RENEWABLE ENERGY POTENTIAL USE IN SOLAR –POWERED ELECTRIC VEHICLE CHARGING SYSTEM WITH VEHICLE –TO- GRID ENABLED SMART TECHNOLOGY

Praveen kumar sharma[1], Nilam N. Ghuge[2,] AnjanaTiwari[3]

1. Research Scholar, University of Technology, Jaipur, Rajasthan, India,
2. Professor ,Department of Electrical Engineering, JSPM's Bhivarabai Sawant Institute of Tech. & Research, Wagholi, Pune, India. 412207
3. Professor Department of Electrical Engineering, LIET College, Alwar Rajasthan, India,

Abstract.

Renewable energy sources have good potential to provide solutions for the long-standing energy problems being faced by the developing countries. The renewable energy sources like as wind energy, solar energy, geothermal energy, ocean energy, biomass energy and fuel cell technology can be used to complete energy shortage in India [1].

India has adopting responsible renewable energy technology and taking positive steps towards carbon emissions. It conveys sustainable clean energy that is gotten renewable natural asserts. Renewable energy will be utilized decrease the expense and demand of petroleum products for this we use solar photovoltaic energy incorporate the development of electricity and heat for variety of applications [2].In this paper examine the plan and improvement a charge regulator based solar charging system for electric vehicles . The proposed system implementation will bring down the cost of electricity. In recent year's solar powered charger have emerged as an appealing replacement for the grid in managing the charging of electric vehicles. These chargers are emission free clean power for recharging electric. Interaction with electric vehicles will be one of the important technologies in future smart grids, contributing to the autonomous functioning of the power grid. The notion of an on-board bidirectional charger utilizing V2G and V2H technologies is presented. Due to lower carbon dioxide emissions and increasing fossil fuel prices, the electric vehicle has become more competitive than the conventional internal combustion engine vehicle. However the EV was not generally embraced on the market due to restrictions such as expensive car costs limited charging infrastructure and limited all-electric driving range. EVs are cars that are partially or completely electric-powered. Electric vehicles offer minimal operating expenses since there are fewer moving parts that need to be maintained, and they are also very environmentally friendly because they consume little or no fossil fuel [3].

KEYWORDS- Electric vehicles, hybrid electric vehicles, charging methods, optimization sustainable urban mobility

1 .INTRODUCTION

Reserves will be exhausted in less than another 10 decades. Fossil fuels account for over 79% of the primary energy consumed in the world, and 57.7% of that amount issued in the transport

sector and are diminishing rapidly. The exhaustion of natural resources and the accelerated demand of conventional energy have forced planner sand policy makers to look for alternate sources. Renewable energy is energy derived from resources that are regenerative, and do not deplete over time[1]. Global renewable energy capacity grew at rates of 15–30% annually for many technologies during the five-year period 2002–2006, including wind power, solar hot water, geothermal heating, and off-grid solar PV [1].

Energy is a basic requirement for economic development and in every sector of Indian economy. It is thus necessary that India quickly look toward sew and emerging renewable energy and energy efficient technologies as well as implement energy conservation [2].

The non-renewable global energy use has significantly raised the demand for fossil fuel resources by different sectors of the economy, resulting in a constant CO2 emission from these sectors with the energy sector contributing substantially to this emission. The increase in the impacts of global warming, climate change challenges, and a rise in world temperatures, can be linked to CO_2 emissions, which pose a prolific threat to the sustainability of the ecosystem. Because of the contaminant emissions created by nonrenewable energy resources, it is projected that the world average temperature would rise by approximately 2°C by 2050 to tackle these issues, timely and productive efforts must be taken to reduce adverse ecological effects while also exploring efficient and cost- effective renewable energy sources. These techniques have been the interest of numerous studies over last few decades with the goal of enhancing process performance. According to a study carried out by the International Renewable Energy Agency in 2018.The cost of electricity generated by renewable energy sources have decreased gradually over last few years. Many nations throughout the world have benefited from this cost reduction by incorporating renewable energy sources into their national power systems. The application of renewable energy sources to generate electricity has become increasing popular as the world's energy consumption continues to rise as a result of the expansion of global industry and urbanization. [2]

Recent events have reduced the otherwise steadily increasing annual percentage of the global population with access to electricity for the first time in years. Due to long distances to grid infrastructure off-grid renewable energy systems are economically viable options to provide larger electricity access in developing regions. Even in industrialized countries with nationwide electrification many local communities are striving for autonomous energy systems with 100% renewable energies often motivated by economic, environmental and/or social reasons Decreasing costs for renewable energy technologies as well as current cost uncertainties relating to supply from centralized infrastructures will probably further increase the economic incentives for energy autonomy[4].

1.1 Electric vehicles & energy sources

All cars that draw their power from batteries will be considered electric vehicles (EVs). The typical internal combustion engine vehicle (ICEV) produces mechanical energy to drive ahead using either petrol or dieselfuel. Various EV advances are as of now being used or in the beginning phases of development, as nitty gritty in Jorgensen. A little electric battery is incorporated into a cross breed electric vehicle (HEV) to control the gearbox framework and improve burning motor execution. HEV batteries can be powered by a motor or by dynamic

energy recuperated during regenerative slowing down. Since this vehicle is generally powered by fluid fills, HEVs are eco-friendly. Comparative in idea to a HEV module half breed EV (PHEV), however witha greater battery or grid association. The grid association works with the force of the batteries' charging, and bigger batteries empower longer all-electric reaches. Future hydrogen economic visions also involve the transportation of FCVs. The vast majority of hydrogen produced worldwide is created from fossil fuels, and there are still certain challenges to developing a hydrogen economy. Moreover, even however hydrogen created through electrolysis addresses a sizable future use of environmentally friendly power, the change to a hydrogen economy is a complicated topic that is past theextent of this exposition. If manageable bio fuels can supplant ordinary transportation fills like ethanol and biodiesel, HEVs can likewise be delivered from RE sources. Both PHEVs and BEVs might use all of the sustainable power from the grid, empowering PHEVs to utilize bio fuels in their gas-powered motors. [5]

1.2 Charging & grid connections

The battery charge is balanced out by, for example, staggering the charging schedule by three hours at different times. The nighttime charging strategy involves pausing the charging process during the middle of the night, when the cost of electricity is lower, so that the batteries start the morning completely charged. Utility or device operators intelligently regulate the process by which vehicles receive intelligent charging. The charging mightbe done directly, or it could be done indirectly. According to Dillinger and Wietschel, indirect charging is preferable to direct charging in most circumstances.

When using smart charging, the vehicle will begin charging at the point in time when it will be of the greatest benefit. And this could happen after the price of electricity is low, after demand is low, and when there is excesscapacity in the system. The rate might shift relying upon such qualities as those picked by the driver; the main requirement is that the vehicle should be completely energized before breakfast. An electric vehicle (EV) with the capacity to either store electricity or return it to the electric grid is alluded toas a V2G skilled EV. The Power V2G idea was at first presented by either Kempton or Legendre, and it is a fascinating one. The creators recommended that V2G might be used to produce a return for its proprietors under specific circumstances, for example, when electricity is utilized to offer important types of assistance to thegrid. A power supply that is capable of V2G will be able to store the renewable energy that is produced during times of low demand and then send it back into the grid when it is required [5].

2. Renewable Energy Use in Electric Vehicle)

A vehicle that propels itself using one or more electric motors or traction motors is referred to as an electric vehicle (EV). Electric vehicles can be self-contained using a battery, solar panels, fuel cells, or an electric generator to convert gasoline to electricity, or they can be fueled by electricity from sources outside the vehicle through a collector system. Electric vehicles (EVs) include, but are not limited to, surface and underwater craft, electric Aero plan’s, and electric spaceships. EVs initially appeared in the middle of the 19th century, when electricity was one of the preferred forms of motor vehicle propulsion. At the time, gasoline-powered cars were

unable to match the comfort and ease of operation that electric vehicles offered. While modern internal combustion engines have dominated motor vehicle propulsion for almost a century, electric power has remained prevalent in other vehicle types, such as railways and smaller vehicles of various kind [3].
Electric vehicle (EVSE) is experiencing rapid growth because of five key global trends.

1. Fossil fuel depletion.
2. Growing public awareness.
3. Advances in technology.
4. The development of electric motors and electronic control systems.
5. Advances in EV supporting technologies

2.1 Types of electric vehicles

Battery Electric Vehicle (BEV

BEVs are also referred to as all-electric cars (AEV). Electric drive trains powered solely by batteries are used in BEV-based electric vehicles. The large battery pack that houses the electricity needed to power the car can be charged by plugging it into the power grid. One or more electric motors are then powered by the fully charged battery pack to drive the electric vehicle. It is fully electrically powered. When compared to hybrid and plug-in hybrid vehicles, these are more efficient.[3]

Plug-in Hybrid Electric Vehicle (PHEV)

Uses a battery that is charged by an external socket and an internal combustion engine (they have a plug). This implies that electricity, rather than the vehicle's engine, can be used to recharge the battery. While less efficient than BEVs, PHEVs are more efficient than HEVs. The term "series hybrid" also applies to PHEVs. Both an engine and a motor are present. You have a choice of two types of fuels: conventional fuel (like gasoline) and alternative fuel (such as bio-diesel). A battery pack that can be recharged can also power it. The battery can receive external charging.[3]

Fuel Cell Electric Vehicle (FCEV)

Another name for FCEVs is zero-emission vehicles. To create the electricity needed to power the vehicle, they use "fuel cell technology." The fuel's chemical energy is directly converted into electric energy. Chemical energy is converted into electric energy. Consider an FCEV powered by hydrogen.

Hybrid Electric Vehicle

HEVs are also referred to as parallel or series hybrids. HEVs have an electric motor in addition to an engine. Fuel powers the engine, while batteries provide electricity for the motor. Both the engine and the electric motor turn the transmission at the same time. Wheels are then propelled by this. Both the internal combustion (typically gasoline) engine and the battery-powered motor power train are utilised by the vehicle. When the battery is dead, the petrol engine is used to both propel and charge the vehicle. Compared to fully electric or plug-in hybrid vehicles, these cars are less efficient.[3]

THE KEY COMPONENTS IN EV

The key components are the propulsion parts. Fig 1 shows the configuration
Components Needed for a Solar EV Charging Station

1. an EV charger
2. a strong base for a standalone solar charger
3. Software that is sufficiently intelligent for billing and other tasks
4. battery-based energy storage (exclusively for solar energy charging stations that are off grid)
5. 5 Solar panel array installed on the ground for capturing solar energy

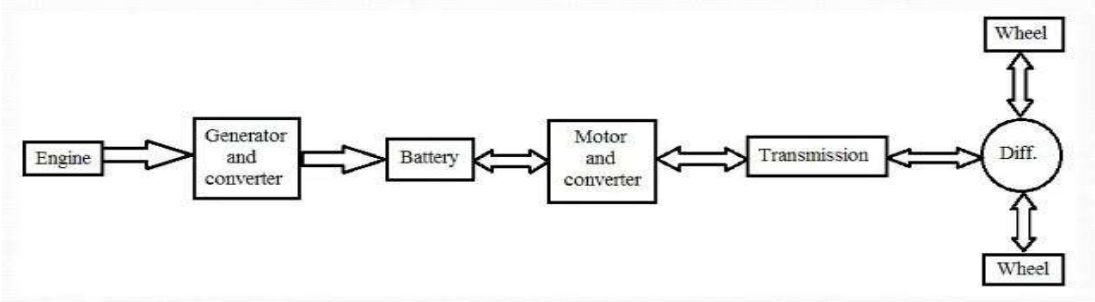

Fig 1: EV Configuration

3. EV Charging Methods

Battery exchange, wireless charging, and conductive charging are the three main charging techniques. The conductive charging is further divided into pantograph (Bottom-up and Top-down) and overnight charging, as shown in Figure 2.

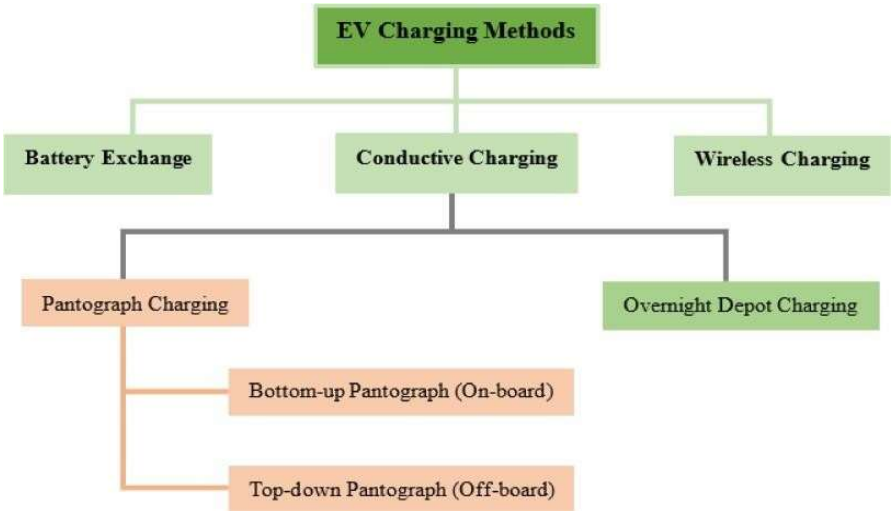

Fig 2. EV charging methods

Battery Swap Station (BSS)

The battery swapping technique is also known as "Battery Exchange," and it is based on the BSS owner receiving monthly rent for the battery. The BSS's slow charging mechanism helps to extend battery life. Locally produced Renewable Energy Sources (RESs) such as solar and wind are easier to connect into the BSS system. One of the key benefits of this procedure is that the drivers do not have toexit the car and can swiftly replace the drained battery[7]

Wireless Power Transfer (WPT)

Two coils are used in this technique, which is based on electromagnetic induction. The primary coil is installed on the road, while the secondary coil is installed inside the car. WPT technology has recently gained popularity in EV applications due to its ability to allow EVs to recharge securely and easily[7].

Conductive Charging (CC)

Conductive charging necessitates an electrical connection between the car and the charging outlet and offers several charging options, such as level 1, level 2, and level 3 charging, as well as high charging efficiency owing to the direct connection. For a public charging station, two power charging levels (Levels 2 and 3) are used. The distribution system is less affected by the first two levels (Levels 1 and 2).Conductive charging lowers grid loss, maintains voltage level, prevents grid power overloading, offers active power assistance, and can provide reactive power adjustment by using the vehicle's battery. Level 3 has a variety of effects on the distribution system, including voltage variation, system dependability, and transfer/power loss[7].

Overnight Depot Charging

The overnight depot charging mechanism may be set up to charge slowly or quickly. It's commonly found at the end of the lines and is utilized for charging at night. Slow charging is thus the most advantageous choice because to its little impact on the distribution system. The Pantograph charging approach, on the other hand, is appropriate for applications that demand a large battery capacity and rapid charging.[7].

- **SOLAR ENERGY**

Although the Sun is a very potent energy source and sunlight is by far the most abundant energy that Earth receives, the intensity of sunlight at the planet's surface is actually rather low. The massive radial radiation radiating from the far-off Sun is mostly to blame for this. Earth's atmosphere and clouds cause up to 54% of the incoming sunlight to be absorbed or scattered, which results in a relatively small additional loss. Nearly half of the sunlight that reaches the earth is composed of visible light, while the other half is made up of infrared radiation, with smaller amounts of ultraviolet and other electromagneticradiation.

Since the Earth receives solar energy every day in the amount of nearly 200,000 times the world's daily electric generating capacity, the potential for solar energy is huge. Even though solar energy is free in itself, the high expense of gathering, converting, and storing it prevents widespread use of it. Although the former is simpler to achieve, solar radiation can be transformed into electrical energy as well as thermal energy (heat)[3,7]

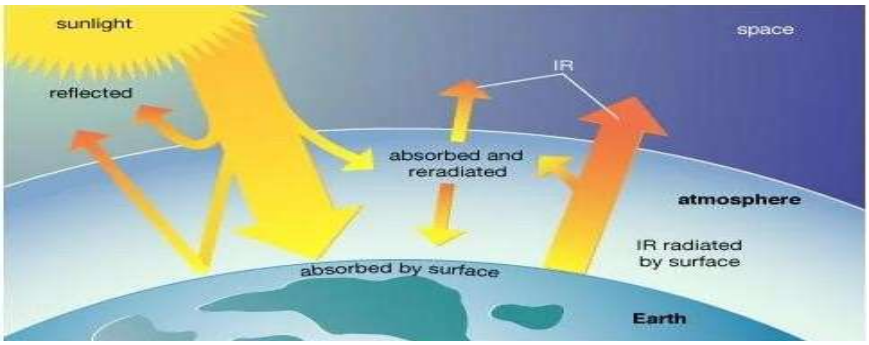

Figure 3. Solar Energy

SOLAR POWERED ELECTRIC VEHICLE CHARGING STATION

Meaning

One of the most effective ways to lessen India's reliance on fossil fuels for the powering of various modes of transportation is through solar charging stations for electric vehicles. This is because electric vehicles typically use electricity generated from fossil fuels, which is a major cause for concern It is essential to implement solar charging for electric cars and bikes as the popularity of electric vehicles rises. There are currently two types of solar charging stations for electric vehicles, depending on the configuration. We can investigate the viability of developing a PV-based infrastructure for electric vehicle charging. The technology is made to be used at workplaces to charge employees' electric vehicles while they are left parked during the day. The goal is to use PV energy as much as possible for EV charging while utilizing the grid as little as possible. Such an EV-PV charger's benefits include[

- Because EV charging uses locally produced, environmentally friendly power from solar panels, thereis a decreased need for energy from the grid.
- EV batteries also serve as energy storage for PV, which lessens the detrimental effects of integratinglarge amounts of PV into the distribution network.
- An extension of Vehicle-to-Grid (V2G) technology, in which an EV serves as a controllable spinningreserve for the smart grid, is made possible by the long parking times of EVs.

Figure 4: Solar Energy Charging for Electric Vehicles

Types of Solar Based Electric Vehicle Charging Station

The key to significantly lowering our reliance on fossil fuels is the integration of solar energy and EV charging. There are many different ways to get electricity, so it's essential that electric vehicles run on renewable energy sources. A solar charging station will likely be installed at every home that has a solar energy system in the coming years as electric cars become increasingly popular. For this to happen, we will need to think about refueling our cars differently and for our energy infrastructure to naturally evolve [7]

Off-grid Solar Based Electric Vehicle Charging Station

The charging station is not connected to nearby utilities in this configuration. As a result, it is alsoknown as an autonomous EV charger. Here, the battery storage system is fueled by the solar panel array.Additionally, this battery storage system meets the charger's entire power requirement. This kind ofcharging station can be installed almost anywhere because it doesn't require a connection to the grid.Additionally, they are simple to install because the majority of them have a sturdy steel foundation. "Electric Vehicle Autonomous Renewable Charger" is another name for an off-grid auto charger. Nolocal utility connection is necessary. The entire system's power requirements are met by this energystorage system, which is powered by the solar panel array. Since there is no requirement for a connectionto the electrical grid, off-grid electrical car chargers can be installed almost anywhere. A sturdy foundation is necessary because the independent solar array canopy attracts a lot of wind. Some off-gridsolar energy chargers have a large, ballast-serving base plate made of steel. [7]

On-grid Solar Powered Charging Stations for Electric Vehicles

Because the energy produced by the solar array is stored in the grid rather than in batteries, the cost of anon-grid solar EV charger is unquestionably lower than that of the off-grid version. You receive credits from the utility provider when you feed the grid, which you can use to charge your electric vehicle. Yourexcess energy is sold to the utility company. The simplest way to power your electric car with solar energy is with a grid-tied solar energy system. Whether or not your home requires the power at the time, a grid-tied solar energy system will feed the energy into the grid. Therefore, the electricity generated at home is sold to the utility company whenyour solar energy system is feeding the grid and you are at work. That

power will be returned to you by the utility company in the form of a credit. You can use that credit to recharge your car at home after leaving work and leaving it parked there **[3,7]**

- **SYSTEM DESIGN**

The system design of the solar EV charging station will examine the optimal design for the photovoltaic (PV) system to satisfy the EV charging requirements. Simple charging systems, such as Gaussian EV charging, will be developed to assist in synchronizing EV charging with PV generation and reducing grid dependence. The use of alocal storage will be found to aid in regulating the diurnal solar variations, but will have a little effect on overcoming the seasonal solar variations. Despite the India's lower solar insulations, a 10kWp PV system will produce an average of 30kWh per day. This is enough for a Nissan Leaf EV to travel 55,000 km per year. Summerand winter energy yields will vary by up to five times, which is a phenomenon that cannot be fixed with a solar tracker. The PV converter rating will be 30% smaller than the PV array due to the lower insulations, with only a 3.2% energy loss. Simple charging strategies, like Gaussian EV charging, will be suggested in order to better match EV charging to PV generation and lessen reliance on the grid. It will be discovered that using a local storage could manage the diurnal solar variations but will have a little impact on overcoming seasonal solar variation. Finally, various approaches to connecting a single EV-PV charger to a number of EVs at work will be suggested [3]

PV System Design

The three-port 10kW converter connected to the 50Hz AC grid will be selected as the optimal system architecture.The grid-connected EV-PV charging system's major source of power is solar energy. A 10kWp photovoltaic (PV)array will be installed at the workplace to generate the solar energy. The panels would be positioned as a solar carport or on the roof of the building.

To enable solar charging of EVs, the power converter design will look into power converter topology, semiconductor device technology, power density, efficiency, closed-loop control, and EV charging standards. Simply put, it is the hardware that makes it possible to charge EVs using solar energy. The current methods for solar-powered EV charging will involve using a DC/AC solar inverter to draw power from a PV array and an AC/DC EV charger to recharge the vehicles. Figure 5 illustrates these using separate power converters for EV and PV.[3,7]

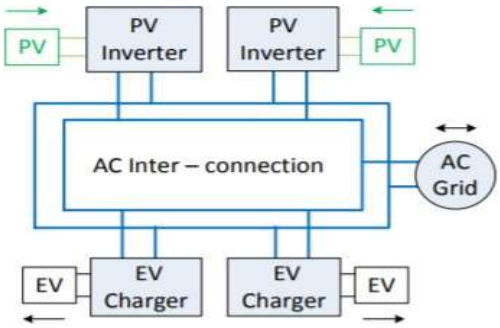

Figure 5 The current method for solar-powering EVs uses a DC/AC solar inverter to extract PV power

- **Benefits of Electric Vehicles**

Environmental Benefits

Since EVs don't emit tailpipe emissions, they don't contribute to air pollution or greenhouse gas emissions. Even when fossil fuels are needed to generate energy power the EV, it emits less pollution than a typical gas-powered vehicle [8]

Lower Operating Costs

Compared with regular cars, EVs offer lower running costs. In general, electricity is less expensive than petrol or diesel, and as electric vehicles have fewer moving components, they require less maintenance. Due to electric motors' excellent durability compared with internal combustion engines, they also often have longer lifespan [8]

Energy Independence

Renewable energy sources, including solar or wind power, may power EVs. This Lessens reliance on fossil fuels and may increase the sustainability of energy use [8]

Efficiency

Compared with conventional cars, EVs are more efficient. The efficiency of the power plant will also affect the well-to-wheel (WTW) effectiveness. Compared with diesel cars, which vary from 26% to38%, the overall WTW productivity of petrol vehicles ranges from12% to 28%. In comparison, the WTW efficiency of Evs powered by natural gas power plants ranges from 14% to 30%, while EVs powered by renewable energy show an overall efficiency of up to 70%[8]

Convenience

EVs may be charged at residences or public charging stations, so going to the petrol Station is no longer necessary. Additionally, many EVs include capabilities that enable drivers to remotely warm up or cool the cabin, which may be helpful in extremely hot or cold weather [8]

Performance

Electric motors can produce instant torque, allowing EVs to accelerate quickly. They could also have a lower center of gravity, making them more maneuverable and stable [8]

7. Advantages of Electric Vehicles (EVs) in India

- Lower running costs.
- Low maintenance costs.
- Tax and financial benefits.
- Better performance.
- Zero tailpipe emissions.
- Easy to drive and quiet.
- Convenience of charging at home.
- No fuel, no emissions.

8. Disadvantages of Electric Vehicles

- High initial cost
- Charging station limitations
- Recharging takes time
- Limited options
- Less driving range

9. V2G "VEHICLE TO GRID"

V2G, which stands for "vehicle to grid," is a technology that allows energy to be returned from an electric car's battery to the electrical grid. A car battery can be charged and drained based on various signals, such as energy generation or consumption locally, with the use of electric vehicle to grid technology, sometimes referred to as car-to-grid. Electric needs are steadily rising against the backdrop of the energy transition, in part because of the advancementof electric transportation. By 2040, 50% of all new automobiles sold will be electrified, predicts the Bloembergen research. In a period of global turmoil, it will be necessary to power all of these cars in a smart and practical manner.

The electric car has the ability to store, distribute, or even produce power, much like a home with solar panels. A new generation of interactive cars known as Vehicle To Grid or V2G has replaced the passive electric vehicle, which does nothing except consume energy. V2G technology, as its name suggests, is the practice of feeding electricity stored in an electric car's batteries back into the electrical grid while it is parked. A smart grid is an electrical network system that employs information technology to regulate energy usage, and this technology is anelement of it. [3]

The smart grid, on a global scale, encourages data sharing between suppliers and consumers to address an important issue: energy storage. Large amounts of electricity are challenging to store. Real-time balance is required for management. Either not enough electricity is produced to power the network, or too much is produced and much of it is wasted. In this effort to modify the electrical flow, V2G may have a significant role [3].

10 CONCLUSIONS

In general their decreased consumption of petroleum and increased productivity offers economic benefit to buyers, society, automakers and policymakers over the lifetime. This paper provides a detailedoverview of the literature, overview, and guidelines for HEV, PHEV and BEV penetration rate studies into the Indian Market. The recent initiatives and various subsidies by the Indian Government will help push the e-mobility drive in India

It will be concluded that the three sub-converters will be coupled on a 750V central DC-link as part of the converter's modular design: an interleaved boost converter for solar energy, a three-phase inverter forthe AC grid and an interleaved fly back converter for electric vehicles. This will demonstrate how the use of Sic devices in a QR mode fly back converter can achieve excellent efficiency even at high powers, despite though the fly back will be typically thought to be only suited for low powers

11. References

1. Ashwani Kumar, Renewable and Sustainable Energy Reviews 14 (2010) 2434–2442,https://www.researchgate.net/publication/221991068

2. Praveen Kumar Sharma , Toward Sustainable Urban Mobility :Designed implementation of A solar powered electrical vehicle charging system with vehicle to grid enable smart technology Airo Journals, Analytical Reviews –Volume 3 | Issue 2 | August 2023.

3. Ms. Anjana Tiwari, ELECTRICAL VEHICLE : A NOVELAPPROACH

4. TO DEVELOPING A SOLAR POWERED ELECTRIC VEHICLE CHARGING SYSTEM UTILIZING VEHICLE TO GRIDENABLED SMLOG IJFMR 23057482 Volume 5, Issue 5, September-October 2023

5. Jann Michael Weinand, Forschungszentrum Jülich GmbH, Institute of Energy and Climate Research – Techno-economic Systems Analysis (IEK-3), 52425, Jülich, Germany

6. Praveen kumar sharma , CLEAN ENERGY INTEGRATION IN ELETRIC MOBILITY:ANOVEL APPROACH TO SOLAR POWERED EV CHARGING USING VEHICLE TO GRIDENABLED SMART TECHNOLOGY IJRAR Septembe 20 Volume

7. Akshya Kumar Sahoo; Sudipta Rudra; Ashima Sindhu Mohanty "Artificial intelligence based electric grid operation enabled with data encryption" International Conference on Electrical, Electronics and Optimization Techniques.

8. Praveen Kumar Sharma, Ms. Anjana Tiwari , A Study on Electric Vehicles Charging SystemUtilizing with Solar Energy, IJFMR23057482 Volume 5, Issue 5, September-October 2023

9. Fayez Alanazi, Civil Engineering Department, College of Engineering, Jouf University, Sakaka 72388, Saudi Arabia