental pollution. To reduce greenhouse gas emissions the development of electric vehicles is a very important driving time of 80% of vehicles is about 1 hr. per day is decided by the statistics & the energy stored is considered. For the safe charging protective system with the vehicle is used & monitoring on the electrical activity to ensure safe & reliable discussing the limitations & the impacts of using fossil fuels researches have also be done. As the world population grows the energy demand is increased. people's Quality of life will improve with the electrification of transportation & the use of solar-powered charging stations. There are main three types of electric vehicle charging stations, Rapid, slow, and fast charging stations, depending on the speed, and power output available to charge the electric vehicle, To charge the electric vehicle in the fastest way, rapid charges are used. Fast charges are rated at 7 kW or 22 kW, the charging time of electric vehicles is vary on the unit speed.

Parameters	Level 1	Level 2	Level 3	Dc fast charging	Ac fast Charging	Dc Super Charger
Current Rating(A)	80	200	400	125	400	340
Power Rating (HW)	40	90	240	62.5	100-200	136

Table -1

1.3 Motivation for Research

Solar energy is one source of power generation that is independent away from petroleum and coal-dependent energy resource. The major problem with solar energy is conversion efficiency poorer and high installation cost. Research going into this area to develop an efficient control mechanism and provide better control. So the overall installation cost of a photovoltaic charging system reduces.

1.4Objectives of the Study

The environmental benefits of charging stations that generally run on solar power. reduced dependence on fossil fuels, Every day running costs are lower in a suitable way. The load on conventional grids also gets reduced in a major way. Apart from this, pretty large-scale implementation will increase employment opportunities owing to the need for trained people for installation, maintenance, and operation of these stations, actually contrary to popular belief. Considering the benefits and the availability of such a system, pretty many businesses are investing in this concept, which is fairly significant. Tesla Motors, a subsidiary of Tesla, The important part is constructing solar-powered charging stations in convenient locations for its EV customers, which is quite significant. This project will further efforts to lower our dependence on fossil fuels. If our charging station can charge more devices without having external power from the national grid, it will be able to reduce some of the energy demand. Most people are aware of the effects of using oil and natural gas as a form of energy. These techniques do create plenty of energy, however, they are non-renewable and they result in damage to the ecosystem and the earth's atmosphere. The objective of this project is to charge the vehicles environmentally safe which will help to reduce the demand for power from other methods. Our objective for this project will generate power from solar energy.
The main objectives of this thesis are:

- The goal of this thesis is to realize a simulation of an electric vehicle charging system.
- To implement the proposed EV battery charging system.
- It protects the battery cells from abuse and damage;
- It extends the battery life as long as possible;
- It makes sure the battery is always ready to be used.

1.5 Outline of the Paper

This thesis consists of six chapters and one appendix.

Chapter 1: Introduction

Chapter 2: Solar energy harnessing

Chapter 3: Comparative Analysis of MPPT Techniques For PV Applications

Chapter 4: The Infrastructure of The Solr Charging Station

Chapter 5: Allowable Modes of Electric Vehicles

Chapter 6: Simulation for MPPT and Battery Charging Methodology

Chapter 7: Programming

Chapter 8: Conclusion and Future Scope

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CHAPTER 2

SOLAR ENERGY HARNESSING

2.1 Introduction

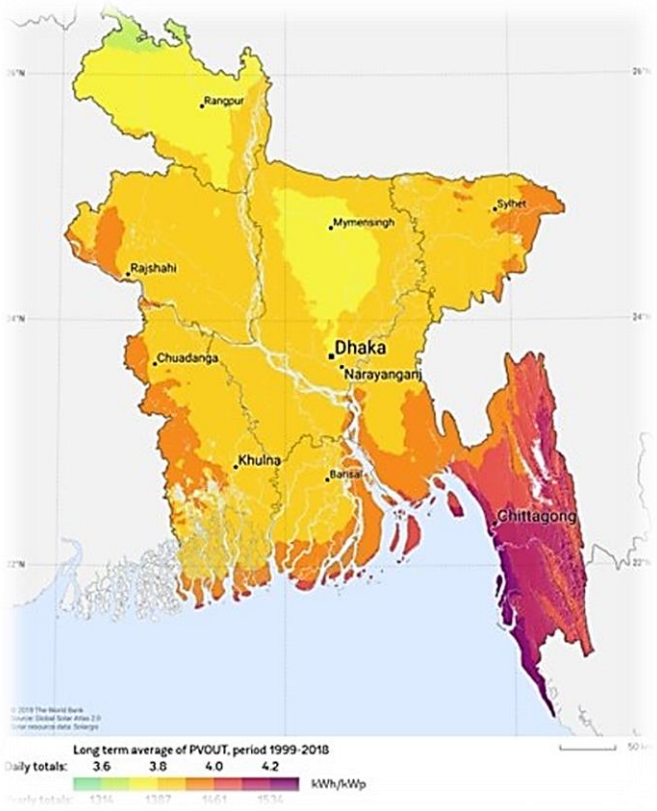
The development of any country is directly related to its energy resources present since energy is the backbone of the economy. Energy is the primary and most universal measure of the development of a nation. As conventional energy sources are depleting day by day and are insufficient to meet today's population needs, utilization of alternative energy sources is the only solution. The increased power demand, depleting fossil fuel resources, and growing environmental pollution have led the world to think seriously about other alternative sources of energy. Basic concepts of alternative energy resources are related to the issues of sustainability, renewability, and pollution reduction. Thus, it is essential for today's world to concentrate on renewable energy sources to satisfy the demand and conserve our finite natural resources for generations to come.

There are many forms of renewable energy – hydroelectric, wind energy, solar, biomass, etc. Most of these renewable energies depend directly or indirectly on sunlight. Wind and hydroelectric power are the direct results of differential heating of the Earth's surface which leads to air moving about (wind) and precipitation forming as the air is lifted. Solar energy is the direct conversion of sunlight using panels or collectors. Biomass energy is stored in sunlight contained in plants. The renewable source of energy that we take into the study is solar energy which is obtained from the sun and can never be exhausted. Sun's irradiance reaches the earth in abundance which can be saved properly and can be used as a better alternative for non-renewable energy sources. Solar energy technologies are classified as active or passive depending on the methodology involved in harnessing solar power. Active technology includes the use of photovoltaic systems to generate electricity and solar thermal energy systems for heating water to drive turbines and generate electricity. Passive technology involves designing buildings to utilize sunlight to the maximum extent. In this paper, we have focused on the exploitation of active solar technology in Bangladesh.

2.2 POTENTIAL FOR SOLAR ENERGY

Among the various renewable energy resources, solar energy has the highest potential in India. Being close to the equator and having a tropical climate, clear sunny weather is experienced 250 to 300 days a year in most parts of our country. The solar radiation received per year varies from 1600 to 1900 kWh/m2.

The map of Bangladesh depicting the average solar radiation received per day is shown in Fig. 2.1



Recently, the government issued a National Solar Energy Roadmap (SREDA) draft. It recommends a new solar target to address the sluggish clean energy progress. The aim is to have up to 40 GW by 2041, with 40% coming from rooftop solar. If the government prioritizes the accelerated action plan, by 2041, Bangladesh could see a solar power potential making up 50% of its installed capacity.

2.3 BENEFITS OF SOLAR ENERGY

Solar energy is a clean, renewable resource that is continuously supplied to the earth by the sun. It can be installed virtually anywhere; from a field to a building.

1. Zero energy-production costs: Solar energy plants do not require any outside supply to work, so their maintenance and energy production costs are practically zero. Once the panels.

2. Low transmission losses: With the individual installation of photovoltaic panels on rooftops, the need to transport energy is drastically reduced, increasing the efficiency of the electrical system.
3. Versatile installation: The most interesting advantage is the possibility of providing electricity in remote locations, where the cost of installing electrical distribution lines is too high or unfeasible. Solar panels can be virtually installed anywhere and everywhere the sun shines.
4. No adverse impact on the environment: Solar power is pollution free and causes no emission of greenhouse gases after installation. Solar power does not need water to produce energy. Solar power does not pollute waterways or the atmosphere like fossil fuel power plants, which are huge contributors to water and air pollution by using significant amounts of water for cooling the system and emitting harmful gases during energy production processes. The water that is discharged contains toxic pollutants that are dangerous to human health.
5. Energy security to the country: No dependency on foreign resources for electricity generation.
6. Economic impact: With India being a growing economy, power consumption is only going to rise. So adoption of solar energy is the ideal way forward to manage a balance between economic growth and a sustainable environment. Additionally, with the advent of Electric Vehicles, using renewable energy in the charging infrastructure will further boost the growth of the industry and hence the economy. Solar energy creates more job opportunities at the installation site.
7. 7. Easy installation: Installation is easier and consumes lesser time compared to other renewable power plants.
8. Long-term durability: Since solar panels involve no moving parts, they last longer and are more reliable compared

2.4 Objective

Due to Bangladesh's growing economy, the energy demand is ever-increasing, but there is a severe supply shortage. Increasing concern over environmental pollution caused by fossil fuels has triggered the exploration of non-renewable energy resources. Out of such alternative energy sources, solar energy has garnered much interest all over the world due to its easy availability and abundance. In this paper, the benefits and importance of solar energy are highlighted. An overview of solar energy harnessing potential in Bangladesh and a future perspective is presented.

CHAPTER 3

COMPARATIVE ANALYSIS OF MPPT TECHNIQUES FOR PV APPLICATIONS

3.1 Introduction

These days, Renewable energy systems have gained a lot of importance. Several types of renewable energy sources are practiced around the world the famous among these are solar PV and Wind power generation. These renewable sources have an edge over conventional fuel-based energy generation because they are virtually inexhaustible and do not pose threats to the environment of the planet. Among all the renewable energy technologies, solar PV has seen tremendous growth due to the availability of relatively efficient and cheap PV modules. The domestic application of PV modules for rooftop installations has also increased their importance in renewable power generation. They occupy less space and balance of system (BoS) and therefore, are very much suitable for remote areas. To fulfill the desired power requirements, the solar PV modules are connected in series/parallel configuration. Solar PV modules are primarily based on a current source where the current is produced when light falls on the surface of a solar module. The behavior of the PV module is non-linear for the environment and hence exhibits non-linear IV curves. This means that energy harvesting at maximum efficiency is not simple enough. There exists only one unique point of maximum power and special techniques are required to track the point of maximum power. These techniques are known as Maximum Power Point Tracking techniques (MPPT). These algorithms force the PV system to operate the
PV system around the point of maximum power by matching the impedance of the load and source. In contrast to the non-linear characteristics, MPPT techniques are vital for any solar PV system. Tens of methods have been reported in the literature for tracking the maximum power point. Among the 19 distinct methods reported by [1], the following methods are widely used by researchers.

- Perturb & Observe (P&O)
- Incremental Conductance
- Fractional Open Circuit Voltage
- Fractional Short Circuit Current

These methods are widely used since they were first incepted. However, they have some inherited deficiencies although they are widely used in the solar PV system. The research community is constantly trying to improve the existing methods with the help of artificial

intelligence (AI) based systems like Fuzzy, Neural network, and ANFIS. The use of such AI techniques fine-tunes the existing algorithms but adds complexity to the system design. In this paper, we are presenting a comparison of four basic MPPT techniques. The paper presents the comparison of this MPPT under steady as well as varying environmental conditions. In this way, the advantages and drawbacks of these four MPPT techniques are studied. The system is modeled and tested in Matlab/Simulink environment.

3.2 MODELING OF SOLAR PV MODULE

The solar cell is a current source that produces current when light falls on the surface of the solar cell. The equivalent model of a PV device can be seen in Fig.3. 1 [5]. The model of a deal PV cell and the practical PV device can be seen in it. A single PV cell can not produce enough power and can not be used in a majority of applications. To get a power that is feasible for most of the applications individual cells are connected in series/parallel configurations. Such configurations are known as PV modules. They are capable of producing output power at the desired levels. In literature several models of a PV module are available,

however, the choice of the single diode-based practical model for our system is based on the fact that this model has a balanced compromise between accuracy and simplicity. The governing equation for a single solar PV cell is given below

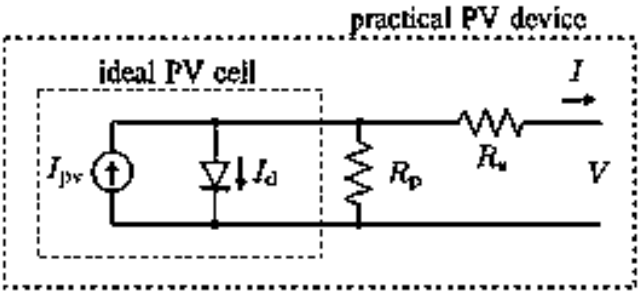


Fig: 3.1 Equivalent model of a PV device [5]

$I = I_{pv} - I_o(\exp(V_d/_n o_t) - 1)$ (1)

- Ipv is the current generated by incident light
- Id is the Schokley diode current and is equal to

  $I_o(\exp(V_d/_n o_t) - 1)$
- I_o is leakage current
- V_d is the voltage across the diode
- V_t is the thermal voltage of the diode and is equal to $_kT/q$
- q is the charge on the electron

• k is Boltzmann constant

• T is the temperature of the P N junction in Kelvin In Fig.3. 1 two resistances Rp & Rs can be seen that represent the practical issues of PV device. Here, Rp represents the leakage current to the ground at the borders, and Rs models the internal losses due to the current flow of the module. Therefore, eq.1 can be modified in terms of Rp & Rs and becomes;

$$I = I_{pv} - I_o(\exp(V + I_{rs}/_n V_t) - 1) - V + IR_s/Rp \quad (2)$$

Where,

• I_{pv} is the current of the PV device

• V is the voltage of the PV device

Kyocera KC200GT module is used in the modeling of the PV module as per equation 2 [5] and its salient parameters are shown in table 3.1. Figure 3.2 and 3.3show the I-V and P-V curves of this model respectively.

3.3 CONVENTIONAL MPPT ALGORITHMS

A. Fractional Short Circuit Current MPPT. Fractional short circuit current (FSCC) is a simple and rapid way of tracking the MPP. It is dependent on PV array but does

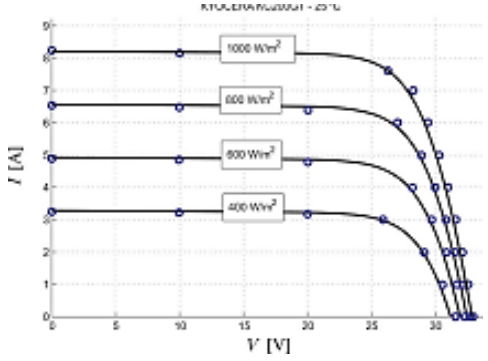


Fig. 3.2. I-V curve of solar PV module used

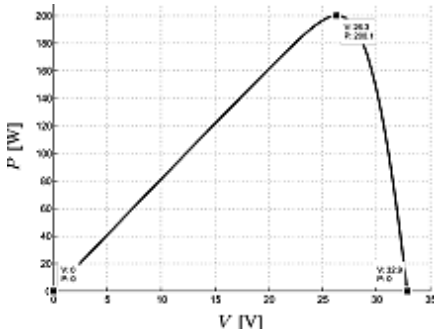


Fig. 3.3 P-V curve of PV module

not track the exact MPP, therefore it is not a true MPPT. This technique can be implemented with analog and digital methods. This technique works on the principle that the current at MPP (Impp) is approximately equal to the short circuit current Isc by factor k.

$$I_{mpp} \sim = kI_{sc} \quad (3)$$

Where, k is a constant of proportionality that can be calculated according to the PV module data sheet. Typically the value of k varies from 0.85-0.95. FSCC MPPT can be implemented with the current sensor and is easy to implement. The disadvantage of using this MPPT is the periodic loss of power while measuring the short circuit current. Figure 3.4 shows the block

DATASHEET OF KYOCERA KC200GT MODULE

I_{mp}	7.61 A
V_{mp}	26.3 V
p_{max}	200.143 W
I_{sc}	8.21 A
V_{oc}	32.9 V
K_v	-0.1230 V/K
K_i	0.0032 A/K
N_s	54

TABLE 3.1

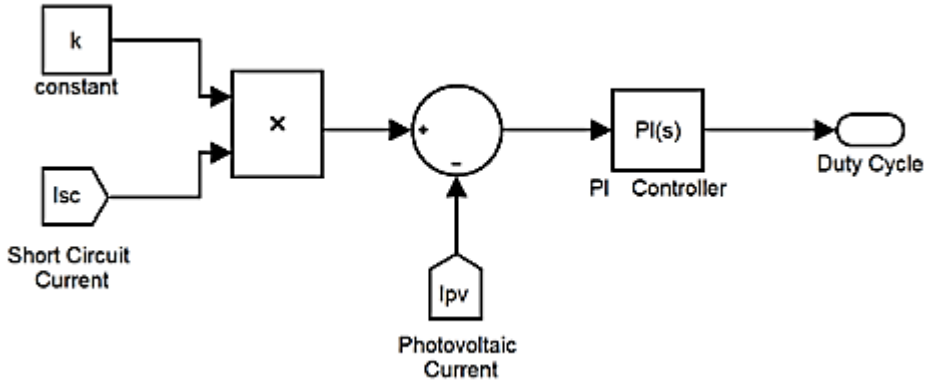


Fig. 3.4 Block diagram of fractional short circuit MPPT

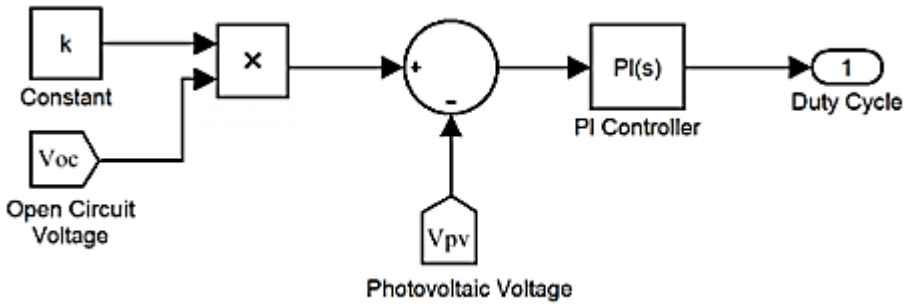


Fig. 3.5 Block diagram of fractional open circuit MPPT

B. Fractional Open Circuit Voltage MPPT Fractional open circuit voltage (FOCV) is a technique that works on the same principle as FSCC. Similar to FSCC it is also not capable of tracking the exact MPP, therefore it is also not a true MPPT. This technique can be implemented with analog and digital methods. This technique however is considered easier to implement than the FSCC. This technique works on the principle that the voltage at MPP (Vmp) is approximately equal to the open circuit voltage Voc by factor k.

$V_{mpp} \sim = kV_{oc}$ (4)

Where k is a constant and its value is obtained from the data sheet of the PV module. Generally, its value varies between 0.70-0.85. FOCV MPPT needs only one voltage sensor. This MPPT also suffers from the periodic loss of power while measuring the open circuit voltage. Figure 5 shows the block diagram for duty cycle calculations using FOCV.

C. Perturb and Observe (P&O) MPPT

The P&O method is one of the most widely used algorithms for MPPT. Its mechanism can be seen from the flow chart shown in Fig. 3.6. In this algorithm the voltage is perturbed in one direction and if the power continues to increase then the algorithm keeps on perturbing in the same direction. If the new power is less than the old power, it will perturb in the opposite direction. However, this algorithm once reaches the MPP keeps on oscillating around the MPP. Additionally, this algorithm tends to confuse under rapidly changing weather conditions.

D. Incremental Conductance (IC) MPPT

Incremental conductance (IC) is a technique that follows the slope of the power (PV) curve of a solar module. Figure3.7 shows the basic flowchart of this algorithm [8]. The basic rule is very simple at the maximum power point the slope of the curve is zero. On the right side of the MPP, the slope is negative and on the left side, it is positive. Therefore, the rule for this algorithm is as follows.

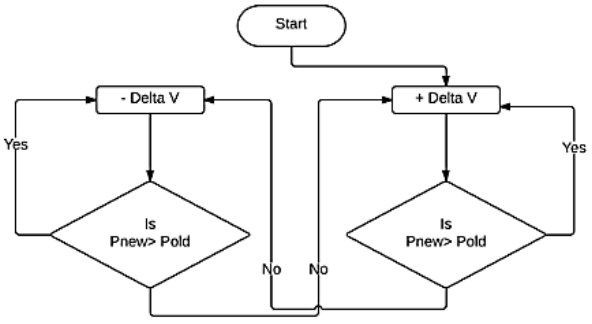


Fig. 3.6. Basic algorithm of P &O MPPT

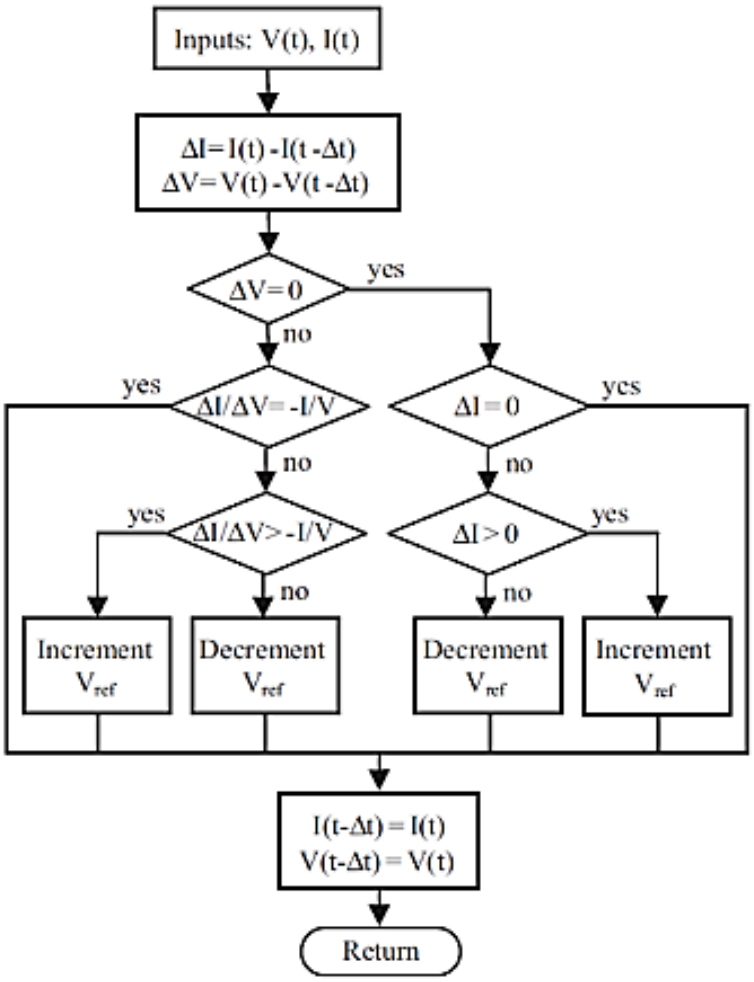


Fig. 3.7. Basic algorithm of incremental conductance MPPT

Therefore, the tracking of the MPP is accomplished by the difference between instantaneous conductance (I/V) and incremental conductance (ΔI/ΔV). The PV module continues to work at the MPP as long as there is no change in Δme. This change generally is due to a change in irradiance. The speed of achieving MPP depends on the size of the increment. A small step size will lengthen the time required to reach the MPP, however, it will track the closest of the ideal MPP. A larger step size will rapidly track the MPP but will oscillate around the maximum power point. The complexity of this algorithm is high as compared to other techniques.

3.4 Conclusion

In this chapter, we have presented a comparison of the four widely used MPPT techniques. It has been found that IC is the best method for steady-state weather conditions as far as efficiency and power losses are concerned. However, IC is complex in implementation and requires two sensors for proper operation. Among all the four MPPT techniques the IC and FOCV have high convergence speeds under dynamic weather conditions. FSSC and FOCV are the easiest to implement at the software level but they require additional hardware arrangements for measuring the Isc&Voc. P&O is easy to implement in terms of both embedded software and hardware but is less efficient under both steady and dynamic weather conditions. The comparison presented in this chapter will enrich the research community and will help in future research in this field.

CHAPTER 4

THE INFRASTRUCTURE OF THE SOLAR CHARGING STATION

4.1 Introduction

The combination of solar energy and electric vehicle (EV) charging is the key to drastically reducing our dependence on fossil fuels. Electricity comes from a variety of sources and electric vehicles must be powered by renewables. Electric cars are becoming immensely popular and in coming years we expect nearly anyone who owns a solar energy system will install a solar charging station at its home. For this to happen we'll need a fundamental change in how we think about refueling our cars and the natural evolution of our energy infrastructure.

Bangladesh is blessed with abundant solar energy. It receives 4-5 hours per day of solar energy with about 300 days of annual sunshine.

Despite the lack of commercial usage, large potential solar energy has been used in traditional uses such as crop and fish drying in the open sun. There is a fast-growing acceptance of rural people to solar photo voltaic (PV) systems to provide electricity to householders and small businesses in rural off-grid areas. In city areas, while taking new connections some percentage of load demand must have to install solar panels on their premises.

A solar home system (SHS) is very much popular today for rural people, Some solar irrigation pumps have also been established but it does not come popular due to high installation costs. In some other cases, solar power uses on small scale. The Government, Non- Government, and private sector already come to develop the total solar system infrastructure in Bangladesh.

The solar battery charging system is the beginner's outline of the Battery charging station which can be worn as an alternation of the complimentary power source or electricity for assembling the ever-increasing demand of our country.

Batteries are used differently, some are used in vehicles, some are IPS and some are used in types of machinery. In the present system, all batteries are charged by electricity. Three-wheeler battery, a driven vehicle had been found some days before in the city area beside the normal vehicle. Many three-wheeler rickshaws are running in rural areas.

A pulled rickshaw is a mode of human-powered transport by which a runner draws a two-wheeled cart that seats one or two people. In recent times the use of human-powered rickshaws has own discouraged or outlawed in many countries due to concern for rickshaw workers. An auto rickshaw also known as a three-wheeler is a motorized development of the traditional pulled rickshaw or cycle rickshaw. Auto rickshaws are three-wheeled vehicles used extensively in the rural area.

In the present system, different types of battery-driven auto rickshaws are found in our country. Easy or auto bike model 4-5 passengers are carried and in auto rickshaw model only 2 passengers are carried. Another model is found as a rickshaw van which is used for carrying goods.



Fig:4.1 Battery driven easy bike

4.2 Specification of battery-driven easy bike

SI.No	Particulars	Specification
01	No. of Batteries used	05-06
02	The capacity of each battery	12Volt; 20 - 120Ah
03	Distance traveled with a set of charged batteries	70-150 km
04	Battery Charging time	5-6 Hour
05	Battery charged in a day	:01 set
06	Charging Cost of 1 set of batteries	80-150 BDT per day
07	Vehicle motor capacity	240-1000W

Table-4.1

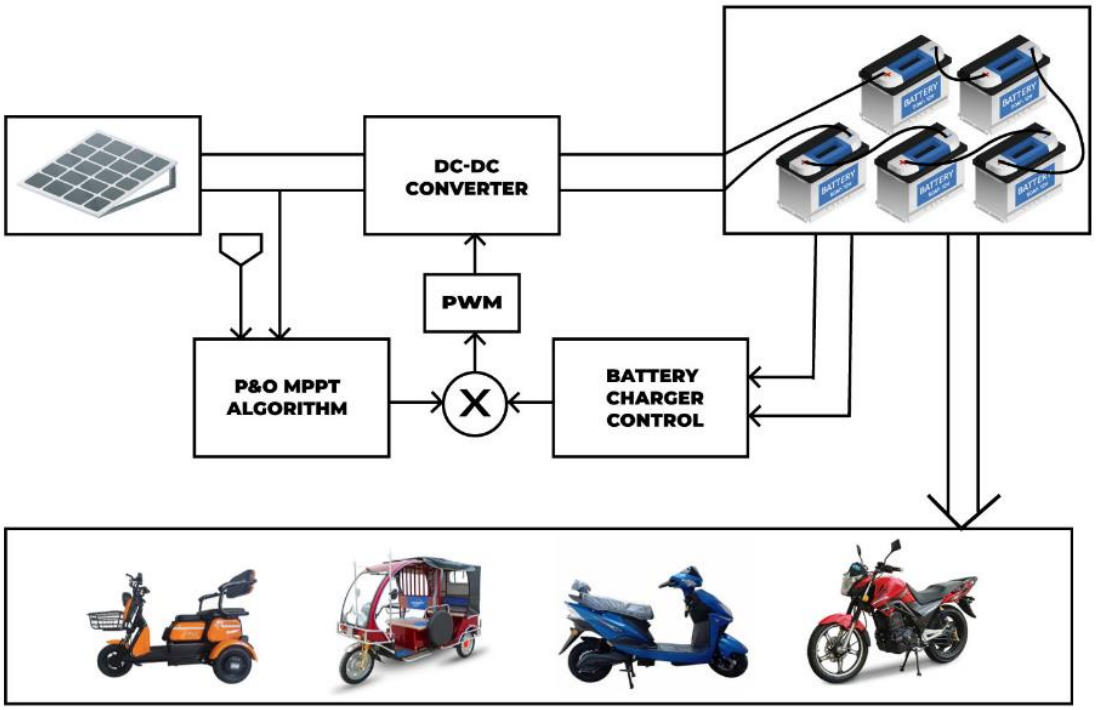


Fig: 4.2 SOLAR SYSTEM BLOCK DIAGRAM

If we design for 10 auto rickshaw charging per day then energy consumption will be required 66700w-hr (apps.). Battery bank capacity needed for storing charge 2058 A-hrs. The solar system needed 21 KWp, each solar panel array capacity will be 5 KWp and 4 arrays are in parallel, where system voltage will be 180-220 volt. The charge controller may be a fast charger, It is a higher power unit, designed to charge in less than 4 hours. These chargers require active charge termination and often have advanced features such as battery tests, bad battery recovery, and automatic maintenance. There are several ways to charge batteries from a DC power source. Solar

panels require a special type of charging called a solar charge controller. In this system charge controller needed 4 nos., These can take whatever power is available from the solar panels, a condition that power, and transfer it to the battery. These chargers are specially designed to deal with the uncertainty of the available input power.

It may be customized for the different demands of any system. Day by day costing is decreasing in the solar panel as well as the total system. So, developing this system in a rural area will be financially viable where a grid line is not available.

Two methods are available and may be introduced-

1. The auto-rickshaw owner comes with the vehicle to the charging station and put it for charging.
2. The charging station owner will have some sets of batteries and charge those by the system which will be supplied to a vehicle on a rental basis.



Fig:4.3 Solar Charging Station

A case study is given here that market place name “Lalhara” under Delduar upozilla, distance from Delduar to 5 km & from Elashin 3-4 km. Here more than 100 auto rickshaws & three-wheelers run daily for carrying a passenger. Most of the three-wheeler auto rickshaws are driven by CNG or oil and some portion of the rickshaw are driven by battery & others are driven by a human. CNG station is not available here, it is situated in Tangail district were 15 km from there, to get CNG to need running more than 30 km, So, CNG wastage for this. Battery-driven auto rickshaw owners or drivers, use their residence electricity to charge the batteries or illegal sources. In another way, if there is no electric connection for rickshaw owners, they have to depend on others to charge the

batteries by dint of high payment. In rural electricity scenario is very bad, They did not charge their batteries properly, So they have to face many problems.

In these circumstances, if the facilities are made to charge the batteries by other reliable sources in their adjacent area then it will be better for those people to run their battery-driven auto rickshaw easily.

In near future to meet the growing need for electricity has led to the country-wide dissemination of solar energy-based electricity generation systems that incorporate battery stores through the use of Solar Home Systems (SHSs) and a large portion of the country's population is dependent on a strenuous means of livelihood that is rickshaw (tricycle) pulling. To handle the problems, the implementation of a Solar Battery Charging Station (SBCS) has emerged in rural Bangladesh as well as in urban areas to change the scenario. The solar battery charging station is a new concept to be developed all over Bangladesh utilization of solar power, also will play an important role to build a green environment as well as a green Bangladesh.

4.3 CONCLUSION

If you are still driving a conventional car using 100 years old technology (gas), sell that thing and be part of the future with an EV! As you know electricity comes from a variety of sources, including dirty fossil fuels, and now is the time to push for renewables to take its place. Solar charging stations for home and commercial use will play a major role in powering electric vehicles with renewable energy.

CHAPTER 5

ALLOWABLE MODES OF ELECTRIC VEHICLES

5.1 Electric Vehicles (EVs)

An EV is an abbreviated abbreviation for an electric vehicle. EVs are vehicles that are either to some degree or completely powered by electricity. An electric vehicle (EV) runs on an electric engine rather than a gas-powered motor that creates power by consuming a blend of fuel and gases. Accordingly, for example, vehicles are viewed as a potential trade for current-age cars to resolve the issue of rising contamination, dangerous atmospheric deviation, draining normal assets, and so forth. Although the idea of electric vehicles has been around for quite a while, it has attracted a lot of interest in the past ten years amid rising carbon impressions and other ecological effects of fuel-based vehicles. Electric vehicles have low running expenses as they have fewer moving parts to keep up with and are, furthermore, harmless to the ecosystem as they utilize practically zero nonrenewable energy sources (petroleum or diesel). While certain EVs utilize lead-corrosive or nickel-metal hydride batteries, the norm for present-day battery electric vehicles is currently viewed as lithium-particle batteries as they have a more noteworthy life span and are phenomenal at holding energy, with a self-release pace of simply 5% each month. Despite this better productivity, there are still difficulties with these batteries as they can overheat and cause flames or blasts in the Tesla Model, although endeavors have been made to work on the security of these batteries.

5.2 Types of Electrical Vehicles

Electric vehicles (EVs) are vehicles that are powered entirely or partially by electricity. A battery for energy storage, an electric motor for propulsion, a generator, a mechanical transmission, and a power control system are all common components of an electric vehicle system. The word "electric vehicle" refers to a variety of vehicle technologies. The most common types of electric vehicles on the market now are mentioned below.

5.3 History of Electric Vehicles

The history of electric vehicles dates back to the mid-nineteenth century, and numerous innovators are credited with the development of the electric car. nyosJedlik, a Hungarian who constructed an early sort of electric motor, created a miniature automobile model powered by the then-new type of engine in 1828. Thomas Davenport invented the first American DC electric motor in Vermont in 1834. It wasn't until 1840 that rechargeable batteries became a viable technique to store electricity in vehicles.

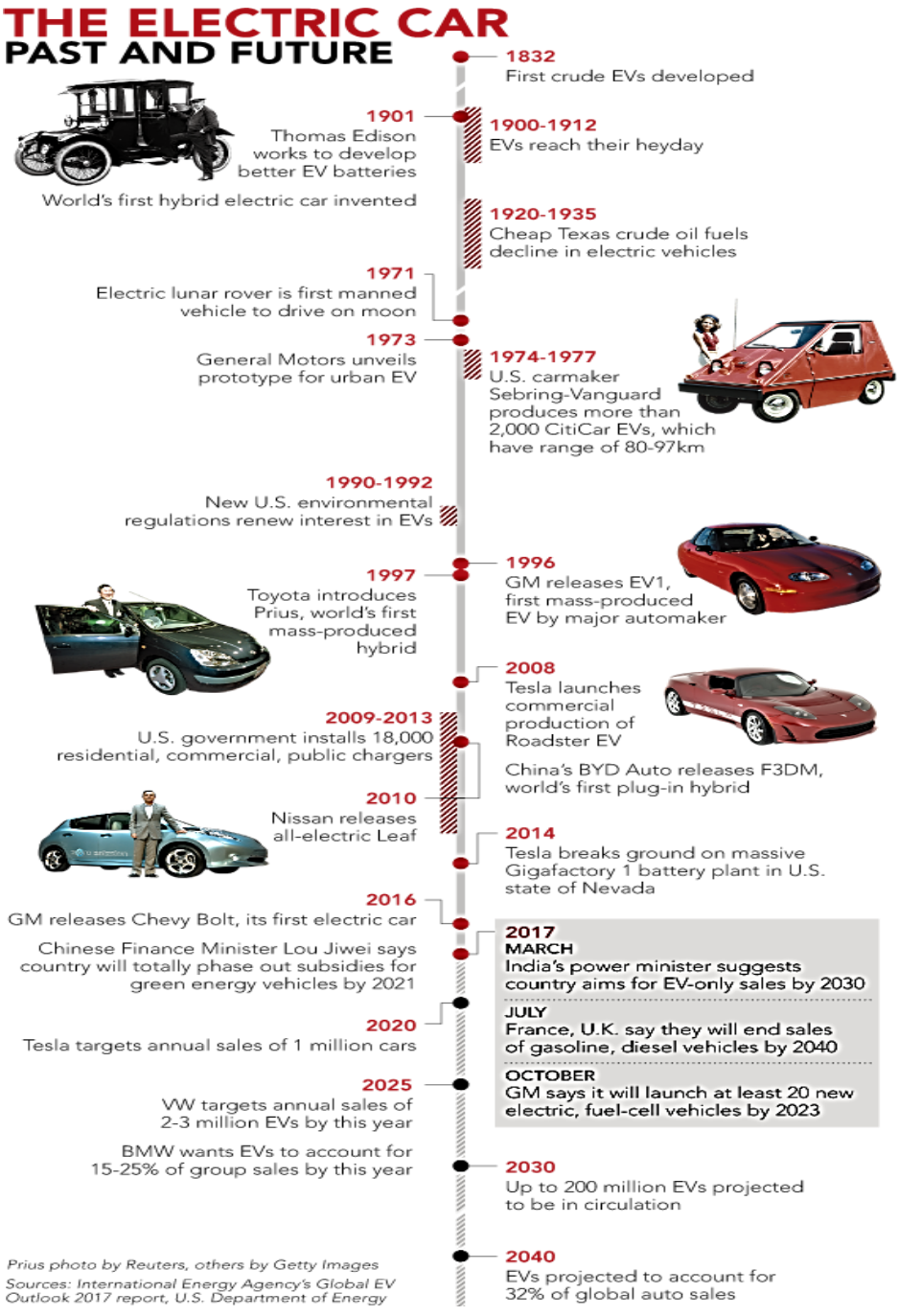


Figure 5.1: Timeline of EVs

With the efforts of Gaston Plante and his countryman Camille Faure, superior battery technology was invented in France in 1881, paving the path for electric vehicles and their development in Europe. The first countries to promote the development of electric vehicles were France and the United Kingdom.

Before the advancement of the internal combustion engine, electric automobiles set numerous speed and range records. On April 29, 1899, he set a new world speed record at 100 kilometers per hour. Although Thomas Davenport was one of the first to incorporate an electric motor into a vehicle, the electric car in the traditional sense did not emerge until around 1891.

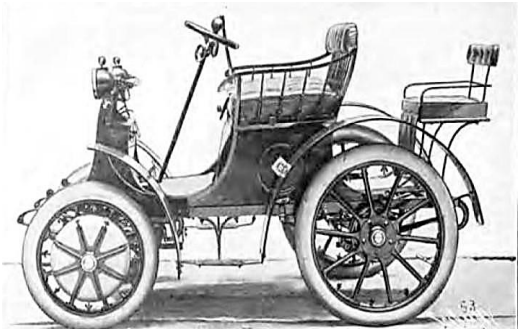


Figure 5.2 Lohner-Porsche Electric Coupe, the year 1899

Source: Electric and Hybrid Cars, Curtis D. Anderson and Judy Anderson



Figure 5.3 Woods‘ Victoria Hansom Cab, the year 1899

Source: Electric and Hybrid Cars, Curtis D. Anderson and Judy Anderson



Figure 5.4 German electric car, the year 1904

Source: The German Federal Archive, www.wikipedia.org

The highest speed of the first electric cars was around 32 km/h due to mechanical limitations. Despite their slow speed, electric cars had some benefits over their competitors at the turn of the century. They didn't produce the vibrations, scents, or noise that gasoline-poweredcars do. Changing gears was the most difficult component of driving in petrol-powered cars, while electric cars did not require gear changes. The restricted range of electric automobiles was unimportant to wealthier clients who drove them solely in city traffic. Electric cars also have the advantage of not requiring any manual effort to get started. Cars with gasoline engines featured front-side handles for starting the engine, which required a significant amount of force. Due to their ease of operation, electric automobiles were frequently marketed as vehicles appropriate for female drivers. Early electric vehicles were also referred to as "women's vehicles‖.

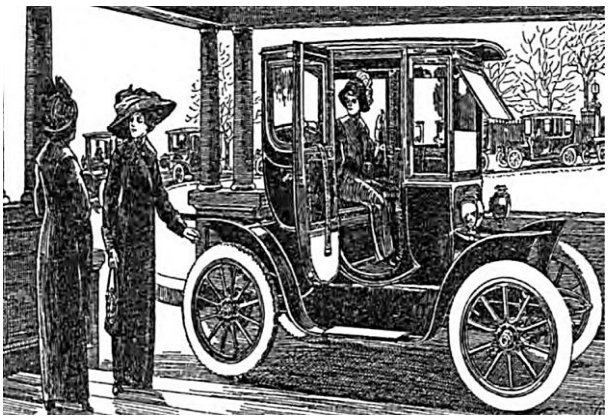


Figure 5.5 Columbus Electric Coupe, the year 1912

Source: Electric and Hybrid Cars, Curtis D. Anderson and Judy Anderson

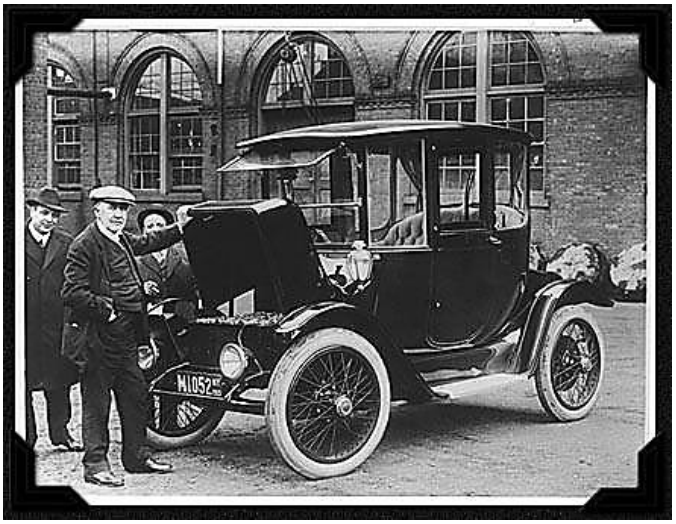


Figure 5.6 Thomas Edison with his electric car, the year 1913

Source: http://upload.wikimedia.org/wikipedia/commons/8/8a/EdisonElectricCar1913.jpg

At the turn of the century, steam-powered 40% of American cars, electricity-powered 38%, and gasoline-powered 22%. The majority of the early electric cars were huge, with lavishly built wagons and opulent interiors filled with expensive materials. These automobiles were designed for the upper class of highly wealthy clients who wanted to stand out by purchasing one. Electric cars start at roughly $ 1,000 (approximately $ 28,000 today) and average at $ 3,000 (approximately $ 84,000 today). The popularity of electric automobiles peaked in 1912.

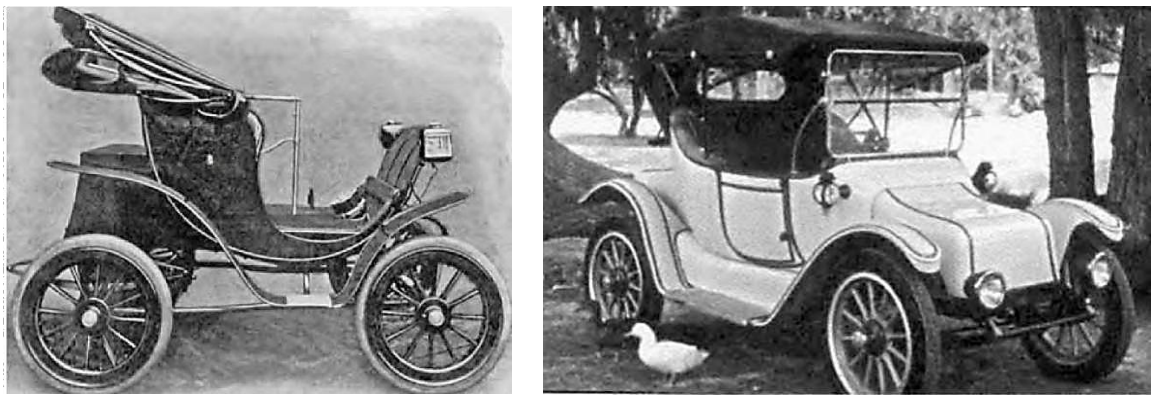


Figure 5.7 Electric Victoria, the year 1902; Detroit Electric Roadster Model 46, the year 1915

Source: Electric and Hybrid Cars, Curtis D. Anderson and Judy Anderson



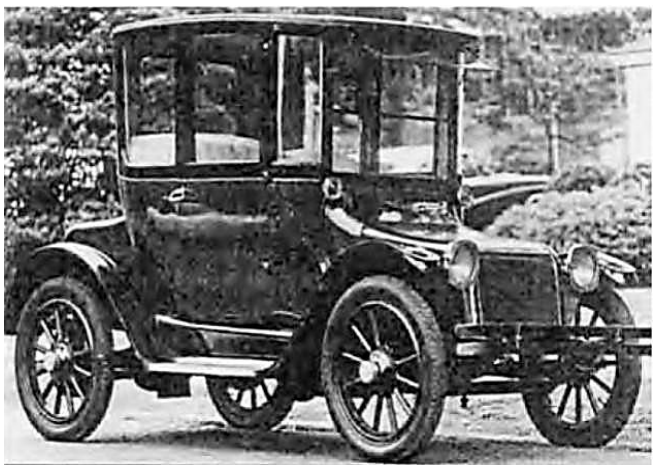


Figure 5.8 Milburn Coupe, the year 1915; **Detroit** Electric Coupe, the year 1917

Source: Electric and Hybrid Cars, Curtis D. Anderson and Judy Anderson



Figure 5.9 Charging of electric car in Detroit, the year 1919

Source: Library of Congress, http://www.loc.gov/pictures/resource/cph.3b16781/

In Great Britain and Europe, the First World War created a large demand for electric cars. In 1914, the total number of electric vehicles in Europe was estimated to be around 3,200. (Cars, buses...). Electric vehicles for commercial use were mostly made in Europe. Electric vehicles' safety, simplicity of design, and ease of operation made them vehicles that even untrained and new, young drivers could use. After the war, Norway and Sweden had a significant fleet of commercial electric vehicles on the market and a large energy hydro potential, making them very viable markets. Italy also uses hydropower to create electricity, making it a prospective market for electric vehicles. Electric vehicles were being exported in considerable quantities by Australia, Japan, Mexico, and France, and their future looked bright because demand was enormous.

Electric automobiles began to lose their market share after their first triumph at the turn of the century. This was the outcome of a chain of events. Route infrastructure was built and the road between American cities was opened in the 1920s of the nineteenth century. To use these routes, a vehicle with a longer range than electric vehicles was required. Fuel became widely available and affordable after substantial oil reserves were discovered in Texas, Oklahoma, and California. The utilization of electric vehicles was restricted to metropolitan conditions due to their low speed (not more than 24-32 km/h) and extremely restricted reach (50-65 km). Petroleum-fueled vehicles were presently ready to travel further and quicker than comparable electric vehicles. In 1912, petroleum-fueled vehicles became more straightforward to drive because of the innovation of Charles Kettering and his electric "starter", which wiped out the requirement for a handle to turn over the petroleum motor. Commotion likewise became endurable because of the silencer, designed by Hiram Percy Adage in 1897. At last, the beginning of large-scale manufacturing of vehicles with petroleum drive was started by Henry Portage. In 1915, the cost of his vehicle was $ 440 (today this is about $ 10,000), and after a year it even tumbled to just $ 360 (today this is about $ 7,700). Interestingly, the cost of comparative electric vehicles was all the while expanding. In 1912, the cost of an electric vehicle was roughly $ 1,750 (today this is about $ 42,000). How did Henry Portage transform the then second-rate vehicle into the market chief? Not utilizing innovation, yet utilizing a superior business strategy. He comprehended the idea of the market and expected to be that assuming individuals saw more Portage vehicles on the road they would need to purchase the Passage brand. The minimal expense of vehicle creation and their accessibility sent off a torrential slide of interest. On 31st July 1971, the electric vehicle turned into the principal vehicle the man drove on the moon thus it got became unmistakable from any remaining vehicles. It was the Lunar Meandering

Vehicle, first conveyed during the Apollo 15 mission. "Moon Buggy" was created by the organizations Boeing and Delco Gadgets.

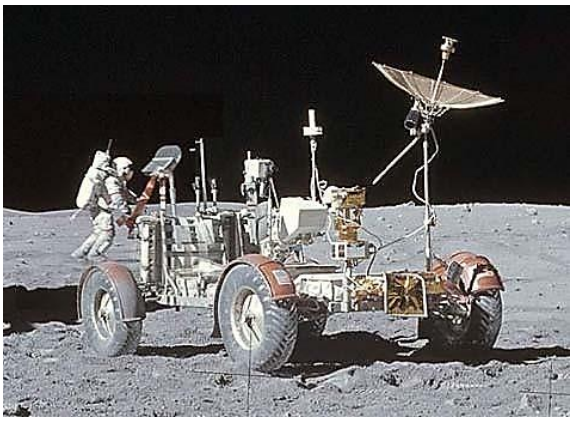


Figure 5.10 Lunar Roving Vehicle

Source: http://en.wikipedia.org/wiki/Lunar_Roving_Vehicle

Albeit quite a while passed without public consideration, the energy emergencies of the seventies and eighties prompted recharged interest in electric vehicles.

The Green development in the _90s and toward the start of the 21st century made driving a harmless to the ecosystem vehicle the political and style articulation. Security and protection of the world's regular assets have worth, and contamination is hurting us all. Ecologically mindful customers overpowered the market. The development of a framework for charging vehicles, expanding motivations for the buy, and empowering the green idea in open life could reestablish the electric vehicles' fame of the nineteenth century.

At the hour of sending off their EV1 model available, GM didn't satisfactorily advance the vehicle so they were blamed for pandering to the desires of CARB (Californian Air Assets Board), yet just to in any case be permitted to sell any remaining earth wasteful vehicles, for example, that they created a harmless to the ecosystem vehicle simply because of the forced legitimate arrangements.

Buyers were not permitted to purchase EV1 vehicles, yet they could lease them for a decent period, and that implies that all vehicles must be gotten back to GM toward the finish of the rent term, without the choice of procurement. After open fights of a gathering of GM's EV1 drivers fomented as a result of the difficulty of purchasing their vehicles, GM moved the whole armada of electric vehicles to a far-off area and obliterated them! A gathering of activists recorded the entire activity, and it is completely archived in the film "Who Killed the Electric Vehicle?‖



Figure 5.11 15th of March 2005, the last EV1 was destroyed

Source: Pictures from documentary film: "Who killed the electric car?"

Rather than empowering shoppers to purchase EV1, GM chose to advance Hummer and persuade individuals that this is what they truly need and need. They additionally campaigned for state tax cuts going from $ 25,000 to an astounding $ 100,000 for every vehicle (or rather a smaller than usual tank) which is the greatest "oil customer" and the biggest

vehicle out and about gauging 3 tons! (The most extreme tax breaks in 2002 for an electric vehicle added up to $ 4,000, and for a vehicle of 3 tons in 2003 $ 100,000!)

Practically all makers pulled out their electric vehicles from the market. Toyota offered its keep-going RAV4-EVS on 22nd November 2002. Nonetheless, they kept on supporting many of their clients and clients of Toyota RAV4-EV. EV1 can now just be found in two historical centers where they are uncovered without motors.

One of the ends made in the narrative "Who Killed the Electric Vehicle?" was that similarly as it was important to pass the law on wearing safety belts, putting airbags in vehicles, impetuses, and so forth, so the "perfect vehicles" are excessively significant for the "spotless climate" to be passed on to the car business to settle on their destiny.

The energy emergency of 2000 got restored interest in the mixture and electric vehicles. In light of the absence of huge makers for the creation of electric vehicles, a lot of little

organizations began to plan and publicize electric vehicles to people in general. In 1994, REVA Electric Vehicle Organization was set up in Bangalore - India, as an endeavor of the Maini working closely together Gathering India and AEV of California. In numerous nations, REVA doesn't satisfy the states of an engine vehicle qualified to drive on interstates, and it is sorted into different classes, for example, in the USA the alleged Area electric vehicles (NEV) and weighty quadricycles in Europe. Until Walk 2011, REVA sold more than 4,000 vehicles all over the planet and it is accessible in 26 nations.

Pike Exploration gauge that in 2011 there were just about 479 000 NEV vehicles on the planet. The top selling NEVs are Worldwide Electric motorcars (Pearl) vehicles, with more than 45,000 vehicles sold as of December 2010. The development of the Think City all-electric vehicle, with the greatest speed of 110 km/h and scope of 160 km, was sent off in 2008 by the Norwegian maker Think Worldwide, however, because of monetary troubles the creation was ended. North of 1000 Think vehicles was sold in a few European nations and the USA. In June 2011, the organization defaulted on some loans, and the creation was ended. The new proprietor planned to restart the creation in mid-2012 with a somewhat adjusted idea of Think City.



Figure5.12 Think City

Source: http://en.wikipedia.org/wiki/Think_City

Californian producer of electric vehicles, Tesla Engines, 2004 began the improvement of the Tesla Roadster model, which was first conveyed to clients in 2008. Tesla Roadster is the principal electric vehicle adjusted for American interstates and accessible in sequential creation in the USA. From 2008 to December 2011, a larger number than 2,100 vehicles were sold in 31 nations. Tesla was likewise quick to present lithium-particle batteries in its vehicle

creation, and Roadster is the principal vehicle that has a reach more prominent than 320 km on a solitary charge and can arrive at a speed of north of 200 km/h.



Figure 5.13 Tesla Roadster

Source: www.teslamotors.com

In June 2012, the organization Tesla Engines started conveying Tesla S model (vehicle). This model saved the organization, which was very nearly breakdown. Not at all like Roadster, which is an energetic two-seater, is Model S an extravagant vehicle for the entire family. The essential cost of the Model S in the US market is around 60 thousand dollars, and this year they intend to convey 5,000 vehicles.

The fundamental model accompanies batteries that permit a scope of as much as 258 kilometers, however, Tesla Engines likewise offers batteries of more noteworthy limit that permit this model to have a scope of up to 370 and surprisingly as much as 483 kilometers.

Tesla Superchargers are quick charging stations put on traffic courses in North America. As of now, just six stations are dynamic, yet the arrangement is to have around 100 of them by 2015. They are intended to fill about a portion of the battery limit in thirty minutes. This is extra 240 kilometers. These quick charging stations are situated where you would somehow or another need to stop: close to cafés, bistros, and retail plazas. In many spots, sun-oriented cells are placed on the top of the charging stations so the power is delivered from environmentally friendly power sources.



Figure 5.14 Tesla Superchargers



Figure 5.15 Tesla Model S

Source: www.teslamotors.com



Figure 5.16 Tesla Model X

Source: www.teslamotors.com

Mitsubishi I-MiEV was sent off in July 2009 for armadas of clients in Japan, and for different buyers in April 2010, trailed by deals in Hong Kong and Australia through a renting model. IMiEV was sent off in Europe in December 2010, including similar renditions under different brands Peugeot Particle and Citroën C-Zero.

5.4 Electric Vehicle Technology

Electric vehicles (EVs) utilize a bunch of batteries to store the electrical energy that controls the engine. The batteries are charged by connecting the vehicle to a power source in a charging station. The electric engine acts as a generator during slowing down which charges the batteries.

5.4.1 Working principle of Electric Vehicles

Electric vehicles (EVs) have an electric engine rather than a gas-powered motor. The electric engine is fueled by a huge footing battery pack and connected to a charging station to charge. It runs on power, subsequently, the vehicle radiates no exhaust from a tailpipe and doesn't contain the average fluid fuel parts, for example, a fuel siphon, fuel line, or gas tank.

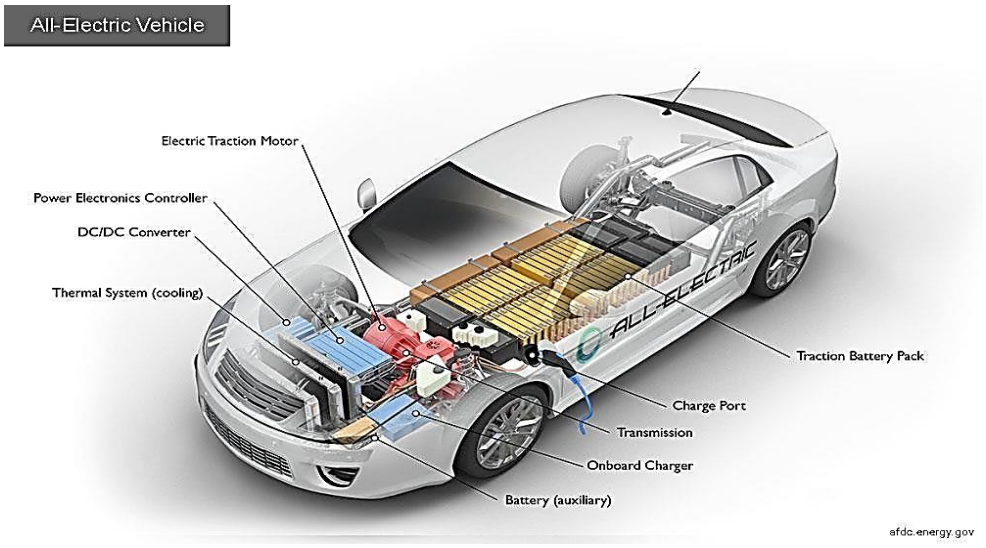


Figure 5.17 All-Electric Vehicles

5.4.2 Key Components of an Electric Vehicles

The parts of the electric vehicle are displayed in Figure 5.17

Battery: The batteries give the power to control vehicle extras in electric drive vehicles.

Charge Port: The charge port interfaces the vehicles to an outside power supply to charge the battery pack.

DC/DC Converter: It changes over higher-voltage DC power from the footing battery pack to the lower-voltage DC power expected to run vehicle extras and re-energize the assistant battery.

Electric Footing Engine: It drives the vehicle's wheels utilizing power from the foothold battery pack. The engine some of the time goes about as a generator during slowing down.

On-Board Charger: It takes the air conditioner power through the charge port and converts it to DC ability to charge the foothold battery. Battery qualities like the voltage, current, temperature, and condition of charge while charging the pack are checked.

Power Hardware Regulator: It deals with the electrical energy stream, and controls the speed ofthe electric engine and the force it produces.

Warm Framework: This framework keeps an appropriate working temperature scope of the motor, electric engine, power gadgets, and different parts.

Transmission: The transmission moves mechanical power from the electric power source to drive the wheels of the electric vehicles.

5.5 Batteries of EVs

Hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and all-electric vehicles all rely on energy storage systems like batteries (EVs). Lithium-ion batteries have become the most widely used batteries in portable consumer devices such as cell phones and laptops due to their high energy per unit mass, high power-to-weight ratio, high energy efficiency, good temperature performance, and low self-discharge features. This battery is recyclable, but the cost of recovery is extremely high, making it a difficult task for the business. Other choices include nickel-metal hydride and lead-acid batteries, but they are less effective than lithium-ion and their availability is dwindling.

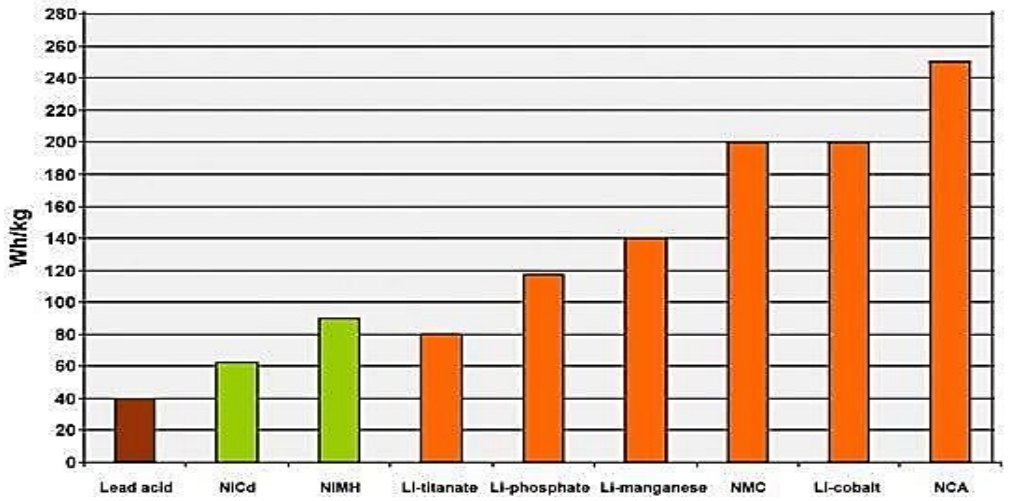


Figure 5.18 Comparison of Batteries

The batteries used in electric vehicles are not the same as those used in electrical devices. They must have a large storage capacity while remaining compact and light in weight, as well as reasonably priced. In electric vehicles, there are several distinct types of batteries. Sodium Sulfur (NAS), flow batteries, lithium polymers, lithium-ion batteries (Li-ion), and nickel metal hybrids are among examples (NiMH). Because of their lightweight and superior efficiency as well as energy capacity, the last two are commonly employed in all available electric vehicles. They also deliver the highest acceleration and driving distance performance for electric vehicles.

5.5.1 Battery Technologies Used in Electric Vehicles

Various battery technologies with varying nominal voltages and energy densities are now available and being developed. Table 5.1 lists battery technologies and attributes that are routinely utilized in electric vehicles and are still being researched.

Battery Types	Nominal Voltage (V)	Energy (Wh / kg)	Cycle Life	Memory Effect	Operating Temperature (°C)
Pb-acid	2		1000	No	-15, +50
NiCd	1.2	50-80	2000	Yes	-20, +50
NiMH	1.2	70-95	<3000	Rarely	-20, +60
Zebra	26	90-120	>l200	No	+245, +350
Li-ion	3.6	118-250	2000	No	-20, +60
LiPo	3.7	130-225	>l200	No	-20,+60
Zn-air	1.65	460	200	No	-10, +55
Li-S	2.5	350-650	300	No	-60,+60
Li-air	29	1300-2000	100	No	-10, +70

Table 5.1 Battery Technologies Used in Electric Vehicles

5.5.2 Lead-Acid (Pb-Acid) Battery

Lead-corrosive batteries are an old-type battery innovation that is often utilized in numerous applications. Batteries comprise primarily certain, negative terminals and electrolyte liquids. In this kind of battery, lead is utilized in the negative terminal, lead dioxide is utilized in the positive anode (PbO_2) and sulfuric corrosive (H_2SO_4) is utilized as electrolyte fluid. The primary benefits of lead-corrosive batteries are their affordability, high release current, and no memory impact. Notwithstanding these benefits, it has a few disservices. The principle disservice is that battery duration is diminished when not being used. Moreover,low result voltage and low energy thickness are a portion different hindrances.

5.5.3 Nickel Cadmium (NiCd) Battery

Nickel-cadmium batteries are a protected and modest innovation. Nickel-cadmium batteries use cadmium/cadmium hydroxide (Cd/Cd(OH)2) on the contrarily charged terminal, nickel hydroxide/nickel bull hydroxide (Ni(OH)2/NiOOH) on the decidedly charged anode, and potassium hydroxide (KOH) materials as the electrolyte. NiCad batteries can be energized multiple times. In any case, the batteries should be completely released before charging. At the point when the battery is charged before it is completely released, the charge limit drops and this will abbreviate the existence of the battery. This is known as a memory impact. This battery, which gives a high release currently, has a higher energy thickness than lead-corrosive batteries. In any case, this battery innovation has critical burdens. These are high release current worth, low charging proficiency, and awful memory impact.

5.5.4 Nickel Metal Hydride (NiMH) Battery

Ni-MH batteries contain a wide range of mixtures like titanium, nickel, manganese, cobalt, aluminum, vanadium, zirconium, iron, and chromium. These batteries are strong and can be re-energized more than once. Ni-MH batteries produce 1.2V potential in a battery unit. Ni-MH batteries have high energy limits. Like Ni-Miscreant batteries, Ni-MH batteries ought not to be completely energized without releasing, as the memory impact likewise applies to these batteries. Even though Ni-MH batteries appear to be invaluable in many regards, the main downside is that the release times are very short when not being used.

5.5.5 Lithium Ion (Li-ion) Battery

Lithium metal oxides are utilized as sure cathodes in lithium-particle batteries with the benefit of low harmfulness, high limit, and inexpensiveness contrasted with different materials. Ordinarily utilized oxides: Lithium cobalt oxide (LiCoO2), Lithium nickel oxide (LiNiO2), and Lithium manganese oxide (LiMn2O2). Lithium-particle battery innovation has unexpected attributes in comparison to nickel-based battery innovation. It has a higher ostensible voltage and higher energy thickness than nickel-based battery packs.

5.5.6 Lithium Ion Polymer (LiPo) Battery

Lithium-particle batteries have practically similar attributes. The main distinction between them is the utilization of polymer material as an electrolyte in lithium-particle polymer batteries. The electrical conductivity of polymer electrolyte material is higher than other natural fluid electrolytes. Also, the utilization of this material permits lithium polymer batteries to be created all the more effectively, quicker, and with various shapes.

5.5.7 State of Charge (SoC)&Depth of Discharge (DoD)

It is determined as the percentage of the battery's current capacity to the maximum amount of charge that it can hold. It's a battery pack's equivalent of a fuel gauge in a charged electric car. SoC is measured in percentage points, with 0 percent equaling empty and 100 percent equaling filled. When the DoD is 0 percent, the SoC is 100 percent, and when the DoD is 100 percent, the SoC is 0 percent. It's most commonly used when talking about the present state of a battery [9]. Figure 5.19 depicts the SoC and DoD concepts.

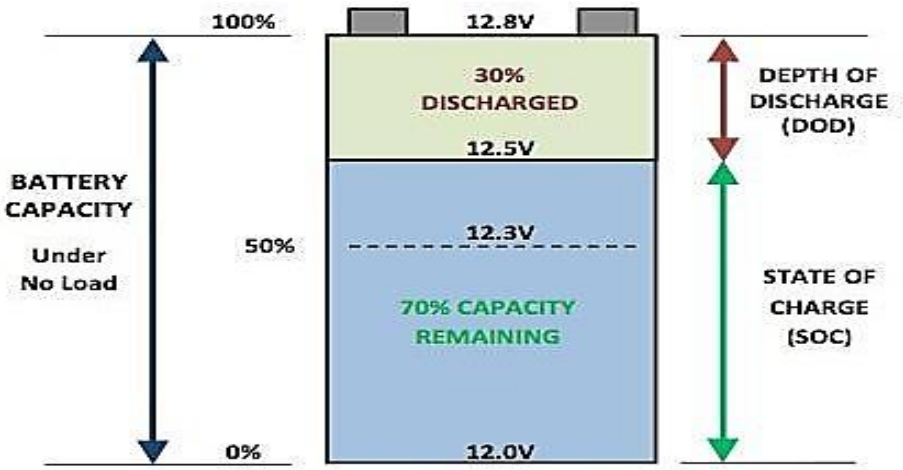


Figure 5.19: SoC&DoD

The Department of Defense (DoD) is the SoC's counterpart. It determines how drained the battery is in comparison to a full discharge when the battery has used up all of its energy capacity. It's measured as a percentage of the battery's total capacity. The Depth of Discharge, or DoD, of a battery, is 100 percent when it has discharged its complete energy capacity. The battery's DoD is 0 percent when completely charged. For example, if you have a 100 amp hour battery and consume 50 amp hours, the battery has been depleted 50%, indicating a 50% depth of discharge.

5.6 Challenges

Presently, EVs face various difficulties which are the disallowing factors for mass sending and commercialization. High introductory expenses, restricted lifetime, and somewhat lackluster showing at low temperature are regularly referred to as the main issues, with the last three straightforwardly including the ESS and BMS of the vehicle [12-15]. The normal lifetime of batteries (commonly characterized by a 20% corruption in battery limit) in EVs is around 8 to 10 years. Practically speaking, the lifetime of the battery is diminished because of the powerful profile of the vehicle during speed increase and slowing down, which can be significantly more than 10× higher than the normal power. The EV invests a considerable lot of energy in low power and inactive modes, be that as it may, it encounters a few high power tops as often as possible. Driving conduct, re-energizing propensities, the profundity of release (DOD), and surrounding temperature are different variables that sway the lifetime of the batteries by shifting degrees. Dissecting the impacts of these elements can work on the capacity of battery models in both execution and lifetime forecast. In this undertaking, a stage is planned and carried out to investigate the impacts of normal release current, the surrounding temperature, and drive cycle elements. Before talking about the previously mentioned stage and its investigation, it is fundamental to have an outline of batteries, normal EV battery sciences, and their related difficulties.

CHAPTER 6

SIMULATION FOR MPPT AND BATTERY CHARGING METHODOLOGY

6.1 PHOTOVOLTAIC CELL

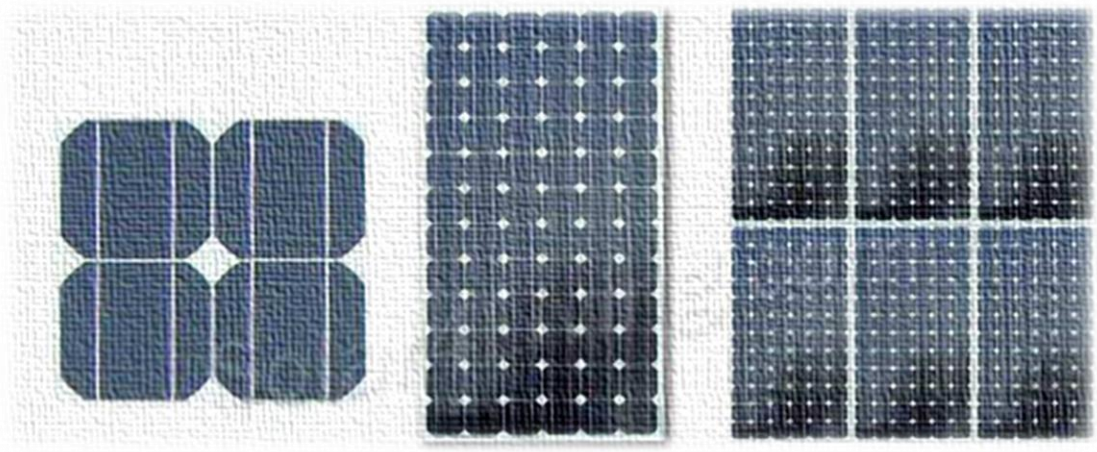
A photovoltaic cell or photoelectric cell is a semiconductor device that converts light to electrical energy by the photovoltaic effect. If the energy of a photon of light is greater than the band gap then the electron is emitted and the flow of electrons creates a current. However, a photovoltaic cell is different from a photodiode. In a photodiode, light falls on the n-channel of the semiconductor junction and gets converted into a current or voltage signal but a photovoltaic cell is always forward biased.

6.2 PV MODULE

Usually, several PV modules are arranged in series and parallel to meet the energy requirements. PV modules of different sizes are commercially available. For example, a typical small-scale desalination plant requires a few thousand watts of power.

6.3 PV ARRAY

A PV array consists of several photovoltaic cells in series and parallel connections.
Series connections are responsible for increasing the voltage of the module whereas the parallel connection is responsible for increasing the current in the array.
Solar Cells Solar Panel Solar Panel



(4 cells) (Module) (Multiple Module)

Figure 6.1 Different solar modules

Here in these projects, Monocrystalline PV Module is used and its electrical specification and the characteristic table is as shown below Battery

Table 6.1 Electrical Characteristics of PV Module

Maximum Power – Pmax	240.09 W
The voltage at Pmax – Vmax	30.2 V
Current at Pmax – Imax	7.95 A
Short - circuit current – Isc	8.46 A
Open – voltage circuit – VOC	37.3 A
Cell per module (Ncell)	60

Mono crystalline cell:

Advantages1. It has the highest efficiency (15%-20%)

2. Space efficient

3. Its life is long

4. perform better than a poly crystalline cell at low light conditions.[4]

Disadvantages-

1. These cells are expensive

2. If it is partially covered with shade, snow & dirt, the entire circuit may break down.

6.4 **MATLAB SIMULINK MODEL**

6.4.1 **MATLAB Simulink Model of Photovoltaic Cell**

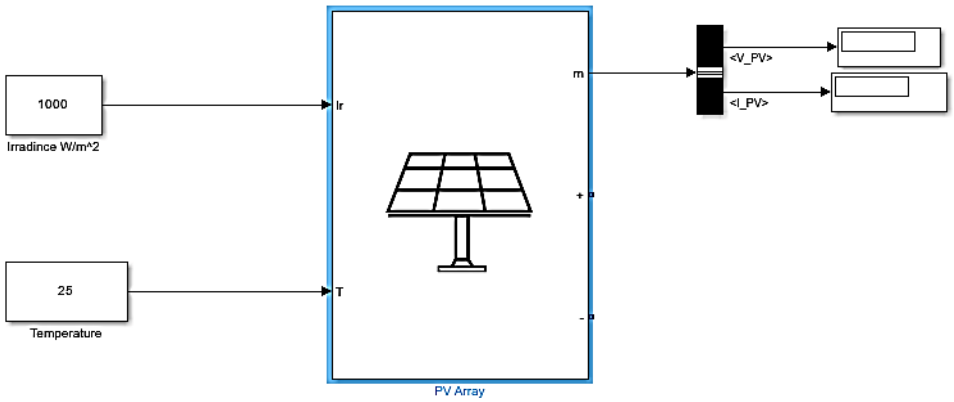


Figure 6.2 Matlab Simulink Model of Photovoltaic Cell

6.4.2 MATLAB Simulink Model of MPPT Control of PWM Generation

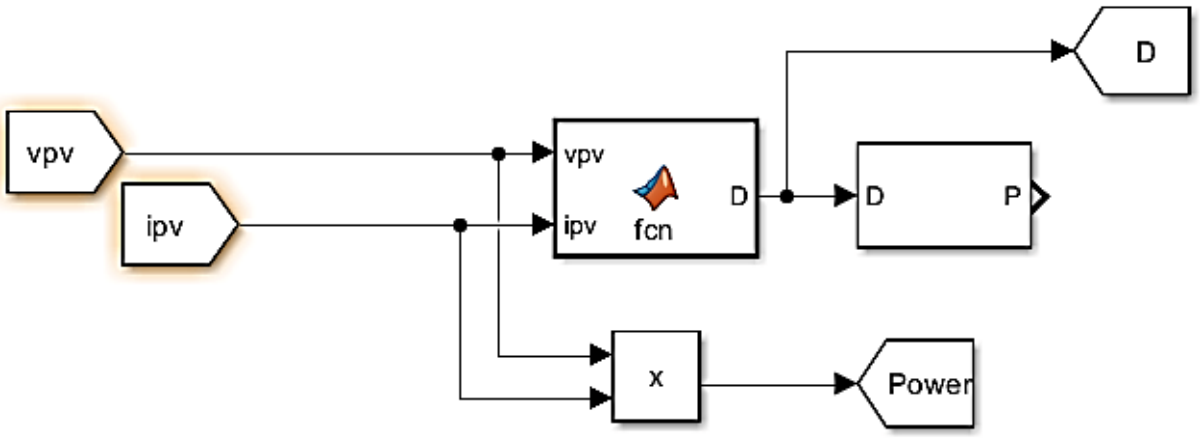


Figure 6.3 Matlab Simulink Model of MPPT control and PWM generation

6.4.3 MATLAB Simulink Model of BOOST Converter and PWM Pulse

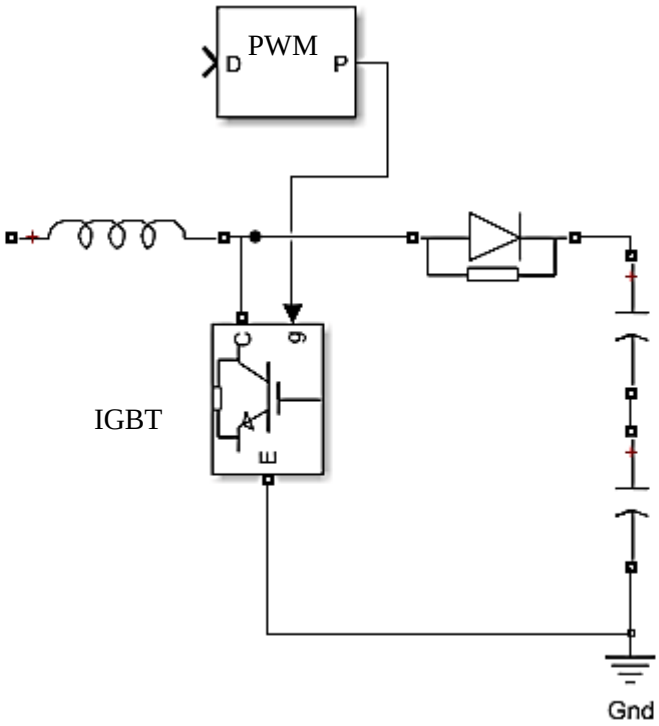


Figure 6.4 Matlab Simulink Model of Buck converter and PWM pulse.

6.4.4 Complete MATLAB Simulink Model

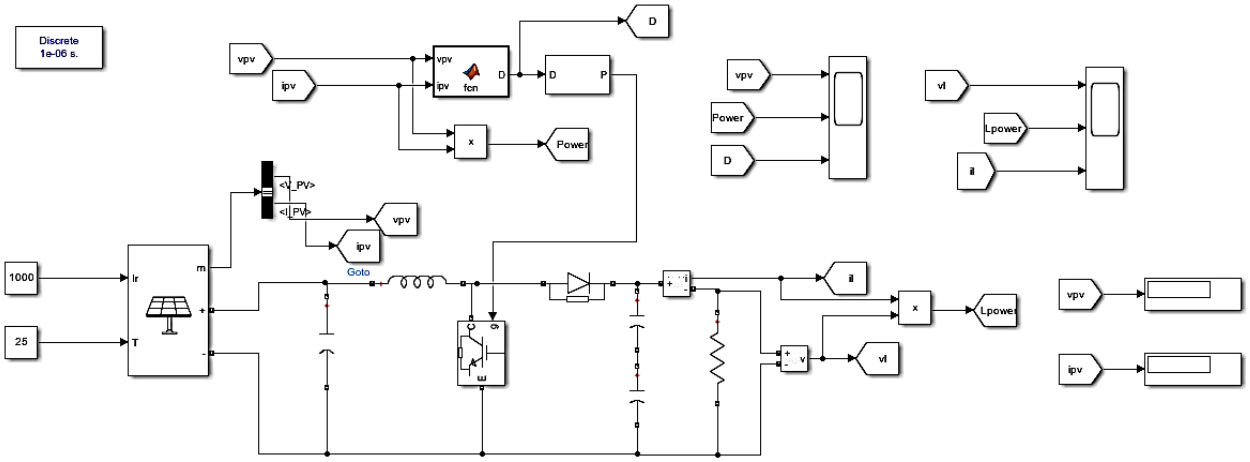
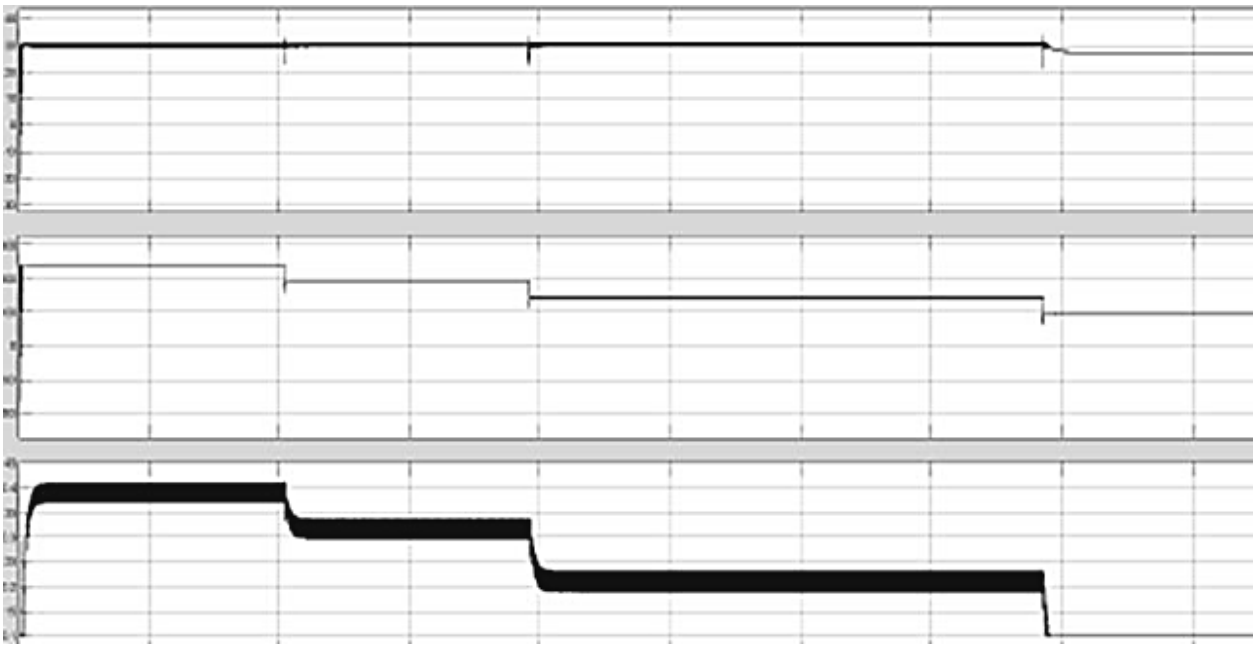


Figure. 6.5 Complete Matlab Simulink Model

6.4.5 MATLAB Simulink Result



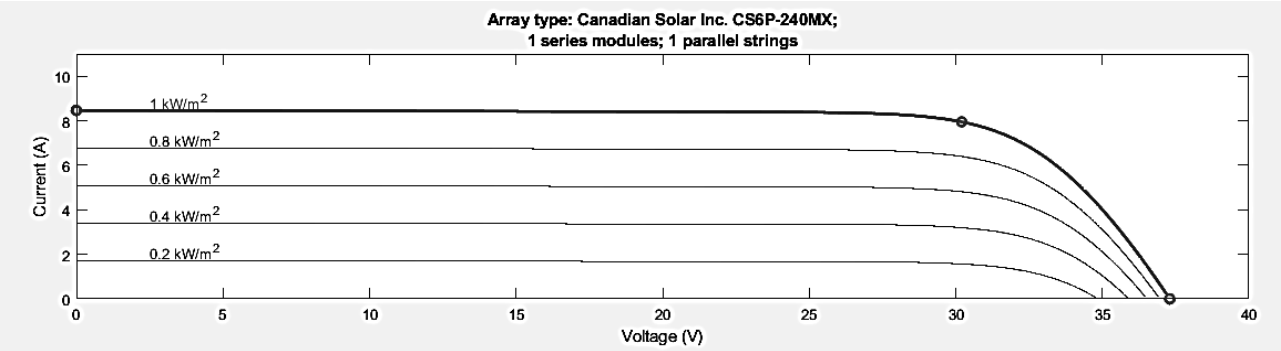


Figure 6.6 CURRENT -VOLTAGE CURVE

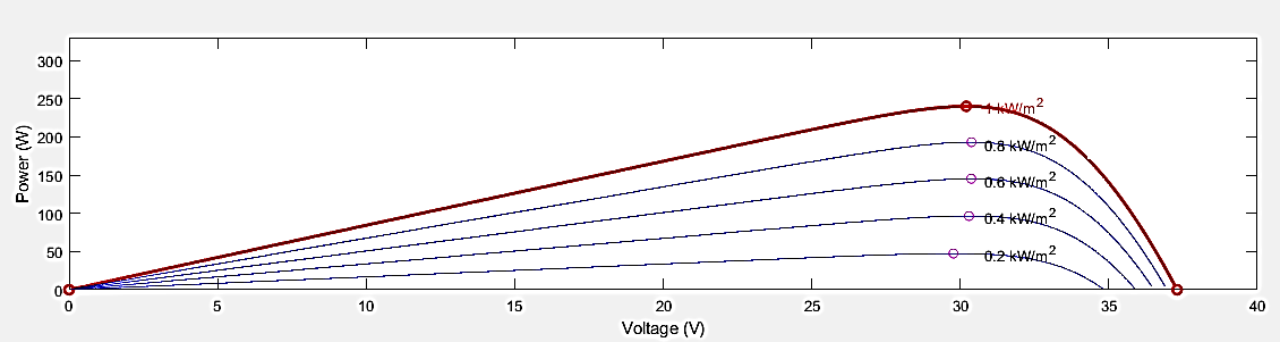


Figure 6.7 POWER-VOLTAGE CURVE

6.5 CHARGING MODES

The solar panel charges a station battery by operating at the maximum power point. This station battery charges an electric vehicle battery through a buck converter by CC and CV charging modes as shown in Fig.1. The feedback loop is the CC and CV charging mode that senses the voltage across the battery and the current through it.

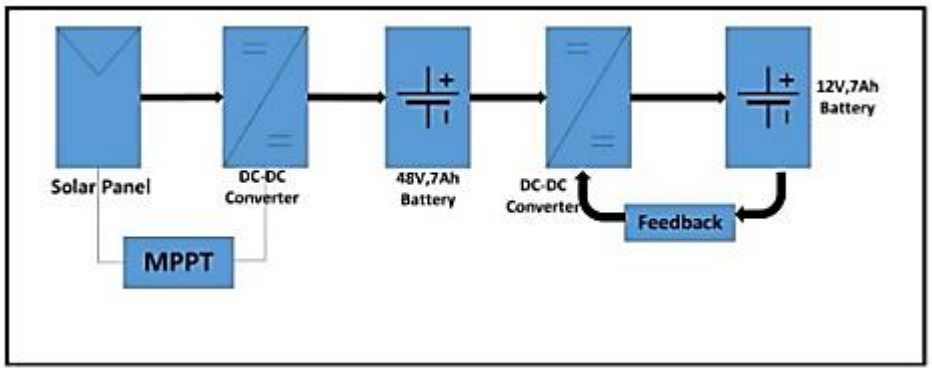


Figure:6.8 Block diagram of solar

A. CC mode of charging

Until the SOC of the battery reaches 95% of its total charge, the CC mode of charging is done. After it reaches 95% SOC, CV charging mode is done. In CC mode as shown in Fig.2, the load current is constantly compared with the reference current and the difference (error) is given to a PID controller. The output signal from PID is compared with a saw tooth wave by a comparator and the duty cycle of the output wave varies accordingly [2]. This output from the comparator is used to drive the buck converter.

B. CV mode of charging

In the CV mode of charging, the voltage across the battery is constantly compared with a reference value of 12V. The difference in the error is used to calculate the reference current and this current is compared with the load current. The difference is fed to a PID controller and the output from PID is compared with the saw tooth wave and the duty cycle of the output wave varies accordingly. This is given as the gate pulse for MOSFET in the buck converter as shown in Fig.3. When the SOC of the battery reaches 95%, a relational operator and a switch toggles from CC mode to CV mode of charging

C. Float stage

Trickle charging. Battery voltage is kept constant, e.g. 14.4 V/13.8 V. Battery current is limited to trickle current. Battery SOC increases from 98% to 100%. SOC is maintained at 100%.

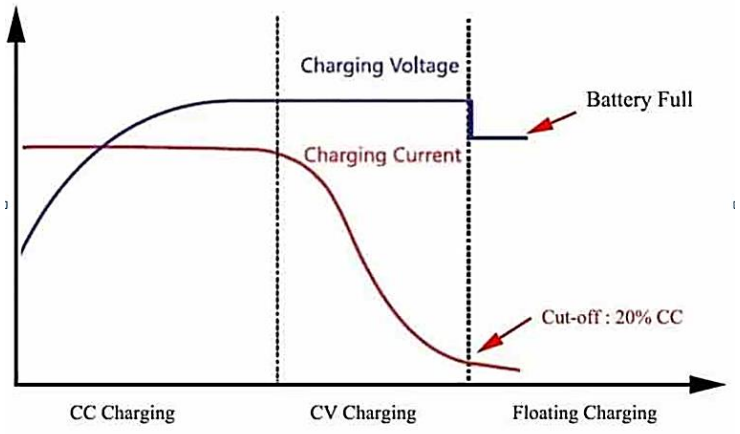
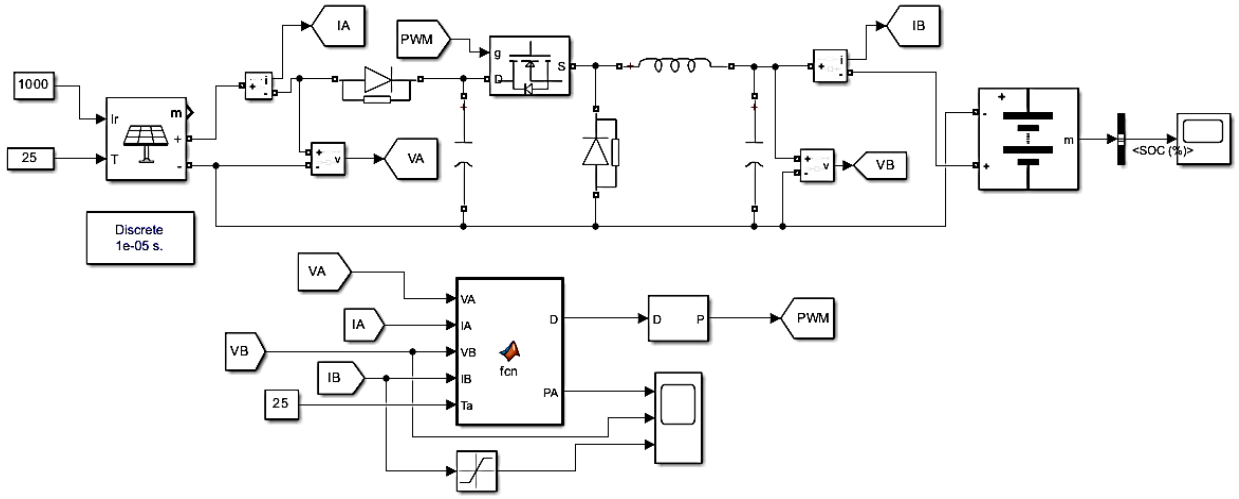
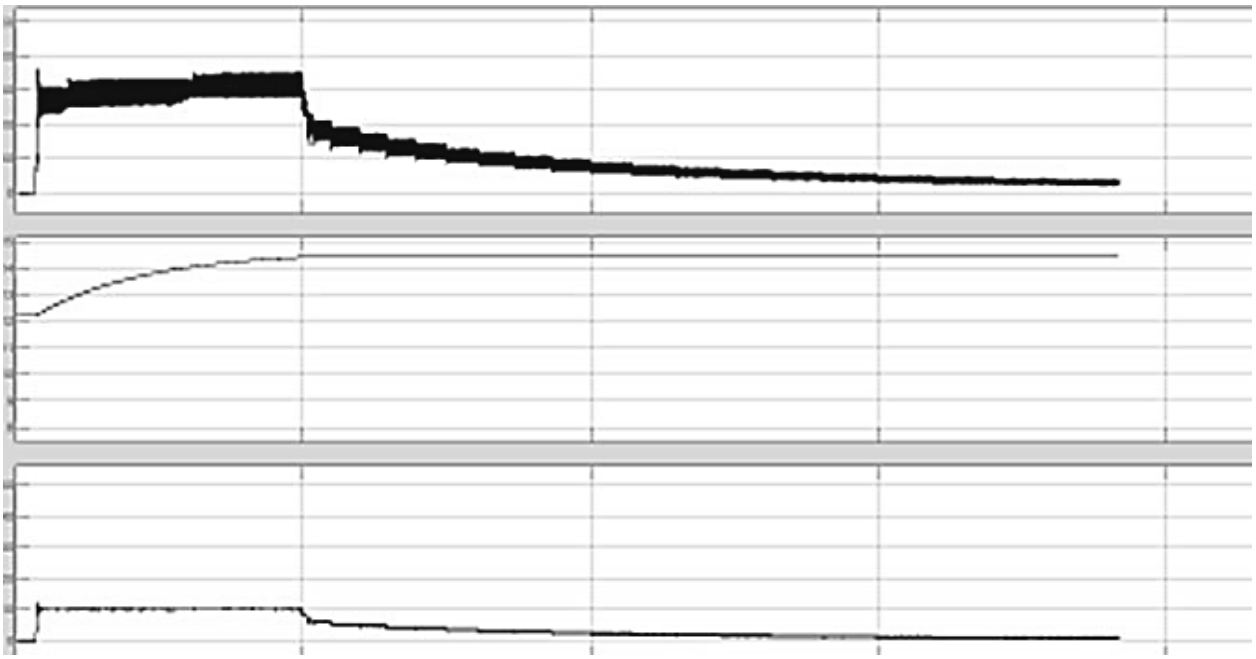


Fig:6.9 Charging Mode

6.5.1 Complete MATLAB Simulink Model



6.5.2 MATLAB Simulink Result



6.6 CONCLUSION

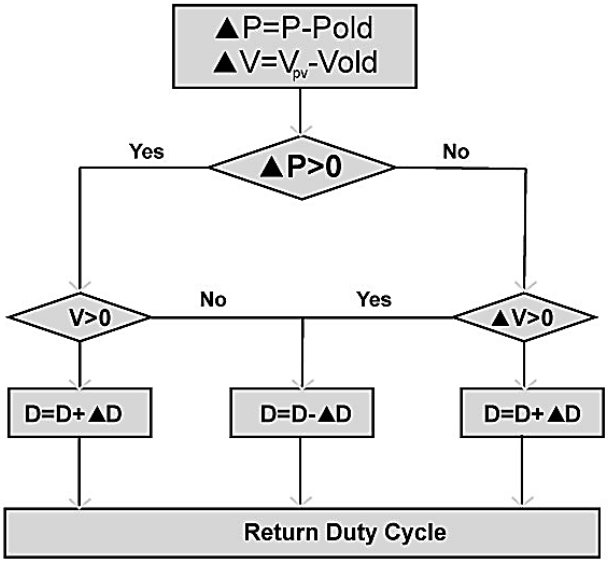
This method presented here controls lead acid battery charging faster and more efficiently. The control algorithm executes the P&O method allowing the module to operate at maximum power point according to solar irradiation, and match load with the source impedance to provide maximum power. This MPPT model is more suitable because of less cost, and easier circuit design. And the efficiency of the circuit is increased by 20-25% in the case of an MPPT solar charge

controller compare to a circuit without MPPT. And also saved the extra energy required in mechanical tracking. The complete solar charger circuit is simulated and the battery is seen to charge as required. Hence, solar power is used as the power source to charge the battery. Implementing solar power as a source to charge the batteries Such a system would also help to expand the grid since the electric vehicles, and non-renewable resources like fossil fuels, which are used in conventional vehicles can be conserved. Vehicles have their sustainable method of charging, which frees up existing power plants for other loads of electric vehicles, and non-renewable resources.

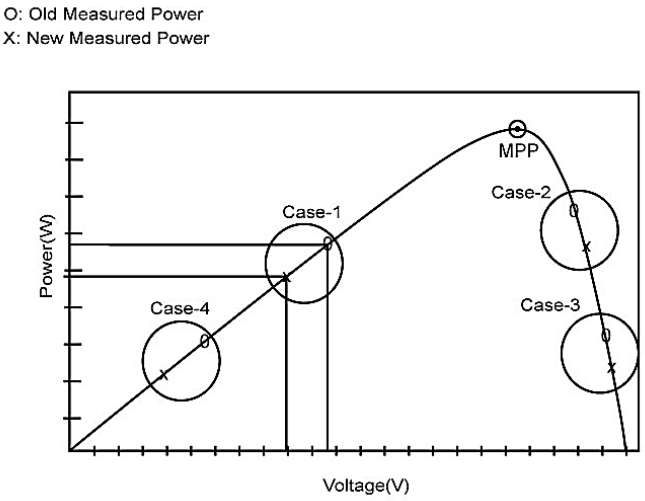
CHAPTER 7

PROGRAMMING

7.1 FLOW CHART FOR P&O(MPPT)



7.2 P_V Curve for P&O (MPPT)

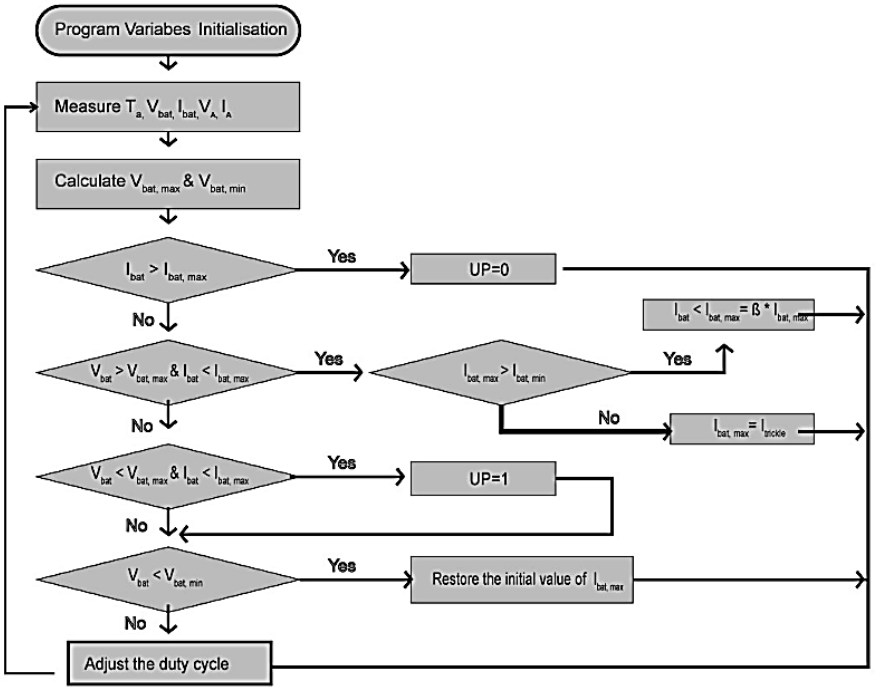


7.3 MATLAB COMMAND FOR MPPT CONTROL SIMULATION

```
function D= fcn(vpv,ipv)
Dinit=.4;
Dmaax=0.9;
Dmin=0.1;
deltaD=20e-6;
persistent Vold Pold Dold;
dataType="double";
if isempty(Vold)
    Vold=0;
    Pold=0;
    Dold=Dinit;
end
P=vpv*ipv;
dV=vpv-Vold;
dP=P-Pold;
if dP~=0
    if dP<0
    if dV<0
        D=Dold-deltaD;
    else
        D=Dold+deltaD;
    end
    else
        if dV<0
            D=Dold+deltaD;
```

```
        else
            D=Dold-deltaD;
        end
    end
else D=Dold;
end
 if D>=Dmax | D<=Dmin
     D=Dold;
 end
 Dold=D;
 Vold=vpv;
 Pold=P;
```

7.4 Three-stage battery charging method(Flow Chart)



7.5 MATLAB COMMAND FOR BATTERY CHARGE CONTROL SIMULATION

```
function [D,PA]= fcn(VA,IA,VB,IB,Ta)
NC=6;
alpha=-0.0035;
VBmin=12.7+((Ta-25)*NC*alpha);
VBmax=14.4+((Ta-25)*NC*alpha);
C=50;
IBmin=C/100;
ITrickle=0.2;
Beta=0.9;
DD=1e-6;
persistent PAP VAP DP UP IBmax
if isempty(PAP)
    PAP=0;
    VAP=0;
    DP=0;
    UP=1;
    IBmax=C/5;
end
PA=VA*IA;
DPA=PA-PAP;
DVA=VA-VAP;
D=DP;
if IB>IBmax
    UP=0;
elseif VB>VBmax && IB<IBmax
    if IBmax>IBmin
```

```
        IBmax=Beta*IBmax;
    else
        IBmax=ITrickle;
    end

else
    if VB<VBmax && IB<IBmax
        UP=1;
    end
    if VB<VBmin
        IBmax=C/5;
    end
end
if UP==0
    D=DP-DD;
elseif UP==1
    if DPA>0
    if DVA>0
        D=DP-DD;
    elseif DVA<0
        D=DP+DD;
    end
    elseif DPA<0
        if DVA>0
            D=DP+DD;
        elseif DVA<0
            D=DP-DD;
        end
```

```
    end
end
if D>1
    D=1;
elseif D<0
    D=0;
end
DP=D;
PAP=PA;
VAP=VA;
```

CHAPTER 8

CONCLUSIONS AND FUTURE SCOPE

8.1 CONCLUSION

This paper presents the solar charging station for sort of electric vehicles, which is generally used to avoid the use of a non-renewable source of energy to charge electric vehicles, which is fairly significant. This study develops a model that combines the solar power station and EVs to mostly reduce pollutants emission from the power generation and transportation sector in a suitable way.

Bangladesh is poised for significant growth in power generation through renewable energy sources. Being close to the equator, Bangladesh is in a favorable geographical location and enjoys an abundant supply of solar radiation, almost throughout the year.

However, if Bangladesh has to reach its full potential in harnessing solar energy, it has to overcome several barriers, which may pose challenges to the stakeholders. Need to attract foreign investors and the development of economical storage technologies are the primary issues we need to tackle. In addition, there are many technical problems, such as high temperatures in several places and harsh environments, which may pose problems for the longevity of solar installations. All stakeholders need to put collective efforts to overcome these challenges and reach the planned targets for solar energy generation.

Perturb & observe method presented here controls lead acid battery charging faster and efficiently.

The control algorithm executes the P&O method allowing a module to operate at the maximum power point

According to solar irradiation, match load with the source impedance to provide maximum power. This MPPT model is more suitable because of less cost, and easier circuit design. And the efficiency of the circuit is increased by 20-25% in the case of an MPPT solar charge

controller compare to a circuit without MPPT.

The complete solar charger circuit is simulated and the battery is seen to charge as required. Hence, solar power is used as the power source to charge the battery. Implementing a solar power source to charge the batteries in such a system would also help to expand the grid since electric vehicles, and non-renewable resources like fossil fuels, which are used in conventional vehicles can be conserved. Vehicles have their sustainable method of charging, which frees up existing overplants for other loads of electric vehicles, non-renewable resources like fossil fuels, which are used in conventional vehicles

8.2 FUTURE SCOPE

In the future, the rate of charging stations will increase. This confirms that an increase of EV charging stations is very necessary within public parking, and along highways, to ensure full coverage and increased appeal for the user. EV charging should be as simple as possible and should be built in parking facilities, near shops, sports, and leisure facilities. When the electric vehicle will park in the parking, this parking is made with solar panels, and with the help of this people will be charged the electric vehicle in the rest position. An increase in charging stations is not only necessary on the road but also for private parking. With the research, electric charging has no higher chance of bursting into flames as

compared to a daily car. Charging stations are tested before production. Whether private or public, all parking will important to increase the quantity of EV charging stations.

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