Review

Debalina De, Uttara Das and Champa Nandi*

A comprehensive approach of evolving electric vehicles (EVs) to attribute “green self-generation” – a review

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Abstract: The population growing faster than before, and availability of transportation options is increasing. Automobiles require combustion engines, which require fuel obtained from underground storage. This underground fuel storage is limited and depleting day-by-day. Many nations have set deadlines up to 2040 to stop producing automobiles that run on underground fuels. Researchers have concentrated on alternative modes of fuel for transportation. The world’s largest Sedan marketplaces will transition to all-electric vehicles by 2035, providing a glimpse of greener future other than a significant financial prospect. Not only Sedan, the entire world is focussing on only green electric vehicles to maintain sustainability. However, electric vehicle charging stations are operated by using many conventional resources. Therefore, this paper aims to show how self-charging electric vehicles can help to reduce emissions caused by the direct use of conventional resources in charging stations along with the up-to-date status quo of the EV market. The key descriptions of electric vehicles on top of the battery’s type which is randomly used in EVs, how the batteries are proficient in preserving and supplying power continuity itself in vehicles are talked about. Finally, the paper is consulting about charging-discharging system of electric vehicles to make the environment cleaner.

Keywords: battery; electric vehicle; energy harvesting; charging system; green environment

***Corresponding author: Champa Nandi**, Department of Electrical Engineering, Tripura University, Agartala, 799022, Tripura, India, E-mail: cnandi@tripurauniv.ac.in
Debalina De and Uttara Das, Department of Electrical Engineering, Tripura University, Agartala, 799022, Tripura, India

1 Introduction

1.1 Background

Because of the swift enlargement of modern socio-efficient, along with the hasty increment of the global net inhabitants, the issue of conventional fuel supplies and global average climate change has gotten much worse condition in recent years (Kuseker et al. 2015; Osorio et al. 2021). Lion’s share part of countries, particularly emerging populated ones, are struggling with the problem of the rising demand for fossil fuels that have already been restricted. To mitigate the effect, concern about expanding non-conventional energy to generate electric power, such as wind, photovoltaic, and hydrokinetic energy has increased, and these resources faced rapid growth over the last 10 years (Heinisch et al. 2021; Manzetti and Mariasiu 2015; Markel, Kuss, and Denholm 2009). Energy demand has already begun to change as a result of global technological advancement. Accordingly, to limit globalization, humanity has become more aware of and inclined to use renewable energy sources rather than fossil fuels. Across the world, the thrust of consumables energy for transport comes after the energy need for the industrial sector. In this field, EVs can be a better choice to make the transportation sector pollution free, despite being used in non-renewable powered charging systems (Femy and Jayakumar 2023). Aside from that, electric vehicles provide environmentally friendly alternatives to fuel-powered vehicles for people’s essential transportation needs (Sanguesa et al. 2021; Tekle 2014; Tseng, Wu, and Liu 2013;). While these compensations are reflected, the use of electrically powered vehicles (EVs) is anticipated to increase shortly. As one of several temporary solutions, regenerative braking has the potential to significantly reduce vehicle dependency on charging stations while also increasing energy efficiency (Schuller and Hoeffer 2014). This technology can be used in hybrid and electrically powered vehicles, but automobile’s kinetic potential is typically lost when the brakes are applied during braking mode (Clarke, Muneer, and Cullinane 2020).

Electric vehicles are charged from the charging station which is mostly dependent on the national grid (Li et al. 2013). Most of the time, this national grid gets power from conventional sources and electric vehicles raise the conventional load demand. Conventional sources based charging stations are the reason for greenhouse gas emissions on the environment (Bhattacharjee et al. 2017; Bhoomika and Darshan 2020; Nandi, Bhattacharjee, and Reang 2018; Quartey and Adzimah 2014; Tomic and Kempton 2007). Currently, Chinese legislation encourages the development of electric vehicles and green carbon-free energy sources to avoid the emissions. China is worried now about the average higher emissions of conventional pollutants and CO_2 from mobility, public transportation, and other factors (Chen et al. 2018). In such conditions, EVs will play a major part in smart cities in the upcoming years (Alesiani and Maslekar 2014; Berkel and Heesbeen 2017). To give attention to these realities, research has begun emphasizing sustainable development and has developed cutting-edge energy conservation techniques. For that, a variety of technologies to use renewable energy sources are being used in practically, especially in industries (Karthikeyan et al. 2019). Numerous alternative battery-powered vehicles are now manufactured to ensure more advancements in automobile technology (Rahaman and Patil 2015). These cars don't emit any harmful pollutants, making them not only recyclable but also ecologically aware.

In the current scenario, different types of hybrid electric vehicles are already secure place in the automobile market and are comprised of variable self-regulating ICE or electric motor set-up. The strategy of controlling such vehicles is significantly influenced by the component size of electrically energized motors and ICE. As a result, the lesser size of the ICE is directly related to a higher hybridization ratio (Poullikkas 2015). From the large automotive market, electrically driven power trains, to a huge margin of EV's production have obtained a pre-dominant methodology in Europe and China (China secured second rank in the world in 2014 with 150,000 ownerships of EVs across the world). If intelligent technologies help EVs, the EV technology will get a rapid growth in the energy market (Du, Ouyang, and Chen 2017). According to the European Transport Roadmap, the number of internal combustion engines across the world will be halved by the end of 2030. The demand for EVs will face rapid growth by the year 2050 to turning the major urban areas into a CO_2 free zone. To withstand this situation battery charging infrastructure should be in a proper way to energize the cooperative control strategy of flexible EVs (Santos et al. 2019). By using the beneficial advancement of sensors, IoT-based equipment, smart systems, and by re-scheduling future manufacture-based monitoring systems, future EVs can stand with cost-effective design. Therefore, recharging batteries and the development of the characteristics of batteries can increase the vehicle's performance range with no environmental effects (Mierlo et al. 2021).

1.2 Objectives

The main objectives of the paper are:
- To give an overview of the discharging and charging systems with the traction battery pack of electric vehicles.
- To display deficiency standpoint by considering different positional demands of different types of electric vehicles.

1.3 Organized the paper structure

The following is how this paper is structured. Section 2 is discussing about electric vehicles, their types, and the current market situation of EVs. Section 3 demonstrates how technologies are used and how important they are for EV technology's development. Section 4 summarises the most relevant surveys from the literature on self-charging EVs. Section 5 shows the discussion about previous works. Finally, Section 6 represents the conclusion of the paper.

2 Electric vehicle

2.1 Types of electric vehicles

Electric cars are split into three categories depending on how they are connected to an energy source (Bhatti et al. 2016; Electric Car Use by Country; https://e-amrit.niti.gov.in/types-of-electric-vehicles).
- **An electric vehicle with plug-in technology or PHEV** – These vehicles are the combination of either a diesel or gasoline-powered conversion-based locomotive with an electrically energized motor, with a larger battery to provide a significantly longer electric range. To fully recharge, this must be plugged in.
- **A hybrid electric vehicle or HEV** – A vehicle that combines a diesel or gasoline-powered locomotive with a coupled electrically powered motor and a battery. These can be used separately or in combination.
- **Battery-powered electric automobile or BEV** –An automobile that operates solely on electricity and is propelled by a powerful motor (electrical energy based) (s) and a large battery.

2.2 Difference between most popular types of EV batteries (lithium-ion battery vs. zinc–air battery or metal–air battery)

In EVs, there are various types of rechargeable batteries are used, like: Li-ion, Zn–Air, Nickel–Metal Hydride, Lead-acid, and ultra capacitors. Among all, Li-ion batteries are frequently used. The EV's batteries are made up of the collection of lithium-ion batteries. The battery set consists of 16 modules, and each containing 7000 cells. In rechargeable batteries, Li-ion has a greater efficient performance with a range above 99 %. The EV battery manufacturing industry is dominated by China, a major producer of lithium-ion batteries (Lee et al. 2016; Miao et al. 2019). Indian EV manufacturers currently importing lithium-ion batteries primarily from China. Although lithium-ion batteries are widely used, but, they have several disadvantages like sensitive to high temperature, costly, short lifespan including a limited supply. Additionally, Li-ion arrays cannot come across the diverse requirements in the markets. The electric vehicle industries have grown rapidly in recent years due to the government's encouraging policy-support and to reduce environmental pollution.

Recently, EV's Li-ion batteries are replacing by zinc–air batteries as Lithium is not available easily. Therefore, because zinc is abundant in India, fewer Li-ion arrays would need to be imported for Indian Electric Vehicles. Financially, zinc–air batteries cost less per kWh than lithium-ion batteries, which cost in-amongst \$200 and \$250 per kWh, but the Zn–air series of cells cost around \$150/kWh. As usage grows, prices are expected to fall below \$100 kWh. Zn–air water-based batteries comprise of more life as compared to other conventional batteries. These batteries have a fast recharge rate. Zn–air series cells could be used in two or three-wheeled electrically powered automobiles. In theory, lithium-ion batteries have a much lower energy concentration than air-metal arrays. The most recent developments for lingering life in air-metal arrays were done for both aqueous (Zn–air) with non-aqueous (Air–Li) systems (Li and Lu 2017). Figure 1 shows graphical representation of Theoretical Energy Density of different metal–air batteries.

2.3 Global market position of the electric vehicle

The overall number of new car registrations in 2020 did not increase significantly. The COVID-19 pandemic and the subsequent recession had a significant impact on the global market for automobiles of all types. Due to the pandemic, expectations for global EV sales were extremely unpredictable at the start of the year. However, 2020 was a surprisingly good year for global EV sales, with a 43 % increase over 2019. This, 2022–2023 has a different set-up as the global market is facing rapid growth. The crush on EVs spread rate across the world was noticeable as the globalization of the selling rate of EVs in the year 2022 faced accelerated growth. The crucial challenge of decarbonisation has been taken into account by many developed countries seriously. It can be stated that for the recent 5 years including the current year, a great number of 3.2 million and more plug-in EVs had been already registered. The global suitable sales of passenger EVs have touched the range of 71 % increment which is noted by Counterpoint's Global Passenger Electric Vehicle Model Sales Tracker in the year 2022 (Xue et al. 2021; The Global Electric Vehicle Market). In terms of electric vehicle sales, the year 2021 represents a significant advancement. Moreover, different industries are unmistakably manufacturing for fulfilling the ambitious goal of zero-emission targets set by 2050, which will be primarily driven by electric vehicles. Figure 1 displays graphical

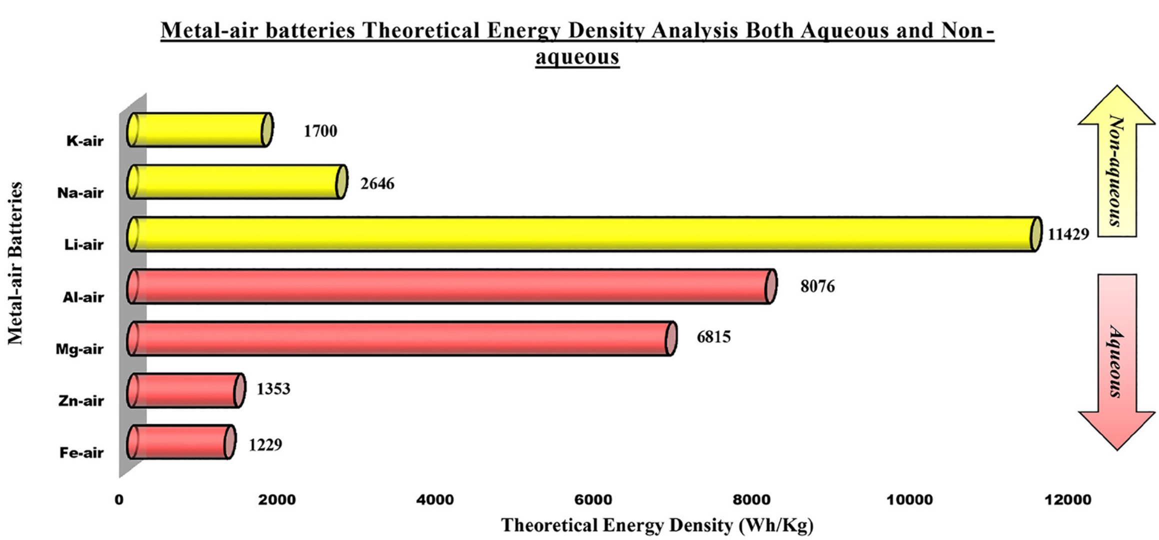

Figure 1: Graphical representation of theoretical energy density of different metal–air batteries (Li et al. 2017).

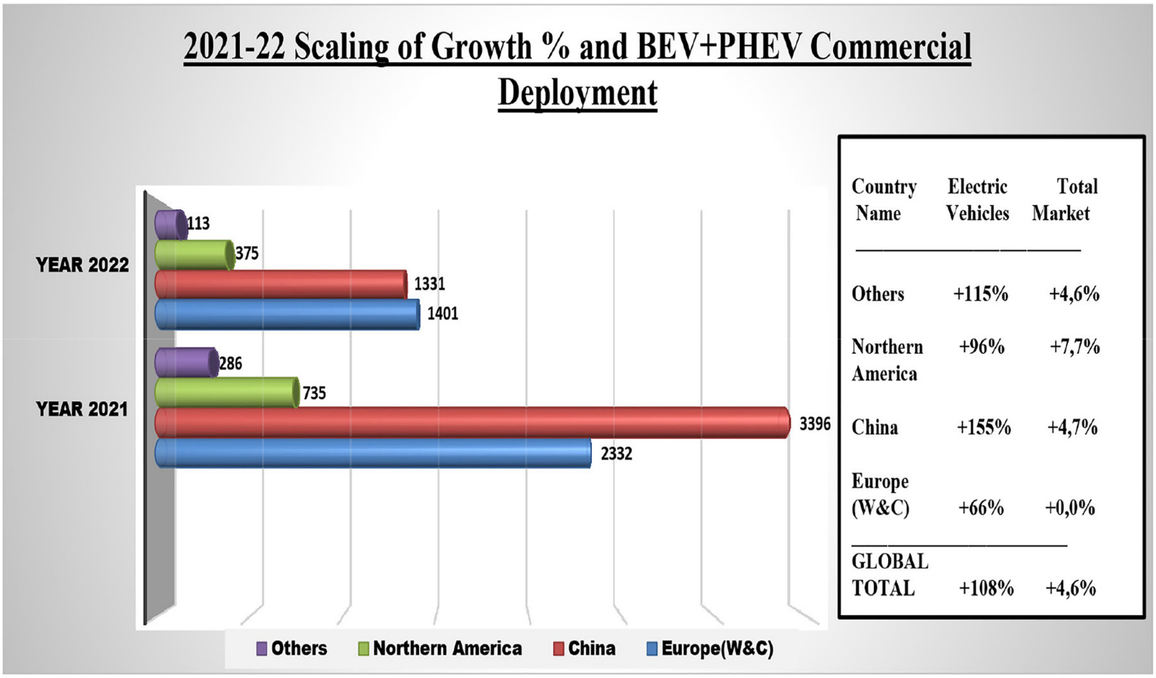

Figure 2: Graphical representation of BEV + PHEV Car Sales and the country-wise Growth (The Global Electric Vehicle Market).

representation of BEV + PHEV Car Sales and the country-wise Growth in percentage (Figure 2).

3 Different technologies used in EV and their importance

3.1 Charging a battery

When charged, the AC motor drive converts to a rectifier named Power Factor Correction or PFC, but the bidirectional stage of DC–DC continues to enthusiastically regulate the V_c potential. The battery pack and DC–DC converters include two battery packs. There is also a bridge rectifier single-phase source, a 3F capacitor, an electromagnetic interference filter, and a mechanically operated switch to trigger the motor's centre tap. It is also necessary to measure the rectified voltage. All other power charge measures are already available for regulating the motor drive (Pellegrino, Armando, and Guglielmi 2010). A 12-V auxiliary battery is required in EVs to power the vehicle's numerous electrical components, drive and control circuits. The EV's drive's supplementary battery operates in buffer mode. When the car is turned on, the 12-V battery powers the load, even though the propulsion battery array supplies it via a DC–DC converter. This technology relies heavily on the car's speed because it works best when it is moving at a high speed. In this case, a vertical axis wind turbine was implemented. Using CATIA V5 software, the dimensions of vertical axis wind turbine blades are both calculated and applied. In this application, a power boost (DC-to-DC) converter is implemented to level up the potential range and output of the arrays in electric automobiles (EVs). The voltage controller is also involved to keep the potential difference constant across the internal circuitry (Hussain et al. 2021). The charging behaviour of automobiles is first simulated using Monte Carlo simulations based on statistical distributions of various fleet types. Individual vehicle charging behaviours are then calculated and averaged to define the EV fleet by collectively charged requirements. This study looks into the EVs' hybridized energy hub technology to predictably charge these battery boxes. The foreseen AC-motor (ACM) was subjected to performance investigation of the generator under variable loading conditions that include 0.5 kW, 2 kW followed by 4 kW. Further to that, the envisaged automatic charging arrangement had been tested using deprived of variable frequency transformer (VFT). The wound rotor induction motor (WRIM) of the VFT is reflexively linked to the dc power motor drive (DDM). The SG powers the battery packs while the car is moving. The Yingli Green Energy (YGE) 60 solar module has been tested at various levels of irradiation (Chellaswamy, Balaji, and Kaliraja 2019). Therefore, the above description demonstrates how critical it is to develop innovative energizing technologies to solve the barrier and promote the use of EVs.

3.2 Aerodynamics analysis

Aerodynamics is the study of how a moving vehicle interacts with air motion. The best places to put a wind turbine on a car, according to three different models, are (1) in the front phase of the shield, (2) at the highest point of the vehicle top, and also (3) on the ridge of the car. The vehicle models measure in 4.2 m in length, 1.7 m in thickness, and 1.8 m in height. Each model's anterior space for the air-driven turbine technology is calibrated to be 0.2 m × 0.75 m. The required boundary size is $15 \times 15\ m^2$ in entrance and outflow region with a 30 m length. To calculate both the drag and lift coefficient, simulations of all three models will be run under similar conditions with an input velocity of 25 m/s (90 km/h) (Mohd et al. 2014).

3.3 Regeneration system

The regenerative braking system reduces vehicle emissions. The energy from the braked parts is removed, stored, and reused using braking technology (Clarke, Muneer, and Cullinane 2020). To harvest more power in a potential way, new power fruitage, and consumption arrangements have been projected for the retirement co-ordination. The new ESS and coordinated control of the two actuators are used to accomplish this. As the regulator of the external actuator (second actuator), a skyhook control technique is used to separate the shaking of the vehicle frame. For the second actuating part, exterior control is designed to mimic the operation of a damper (passive) and continuously gather power. The controller of the inner portion is issued to manage the current flow through the two actuators to attain the required harvest forces with the external regulators' forces. While second actuator's inner controller only contains the buck-boost converter, the first actuator inner controller includes the inverter (3-phase), controller, and the boost-buck controlling. Regarding this suggested ESS, the well-defined control approach could be implemented by utilizing road data from additional brand-new technologies. For example, road classification technology followed by an intelligent transportation system (Long et al. 2020). A 3D model of CAD with two channels was created in Solid Works using two different cross sections of electric cars – a large front side and a smaller ending portion for the passageway. A CFD portion of electrically powered car investigation was performed by a Fluent named ANSYS. The intake capacity of the vehicle was set at 100 km/h. The cross-sectional air flow rate is incremented and is used to power both fans of the turbine which are located in both channels surrounding in the both compartments of cars. For the maximum efficiency and torque generation, a five-bladed fan was analysed with Q-Blade software with help of NACA aerofoils. Two numbers of alternators were coupled to the fans. To achieve the required output potential by converting it to the higher level of potential, the system requires energizing a high-powered automotive battery bank by eliminating the rectifier of the AC–DC diode bridge (Gupta and Kumar 2021; Hamid, Sheeba, and Sofiya 2019).

3.4 Reaping potential from a rotational wheel using a pendulum

The weighted pendulum in the current energy harvester design is made up of eight magnets permanently arranged in a floppy-shaped arrangement and eight corresponding coils attached to the wheel (Gupta and Kumar 2021). A weighted structured pendulum is associated with a spinning wheel by the frictionless axis. They define two coordinates to represent the motion of the revolving helm and the one-sided bob: a moving frame and a fixed (x,y), (ε,n). As the wheel rotates, a weighted pendulum oscillates (Wang, Chen, and Sung 2012).

3.5 Harvesting energy using piezoelectric material

The leading component of the generator is a tube with a piezoelectric stream of light installed at every end; when forces are applied to the tube, a tiny ball bearing can swing freely in reaction, impacting the piezoelectric beam (Wanga, Chenb, and Sung 2010). The design of a wheel vibration measuring system is described in this broadside. The outside of the hub is glued with a DYTRAN tri-axis accelerometer 3133A2. The accelerometer is glued to the get-up-and-go harvester's position to ensure that the measured effects accurately show the energy harvester's condition during excitation. The power harvester centred on the cantilever piezoelectric is intended and manufactured based on the individual vibration in the wheel. Its natural frequency is 45 Hz. The capacity of the power gatherer to generate electricity is tested using the designed testing system. The piezoelectric cantilever projected output stream of light is rectified into the direct flow of current with minimum levelled impedance, along with minimum levelled potential and maximum flow of current through the LTC3588. Rectification is implemented at the fit of the loads in the portion of the tire. It can collect output from the piezoelectric structure by converting it into a highly active energy for micro-controller with smart sensors, or wireless transmission devices (Manla, White, and Tudor 2009).

3.6 Self-charging vehicle

The bicycle is outfitted with PV panels and a hub motor for easy riding. A solar controller is connected to the batteries to convert solar power into electricity and is kept in batteries, which provides power to the hub motor. The throttle and motor controller are also used to control the speed of the bicycle (Zhu, Han, and Zhao 2017). The solar panel is mounted on the car's roof. Using a converter (boost-buck) and the relay's circuitry, the solar panel's potential could be used to control the batteries. By sensing the microcontroller signal, the relay circuit can be tripped. Sometimes, a relay circuit is used to alternately charge the batteries (Karthikeyan et al. 2019).

3.7 Energy harvester for connected vehicles

The initial component of some self-charged EVs is a fan that converts the kinetic energy of the blades into wind power. It is placed toward the forward-facing of the car. This fan is attached to the PMDC motor's shaft, which will rotate it. The harvested electricity from this EV can be calculated using parallel and series voltage and current sensors respectively. The relay will turn on if the voltage across the battery shows between the mini-set potential voltages, if not, it will remain off. Limiting the abundant power bank is exciting. This can be controlled from remote distance. The results of this access are thankful for the development of a mobile app that used a Bluetooth module (Kumar et al. 2019).

3.8 Power generation using the front and roof side of car

The renewable energy sources are strategically placed with the vertical axis turbine (wind-driven) in the anterior of the vehicle and the monocrystalline panel (solar-powered) on the roof. Electric vehicles are propelled forward or backward by single or more electrically powered motors that draw stored energy from rechargeable batteries (Khan et al. 2021).

3.9 Recovery energy from the moving car

When the VAWT is integrated into the highway median, wind from both sides of the median will affect its output. The template did not account for vertical side flow. The research found that the superficial archetypal can accurately predict how new thriving VAWTs will perform (Saleem et al. 2020).

3.10 Portable charger

This is best way to place the charger at the front of the scooter. The coupling method of charger is to attach an iron shaft as the mediocre to bond a wind-powered turbine to a DC generator. After the electrical energy has been transformed, the converter (Buck) is implemented to generate a stable 5 V. When combined with a load, a super-capacitor acts as a power storage device, storing and discharging electricity (Tian, Mao, and Li 2017).

3.11 Charging station

The long prime windings are mounted under the road and the subordinate pick-up windings are put in below the frameworks of each electric vehicle for the CPT system on-road energizing. The potential voltage is conveyed to the electrically powered vehicle when the vehicle is moving over the CPT structure and the secondary and primary are electromagnetically connected (Subhashini, Abdulla, and Mohan 2018). In another case, the solar photovoltaic array, battery bank, fuel cell, wind turbine are all connected to a DC bus that makes up the DC portion. The small-scale Distributed Energy Resources (DERs), wind energy, and solar energy are all connected by an AC bus in the AC portion (Diesel generator) (Stamati and Bauer 2013). The PV/battery/wind hybrid potential resource configuration is used for PHEVs. It is made up of a Li-ion-based (re-energizing) battery that has the primary power storing scheme, a DC to DC (bidirectional) buck-boost controller coupled to the rechargeable arrays, a DC/AC single-phase inverter with a bidirectional facility installed among the grid, and the set of batteries to supply vehicle-to-grid (V2G) action, a PV powered unit as the second potential cause, a DC/DC boost controller with unidirectional facility connected to the PV segment (Pavan, Vijayendra, and Shashikala 2020). In this way, the hybrid-powered proposed rapid arraigning system can be applied to two EVs at the equivalent instance. The scheme has a DC-powered bus-bar that has the core assembly between each of the controllers and inverter. An inverter power flow with a bidirectional facility connects the system to the grid. This gives the ability to the system to flow power to the grid (S2G). If the scheme has sufficient vitality and does not have any problem when the EVs are charged, the structure can afford the potential voltage to the grid (Fathabadi 2018).

4 Case study

4.1 Two wheelers

Converting a regular bicycle into an electric bicycle powered by a hub motor and a battery, as well as converting an electric bicycle into a solar cell-powered cycle, is one mechanism for the mandate. The solar panels are attached to the bicycle and the hub motor is linked to make riding easier. A solar controller is linked to the battery. Some vital highlights are:

- A normal bicycle has an uppermost speed of 15 km/h, whereas a solar bicycle has a top speed of 25 km/h.
- Human power is required for regular bicycle riding, whereas solar and human power is both required for solar bicycle riding.
- A standard bicycle weighs 18 kg, whereas a solar-powered bicycle weighs 35 kg (Kumar et al. 2019).

The major goal of the research paper is to grow a wind-powered power source that can replenish the automobile's battery. It can be accomplished by intensifying a wind turbine on the vehicle's frame to decrease mass and preserve torque. The charging circuit of the battery customs the voltage twisted by the wind turbines rotation. This circuit can renew each battery separately to prevent consequences in discharge. It was a hardware-based model. Few important outputs from the hardware model are:

- When the density of air ρ = 1.1839 kg/m^3 [Think through the air density at 30°]
  - The speed is 4500 RPM, and the power is 18 W.
  - The speed is 4000 RPM, and the power is 17.4 W.
  - The speed is 3500 RPM, and the power is 16.8 W.
  - The speed is 3000 RPM, and the power is 16.2 W.
- While the solidity of air ρ = 1.12041 kg/m^3 [Consider the air density at 20°]
  - The speed is 4500 RPM, and the power is 18.2 W.
  - The speed is 4000 RPM, and the power is 17.6 W.
  - The speed is 3500 RPM, and the power is 17 W.
  - The speed is 3000 RPM, and the power is 16.4 W.
- At what time does the concentration of air ρ = 1.1644 kg/m^3 [Contemplate the air density at 30°]
  - The speed is 4500 RPM, and the power is 17.8 W.
  - The speed is 4000 RPM, and the power is 17.2 W.
  - The speed is 3500 RPM, and the power is 16.6 W.

The speed is 3000 RPM, and the power is 16 W (Fahima et al. 2021). An on-sheet cell energizer configuration is shown that is entirely grounded on the power mechanisms of the EV motor initiative. The proposed solution satisfies all of the requirements for battery chargers, including reduced size, cost-effectiveness, maximum efficiency, and exceptional robustness. The anticipated on-sheet energizer alignment has been mounted on a prototype of an electric scooter. Some propulsion batteries are:

- A fully charged propulsion battery (220 V) with a high load current (3 A) (0.8 A).
- 150 V of low charge and current is 0.8 A for propulsion of battery (Solero 2001).

Disadvantages: The number of the studies on propulsion battery is very less.

4.2 Charging station of EV

Capacitive Power Transfer (CPT) is known as power transfer without contact for on-road power provided to electric automobiles. The main focus is on the charging system and how charging is possible while driving without physical interconnection. The CPT has two windings, one on the road and one beneath the car chassis, which allows electromagnetic power to be relocated. This paper investigates the implementation of such on-road repowering systems to increase the range of driving quality with reduced EV array size. The percentage of the covered distance on the road by considering the system's power and power allocation capacity was calculated. Some design thoughts are mentioned, such as the spreading and length of CPT sectors on the road. For example, if the on-road system transfers 25 kW and there is 40 % road coverage, an EV with a typical-size battery (24 kWh) could drive 500 km. An EV with half of an array power or 50 % capability requires approximately 30 kW from the CPT system (Subhashini, Abdulla, and Mohan 2018). The survey target is to measure a hybrid fast DC charging location to reduce peak demand during indicating periods. When combined with dynamic data, the proposed energy management algorithm produces additional consistent outcomes for such system actions. With the projected controller algorithm, peak grid demand is compacted by 45 percent, and the lifetime of the battery is extended due to additional controlled charge-to-discharge synchronization. This can help to reduce peak challenges upon the grid while also reducing negative effects like stability, potential vacillations, losses, and system errors (Fathabadi 2018). The primary goal of this study is to identify the best alignment or combination of non-conventional resources, potential, storage schemes, and a conventional diesel generator set for off-grid electric vehicle charging. The idea is to use a hydrogen-based system to charge batteries in electric vehicles, allowing them to be self-sufficient. It is naturally compatible with a mobile charging solution. The fuel chamber can power the 40 kW arrays, which are then used to power the electric vehicle and are powered by hydrogen stored in on-site tanks. Finally, it is possible to reduce the strain on the existing electrical infrastructure by taking advantage of the affordable availability of EV charging stations in remote locations. If there is possibility to take advantages of the affordable obtain ability of EV powering stations in remote locations, it is possible to reduce the strain on the existing electrical setup. An appraisal of off-grid and grid-connected EV powering stations is ended, and it is discovered that the off-grid energizing station have recovering possibility (Stamati and Bauer 2013). They look at the ecological inferences of investing in various types of electrically powered automobiles and charging modes (slow and fast) under different wind distribution levels. They completed this in Beijing in the year 2020 as an event investigation and hour-based simulations of automobile charging performance and potential system processes. Assessing slow repowering, they discover that speculations in electric secluded light-performance vehicles can outcome in significant CO_2 emissions reductions at various wind penetration levels. The quick-charging option, on the other hand, is harmful. Electrifying automobiles are the most operational way to reduce NOx releases, a major forerunner to air pollution (Chen et al. 2018). This work presents an integral array charger for a plug-in scooter with high potential cells and an interior-stable magnet motor to pull the drive. The controlling of the energizer is done by the scooter firmware regulator, which is created as a point-fixed controlled DSP. The embedded battery supervision system in the battery pack determines whether the charge mode is current-controlled or voltage-controlled. The research and planning charger's effectiveness is demonstrated experimentally on an electric scooter prototype model outfitted with two Li-ion cell packs rated 260 V, 20 Ah (https://www.greencarcongress.com/2017/07/20170706-bnef.html). A modest commercial three-bladed rotor-based wind-electric battery-charging system has been thoroughly scrutinized. The system comprises a six-pulse rectifier, a synchronous generator with permanent magnets, and a power bank with a controlled charger. A smooth-state power cover is expected based on the material of electric naked through experimentation and the aerodynamic enactment of the rotor computed via a variant of the blade element momentum (BEM) theory created by their research. The aerodynamic coefficients were calculated using the commercial CFD solver Visual-Foil, which was designed specifically for aerofoil characterization. When the BEM simulation was run in the erratic Reynolds number mode, a moral forecast of the manufacturer's power curve was obtained for wind speeds ranging from 2 to 12 m/s (Nez et al. 2006). A semi-empirical battery wear model has been practically provided for charging arrangements for EVs. The projected battery wear model is based on extensive investigational data from the manufacturer's life cycle. It involves the variable cost of the battery in simulation to see how it affects the control scheme. Wearing costs for a $9000 & 16-kWh battery is calculated (Han, Han, and Aki 2014). They propose a hybrid artificial intelligence-based EV charging behaviour prediction scheme for the 5G smart grid, which will identify targeted EVs and prediction of the energizing behaviour. As hardware is used for realizing hybrid synthetic intellect algorithms, they create an original smart grid network design based on network slicing and edge computing. In connection with forecast correctness and precision, simulation results show that the projected prophecy scheme outperforms numerous state-of-the-art EV charging behaviour prediction methods (Sun et al. 2020). Using data from the American Housing Survey and the Residential Energy Consumption Survey, they assess prevailing and potential alleging arrangements for plug-in automobiles in US households. Parking spaces are owned by a solitary 61 % of households and 47 % of automobiles. As a result of the split incentive, increasing PEV penetration above 47 % will necessitate charging substructure at rental items, which involves the split incentive creating investment obstacles (Traut et al. 2013). This paper provides an overview of electric vehicle knowledge and charging procedures. It covers a wide range of electric car-related topics, such as the rudimentary kinds of these automobiles and their technical properties, fuel efficiency and CO_2 emissions, electric vehicle charging processes, and ideas for grid-to-vehicle clean grid topologies. For such vehicles to have zero emissions from a comprehensive study, the electricity used to recharge the batteries must be generated from renewable or clean sources (Poullikkas 2015). This study investigates how public charging infrastructure may increase the percentage of electric driving that plug-in hybrid EVs may exhibit, thereby lowering their gas consumption. It has been discovered that public charging offers greater fuel savings for hybrid vehicles with smaller batteries than home charging alone by encouraging within-day recharge and providing a comprehensive public service. As a result, plug-in hybrid EVs are likely to consume less gasoline and spend less money on energy. The paper wr about vehicle activity data from a global positioning system tracked domiciliary transportable survey in Austin, Texas, is a jumble-sale to estimate the gasoline and power consumption of PHEVs (Dong and Lin 2012). This paper focuses on scrutinizing faster-charging station usage patterns as well as the role of fast charging in comparison to other charging methods. These trends are investigated in terms of vehicle technical capabilities, and it is discovered that the rate of quick charging decreases when battery capacity increases. Data has been obtained from Multi Tank Card, a major Dutch mobility provider. According to the results of the spatial analysis, most fast charging occurs far away from the home, indicating that most charging sessions take place “on the highway”. This demonstrates some future possibilities for quick charging in cities with a plentiful supply of on-street parking spaces (Wolbertus and Hoed 2020). This paper presents the findings of the Western Australian Vehicle Trial (2010–2012) and the ongoing Perth Electric Vehicle Charging Research Network. For EV trial users, web software is used. The energy used by automobiles to perform the grid between 8 and 10 a.m., when the vehicles were at work, according to the findings. During the day, charging stations supplied the most energy to EVs, which could be offset by solar/PV systems (Speidel and Braunl 2014). An Act BM micro simulation prototypical for the region of Flanders is used to simulate the daily sequential and spatial behaviour of EVs in Belgium. The FEATHERS model’s vehicle mobility data is initially used to determine the proportion of drivers who could use an EV without changing their regular mobility habits. The GAMS® and Cplex Solver optimizers were used to solve the unique problem for each agent. 81 % of drivers would only need night charging for the daily activities in the Flanders region to manage their schedule while driving an EV. This percentage rises to 92 % if the infrastructure’s immediate slow charging is available (Gonzaleza et al. 2014). This broadside builds an optimization model to identify the minimum battery ranges required 3 to meet 100 % of individual travel demands while accounting for public charging infrastructure accessibility. The important points found from this paper:

- 45.5 % of taxis have an ideal 100–200 miles range.
- 77–78 % of cloistered cars and cabs have a range of a battery of fewer than 30a 0 miles.

Increasing the service range of charging infrastructure by reducing the minimum required battery options is the final goal of the paper (Shi et al. 2018). The paper employs a mobility model, a power cell model, and a solar simulation with dignified data for PV-based generation for vehicle evaluation. In the absence of additional solar generation, they demonstrate that energizing four million automobiles from the grid has a tendency to exceed the grid’s capacity. PVLib Python is used to simulate solar PV generation using historical weather data. PVLib Python is a MATLAB extension version to PVLib. South Africa’s reliance on coal for electricity generation led to the unexpected discovery. The annual of total CO_2 emission has increased by 23 %, from 2251 to 2777 kg CO_2 per year (Buresh, Apperley, and Booysen 2020). It suggests the concept of generalized energy in IIS, which is based on the power flow between IIS and EVs as well as between IIS and the authority grid, for systematically evaluating IIS’s energy capacity. A CES algorithm and simulation are used at various charging and discharging load states. To validate the effectiveness of the proposed charging/discharging strategy, a dynamic load profile is created. Ten electric automobiles are divided into two groups of five. At 4:00 and 7:00 O’clock, the leading set of batteries is replaced two times in a single cycle. Similarly, the second set exchanges batteries at 16:00 and 19:00 O’clock (Xie et al. 2015a).

Disadvantages: Previous studies have faced the problem regarding lack of cost data (https://www.greencarcongress.com/2017/07/20170706-bnef.html; Long et al. 2020; Nez et al. 2006; Traut et al. 2013; Wolbertus and Hoed 2020). Some, on the other hand, have discussed some critical information. Due to the long parking times for battery exchange, a charging station is required in this situation that will allow for slower charging and lower station costs while also increasing EV usage.

4.3 PV/wind-based EV

The solar/wind-based system on the electric vehicle can charge the batteries during the movement. The battery charging system of an EV can be powered by 420-W flexible solar on the car roof and 400-W microwind at the front of the vehicle condenser. The software MATLAB is used here to design the system. Within one sunny day, the panel (PV-based) and micro-turbine (wind-based) both added extra potential to energize the Lithium (Li)-ion battery with 30.7 kWh (Elma 2020). A hybrid renewable resources such as the air generator and photovoltaic systems are used here to generate energy to automatically recharge the e-vehicle (EV) packing system. This study describes a mechanized charging apparatus (ACM) that re-energizes the battery packages automatically, eliminating the unnecessary wait for re-energizing EVs and increasing charging levels. The MATLAB-Simulink model is used to create the proposed ACM. The outcome potential of the turbine (airflow) is distinguished for three different speed circumstances. The performance of the PV has been subjected to various irradiance intensities. A sequence of lessons under various load conditions was considered for the established ACM model. The vehicle’s efficiency and coverage distance, as well as the THD of the harvest current and voltage potential, have all been investigated. The simulation results show that ACM has sufficient performance characteristics for charging EV batteries without the use of recharging stations. Spontaneous EV charging increases EVs use, which drastically reduces the use of fossil fuel vehicles, resulting in significantly lower CO_2 and CO-related emissions (Chellaswamy, Balaji, and Kaliraja 2019).

The intention and implementation drive scheme of hub was for hybrid and all-electric automobiles. Firstly, a hub-driven hybrid electrically powered automobile was built using MATLAB-SIMULINK. Two brushless-based DC machines of 15 kW each were designed and built to fit inside the wheel rims. Finally, introductory road tests are carried out, yielding encouraging results. For the various cycles, ICE, Electric Initiative, and Battery potential for optimizations are investigated (Singh, Jha, and Sinha 2011). The study intends to look into how a power train reduces daily carbon releases from hybridized (plug-in) electric automobiles. Several persuading factors are being inspected, the protocol of the charging, time, on-way potential organization technique, battery capacity, and grid emission (carbon-based). For the quick simulation of the hybrid power train, the quasi-static modelling method is used. So, ICE and HEV cannot interact with renewable energy to reduce CO_2 intensity when charging from the grid and their batteries are used less than in PHEV circumstances. Only PHEV cases are evaluated to avoid outcomes that are simple to understand (Hu, Zou, and Yang 2016).

Disadvantages: Previous studies have faced lack of charge information (Chellaswamy, Balaji, and Kaliraja 2019; Singh, Jha, and Sinha 2011). However, some have discussed some critical information. The electric vehicle (EV) is a better option among all vehicles than traditional systems for maintaining a healthy and environment-friendly environment, and it is thoroughly worth the investment.

4.4 Wind turbine placed on the front side

The wind-powered turbine is installed on the top portion of the grille of the vehicle. For a 3D turbine design, CATIA V5 software is used in the paper (Hussain et al. 2021). In the result it is found, when the car is travelling at 40–60 kmph, the VAWT produces 0.5 kW (Hussain et al. 2021). A unique approach for harnessing energy from a small-scale wind turbine is presented for the result of vehicle mobility, this system will give support to the communications primitives in electric vehicles and enabling a wide range of IoV (Internet of Vehicle). The best orientation for maximum conversion efficiency is advised using aerodynamics assessment. It is done for both hardware and software-based systems, and used ANSYS software. The wind turbine is housed inside the vehicle's front grille. Using MIT App Inventor, they invented an Android app that displayed the battery percentage as well as the electrical input and output signals. By using the HC-05 Bluetooth module, all such data were relayed from an Arduino to a mobile device via Bluetooth. The DC generator generates a total load voltage of 35 V, resulting in a 100 W supply (Khan et al. 2021). In this, a wind turbine is mounted on a motorcycle to serve as a portable charger. While transiting from one place to that other, a charging system for electronic devices is fitted on the motorcycle. To begin, a portable charger is powered by a wind potential harvesting system. The motorcycle has a speed range of 50–100 MPH and specific sorts of blades (2, 3, 4, and 5). Second, while simultaneously charging the power bank, a supercapacitor is implemented as the potential storage facility for an Arduino microcontroller. At 1297 RPM, the maximum voltage produced is 17 V, which is enough to run the entire system, as it appears to require 5.3 V to ride (Zhu, Han, and Zhao 2017).

Disadvantages: As little more than a consequence, a battery charging system is designed, and this is capable of producing the required power for charging, resulting in a significant economic opportunity and a cleaner environment.

4.5 Wind turbine placed on the car hood side

An air-driven turbine (vertical axis) was installed to improve power from moving cars'. It was intended to be installed alongside a car lane and run on the vehicle's wake. Transient computational fluid dynamics was used in the simulation (CFD). The VAWT was able to produce a concentrated power output of 100.49 J from a car's wake as proof of the plan's feasibility. The domino effect shown that the car's speed increased (Tian, Mao, and Li 2017).

Disadvantages: Estimating data is insufficient because they have only discussed recovering potential from the stir of a motion-activated car.

4.6 Solar panel placed on the top of the car

The suggested project entails creating a self-charging, battery-powered vehicle for one passenger weighing up to 50 kg. This technique was developed to create a self-charging battery electric car that recharges the batteries using the energy from rotating wheels, introducing a system that eliminates pollution from the car. It is a hardware model that employs solar panels. To charge the batteries from the sun, a buck-boost converter and relay circuit are used. Stepping up or stepping down the solar source to a constant voltage of 12 V is possible. The voltage can charge the batteries in two ways using a relay circuit. It can be tripped by sensing the signal from the microcontroller (Karthikeyan et al. 2019). To swap the engine of internal ignition, a small-sized photovoltaic (PV) section mounted upon the PHEV's top and a micro air turbine mounted at the front side of the PHEV along with the air conditioning arrangement's condenser are projected. The primary energy storage device is a 19.2 kWh Lithium (Li)-ion battery, with a PV module, an air power conversion system (WECS), and a micro air flow turbine serving as green and renewable power with auxiliary power sources. A cell array/PV/airflow hybrid energy source demo has been built. An investigational verification shows that using the PV structure and micro air turbine can improve 19.6 km to the array of cruising along the PHEV weighing 1880 kg over two sunshiny days, as well as maximum efficient power and speed of 91.2 percent and 121 km/h, respectively when associated to normal PHEV operation. Using the pulse width modulation (PWM) technique, this work also provides highly an exact DC-link potential directive and generates a suitable 3-phase stator current for the traction motor (Pavan, Vijayendra, and Shashikala 2020).

Disadvantage: very less number of cost data found from previous studies (Pavan, Vijayendra, and Shashikala 2020). Some have discussed some critical information about PV arrangement.

4.7 Analysis of aerodynamics

A wind-powered turbine system is used for the improving the performance of aerodynamics equipped moving car. ANSYS is used to govern to force drag of the car, and the fluent software was used to simulate three carousels of the car with different positions of the wind turbine. Some important highlights from the paper are:

– Drag force on No wind turbine is 0.39.
– Drag force on the front side of the vehicle is 0.39.
– On the Hood side of the vehicle is 0.45.
– On the Roof side of the vehicle is 0.51.

The spot of a wind turbine implementation, based on experiment, will affect how air flows around a car's body and how will the vehicle accomplishes aerodynamically (Mohd et al. 2014). There is a dearth of price information as they have attentive only to the aerodynamics analysis.

4.8 Pendulum mounted on the wheel

The authors propose a biased-bob-type magneto-electric harvester system configuration for generating power from a spinning roll. The natural frequency of a suitably weighted pendulum, where oscillation occurs for variations in the periodical module of tangential gravitational power, could keep up through the spinning regularity of the roll at variable speed, unlike traditional energy harvesting devices. Similarly, the pendulum fluctuates at a bulky angle with angular velocity, producing a significant amount of energy. The physically active structure of the pendulum was created primly, followed by the mathematical solution of gesture using the Lagrange procedure. The control harvesting scheme was then developed using Faraday's law of electromagnetic induction with Lorentz's force law. It is a numerical as well as an experimental model with several hundred microwatts of power output (Gupta and Kumar 2021). It is a numerical as well as an experimental model. A well-biased pendulum was used in this study to extract power from a spinning roll composed of a bob and additional weights oscillating a bob cannot oscillate with a bulky angle at any wheel velocity. Three well-attributed weights assisted the pendulum in naturally adjusting frequency to meet the well-oriented frequency in this study. As a result, a well-oriented pendulum can oscillate with a significantly large angle and maximum velocity at different wheel speeds. The obtained kinetic potential was renewed into electrical power via electromagnetic property induction. A mathematical analysis exposed that the well-designed exposing generated energy is in the MW range. The numerical results obtained by implementing the well-weighted swing logical model matched the experimental results very well. The angle of swing of the weighted bob was measured at 43° at a roll revolving speed of 350 RPM, which was 8 times that of the low-weighted design, indicating that the new plumb design wavered at superior angles (Wang, Chen, and Sung 2012).

Disadvantage: the layout has the probability to provide a trustworthy, low-cost power source for Tire Pressure Monitoring systems (TPMS) system only.

4.9 Regenerative braking system

A new re-forming active deferment system with dual actuators for in-wheel, relying on the advanced damper mechanism with the dynamic scheme is proposed. It's a model based on simulation.

– A dual actuator that reduces vehicle vibration while also improving energy conservation performance.
– Boost-buck, multiple feedback signals to control current for manage generator damping force.
– Quantitatively examined ESS terminal voltage effects and created a hybrid ESS with threshold power management for high recovery efficiency.

The fallouts display that the anticipated powers of damping actuators are indeed talked irrespective of voltage circumstances. The comfort level of the ride and overall presentation of the vehicle is upgraded by 52 % and 14 %, correspondingly. Furthermore, the variable thresholds strategy outperforms the fixed one in terms of regenerative efficiency. After subtracting active co-related energy, the regenerated average power on four classes of roads (A < B < C < D) is 4.9, 17.7, 49.2, and 45.0 W, accordingly. The proposed scheme has been validated as a practical resolution for concurrently improving vehicle dynamics and potential conservation presentations (Mohd et al. 2014). A new renewing decelerating system has installed for the application of HESS to EVs powered by the BLDC (brushless DC) motor. MATLAB/SIMULINK is used to model the proposed Regenerative Braking System. The system's simulation outcomes are –

- With a battery, the ESS reveals that the battery begins at 100 % and drops to 88 % after 10 s.
- The outcome of the super capacitor pack battery simulation, the battery's SOC is improved here when compared to batteries alone.
- There is energy regeneration when braking. SOC rises between 7 and 10 s (energy regeneration).

When it comes to electromagnetic torque, energy regeneration occurs between 4 and 6 s after braking, results a negative torque (Gonzaleza et al. 2014). The study proposes an induction-motor-driven EV for regenerative braking (RBS) with a battery energy storage system (BESS). They have used MATLAB software for simulation purposes. The vehicle's kinetic energy is absorbed by energy storage during regenerative braking or energy regeneration. As a result, an electronic interface is no longer required. The PI controller in the PMW inverter controls the duty cycle of the PMW to maintain consistent torque braking (Mahija and Pal 2022). This research explored the vehicle's energy recovery system to reduce carbon emissions. In this technology, a DC–DC converter, an ultra-capacitor, and an auxiliary electric motor/generator are installed alongside the vehicle's internal combustion engine. From the Skoda Fabia, the CO_2 secretions are compact from 140 g/km to 108.4 g/km. Fuel feasting drops to 4.05 1/60 km when driving outside of cities. In urban driving mode, CO_2 discharges are compacted from 144.8 g/km to 67 g/km, resulting in increased energy efficiency (Clarke, Muneer, and Cullinane 2020).

Disadvantage: to be careful, automobile batteries must have high specific power, energy, safety, low cost and maintenance, and environmental adaptability.

4.10 Piezoelectric material fitted in the wheel

To generate energy from a spinning automobile wheel, a Thunder piezoelectric generator is used. The effect of revolving forces created at an automobile rim and the mechanism used to convert rotational forces into piezoelectric energy. A 2 cm^3 shaped generator produces 4 MW of electrical power at 800 RPM via a 0.12 m diameter test wheel. According to the analytical domino effect, the originator could generate control on a 13-in.-diameter wheel with a linear speed of 28.4 MPH (Wanga, Chenb, and Sung 2010). A wheel vibration measurement system is installed to measure wheel vibration at various speeds. The wheel's vibration characteristics are then investigated. Finally, a cantilever of a piezoelectric-based prototype is premeditated and verified.

- One of the two peaks has a frequency of 30 Hz, while the other has a frequency between 30 Hz and 60 Hz.
- According to the tests, the energy harvesting system can produce more than 12 MW of power.
- The energy-harvesting circuit based on the LTC3588 can convert and rectify the cantilever beam output to maintain a steady direct current of 3.3 V to power the electric equipment (Manla, White, and Tudor 2009).

To determine the energy harvested from vehicle tire excitation caused by rough roads, an iterative method is used to develop a conjectural model for a dual-mass piezoelectric ring tire farmer. A series of square PZT4 patches are evenly embedded circumferentially in a polymer ring to form the piezoelectric ring harvester. The results show that a harvester with a central angle h of 30, 0.25 m, 0.01 m, and 3 and wing radius, width, and thickness of 30, 0.25 m, and 3 can generate up to 42.8 W (Xie and Wang 2015b).

Disadvantage: there is an insufficiency of pricing data as they have talked about only energy generation when the car wheel revolves.

4.11 Energy harvesting at a shock absorber

The paper aims to investigate a potential-harvesting scheme for electric vehicles that takes advantage of vibration energy at a shock absorber. At the converter, the perturb and witness maximum power point tracking (P&O MPPT) arrangement is used to obtain electrical potential from a linear electromagnetically excited originator. The energy-collecting arrangement was validated with the PLECS version 4.4 simulation tool and the structure's active potential converter. The rated speed of the sub-motor was 1500 r/min, with a supreme speed of 3000 r/min and 1:5 gear-ratio between the gear ratio machine and the sub motor. The tremor speed of 0.25 m/s corresponds to a rotational speed of 2813.5 r/min under these conditions is considered, which is close to the maximum possible rotational speed of the sub-motor (Lee et al. 2021).

Disadvantage: there is a scarcity of pricing information as they have focused only on the energy harvesting system using the energy of vibration at an absorber of shock.

4.12 Fixed two ducts in the car modelling

Two ducts with varying cross-sections and a fan connected to an alternator were installed in a car model for this experiment. Wind speed and torque analysis were performed concurrently in ANSYS Fluent for alternator power calculations. The speed at the duct's end was between 121 and 147 m/s, and torque was calculated using this speed. Using the NACA 5510 aerofoil and the fan model from the Qblade software, the system is designed. According to the findings, a 23 % increase in total the range would result in environmentally friendly electric vehicles. The results show that above 1200 RPM, the voltage remains constant and the current increases in direct proportion to Revolutions/Minute (Long et al. 2020).

Disadvantage: this technology will aid in the creation of energy at no cost and will provide a much-needed boost to the EV industry, but yet not in commercial stage due to lack of policy supports.

4.13 Vehicle-to-grid technology

The purpose of this work is to design a three-phase battery charger for electric vehicles. The charger is bidirectional, so it can charge and can operate from vehicle to grid function. The software MATLAB is used for designing the model of EV-to-Grid technology. As a result, Case 1 is a sinusoidal voltage source (Charge Mode and Discharge Mode), Case 2 is a harmonic distortion in a voltage source; HDv3 equals 20 % (3rd harmonic), Case 3 is an unbalanced voltage source (zero sequence and negative sequence of the fundamental component: 20 %) (Lozano et al. 2011). Vehicle-to-grid (V2G) technology has been proposed as a means of accelerating electric vehicle adoption (EVs). Apart from communication between the EV and an aggregator, unidirectional V2G is appealing because it requires no additional infrastructure. POP selection algorithms are classified into two types: heuristic smart charging algorithms and optimal selection algorithms. The simulations are run every hour from 8 a.m. to 5 p.m. on each weekday in 2007. The day-ahead price and net load forecast errors are reduced by 100 % every hour because forecasting accuracy improves with time (Sortomme and El-Sharkawi 2010). The purpose of this paper is to present a framework for integrating battery-powered automobiles into the grid as dispersed power properties, acting as controllable loads while off-peak periods and as a storing scheme during the day to offer the ability and energy services to the grid. The BV aggregation is asked to provide 30 MW of regulation services between the hours of 8 a.m. and 9:30 a.m. The simulation results show that as the size of the BV aggregation grows, the ability to provide services increases (Guille and Gross 2009). It is an innovative grid-based solar and wind-powered electric automobile energizing station with vehicle-to-grid machinery. To track the maximum power points of the PV scheme and WECS in the energizing station, a novel fast and highly accurate unified MPPT technique was used. The investigational outcomes obtained from the daily operation of the built EV charging station validated that it not only delivers electric energy to energize EVs but also assists the local town power delivery link in providing enough electric potential in corresponding load management, particularly between 20 and 23 o'clock when grid load demand is peak (Fathabadi 2017).

Disadvantage: previous papers faced lack of cost information (Fathabadi 2017; Lozano et al. 2011). The model should take the lead of battery charge for the selected period while lowering customer charging costs. The additional costs of installing and maintaining the statement network for BV addition must be negligible in comparison to the BV price.

4.14 Vehicle-to-home technology

This update includes a methodology for optimizing energy management and component sizing in a single smart home with PEV, PV arrays, and home-based batteries. They aim to maximize domestic monetary output while meeting the demand for residential power and EV driving. The parameters of a household battery energy storage system (BESS) and electric cost are steadily observed while considering numerous time horizons for optimization, home-grown BESS prices, and PEV types and control modes. The CVX tool is used in conjunction with MATLAB software. Bidirectional power flow from a PEV to a home/home to a PEV reveals that the overall cost is 2.6 % lower in the V2H mode of power flow than in the H2V mode of power flow with unidirectional home-to-PEV power flow (Wu et al. 2017).

Disadvantage: when a suitable optimization time limit is used, the settled CP technique effectively deals with the optimization issues. The home BESS adds to significant effective pricing equivalents when compared to the choice lacking the home BESS.

5 Discussion

Electric vehicles have emerged as a symbol of environmental sensitivity and sustainability because, unlike traditional vehicles of internal combustion, they do not emit deadly pollutants into the atmosphere. Such sustainability lies in the use of electric or hybrid vehicles due to the factors such as their project, key resources used in fabrication, dynamism footprint created during use, and eventual of parts. However, some gaps have been found during the evaluation of previous EV studies. They are.

5.1 Research gap

– The battery technology of EVs is still facing a lack of improvement in terms of energy density, cost, charging speed.
– Charging time is avoided in more cases, accordingly, the emphasis must be on dipping the charging time.
– Alternative materials are required for batteries as battery materials are very less in nature.
– Overcharging the battery causes overheating, performance degradation, and battery damage. Deep discharge, on the other hand, causes permanent damage.
– Priority should be given to a wide-ranging economic viability study for the positioning of a maximum electrified public transport system.
– Internet of EVs concept, including new applications and services.
– The price of the hybrid scheme rose swiftly with the incremented capacity of cells, and mottled with dissimilar capabilities of PV units and wind turbines, given the prominence necessity to reduce the costs.
– Because batteries are so expensive and have such a short life span, there is a growing interest in evolving forward-looking charging procedures and a set of rules.
– The main challenge for battery electric vehicles is their limitless range and the requirement for frequent charging. New algorithm is required to increase the life of battery.
– As all the research is going on the passenger EVs, less number of research is going on heavy-duty EVs like truck, bus etc.
– No research has been found that talks about the reuse of EV's battery. Reuse of batteries can decrease the environmental effects.

5.2 Future scope

– Fast energizing, physical connectionless charging, and charging from non-conventional or sustainable energies are the most likely future trends in the charging of electric vehicles.
– Vehicle-to-power hub and vehicle-to-home are research interests.
– If the car battery dies while driving and there is no nearby charging station, the car can be turned off anywhere. As a necessary consequence, a self-charging scheme could be the elucidation of this badly behaved.
– Because the battery will overheat if it is fast charged and overcharged, a smart charging option should be available. Because this smart charging station will transmit all battery charging data.
– A perfect battery management system should required for EV that can control the bidirectional behaviour of the battery.

6 Conclusions

This study summarised the current condition of electric cars, various electric car types, various technologies used for charging, charging methods, commonly used batteries in electric vehicles, and upcoming innovations. When compared to the upkeep and fuel costs of ceremonial combustion vehicles, the vehicle's upkeep and energy consumption costs are noticeably lower. Because there are no tremors or engine noise, travelling in an EV is more relaxing. Because they have fewer, simpler components, these vehicles break down less frequently. Further to that, engine explosions, vibrations, and gasoline corrosion do not result in the inherent wear and tear that EVs do.

In the case of EVs, batteries are critical because they determine the vehicle's self-regulation. Based on these characteristics, we investigated various types of battery charging methods. We also talked about potential future technologies, such as renewable energy and others, which are expected to be a solution for storing more power and charging it in less time. This type of technology could also help to EV to reach higher ranges, which could encourage driver and user adoption. Compared to internal combustion engines, electric vehicles have numerous advantages and benefits. It is more proficient and cleanser, but it has drawbacks. It is heavier, has a shorter battery life before needing to be recharged, and is more expensive. The battery is critical to the EV's future. If researchers can develop or discover the "super battery," the future of electric vehicles looks promising. As of today, each vehicle has a distinct feature that distinguishes it from the competition. Only time and technological progress will tell which vehicle will triumph in the future.

Concerns about reducing the hazardous effects of vehicle exhaust and climatic intolerance have shifted countries' attention away from traditional oil-powered automobiles. Power and battery players have numerous opportunities. Small-scale businesses can also benefit from EV charging stations. This could benefit the Make in India initiative and provide opportunities for Indian businesses. India can reduce its reliance on imported oil and gas by developing these segments. Not only India, but the whole world can get benefits from this EV.

Imminent smart cities will have a significant impact on the EV industry; therefore, having flexible charging techniques that can respond to consumer needs will be essential.

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