ISSN 2278-3091
Volume 8, No.3, May - June 2019
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse46832019.pdf
https://doi.org/10.30534/ijatcse/2019/46832019

A Review on Solar Wind for Possible Application in Electric Vehicle

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ABSTRACT

The requirement of electrical energy is increasing with a rapid pace. The reason behind this demand is easy conversion of electrical energy into other forms. Transportation of electrical energy is quick and has tremendous application in modern world. A majority of the communities around the world depend heavily on coal, oil and natural gas for their energy needs. These fuels draw on several resources which will eventually diminish, that make them too environmentally damaging or too expensive. To complete the demands and proximate environmental issue, there is need for new technology that helps in generation of sustainable and clear energy. In this paper, technology related to solar and wind with their application has been discussed. By using the combination of these resources, intermittent nature of renewable sources can be reduced. Hybrid solar wind technology can find application in electric vehicle, stand-alone system and grid connected system. The focus of this review paper is to provide the reader with insight of solar, wind and electric vehicle technology that includes their history, advantages, barriers and technology evolution.

Key words : Clean energy, Electric vehicle, Renewable energy sources, Solar; Wind.

1. INTRODUCTION

Fossil fuels, or as we could say the fuels formed with the natural decomposition processes of buried dead organisms have been one of the most used forms for providing energy to the growing population. Energy produced from fossil fuels has been used in transportation, industrial and the power sectors. However, this method of energy production is considered as one of the prime factors contributing in the increase in pollution, resulting in change in the environment. Moreover, incremental energy cost and change in climate are directly linked to the heavy utilization of fossil fuels [1, 2]. To overcome these limitations, researchers and governments across the globe are working on projects in order to reduce the dependence of the current energy production status of various countries and shift the reliance towards electricity powered methods for instance, more dependence on fossil fuels for energy and the call for clean energy has contributed towards the demand for electric vehicles as a mode of transportation. In order to implement the current thoughts, new strategies and to reduce the high fuel prices, electric vehicle is a great alternative [3]. The electric vehicle technology is considered as one of the best solutions for the prevailing issues due to the fact that the EVs (Electric vehicles) have zero tailpipe emissions, which is considered as the desired result for a clean environment. A target has been established for EV in the United States. According to this target more than 200,000 EV will be on road by 2020. Implementation of different public policies in transportation sector has been done in order to support the EV in transport sector of US. Many organization including IWC (International Working Council), IEEE and SAE (Society of Automotive Engineers) are working on codes and standards formation for utility interface of EV.

The main barriers in widespread acceptance of EVs are: deficiency of charging station, incremental cost, battery charging issues and battery life cycle. Also, the generation of electricity for EV's is drawn from power grid and thus the process involves GHG emissions. Thus, the usage of different types of electricity defines the impact EV's have on the environment. Recently, the researchers and developers have been more inclined towards sources of renewable energy so as to favour EV's become more environment friendly than the conventional ICEV's [4]**.** There is various source of renewable energy but for qualifying as a source of fuel in EV the following criteria should meet. It should be sustainable, i.e. it must have an infinite supply for energy without its own extensive use, frequently available and easily transferrable along with being compact which means that it should offer high amount of energy and power density. In 2011, according to the International Energy Agency (IEA) the development of affordable, inexhaustible and clean solar energy technologies will have huge long-term benefits [5, 6]. One of the popular and renewable technologies invented till date have the name "photovoltaic" still present in their list. With the power to absorb solar energy and thereby convert it into energy, makes it one of the best sources of production of electricity.

According to pressure difference at different places there is change in wind speed. The advantage of wind system used in EV is the draft of air produced by movement of vehicle is able to generate electricity even at locations with lesser availably of wind speed. Using solar and wind in EV will

reduce GHGs which is main culprit for environment change.

2. SOLAR ENERGY

The major source of light on this planet earth is the sun containing the solar radiations. Out of the enormous amount of sunlight received, approximately thirty percent is reflected back because of the protective shields. The remaining seventy percent is absorbed by the prevailing elements such as oceans, land masses and the clouds. With the power to absorb solar energy and thereby convert it into energy, makes it one of the best sources of production of electricity.

In India, as per the ministry of new and renewable energy (MNRE) the solar grid interactive power capacity is 159.02 (till April – July 2018) for solar roof top. The target of this program is to raise the level of solar capacity upto10000 MW. For off grid solar photo voltaic achieved power is 90.15MW whereas the target is 200MW. The state wise contribution is shown in Table 1 [7].

2.1 Solar Voltaic- a Brief History

In year 1839 the famous PV phenomenon was discovered that included solar cell "voltaic" with feature of conversion of light's quantum called as "photo" into electricity [8]. Solar cell history has been described in the Table 2 [9].

2.2 Design Methodology of PV System

PV system contains an inverter, PV module, charge controller, load and battery. These components have dedicated function and follows specific methods of control. The principle on which a PV system works is based on the simple fact that solar radiation creates flow of electric energy (DC) in PV module. The energy generated is stored in battery under the supervision of controller that protects battery from excessive discharge and overcharge. The function of charge controller or regulator is protection from overcharging or extensive discharge. Battery is used because on cloudy days, during night, rainy day or low solar radiation PV module will not be able to supply power. At that time charge stored in battery supply power to load. In case of batteries, energy storage in DC form, but the equipment's work on AC. Hence inverter is used which converts DC into required magnitude and frequency AC for device working [10].

2.2.1 PV System Classification

The general classification of solar PV system is in two fundamental types: grid connected for grid tied system and grid-connected for off grid type system. Stand-alone PV systems are best suited for areas where there no power through grid. Direct-coupled system is the simplest one type of stand-alone PV system. In case of directly coupled system i.e. with no battery connection, the system works during day time. Thus, direct coupled systems are not generally used in normal condition [11]. Parts of PV system are Inverter, Solar PV module, Battery, Charge controller, DC load, Cables, and AC load. Along with these, other parameter has to be considered for the designing of PV system, it includes, requirement of load, PV module size, orientation of PV module, availability of intensity and temperature of the place where PV system is required. Whereas, grid-tied system is connected to local grid and with the help of local power supplier, generated solar electricity which is transferred to the grid [12].

Table 1: State-wise major contribution of solar in India [9]

Sr. No.	State/UT	Total Cumulative Capacity till 31.0302017(MW)	Capacity Commissioned till 31.10.17	Total Cumulative capacity till 31.10.2017(MW)	% Contribution
1	Telangana	1286.98	1283.45	2570.43	16.47
2	Rajasthan	1812.93	433.55	2246.48	14.39
3	Andhra Pradesh	1867.23	271.60	2138.82	13.70
4	Tamil Nadu	1691.83	20.24	1712.07	10.97
5	Karnataka	1027.84	464.54	1492.38	9.56
6	Gujarat	1249.37	41.81	1291.18	8.27
7	Madhya Pradesh	857.04	282.95	1139.99	7.30
8	Punjab	793.95	82.85	876.80	5.61
9	Uttar Pradesh	336.73	171.01	507.74	3.25
10	Uttarakhand	233.49	13.40	246.89	1.58
11	Maharashtra	452.37	62.64	515.01	3.30
12	Haryana	81.40	110.04	191.44	1.22

Since Grid-connected PV systems require very little maintenance, therefore they are installed at the roofs of buildings. The PV system for this case is also called as building-integrated photovoltaic (BIPV) systems. The main characteristics of BIPV systems are that they do not cause emission. Hence there is no environment deterioration and resource depletion [13,14]. The PV system cost is determined by location of panel installation, electricity tariff, typical interval energy data and type of system. Hence to determine the net cost of PV system installer is required to know the energy consumption, type of PV

system installation and cost of PV panel. Classification of PV systems:

- Stand alone or off grid application that can be for mid or small size system.
- PV system for large scale building that is for hospitals, commercial building, schools and university with rating less than 1MW.
- Residential PV systems that are roof mounted and have capacity less than 20kW.
- Utility scale PV system that can be in form of solar PV power plant or ground mounted with a capacity less than 1 MW [15].

2.2.2 Methods to Use Solar Energy

There are two ways to exploit solar energy i.e. active and passive. Solar energy passive utilization is done using light or heat of sun without converting in other energy form [16]. For utilization of solar energy in active form, energy is an example of active mode. There is requirement of regular maintenance by PV modules. The generated electricity is eco-friendly and has minimal impact on land in case of small PV module [7, 17].

2.2.2.1 Solar Thermal Power Plant

Solar thermal power plants find application in central tower, parabolic dishes and parabolic reflectors. It is also an example of active mode of solar energy exploitation. The bases of these systems are classical steam power plant. This type of power plant acts as the bases for regional development as they can supply power to small cities [17].

2.2.2.2 Solar Thermal System

This type of system finds application in heating of eatable and water. It is an example of passive mode of solar energy. These systems can be used for domestic purpose as they are easy to operate and install [17].

Table 2: Solar photovoltaics' History

Scientists and Innovation	Year
Alexandre-Edmond Becquerel discovered the photovoltaic effect	1839
Adams and day observed photovoltaic effect in solids selenlum	1877
Thin sheets of selenlum with gold coating for Solar cell with less than 1% efficiency has been developed by Charles Fritts	1883
Solar cell with copper and copper oxide semiconductor-junction was developed by Wilhelm Hallwachs	1904
High purity semiconductor theory developed by Wilson	1931
Effect of PV in cadmium sulphide is discovered by stora and Audobert	1932
Silicon Solar cell was developed by Chaplin, Pearson and fuller at Bell laboratory with 6% efficiency	1954
Initially solar cells were used in orbiting satellite Vanguard 1	1958
Solar cell with 14% efficiency was developed by Hoffman electronic	1960

2.3 Solar Energy Advantages

- Solar energy is abandoned in India hence leads to substantial development [18].
- Eco-friendly nature. No release of carbon dioxide and greenhouse gasses that causes global warming [18].
- The major advantage of solar energy is that it can be used domestically because installation is not constrained by location [19].
- Application of solar energy can be done in various fields such as cooking, heating, corporate and educational organization or electricity generation [19].
  Solar energy is related to strong economy and also act as source of employment. MNRE decided solar energy development as one of its prime goals. It is expected that solar energy will introduce 7 lakh jobs within next ten years in India [20].

3. WIND ENERGY

Wind energy is considered as one of the most efficient way of production of energy which has the capability of to fulfil the needs of everyone across the globe. The kinetic energy of wind is used to produce mechanical energy through the wind turbine (WT) which is further connected as prime mover of generator.

In 2017, the global market of wind power was 52,492 MW and bring to total 539,123 MW globally wind power as shown in Figure 1.

3.1 History

Since the ancient times, the usage of wind energy was already being done even before the major knowledge in this subject in various places such as pumping water, grinding grain and sailing ships. In 1891, Dane, Poul la manufactured the wind turbine for electricity production. In United States, introduction of wind-electric systems was in late 1890s. Following years including the 1930's and 1940's, rural areas had experienced the extensive usage of this energy by plantation of hundreds of thousands of small-capacities wind electric systems.

Rapid growth was seen in the 1990s, majorly led by Germany overtaking the US and becoming the market leader in 1997. Though, with the introduction of Chinese Renewable Energy Law in 2005, the whole statistics changed, making China as the global market leader by the end of the decade. China, presently double the market namely the US, which came back to its position by overtaking Spain in 2007 followed by Germany in 2008. The major change in the list of the top 5 ranking since then was India acquiring a position ahead of Spain in 2015 [21].

3.2 Wind Turbines Basics

The main parts of turbine are shaft, rotor blade and generator. Rotor blade acts as wind barrier and can be termed as turbine's sail.

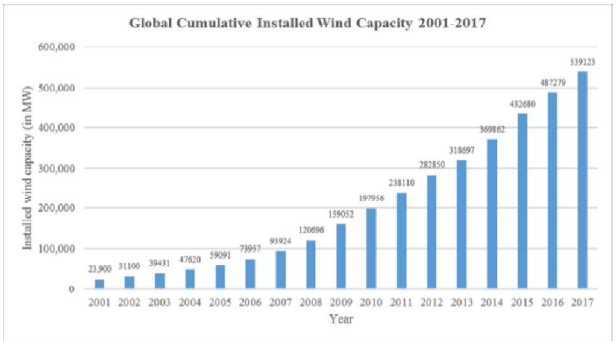

Figure 1: Installed wind capacity [46]

In [22] author has stated about advancement of design of blade. The power in wind is limited, so to extract more power number of blades needs to be increased. Therefore, there is requirement of narrow blade for fulfilment of aerodynamic efficiency requirement [23].

Rotor is mechanically coupled with generator with the help of shaft. Therefore, on rotation of rotor there is transfer mechanical energy to generator via shaft and there is production of electrical energy.

Simple construction of generator consists of coiled wire or conductors along with magnets. It works on the principle of electromagnetic induction. The main parts of wind turbine are rotor, nacelle, tower, gear box, breaks, controller, anemometer, yaw drive, generator and yaw motor as in Figure 2.

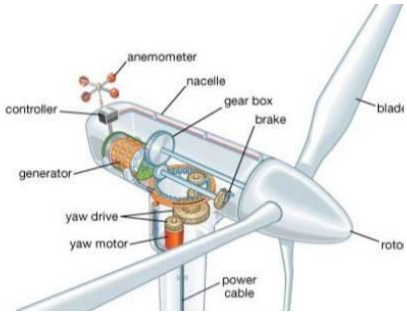

Figure 2: HAWTs components [23]

HAWT is leading manufacturer of wind turbine. The kinetic energy from the blade drives turbine's rotor, rotor is connected to low speed shaft that operated gear box. Control of speed is done via gear box; the gearbox other end is connected to high speed shaft which is in turn joined with generator [24,25]. This Turbine can be variable or fixed speed. In case of variable speed drive there is need of converter to transfer the electricity at correct voltage and frequency. They are popular and widely used. The orientation of turbine affects its structure and dynamic design [26]. The turbine can rotate longitudinally about axes i.e. it can have variable or fixed pitch. In variable pitch turbine effect of aerodynamic torque has dominance and load alleviation takes place. Variable pitch turbine is costly but they are dominating modern market. All parts of blade can move along the axis of pitch in case of variable pitch turbine. The maximum efficiency that can be achieved for wind turbine is fifty nine percent and this factor is called Betz Limit. 100 percent efficiency is not possible because the wind passing through the rotor has kinetic energy [27].

3.3 Types of Wind Turbine

Vertical and Horizontal axes are two types of wind turbine. In vertical axis turbine, rotation of blade is in perpendicular direction to the axis. These are mounted closer to ground and yaw control is not required. Horizontal axis wind turbine (HAWT) consists of nacelle, blade and tower. In order to get better efficiency, superior control and variable blade pitch HAWT are best option [28].

3.4 Wind Energy Conversion System (WECS)

Kinetic energy of wind is utilized to rotate the rotor which is connected to the generator. With the motion in the generator shaft the mechanical energy is converted into electrical energy.

3.5 Control Strategy in WECS

Different types of control techniques are there that are applied in several part of the WECS. These are as follows [29]:

- Grid side power control
- MPPT control technique
- Pitch control technique

3.5.1 Pitch Angle Control

In this technique, turbine blades angle are changed to control the turbine speed. Hence it is crucial for variable speed WECS. It conjointly as certain the safety of turbine when there is abrupt current of wind.

3.5.2 MPPT Control

As the speed of wind is varying in nature hence wind turbine must operate at maximum power point (MPP). MPPT technique permits WTS to extract maximum energy at different speed of wind, hence elevates the efficiency of system [30].

3.5.3 Grid Side and Machine Side Controller (MSC)

MCS permits the operation of WECS at variable speed. It extracts most energy with the wind speed variation and rotor speed varies to get steadiness and maximum power. Grid side control leads to grid code compliance, power quality improvement. There is no role of grid side controller (GSC) in power conversion.

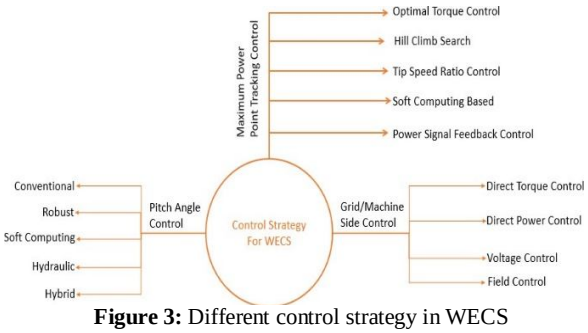

Figure 3: Different control strategy in WECS

4. ELECTRIC VEHICLE

Energy produced from fossil fuels has been used in transportation, industrial and the power sectors. However, this method of energy is causing change in climate and increasing energy cost are directly linked to the heavy utilization of fossil fuels [1, 2]. To overcome these limitations, researchers and governments are shifting towards new strategies i.e. the electric vehicle that helps in achieving green source of transportation along with best fuel economy [3, 4].

4.1 History of Electric Vehicle

The EV technology was introduced in the early nineteenth century and since then they have undergone great changes till date. Slovak-Hungarian priest Anyos Jedelik in 1828 discovered the first electric vehicle that is the toy electric car as shown in Figure 4, which was right after the invention of the electric motor.

Not late after, Robert Anderson from Scotland, invented primitive electric carriage whereas, Sibrandus Stratingh (1785-1841) in Netherlands went after the small-scale invention of electric car in 1835 in Figure 5.

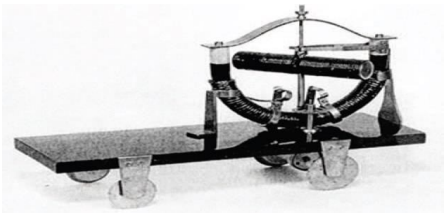

Figure 4: Jedelik's toy electric car [31]

With the introduction of efficient dc electrical motors, a strong exploitation to electrical cars was introduced by Z'enobe Gramme (1826–1901) in France in 1873. Electrician Gustave Trouve (1839–1902) proposed a lead acid battery driven electrical tricycle, at Paris Exposition International d'Electricit'e in 1881.

Figure 5: Stratingh's small electric car [31]

By 1935, electric vehicles stopped being in use. In the time following between 1935 and 60's was a dead end for the electric vehicles along with no use in personal transportation. But since the introduction of gasoline vehicles the increase in the fuel prices, along with the environmental changes with the fuel emissions it was causing, an alternative had to introduce and hence, electric vehicles, again, came in the picture in the 60s and 70s. Many attempts were made to produce practical electric vehicles after the years following 1960's so as to decrease the dependence of vehicles on the imported crude oil [32,33]. The year 2010 following saw the introduction of Battery electric vehicles (BEV's) along with plug-in hybrid electric vehicles (PHEVs), which started to enter into automotive industry [34].

4.2 Latest Trends of Electric Vehicle Sale

The sale of electrical cars has shoot up rapidly in 2017; in terms of numbers the sale of electric vehicle has crossed benchmark of one million units. If sales of 2017 are compared with 2016, there is a rise of fifty four percent in the latter year. By looking at the statistics of sale it can be seen that Northway is world's leading market in terms of sales of electrical vehicles. The market share of this country is thirty nine percent. Next in the list is Sweden and Iceland with 6.3% and 11.7% market share respectively. China is the major game player in the electrical vehicle market, with a share of half of the global sales. In current scenario (i.e. 2017) the share of China is 2.2 %. United states is second on the list of electrical market. The electric car global stock are shown in Figure 6 [35].

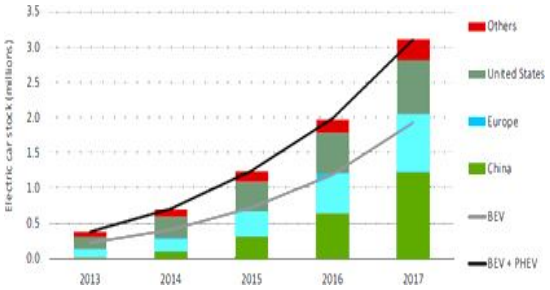

Figure 6: Electric car stock (2013-2017)

4.3 Future Scope of Electric Vehicle

In this section we will discuss about various county's objects and targets regarding the development of electric vehicle for the year 2020-2030 as shown in Table 4 [35].

Table 3: Comparison of various types of solar cells

Cell Type	Crystalline Silicon		Thin Film			Third Generation				Perovskites
	Monocrystalline	**Polycrystalline**	**Amorphous Silicon**	**CIGS**	**CdTe**	**Polymer**	**Nanocrystal**	**Concentrated**	**Dye Sensitized**	
Efficiency	14%-17.5%	12%-14%	4%-8%	10%-12%	9%-11%	~3%-10%	7%-8%	~40%	~10%	31%
Cost	2 times costly as compared to thin film	2 times costly as compared to thin film	Less costly than conventional silicon-cell	Less costly than conventional silicon-cell	Less costly than conventional silicon-cell	Less costly than conventional silicon-cell	Less costly than conventional silicon-cell	Less costly than conventional silicon-cell	Less costly than conventional silicon-cell	Less costly than conventional silicon-cell
Size	Less volume for the same amount of power production	Less volume for the same amount of power production	Wide range of product design from light durable, flexible	Wide range of product design from light durable, flexible	Wide range of product design from light durable, flexible	Wide range of product design from light durable, flexible	Wide range of product design from light durable, flexible	Specialized range of product design	Wide range of product design from light durable, flexible	Wide range of product design from light durable, flexible
High Temp. Performance	Not Satisfactory	Not Satisfactory	Satisfactory	Satisfactory	Satisfactory	Not Satisfactory	Excellent	Excellent	Not Satisfactory	Excellent
Additional details	Oldest PV technology	Economical choice	Required large space and long installation time	Some CIGS have 20% efficiency	Toxic due to Cd	Required large space and Short installation time	Required large space and Short installation time	Required large space and long installation time	Required large space and Short installation time	Minimum space and short installation time

4.4 EV Overview

In today's world, no common man is able to completely afford the price hikes. Not only do the daily necessities cost a fortune but the recent transportation costs which include high crude oil costs have been a major issue. This issue is not only limited to prices, but in all even consists of the prevailing environmental conditions. In such conditions, coming up with more efficient and less polluting vehicles becomes the need of the hour. Electric vehicles become one of the solutions. They are further classified into many types which are discussed in further sections.

4.4.1 Battery Electric Vehicle (BEVs)

The only source of energy in BEVs is battery pack, therefore their complete reliance is based on the amount of battery capacity each holds. Along with that the range of such electric powered vehicles also changes depending upon the battery capacity. On an average, the approximate distance covered by any such vehicle ranges between 100-250km.
However, for the more technologically advanced models, it can vary in between 300-500km [36]. One major drawback that it possesses is the fact that, once such battery is depleted is could take almost 36 hours to get fully charged and replenished as compared to a conventional ICE vehicle. [37, 38].

4.4.2 Fuel Cell Electric Vehicle (FCEVs)

In fuel cell, chemical energy is directly converted into electric energy [39]. This is also termed as 'hydrogen fuel cell vehicles' because the reaction is carried out by using hydrogen During the working of FCEVs, the by product is water which is ejected through tailpipes present in the vehicle. The configuration of an FCEV is shown in Figure 7.
A plus point of these vehicles is that there is no carbon emission as they produced electricity by itself and hence becoming eco- friendly. The most important advantage of FCEVs are that the refilling time required for both conventional vehicle and FCVs is nearly same, which makes it more efficient and compatible method of transportation, thus increasing its chances of becoming adoptable in the near future. [40].

4.4.3 Hybrid Electric Vehicle (HEV)

As the name suggests, Hybrid Electric Vehicle uses both electrical power train and an ICE to provide energy to the vehicle. At low power demand, electric propulsion system is used, which is a great advantage at low speed condition in urban areas [41].

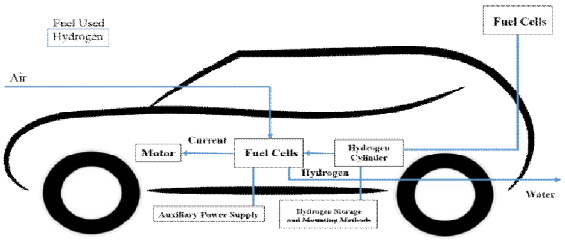

Figure 7: Configuration of FCEV

Full-HEV can be further classified as

- Series full-HEV or Extended range electric vehicle (EREV), Figure 8(b)
- Parallel full- HEV or Hybrid electric vehicle (HEV), Figure 8(c)
- Parallel-Series- full-HEV, Figure 8(d)
- Complex full-HEV, Figure 8(c)
- Plug-in hybrid electric vehicle (PHEV), Figure 8(f)

4.5 Charging

After the drainage of battery, Charging is required for the further movement of the EV, especially in case of PHEV and BEV. The time duration for charging of EV is a main concern. Also, the accessibility and availability of charging station for recharging the EV is quite less as compared to the refuelling of ICE based Vehicles. Now days, there is huge advancement in the power electronic (PE) technology. Usage of PE technology in chargers can elevate its efficiency.

4.5.1 Charging Power Levels and Infrastructural System for EVS

Charging infrastructure and different power levels for charging help us to understand the influence on power grid, charging time, power magnitude, cost and equipment location. Charging infrastructure help us to reduce the requirement and cost of on-board energy storage system. There are many problems regarding the development and dispersion of electric vehicle supply equipment (EVSE) and charging infrastructure such as, Charging time, regulatory procedures, distribution and Demand policies, and standardization of charging stations. EVSE main components are vehicle connector and charging codes, public or residential charge stands, protective equipment and Power outlets, different type of attachment plugs [42-45].

Table 4: Country objectives and target (2020-2030)

Country or region	Objective or target of EV (2020-30)
India	Sales of 30% electric car by 2030 100% BEV urban buses sales by 2030
United States	300 000 EVs in eight states combined by 2025 • ZEV5 mandate in ten states: 22% ZEV credit sales in light-duty trucks and passenger cars by2025 • California: 1.5 million ZEVs and 15% of effective sales by 2025, and 5 million ZEVs by2030.
United Kingdom	Electric cars from 396 000 to 431 000 by 2020.
China	New energy vehicle (NEV) sales share: 7-10% by 2020, 15-20% by 2025 and 40-50% by 2030. 5 million EVs by 2020, including, 0.2 million trucks, 0.2 million buses and 4.6 million PLDVs.
Japan	Sales of electric car 20-30% by 2030
Slovenia	100% electric car sales by 2030.

4.5.2 Battery Charging Techniques and Charging Systems

EV's, Batteries are charged externally with the help of a device known as battery charger. Figure 9 represents the basic system of battery chargers [46].

4.5.2.1 EV Charging Systems

On the basis of Energy transfer mode, EV charging system are classified as Inductive, Conductive charging systems and Battery swapping networks [47-49].

4.5.2.1.1 Conductive Charging Systems

Conductive system requires a physical connection between EV and the supply network. Cable connector is used for transfer of energy from different levels of charging (Level 1, 2 and 3) to EV. This method is efficient and simple for the charging of EV's. It can be used for both on and off board charging as per the user convenience. Tesla Roadster, Nissan Leaf, Mitsubishi i-MiEV and Chevrolet Volt are currently available vehicles which uses Conductive charging systems. [50-53].

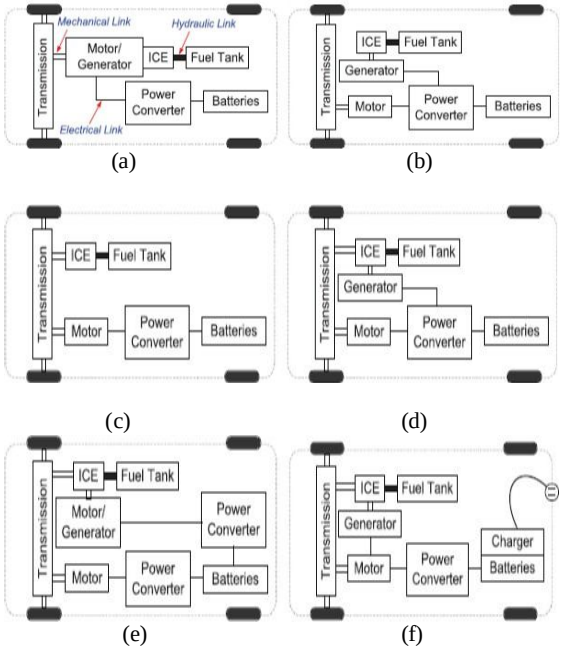

Figure 8: Classification of HEV: (a) Mild-HEV, (b) Series Full HEV, (c) Parallel Full- HEV, (d) Parallel -Series Full-HEV, (e) Complex Full HEV, (f) Parallel-Series PHEV

5. CONCLUSION

The global energy crisis is an important issue at international level. The whole world is looking towards environmental protection and energy security by reducing the dependency on traditional fossil fuels. Generation of electricity through conventional sources and transport sector are the main factor that pollutes the environment. Hence it is the requirement to decrease the pollution by reducing the dependency on traditional fossil fuels. Solar and Wind energy are the potential candidate that can be used as an alternative source as they are abundant in nature and easily available. Along with this Electric vehicle also contributes for maintaining the green environment. This review paper presented an outlook for solar and wind technology development, different PV cells, there merit and the implementation challenges. It also gives a total picture of electric vehicle with special accentuation on charging technology, international standards, fast and slow charging techniques, technical challenges and prospects. As renewable sources are depending upon the climatic condition and intermittent in nature therefore to extract maximum power from them MPPT are used. Comparison of some MPPT techniques has been done in this paper. It can be concluded that the combination of Solar - wind hybrid along with improved MPPT technique will improve the performance of electrical device. This system find application in Electric vehicle, stand alone and grid connected system.

Acknowledgement

We extend our gratitude towards Thapar Institute of Engineering and Technology for providing subscription of reputed generals, without which this work wouldn't reach its best outcome.

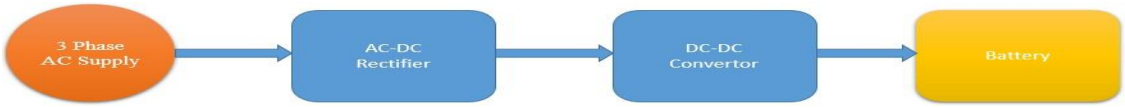

Figure 9: Battery Charger Basic Configuration

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