Hindawi
Complexity
Volume 2022, Article ID 3304796, 21 pages
https://doi.org/10.1155/2022/3304796

Review Article

Advancements and Future Prospects of Electric Vehicle Technologies: A Comprehensive Review

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Received 19 March 2022; Revised 25 May 2022; Accepted 2 June 2022; Published 1 July 2022

Academic Editor: Xiaoqing Bai

Greenhouse gas (GHG) emissions are one of the major problems that the world is facing nowadays. The transportation sector, where vehicles run on oil, contributes a large amount of GHG. The development of electric vehicles to meet the allowed GHG limits has recently been the main focus of research worldwide. Research in electric vehicles (EVs) has observed a tremendous upsurge in recent years. However, reviews that analyze and present the demand and development of EVs comprehensively are still inadequate, and this integrative review is an effort to fill that gap. This study has revealed many thought-provoking understandings related to specific developments, specifically global demand and growth of EVs along with electricity and battery demand, current technological developments in EVs, energy storage technologies, and charging strategies. It also details the next generation of EVs and their technological advancements, such as wireless power transfer. The development of a smart city concept by EV implementation added a new aspect to this review. The summary would be advantageous to both scholars and policymakers, as there has been a lack of integrative reviews that assessed EVs' global demand and development simultaneously and collectively. This review concludes the intuitions for investors and policymakers to envisage electric mobility.

1. Introduction

Electric vehicle (EV) adoption rates have been growing around the world due to various favorable environments, such as no pollution, dependence on fossil fuel energy, efficiency, and less noise [1]. The current research into EVs is concerned with the means and productivity of expanding transportation, reducing costs, and planning effective charging strategies. Regardless of whether it is a hybrid, a modular crossover, or one of a multitude of functional EVs, people's interest will increase with falling costs. Moreover, the development of EVs is based on current and future global demand, which is interconnected to electricity and battery demand. Besides that, the productive development of EVs depends on the improvement of global values, EV policies, comprehensive frameworks, related peripherals, and easy-to-use programming [2]. However, the primary energy source of fossil fuel still commands the world's road transportation, but it is only a matter of time before EVs are adopted; in the next decade, people will begin to rely on electric vehicles.

Although there is virtually no scope for greenhouse gas emissions in EVs, the benefits of transport electrification in mitigating environmental changes become more apparent when the organization of EVs matches the DE (distributed energies) carbonization of the intensity structure. Strategies continue to improve electrical flexibility. The use of EVs usually begins with the formulation of many goals, followed by specifications for receiving and charging vehicles. Electric vehicle approval plans typically include acquisition programs to arouse interest in EVs and stand out from the public charging infrastructure system. On the other hand, the technological development of showcases for EVs has led to the creation of countless charging stations for EVs, with which the electric vehicle network (EV-grid integration) can be connected. Newer charging stations can be divided into private and nonprivate charging stations, which can stimulate medium charging (levels 1 and (2) and fast charging (levels 3 and DC) [3]. The high tolls for EVs are private in moderately charged ports. However, future charging stations are to be developed at commercial locations to make them petrol stations for electric cars with extensive charging ports [4]. Wireless innovation is at the center of the future versatility of electrical equipment. These progressive developments cover the entire value chain of the project and the whole circular economy: research of managers, production and processing of crude oil, battery design, as well as the production, use, and disposal (sorting, reuse, and reuse) of the battery and the solution to overall savings and maintainability [5]. Most of the current progress of the battery depends on lithium particles, polymers of lithium particles, or nickel-cadmium, nickel-metal hydride [6]. Naumanen et al. and their team reported on the method of solid lithium-ion battery cars in China, the European Union, Japan, and the United States. They summarized the bulk of the use of the national battery improvement system at the point of an electric vehicle. China and the United States are the leading licensors and countries that monitor batteries [7]. However, the developing countries can lean on them to maintain the EV-related development and manufacturing R&D sectors. Despite the advancement of battery-based innovations, the battery testing phase, the construction of measuring instruments, the disposal and reuse of batteries, and the conduct of assessments are significant [8]. There will be a change in the amount of CO_2 emitted from the EV fleet's well-to-wheel (WTW) greenhouse gas emissions as energy use and electricity generation carbon intensity both decrease [9]. Thus, EVs could lead the decarbonization of the transportation sector towards carbon neutrality.

Besides that, smart cities are looking for new solutions to address some of the urban dilemmas (environmental, social, and financial) caused by the grid network, development, and the operation of underlying conditions (such as vehicles, waste, energy). However, this cooperation is not always recognizable and should be tested for the most considerable advantage [10, 11]. The use of petroleum products in the transport system causes atmospheric pollution due to the formation of particles and unnatural meteorological changes caused by carbon dioxide and primary air pollutant emissions. There are many mineral-filled vehicles in the world that can carry substances that deplete the ozone layer, which is one of the significant challenges facing the world [12, 13]. Consider that the benefit of answering the request is to improve the charge coordination of using low-carbon or low-carbon energy. Another essential aspect of EVs is the charging of batteries. The charging speed of the battery depends on the type of EV and the main battery charge. In most cases, the charger is divided into four levels, from level 1 to level 4. To complete the checkpoint, an accurate assessment of the relevant conditions for the electric vehicle must be made. Coordination between energy and land use and issues related to changes in global temperature and air pollution are fundamental prerequisites for the transportation sector. Therefore, car manufacturers only need to establish more apparent incentives to see increasingly effective results. In this particular case, there has recently been a concentration of vehicles with selective fuel and EVs. The International Energy Agency (IEA) is taking measures to reduce the similar outflow of carbon dioxide (CO_{2eq}), and many countries have made the introduction of EVs on the market an important goal [14, 15].

To overcome those difficulties, this study presents an innovative approach to EV development to provide an appropriate guideline for developing and nondeveloping countries. EVs coordinate various types of individual achievements and divide the overall field of EVs into several key areas, which can give increasingly important point-by-point data. Consider the benefit of answering the request: to improve the charge coordination of using low-carbon or low-carbon energy. It is assumed that the strength structure representation of the use of DG (distributed generation) assets will be further enhanced and combined with sustainable energy. The following article summarizes EV status, policies, future demand, and EV-related technology, specifically delving into next-generation EVs and their approaches. Nowadays, smart city development and maintenance are hot topics, and electric vehicles are playing an essential role in renewable energy growth. In this regard, this study went through an impact-related discussion. Lastly, the study summarizes and explores some different methods and their advantages and disadvantages. These discussions will give a general framework for increasing EV growth in the world.

However, it is important to see EV growth in the world. Figure 1 shows a summary of the global EV stock and EV sales market. The market share report shows that 3% of the total newly sold vehicles are EVs. As indicated in the Navigant Research report, this number may exceed 7%, or 6.6 million a year worldwide by 2020 [9]. The transportation of EVs has developed rapidly in the last ten years; in 2018, the worldwide transportation volume of EVs was more than 5 million. This is an increase of 63% over the previous year. In 2018, around 45% of EVs were produced in China, where the total number of EVs was 2.3 million, an increase of 39% over the previous year. In any case, 24% of the world's fleet is in Europe, while the United States has 22%. On the other hand, Norway is still a worldwide pioneer in the production of electric cars. About 49.10% of new electric car transactions in 2018 were almost twice as much as Iceland, an increase of 17.50%, and six times as much as Iceland as Sweden, an increase of 7.20% [16]. Most of the existing EVs have been manufactured in recent years, and more than 300 million vehicles will be manufactured by the end of 2018. Of course, most of them are in China. In contrast, two-wheeler electric vehicle sales are hundreds of times larger than anywhere in the world. Transactions with EVs are also increasing. In 2018, more than 460,000 cars are already on the world's roads. In addition, 5 million passenger cars and slow EVs were sold in 2018. All low-speed electric vehicles (EVs) are in China. Shared electric foot scooters, often known as "free-floating" scooters, became extremely popular in major cities throughout the world in 2018 and early 2019. These foot

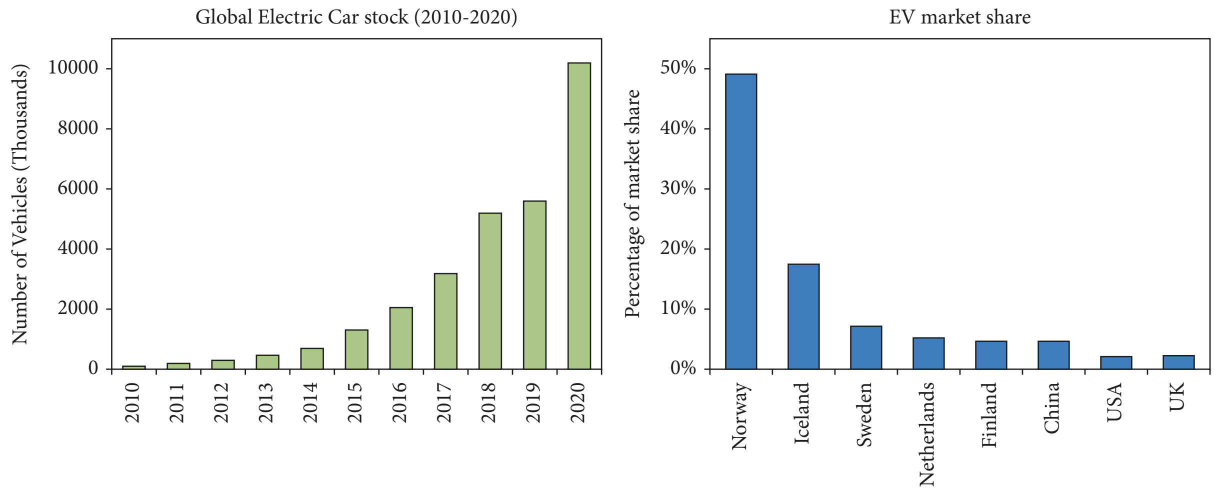


Figure 1: Global EV stock and EV sales market share in 2020. Redrawn and taken permission from Elsevier [17].

scooter conspiracies are currently active in approximately 129 urban areas in the United States; 30 in Europe; 7 in Asia; and 6 in Australia and New Zealand.

Moreover, the structure and configuration of EVs can be found in the next section. The development of EVs is based on current and future global demand, which is interconnected to electricity and battery demand. Besides that, the productive development of EVs depends on the improvement of global values, comprehensive frameworks, related peripherals, and easy-to-use programming [2]. There are several challenges to making EVs inexpensive in the market, such as efficient charging to the battery, battery price, flexibility in charging stations, EV technology innovation systems, EV sharing, and impacts related to EV and policy development. Thus, this review will provide significant approaches to EV growth in the world, which are based on technological advancement, identifying problems, and smart solutions. The following section summarizes the EV status, future EV material demand, and EV-related technology. We can see next-generation EVs and their approaches. Nowadays, smart city development and maintenance are some of the hot topics, and electric vehicles are playing an essential role in renewable energy growth. In this regard, the review went through an impact-related discussion. These discussions will give an overall dimension to resolving EV growth and development in the world.

2. Electric Vehicles (EVs) Status

EVs can be divided into two categories: hybrid EVs (HEV) and each type of all-electric vehicle (AEV) [18, 19]. An AEV is only equipped with a motor controlled by the power supply. AEV can also be divided into battery EV (BEV) and EV fuel cells (FCEV). A BEV is contained within an energy storage system (ESS) and a power control unit (PCU). The difference between BEV and FCEV is that the PCU is connected to a hydrogen tank (HT) and fuel cells (FCs). Thus, the FCEV does not require an external charging system. However, BEV only relies on the external power supply of the network to load a storage unit. A plug-in hybrid EV (PHEV) is a type of HEV that can be powered by a grid. The difference between a PHEV and a mild hybrid electric vehicle (MHEV) is that a PHEV has a smaller fuel engine and can be powered exclusively by a large battery pack. An MHEV blends traditional internal combustion (ICE) with electric power. All BEVs and PHEVs are called EVs. Figure 2 illustrates the classification of EVs and power sources for their wheels [17].

Figure 3 provides specific information about affordable EVs produced by different manufacturers [20–33]. The figure also shows the estimated charging time required to charge the car from 0% to 80% based on various charging principles. Here, the charging voltage in the first stage is equivalent to 110–120 V, the charging voltage in the second stage is 220–240 V, and the charging voltage in the third stage or DC fast charging (DCFC) is 200–800 V. It can be seen that the range of an electric vehicle is based on the battery charge. However, at about 100 kilometers, in some vehicle models and some other models, the battery runs for 200 to 400 kilometers. On the other hand, most of the current EV models run over 400 kilometers in China [34].

3. The Demand of EVs

3.1. Future Global Demand for EVs. To determine the base metals in future energy-based transportation, the first step is to create a situation where the number of EVs and future demand for subsequent metals can be estimated. Figure 4 shows an annual growth of three different types of EVs (BEV, PHEV, and HEV) with historical (2010), and future (2050) year scenarios, such as baseline (BS), Moderate (MS), and Stringent (SS) outcomes. The information used to improve the situation is taken from the integrated model to assess greenhouse effects (IMAGE), which was developed for the database of the shared socioeconomics pathways (SSP). An SSP is a long-term situation that enters the network due to changes in the environment. They depend on five different accounts, which translate into quantitative forecasts of three major financial factors, namely population, currency flows, and urbanization [35].

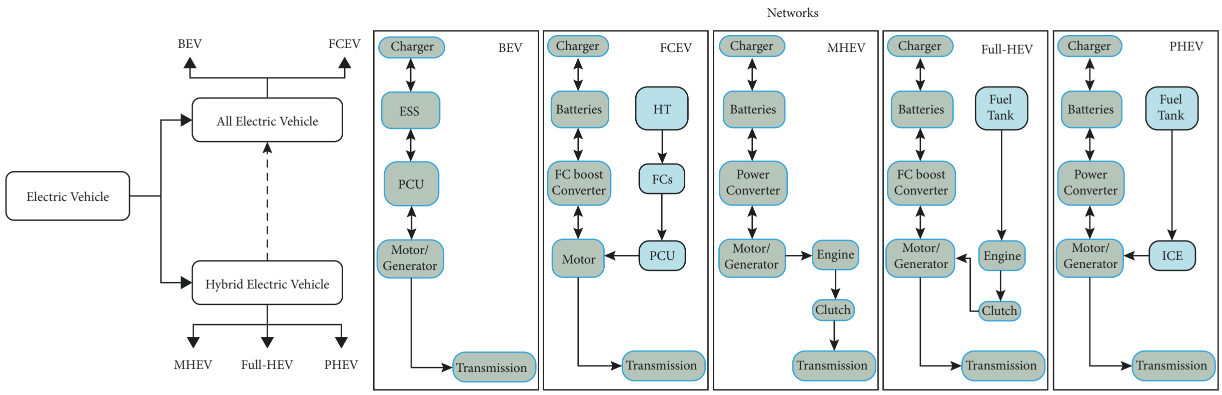


Figure 2: Classifications of EVs.

According to the outcomes of improving the situation, the absolute number of drivers in the basic situation is estimated to go from 1.13 billion in 2011 to 2.6 billion in 2050. Under moderate conditions, the number of station wagons is likely to increase to 2.55 billion by 2050, and to 2.25 billion. In difficult conditions, Figure 4 shows that in these three cases, the supply of three EVs increased from year to year.

3.2. Electricity Demand for EVs. The demand for EVs in the new political scenario is expected to reach only about 640 terawatt-hours (TWh), and the light-duty vehicle (LDV) is the largest pantograph of all EVs in 2030. Facts have proved that EVs are increasingly suitable for power supply systems, so make sure that management does not prevent their use through mandatory electrical structures. It is estimated that by 2030 globally, slow chargers that can be used to provide flexibility services to power systems will account for more than 60% of all electrical energy consumption. Meanwhile, fast charging demand periods such as at night will seriously affect the pile shape in the power structure [16].

3.3. Battery Demand for Electric Cars. The consumption of EVs and the relevant prerequisites for the production of batteries indicate that the automotive sector is more interested in new materials. Overall, by 2030, interest in cobalt and lithium should increase in both cases. Generally, cathode science influences the ability to control investment in metals, especially cobalt. It is necessary to increase the reserves of cobalt and lithium to ensure the expected EV absorption rate [35]. The scale of raw material interest adjustment for EVs also indicates the increase in raw material supply. Difficulties related to raw materials are mainly associated with the growth of creativity, natural impact, and social issues. The identification and directness of raw materials are essential tools to deal with some of these criticisms by maintaining the actual harvesting of minerals [6, 16].

4. EV-Related Technology

4.1. Current EV Technology. The innovation of EVs has aroused great interest from experts, organizations, and strategic developers in many countries. EVs coordinate various types of individual achievements and divide the overall field of EVs into several key areas, which can provide increasingly important point-by-point data [36]. Due to the positive aspects of use and low pollution levels, EVs can promote the decarbonization of transportation, and the growth of low-carbon emission urban areas has thus become one of the models to increase the enthusiasm of the automobile industry [37–39]. In any case, the future success of the electric vehicle business depends to a great extent on innovation [40, 41]. Politicians in many countries, such as Sweden, China, Malaysia, and South Korea, are serious about change in the field of EVs and are developing strategies to support the technological innovation of EVs [42, 43]. However, technological innovation in the field of EVs is an incredibly exciting topic. Figure 5 shows the analysis of the estimated improvement rate, where PE is the power electronics and EM is the electric motor. The figure also shows the estimation steps to improve the domains (power electronics, battery, electric motor as well as charging and discharging subdomains), which is the estimated density of the technological improvement of each domain or subdomain in the EV field.

An improved version of the HNS model (Human, System, and Nature) is offered for the mechanical navigation of EVs. They considered the need for angles (H, N, and S), although they were balanced as another base for support. The model is converted to NHS to show versatility from N to H, then switched to H to S. An increasingly accurate idea of the relationship between people, nature, and systems is that, in practice, the frame within the circle of people is floating around, and two of them fall into the sphere of nature, as shown in Figure 6. As shown in Figure 6, according to the previous model, each of the three representations has been similarly adjusted, but according to their proposed model (NHS), case (a) is more supportable than (b), and (b) more practical and therefore is better than (c). In the proposed model, we need to consider nature, humans, and systems separately. Unlike humans, nature depends on us and will remain without people as long as the structure depends on both humans and nature. As a rule, support implies a reasonable approach, which can limit negative environmental impacts, trying to maintain harmony between all three "columns." The opinions of people and structures should be determined from a natural point of view [44].

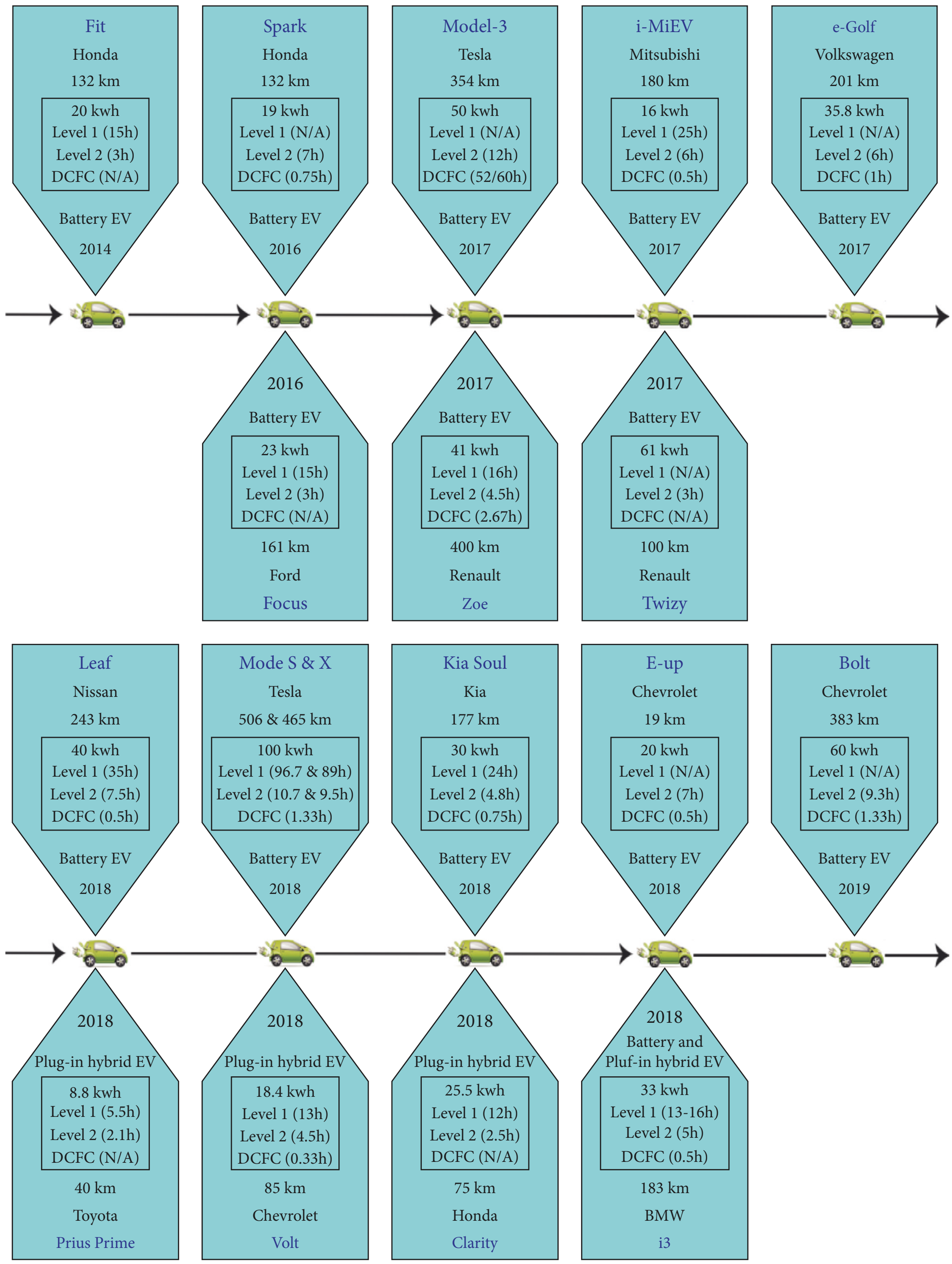


FIGURE 3: The most popular electric vehicle currency positions are listed.

Human and financial factors are critical factors in making progress. Countless people around the world have increased traffic. There are three types of EVs: HEV, FCEV, and EV. According to [45], all PHEVs in a municipal fleet can be divided into six categories:

(1) electric bicycles and bicycles,

(2) street electric cars,

(3) high-speed urban EVs,

(4) low-speed electric cars,

(5) supercars, and

(6) electric bus and electric truck.

We are talking about EVs in highway road cars (level 2). These types of vehicles are modular EVs that are driven by at least one electric motor and that use the energy that is regularly stored in battery-powered batteries. The use of petroleum products in the transport system causes atmospheric pollution due to the formation of particles and unnatural meteorological changes caused by carbon dioxide

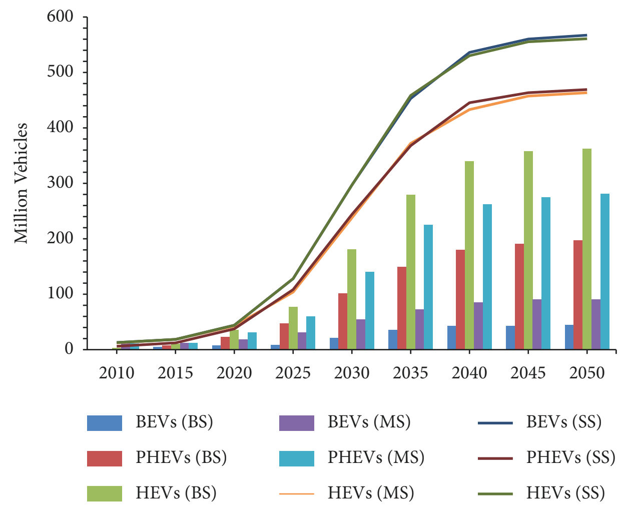


FIGURE 4: Annual growth of three different types of EVs stocks from 2010 to 2050 in three scenarios. Redrawn and taken permission from Elsevier [35].

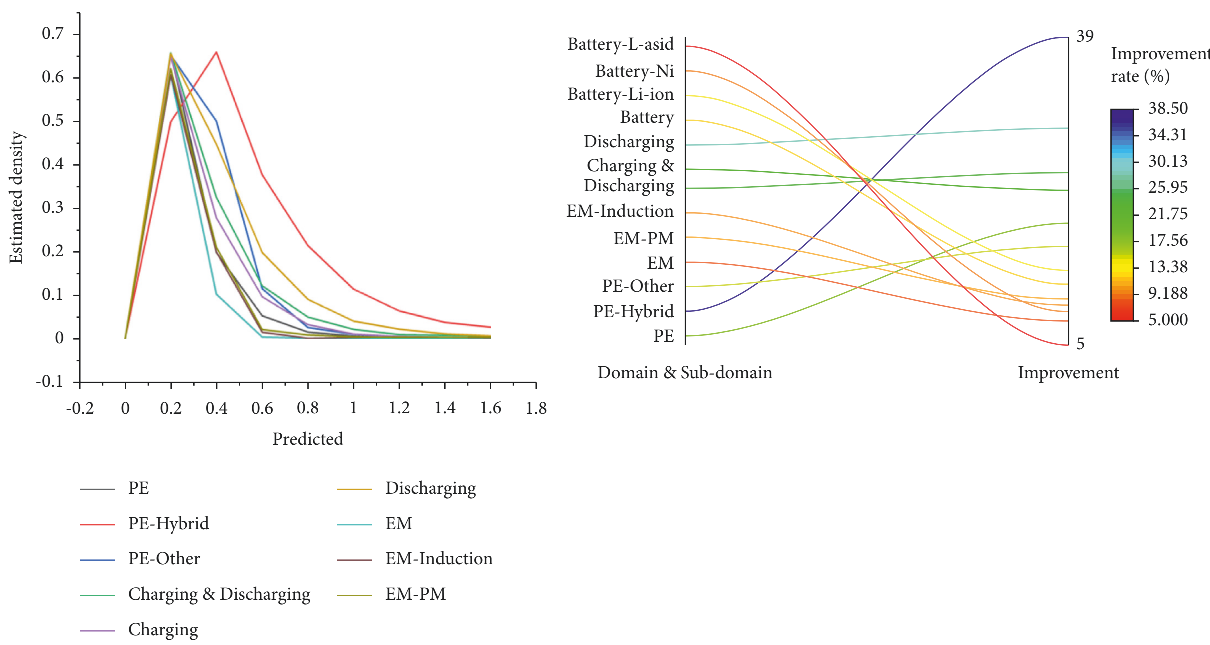


FIGURE 5: The estimated technological improvement rates of domains and subdomains. Redrawn and taken permission from Elsevier [36].

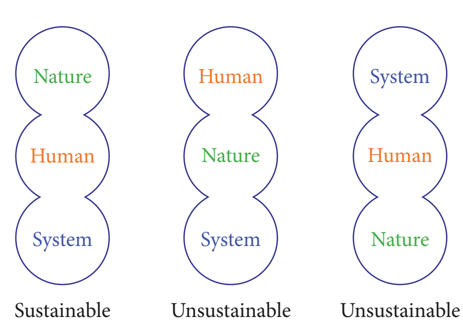


FIGURE 6: Models for humans, structures, and nature (HNS): (a) Sustainable and (b and c) Unsustainable. Redrawn and taken permission from Elsevier [44].

and primary air pollutant emissions. Conventional vehicles on transport chassis have the most significant influence on dangerous atmospheric forms. There are many mineral-filled vehicles in the world that can carry substances that deplete the ozone layer.

Human progress has resulted in present atmospheric changes and ozone-depleting chemical emissions, which are the world's major challenges [12, 13]. According to the announcement issued by the European Commission, transportation is the second most crucial factor in the release of ozone-depleting substances. This is equivalent to a quarter of the ozone layer in the European Union (EU). One of the primary ozone-depleting materials is CO_2 gas, and about 15% of the ozone-depleting elements (i.e., CO_2) are emitted by light vehicles such as pickup trucks and automobiles [46]. In recent years, some research projects involving the integration of electric vehicles into low-voltage grids have been carried out in Denmark, Norway, and Sweden. Figure 7 depicts a model of a grid-connected vehicle. The solar energy is connected to the home power supply for EV charging (during the daytime), which is called a solar to a vehicle (S2V) power supply. This charging process will reverse in the evening when the EV will discharge to home power by way of the vehicle-to-home (V2H) and vehicle-to-grid (V2G) processes. The issue of local area network constraints for locating electric vehicles with sufficient power in low-voltage residential area networks has been researched [13, 47].

4.1.1. Flexible and Innovative System in the Car. The advantages of EVs connected to the network include two-way dynamics. Therefore, this application (Dynamic Mobility between EVs and PHEV) will become an important choice for the smart grid area [48]. In addition, it is often used as the source of an energy crisis. An energy management mechanism is needed to promote the link between household business taxes and fast car charging. The power control mechanism is fractioning in two directions. For example, it works with an inverter to convert the direct current discharged by the battery into alternating current for home use and works with a rectifier (for example, when the current direction is opposite) to charge the battery. However, electric vehicles can be the best option to supply the various utilities because of their facilities and advantages [13, 49], such as the following:

(1) The charging station has large-scale loads compared to residential loads.

(2) In this situation, the transmission capacity has better response speeds.

(3) The charging points are available and have high flexibility.

4.1.2. Future Development Model of Electric Vehicle Network (EVGI). EVs can be used not only for transportation but also as electrical loads (grid-to-vehicle (G2V)), the corresponding energy stock of the grid (vehicle-to-grid (V2G)), the energy stock of various EVs (vehicle-to-vehicle (V2V)), and the energy stock of buildings (vehicle-to-building (V2B)) function system compliance center [17, 50]. In the field of vehicles, some new results are proposed, which can improve the availability and applicability of EVs in the most modern power grids. The latest innovations include proprietary wireless power transfer (WPT), connected mobility (CM), autonomous or autonomous EVs, and EVs' economic saving, and life-saving power network. By using these innovations, the fate of the transportation sector is reversed. Besides, how the future electrical transportation unit is firmly connected to the grid will affect the strength and energy of the automotive industry's innovation in creating these titles. Figure 8 shows a classification, and Figure 9 shows a proposed model for the future development of the EV network.

4.1.3. Renewable Energy Sources. While researching the impact of EV grid integration, it is difficult to overlook the work of environmentally friendly energy sources and the significant impact of the combination of EVs and systems. This section studies the effects of sustainable energy. In Knezovic et al. [52], the analysts considered the possibility and difficulty of coordinating inexhaustible energy sources (for example, based on wind and sun) to provide energy for battery charging, and then started again from the perspective of limiting greenhouse gas emissions. When adaptable loads are used, the problem of reducing the stability of the power structure due to the abuse of sustainable energy has not yet been significantly resolved. PEVs can charge EVs in peak-off hours or when renewable energy is available. Consider that the benefit of answering the request is to improve the charge coordination of using low-carbon or low-carbon energy. It is assumed that the strength structure representation of the use of DE (distributed energies) assets will be further improved and combined with sustainable energy. There is a lack of coordination between the host and the distributed generation energy system (DESS) with sustainable energy, which can be completed under the basic and maximum loads. At the optimal time, additional energy is fed into the grid. From what is written, the work in this field basically meets the broader prospects, which represents the study of the entire future interesting grid system and network [13].

4.1.4. Smart Grid Structure. Currently, the construction of the power grid does not meet the required flexibility. The smart grid is a complex system that is connected to all grid networks. To exhibit all system screen characters for this application, various networks need to be effectively copied, connected, and approved. However, the architect did not pay much attention to the plan of the grid network. The following are the main components of planning a keen system [13, 17].

(1) The substructure of the system must be adaptable and its components must be considered.

(2) The structured grid model should be able to support future expansion.

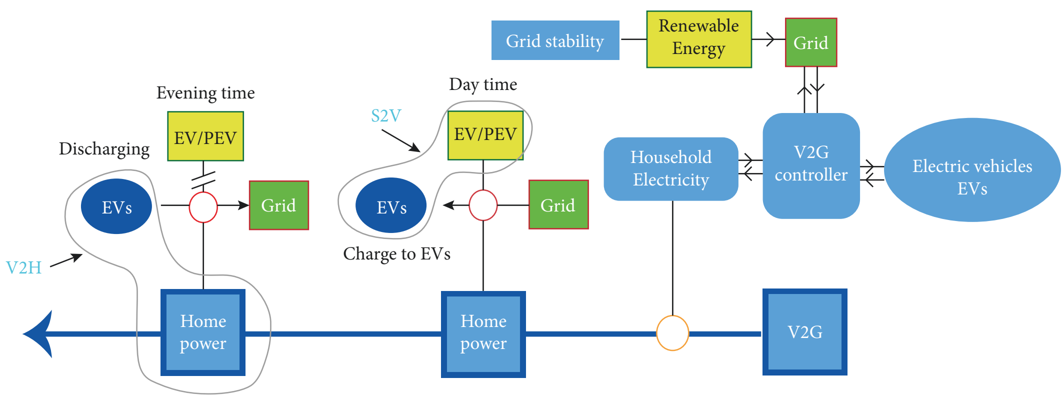


Figure 7: The relationship between EVs and the grid.

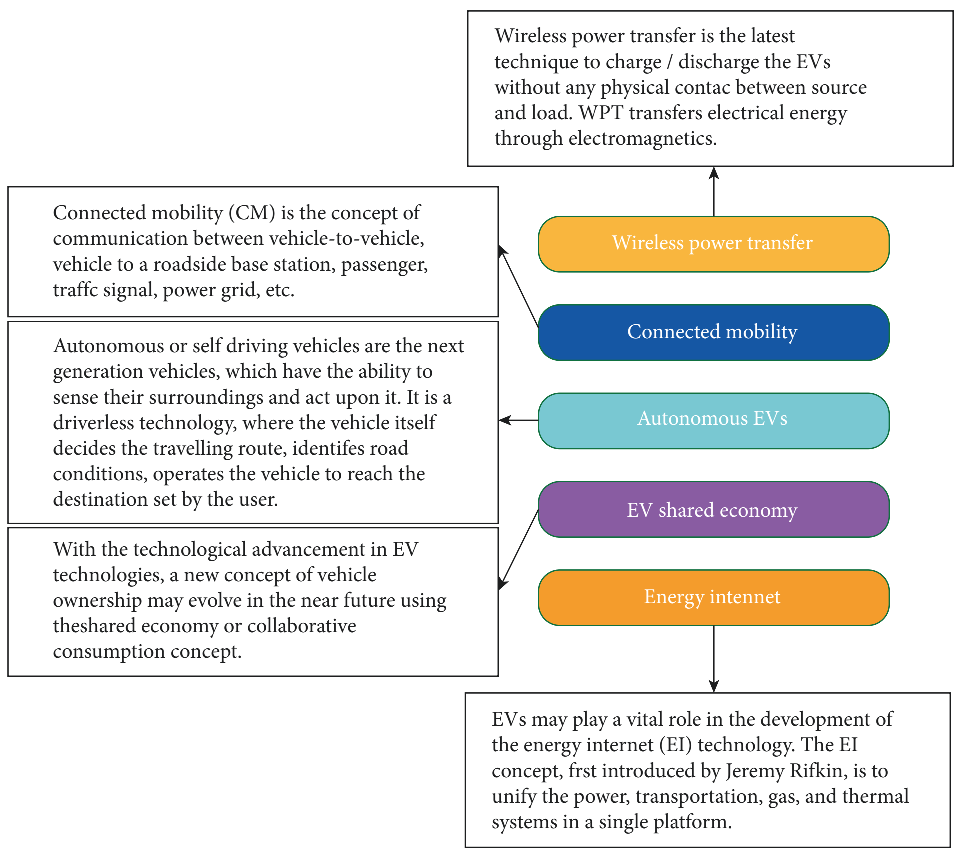


Figure 8: Classification of EV network.

(3) When planning the structure, the structure and points of the programming/device/grid structures should be considered.

(4) If the system update program is activated, it should be executed automatically.

4.2. Energy Storage Technology. Battery innovation is the so-called hot topic related to electric cars. The junction point is the anode, and the electrons move toward the cathode. At the same time, there is no electrical prevoltage during the movement of particles in the electrolyte. Lithium particles (Li particles) and nickel-metal hydride (NiMH) are two types of batteries used in EVs. Cars like the Nissan LeFeng and Mitsubishi iMiev use lithium batteries as an indispensable source of energy. On the other hand, in half of the EVs, such as the Toyota Prius, nickel-metal hydride batteries are used as primary resources [53]. The only source of energy that is remembered in EVs is batteries. It should be measured satisfactorily in order to promote energy transfer continuously. Before the battery is completely discharged, it can now confirm the additional charge generated by the regeneration process, for example, decelerating. Experts note that the safe zone is about 20%, which means that the emission zone should not exceed 80%, although it is possible to determine the state of a slow regenerative charge.

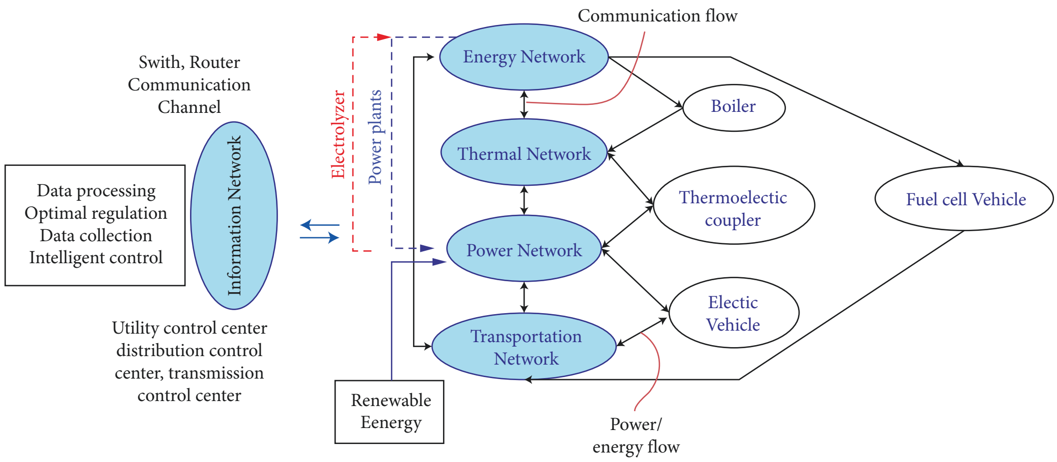


Figure 9: Structure of energy internet. Redrawn and taken permission from Elsevier [51].

Figure 10 shows an example of the EV battery charging capacity.

For this reason, during the hour of charging the battery [54], the stock increases by about 5%. If the highest state of charge (SOC) is 95% of the first SOC and the highest release rate is 20% of the first SOC, the battery size must be determined so that the required limit is correctly reached. The charge state is the current battery charge limit (upper limit), and deep discharge is the battery level released as the upper limit. Although the vehicle battery at the intersection is the primary source of energy for the traction, the goal is that, as with the device being measured, the limit of the required battery should be a series of hybrid organized vehicles [13]. Due to the fact that the internal combustion engine of a plug-in hybrid vehicle of this design distributes the required energy for the pedaling force, the required limit for the battery is small. In addition, batteries used in plug-in hybrid vehicles must flexibly meet the activity requirements. When the car stops at a low speed, it behaves like an electric car battery. In this sense, it is necessary to improve the battery to limit its highest point, freeing its depth to a higher level. To know the energy storage device, energy generation system, and energy sources for PEVs, the details of the approach can be found in Figure 11.

The energy storage (ES) system is a rapidly growing technology. ES gives attention to a solid-state storage system. This is indicative of the fast pace of development in the car battery area, whereas technical performance has a vital role in economic development. A comparative study evaluates the capital costs of different energy storage technologies [54]. The literature report shows that the energy storage capital cost depends on several facts, such as cost per kilowatt, per kilowatt-hour, and kilowatt-hour per cycle. For example, the supercapacitors, li-ion, flywheels, and sodium sulfate storage costs are calculated by kilowatt, kilowatt-hour, and fuel cell, and flow batteries costs are measured by kilowatt-hour per period.

4.2.1. Battery Charging Methods.

Several structures can be used to charge EVs. The power level (kW), the electricity used, the accessories, and the battery types are factors that determine the charging of EVs. The power for moderate charging is approximately 3.3 kW and the power for fast DC charging is approximately 50 kW [55].

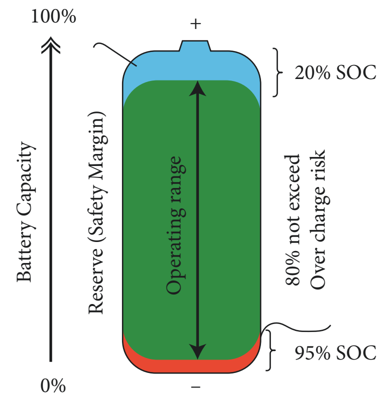


Figure 10: EV battery capacity.

At the simplest level, it is necessary to use chargers to power the battery from a conventional single-phase power source or a level two AC charging station or to connect a plug-in hybrid electric vehicle that is an integral part of the innovation of the complete vehicle. This innovation means that, for example, in Europe, people can connect electricity from a conventional single-phase 230 V AC socket via external vehicle accessories and then convert internal devices to DC to charge the battery. Charging is usually possible at these locations with low voltage frames. On the other hand, more and more people were demanding that the power of the DC station be quickly charged to 50 kW, while the power organized for the Tesla compressor was 120 kW.

4.2.2. Charging Cage for Electric Cars.

Another essential aspect of EVs is the charging of batteries. The charging speed of the battery depends on the type of charger used and the main battery charge. In most cases, the charger is divided into four levels, from level 1 to level 4. In many EVs that use power supplies from home devices, level 1 chargers are EVSE (Electric Vehicle Maintenance) devices compared to implicit chargers that can be used in electric cars to charge fully for

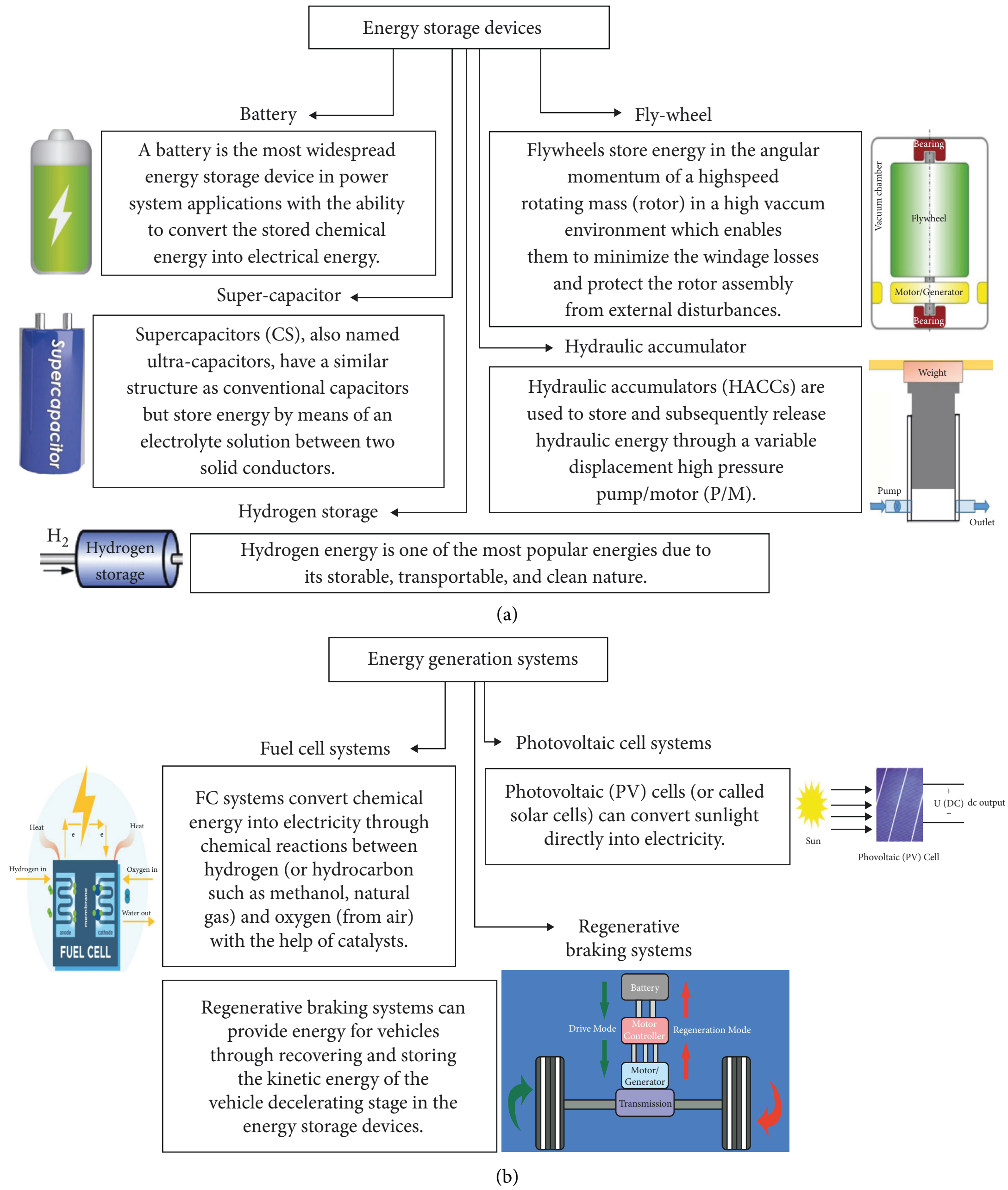
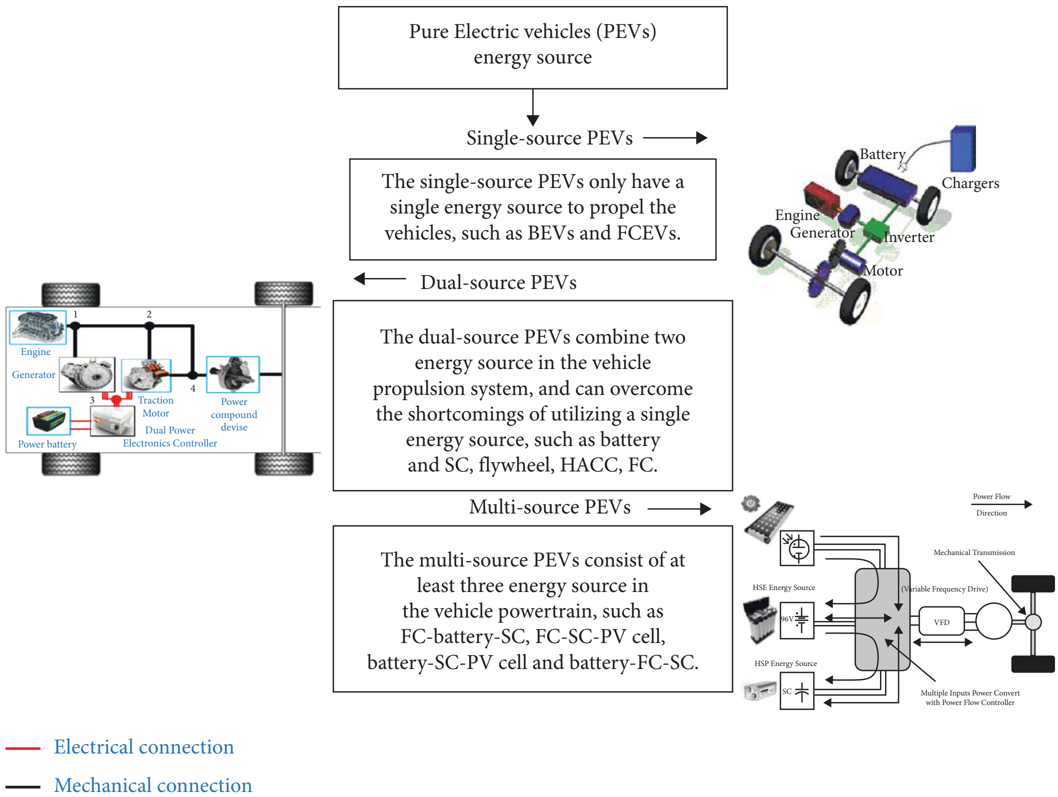


Figure 11: Continued.



(c)

Figure 11: Classification of (a) energy storage devices, (b) energy generation systems, and (c) PEVs energy sources.

7–9 hours. Tier 3 and Tier 4 chargers are chargers that use advanced DC charging methods to charge EV batteries legitimately. This kind of configuration is mostly used in Singapore [56].

4.2.3. Approximate Time to Charge the Battery. The Independent State of Charging: In this state, 55% of the battery charge is completed during a period of low use (from 10 : 00 p.m. to 7 : 00 a.m.), and additionally, 45% is supplied from 7 : 00 a.m. to 10 : 00 a.m. In the subsequent express delivery, 75% of the battery charge of the electric vehicle ends when used less (from 10 : 00 p.m. to 7 : 00 a.m.), and the remaining 25% is made available between 7 : 00 a.m. and 10 : 00 p.m. In this example, synchronous loading or first loading is considered one of the most effective strategies. The transaction costs for energy, a measure of the energy consumption of a battery in the state of charge (SOC), are regarded as the parameters of this technology. In an uncontrolled state of charge, 55% of the charging time of the battery is used during periods of low usage (from 10 : 00 p.m. to 7 : 00 a.m.) and the remaining 45% at 7 : 00 a.m. (10 : 00 p.m.) provided between them [12].

To complete the checkpoint, an accurate assessment of the relevant conditions for the electric vehicle must be characterized. The proposed charging time is shown in Figure 12. It should be noted that one of the primary problems with this strategy is that the charging of connected EVs should be limited during periods of maximum energy consumption. The following mode (controlled state of charge) is considered as follows.

From the beginning, the battery pack and the bend of the battery pack were chosen according to the type of day. If it is possible to restore the possibility that the battery can hardly be fully charged at night the next night, the total load at night should be less than the estimated shutdown time, which depends on the peak load the next day. The updated lithium battery is suitable for charging EVs with a range of 170 kilometers. The maximum battery charge of EVs is around 20 to 30 kWh. EV FC batteries can charge 80% of EVs in less than 30 minutes.

4.3. EVs Next-Generation

4.3.1. EV and HEV Unit Design and Advanced Unit Development Guide. Therefore, the main models of EVs that compete with vehicles with an internal combustion engine (ICE) are battery EVs (BEV), hybrid EVs (HEV), fuel cell vehicles (FC), fuel cell hybrid EVs (FCHEV), and hybrid solar EVs (HSEV). Figure 13 shows the architectures, and the related inspections of ICE vehicles and charging vehicles are summarized. The development of environmentally friendly advanced vehicles based on advanced electric driving technologies should focus on the following aspects: reduction of costs, an increase in productivity, and the

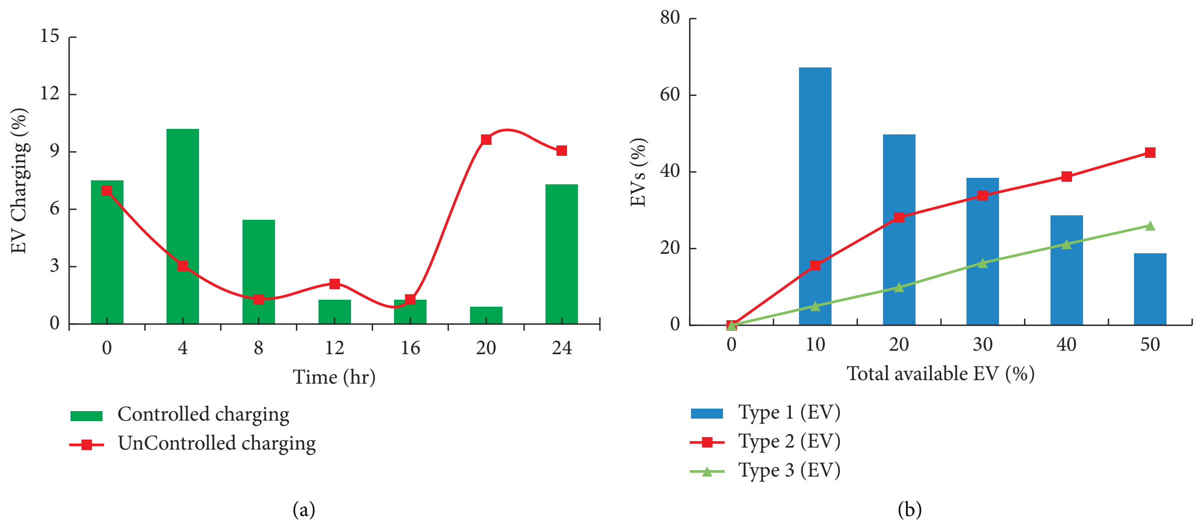


Figure 12: Charging schedule of EVs. Redrawn and taken permission from Elsevier [13]. (a) Charging is limited during peak times. (b) Charging process is completed before 6 a.m.

implementation of high power density [57]. The progress of the key authorizations that can improve the aforementioned engine performance can be summarized as [58–60]:

It is impossible to determine the absolute superiority of one technology over another, and a technological decision must be made after analyzing a number of factors for a particular application. In this context, after protecting the essential requirements for a specific EV or HEV vehicle (torque, power, speed, transmission specifications, etc.), the key features that need to be compared to choose the right technology can be summarized as follows [58, 61]:

(a) space required for installation and allowable weight of the machine (or specific power);
(b) special reliability requirements;
(c) overall efficiency over the entire operating range;
(d) the normal speed of the torque;
(e) overload capacity of the unit; and
(f) the total cost includes material and production.

4.3.2. Technological Approach from WPT. The world has started to discover the wireless power transfer (WPT) system for various applications such as electric cars, home appliances, mobile phones, laptops, home appliances, medical devices, and electric vehicles. Figure 14 shows a classification scheme for various wireless energy transmission technologies. WPT technology can be divided into four main categories: far-field, near-field transmission [51, 62], mechanical force like magnetic gear, and acoustic gear [63–65]. Magnetic transmission technology uses mechanical forces to convert energy. It was initially introduced to replace conventional connected devices and has proven itself for various applications, e.g., for the fixed charging of EVs, driving electric cars, wind energy, and low-performance medical devices [66].

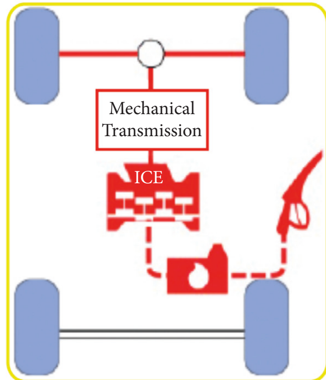
The inductive power transfer (IPT) and EV framework are shown in Figure 15. The frame has two electrically separated sides: ground (transmitter, grid, or basic) and vehicle (beneficiary or optional). The transmitter side is installed on the street to get low repetitive power from the network, convert it to high frequency (HF), and control the transmitter circuit. The EMF generated by the transmitter is combined with the receiver's fluctuations (in the vehicle) to excite the HF voltage and flux in the auxiliary circuit. The optional HF power supply has been recertified to charge the vehicle's energy storage structure (such as a battery). Figure 15 also shows the close relationship between various innovations in terms of performance level, driving separation, and repetitive work [51].

4.4. EV Smart City Development. The idea of a smart city dates back to 2009, proposed by IBM in the United States [67]. The general definition emphasizes the use of information and communication technology (ICT) in vehicles, energy supply, and management personnel, open funds, urban assets of management personnel, and administrative departments in a new era to improve and change the ecological productivity of cities [10]. Besides, this study also plays a significant role, as the so-called "understanding" also implies updating the management structure, in which the monitoring, recovery, investment, and improvement modules are combined to provide a structured strategy [68, 69].

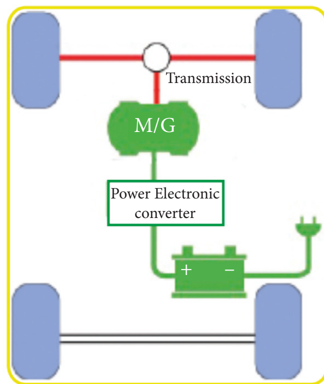
Smart cities are looking for new solutions to address some of the urban dilemmas (environmental, social, and financial) caused by the network, development, and the operation of underlying conditions (such as vehicles, waste, energy). However, this cooperation is not always recognizable and should be tested for the most considerable advantage [10, 11].

Due to the enormous demand for energy and the significant impact on air pollution and other related external influences (such as social security costs), fast, competent, and clean energy and transport structures are one of the main problems that community governments usually face [70]. For example, with regard to a cleaner and more efficient framework, transport policies have been adopted in many

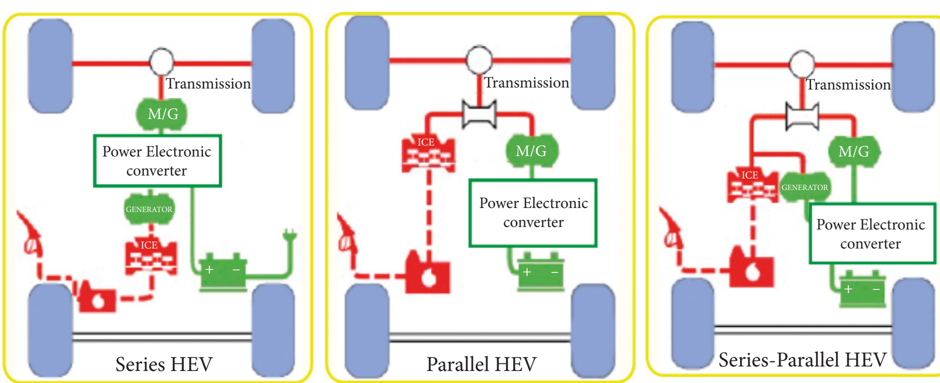
Feature	ICE vehicle
Propulsion System	ICE based
Energy storage	Fuel tank
Energy source	Petrol
Energy source infrastructure	Refueling station
Well-to-tank	88.0%
Tank-to-wheel	12.1%
Well-to-wheel	10.6%
Commercialized	Yes
Smooth operation	No
Emissions	Very high
System complexity	Very low
Bulky	Yes

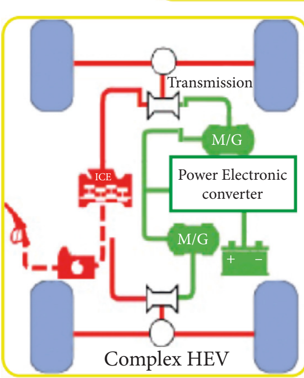


Feature	EV
Propulsion System	ED based
Energy storage	Battery Ultra capacitor Flywheel
Energy source	Electric
Energy source infrastructure	Charging station
Well-to-tank	37.0%
Tank-to-wheel	83%
Well-to-wheel	31.3%
Commercialized	Yes
Smooth operation	Yes
Emissions	No
System complexity	low
Bulky	No

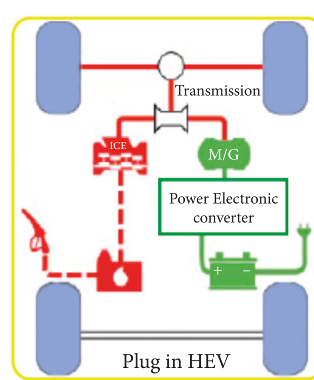


(a)



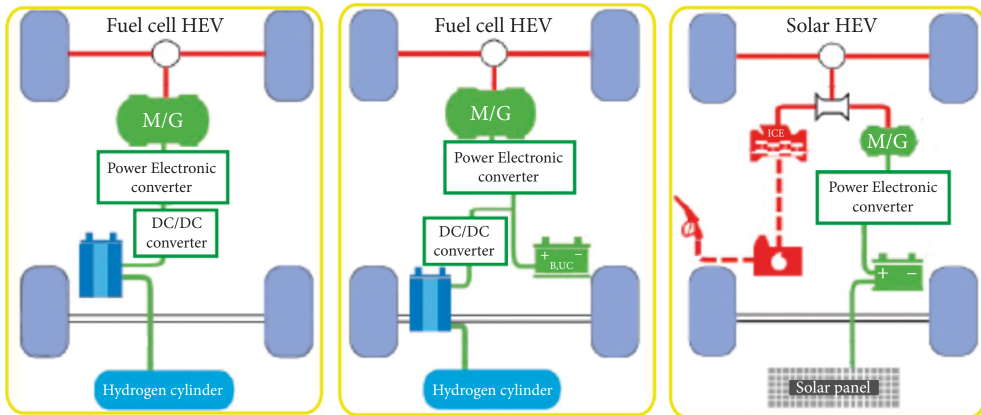


Feature	Plug-in HEV
Propulsion System	ICE & ED based
Energy storage	Fuel tank Battery Ultra capacitor Flywheel
Energy source	Petrol & electric
Energy source infrastructure	Charging station & refueling station
Well-to-tank	Depend on the specifc vehicle
Tank-to-wheel	Depend on the specifc vehicle
Well-to-wheel	Depend on the specifc vehicle
Commercialized	Partially
Smooth operation	Yes
Emissions	Low
System complexity	High
Bulky	Yes



(b)

Figure 13: Continued.



Feature	FC
Propulsion System	ED based
Energy storage	Fuel tank Battery Ultra capacitor Flywheel
Energy source	Hydrogen
Energy source infrastructure	Hydrogen refner & refueling station
Well-to-tank	58.4%
Tank-to-wheel	46.6%
Well-to-wheel	27.2%
Commercialized	No
Smooth operation	Yes
Emissions	Ultra low
System complexity	Very high
Bulky	No

(c)

Figure 13: ICE, EV, EC, and HEV architecture and characteristics. Redrawn and taken permission from Elsevier [58]. (a) ICV vs. EV architecture, (b) HEV architecture, (c) FC and HSVE architecture.

urban areas to reduce pollution [71], and research and development differ from the traditional structure. Among these other options, electric cars are some of the most famous vehicles and deserve a lot of research. For example, the link already includes a method of charging EVs. When presenting an overview of the smart tariff system, reference [50] discusses the use of EVs as a capacity. Fernandez et al. [72] and Beer et al. [73] or its effect on the grid and its use as a representative tool for maintaining sustainable energy in references Baloglu and Demir [74] and Villar et al. [75].

4.4.1. General SEMS Management Scheme. Given these points, Figure 16 shows the overall design of the proposed sustainable energy management system (SEMS) control system. To ensure reliable mobility, the level with the least control level (excitation level) follows the usual method, which depends on the PID (proportional integral derivative) and the rule-based controller. On this floor, there are thermostatic radiator valves (TRV) in each flat, siphons, and valves that feed the thermosiphons, boilers, and storage, as well as switches connected to all other electrical resources [76].

A technical basis of a smart city pilot project in China shows in Figure 17. Government, business, and citizens are the main actors. Based on the infrastructure of information and communication technologies, intelligent management, smart economy, smart citizens, and service are highlighted in detail [69].

As smart cities, smart infrastructure, and ICT-based management are also core components of smart industrial parks. Figure 17 also shows the overall technical structure of smart industrial parks, including smart infrastructure and technologies that support efficient resource management in industrial parks, smart decision support tools that support the evaluation and optimization of smart industrial parks. The stylish design of urban industrial symbols, supporting resources, and the optimal use of energy parks, as well as smooth business models and design software packages ION, support the implementation of smart industrial parks [69].

4.4.2. Overview of V2G, S2V, and V2I Structure

(1) Vehicle to Grid. V2G provides intelligent network operations through DR (Demand Response) services between EVs and the electricity grid. V2G here refers to the transmission of electricity and related data between transport and network systems, which implements the synergy between the two needed to achieve an intelligent city. Figure 18 shows a possible block diagram of a V2G structure [77].

(2) Sun to Vehicle. EVs currently in use worldwide require charging stations similar to those required for fuel-based vehicles. The use of a charging station powered by photovoltaic cells to charge solar energy is called S2V or EV-PV charging [78–80]. Figure 18 shows the smart grid concept

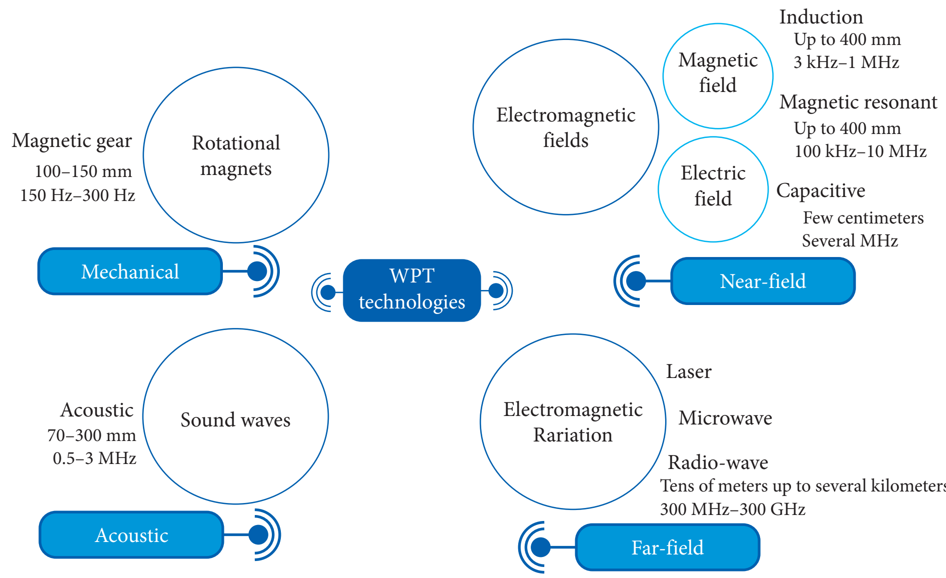


FIGURE 14: Wireless power transfer (WPT) technology. Redrawn and taken permission from Elsevier [51].

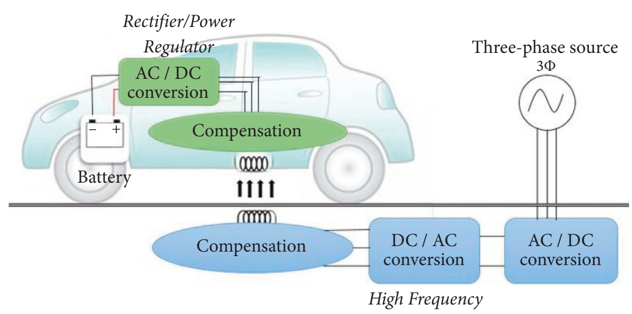


FIGURE 15: Inductive power transfer (IPT) system for EV charging.

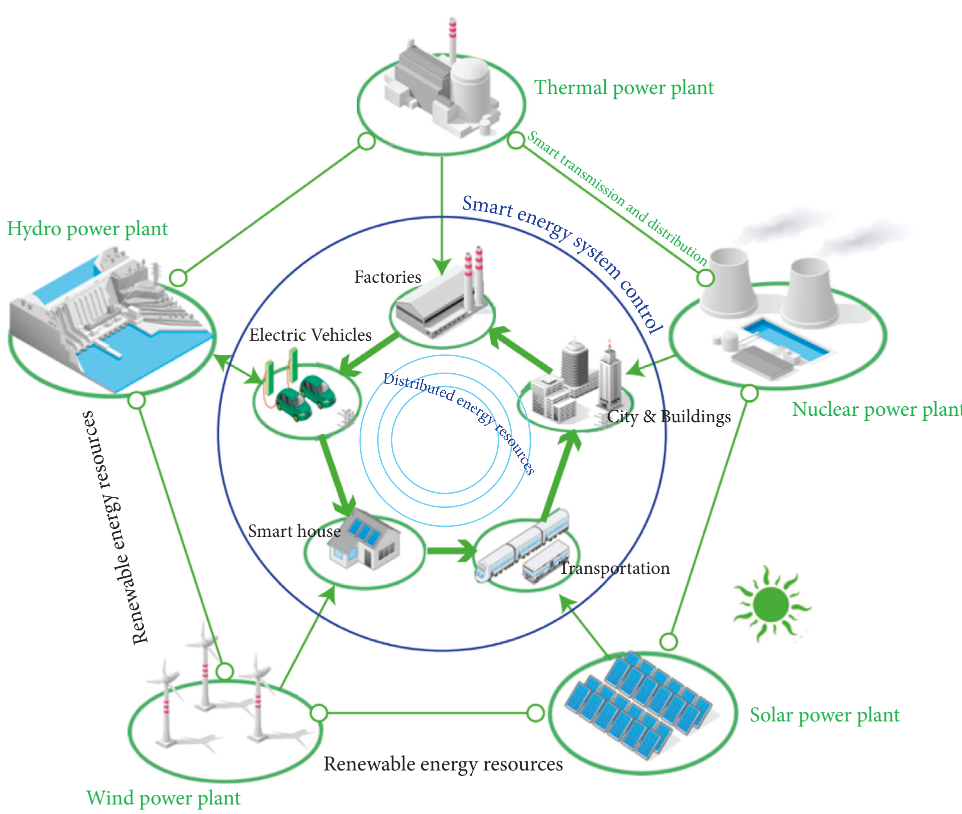


FIGURE 16: Overall energy management system.

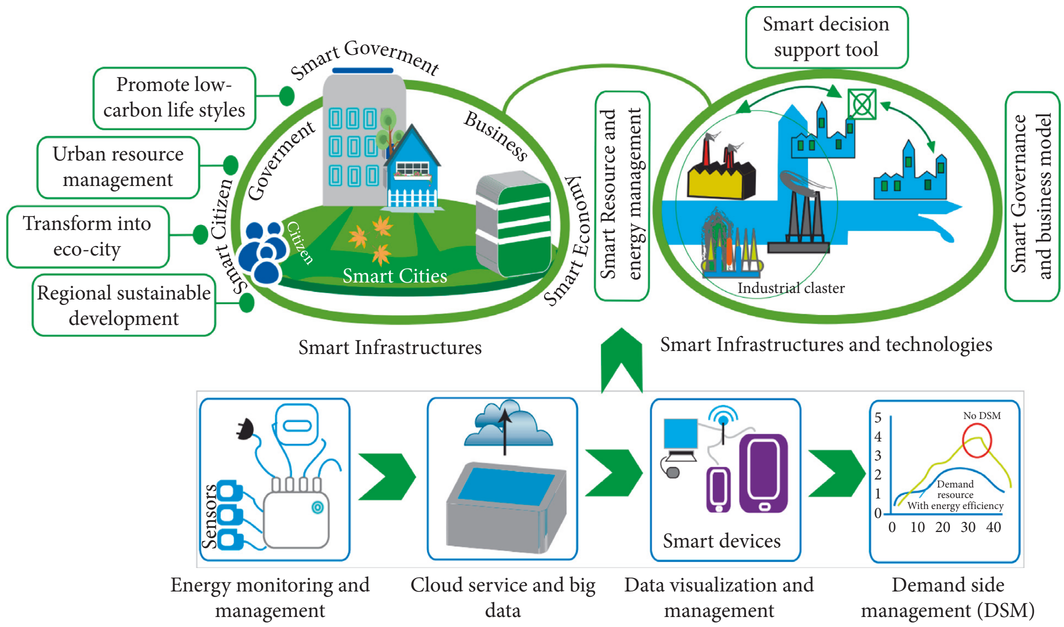


Figure 17: Example of smart infrastructures and smart technologies.

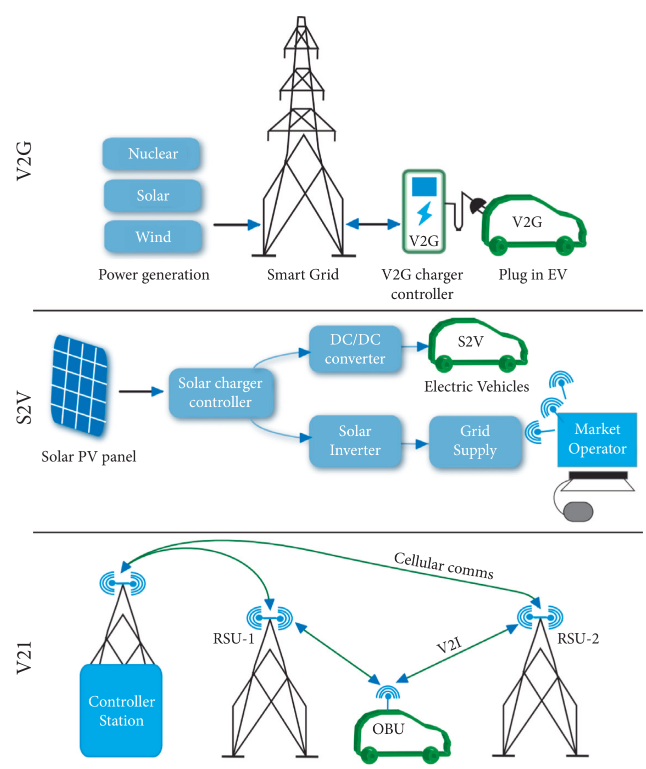


Figure 18: Example of V2G, S2V, and V2I structure.

implemented by S2V. Although the concept and implementation of solar machines are quite old, Birnie mainly uses the term S2V in his work [81]. He suggests that during the day, passengers who use electric cars every day can be charged by solar panels in the parking lot. These solar systems, used as charging stations for EVs, can help balance the current and reduce dependence on fossil fuels, thereby reducing carbon emissions.

(3) From Vehicles to Infrastructure. Communication V2I is one of the latest technologies in the fields of communications and automotive technology. In V2I, cars establish communication with the road unit for the exchange of information. Because of the different vehicle speeds, this architecture tends to create a dynamic performance. Some of the main problems solved with V2I technology are the increase in workload and road safety while reducing the environmental impact [77].

Table 1: Leading countries' national EV battery improvement technology and GHG emission.

Country	Development topic	Main aspect (finding)			
		Economical	Technological	Social	Environmental
China	Operating of EV	Low price, improved efficiency	Improve stability, acceleration sensor, fault detection, wireless communication, wireless transmission, intelligent control; older: Forklift truck, electric scooter	Ensure safety, display panel, intelligent electric vehicle, liquid crystal display, stable operation, USB interface, alarm module, easy use; older: Improve safety	China greenhouse gas emissions 10% by transportation sector in 2019 [82]
	Controlling of EV	Braking energy recovery, vehicle weight	Charge and discharge control; older: Battery service life, supercapacitor, electric braking, remote monitoring	Cruise/drive control, acceleration performance, driving safety, speed control; older: Travel distance	
	The battery module of the EV	—	Stability of battery, anti-collision, replacement battery, battery balancing, battery protection; older: Anti-theft, anti-explosion	—	
	Charging of EV	—	Inductive charging, charging condition, maximum load, charging efficiency, energy transmission, charging pile, charged control; older: Mobile charging, charging power, noncontact	Touch screen, charging schedule, parking lots/spaces	
USA	Operating of EV	Extend battery life, data collection	—	Self-locking	Transportation sector accounted for 29% of total U.S. greenhouse gas emissions in 2019 [83]. Contribution of GHG emission reduction of approx. 0.15% from 2005 to 2019, respectively. [83]
	Controlling of EV	—	Smaller battery	—	
	The battery module of the EV	—	—	—	
	Charging of EV	—	—	Older departure time	
Europe	Operating of EV	—	—	Safety device, reliable operation; older: easy maintenance	Transport accounted for 27% EU-28 greenhouse gas emissions in 2017 [84]. Contribution of GHG emission reduction of approx. 0.035% from 2005 to 2017, respectively [84]
	Controlling of EV	Development cost	Regenerative power generation, integrated control; older: Battery power consumption	Driving experience, user experience	
	The battery module of the EV	Older: Service lifetime	Battery balancing	—	
	Charging of EV	—	Battery condition; older: RFID tag	Vehicle network, mobile device; older: Mobile communication	
Japan	Operating of EV	—	—	—	Japan's transportation sector emitted 12.44% of the country's CO2 in FY2018 [85]. Transport sector: 4.5 million tons (2.1%) decrease in FY2018 [86]
	Controlling of EV	Distance travel, cost reduced battery life, data collection	—		
	The battery module of the EV	—	Housing battery	Quick change	
	Charging of EV	—	—	—	

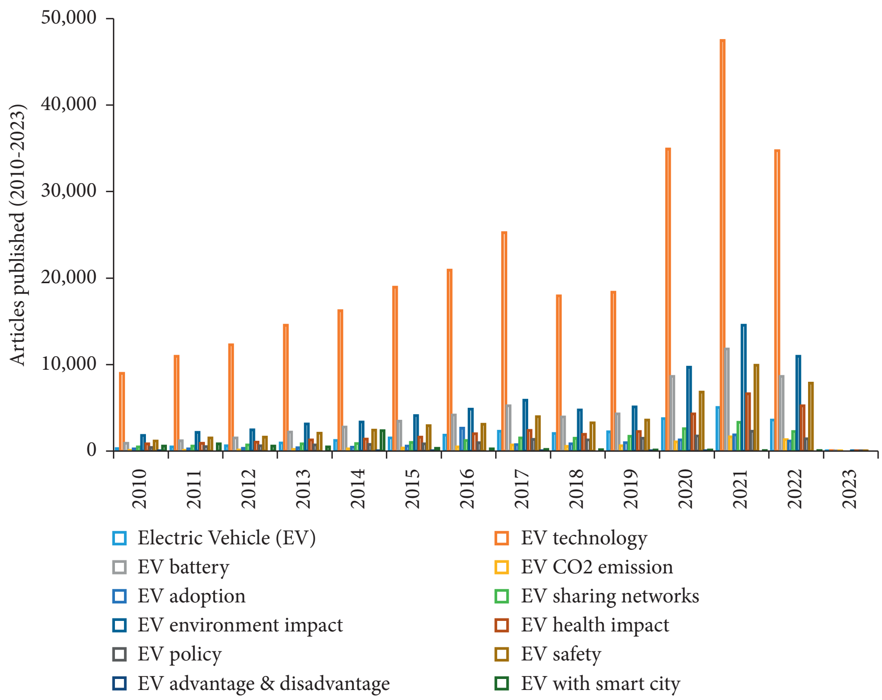


Figure 19: Number of published articles in EV technology, battery, CO_2 emission, adoption, sharing network, environmental and health impact, policy, safety, smart city development, advantage and disadvantage (the data source taken from ScienceDirect).

Figure 18 shows the block diagram of the overall installation of V2I. In this structure, only servers around the domain need the Internet, where information can be prepared and distributed as required. A global server with an Internet office can be used in conjunction with all competent authorities and contains a database for storing all data recorded by vehicles in motion. The car is suitable for continuously separating data about environmental and vehicle conditions, which must be systematically returned to the domain server. These can be completed through the onboard unit (OBU), equipped with a camera, and installing the sensor inside or inside the vehicle. The remote standard IEEE 802.11p (orthogonal frequency division multiplexing (OFDM)) is used to implement the physical V2I layer (PHY) with multichannel ambiguity. OBU can display 2G, 3G, 4G, or Wi-Fi to provide better usability in areas with little traffic.

5. Contribution of EV Technology Improvement and GHG Emission Reduction

Table 1 shows the leading countries' national EV battery technology improvement systems and their contribution of GHG emissions. China and the United States are the leading countries in the area of improving control over EVs.

6. Conclusions, Current Research Trends, and Future Recommendation

6.1. Conclusion. It is expected that progress in the development of EVs and contributions to the overall resources and facilities of renewable energy will improve the global reputation of electric cars. In this sense, additional technology improvements such as appropriate and reasonable charging rules, smart cities, robust adaptive frameworks, and business structures, policy, CO_2 emission reduction, and reduction to measure the impact on the environment, health, and power grid are fundamental to ensuring the most significant advantages from EVs with circulated benefit. Besides, Energy Internet will become an innovative network in the future and will use the latest energy frame panel to compute the energy framework fully. This study introduces all parts of the development structure of electric cars. After incorporating the principles of EVs and their adoption globally, electric vehicles must be widely known in the market. We carefully analyze the known electric car approach guidelines and many components so that future professionals can understand the solutions that will be implemented. Also, the various parts of the current framework used to load the communication and EV sharing networks have been carefully examined and improved, for example, strengths, consistency, control, and coordination strength, including their benefits and drawbacks. This study also suggests future research recommendations to overcome the tide. A letter on the future possibilities for electric cars shows that the exploration area needs to be reviewed.

6.2. Current Research Trends. Figure 19 shows the current research article trends and the number of published papers between 2010 and 2023 on EV-related topics. It can be observed that the current research trends follow the study topic, whereas EV technology is the top hot topic in these research areas. There are 47498 plus articles published in 2021, and the current year's published amount is about 34737. The second position is the EV environmental impact topic. There are 4844 additional articles published between

2020 and 2021, and till this year, 2022, about 10973 materials are already online. However, in the current year, publication topics such as EV battery, EV safety, EV health impact, and EV sharing networks are 8621, 7838, 5219, and 2251 higher than EV policy, EV CO_2 emission, EV adoption, and EV with smart city 1429, 1300, 1150, and 50, respectively. On the other hand, the EV advantage and disadvantage number of articles are significantly low. It is concluded that in the recent years from 2010 ahead, there has been significant progress in electric vehicle technology, which gives this subject the conviction area of exploration.

6.3. Future Recommendation. After reviewing the current research on electric vehicles (EVs) status, it is felt that the novel approaches can be useful to overcome the obstacles to EV development. Besides that, it is unbearable to discuss all the importance in one study. For further improvement, the research needs some future recommendations for enlightening its value, as given below.

(i) The energy storage battery technology needs to be improved for EV adoption, as well as the need to enhance the standard charging ports to user friendly.

(ii) The materials used in EV batteries are challenging to recycle. So, there is a need to find a new energy storage technology.

(iii) EV battery charging with grid connection still has adverse effects. These effects may need time to be reduced, which will increase a great chance to integrate EVs with renewable energy sources.

(iv) Reduce the EV battery temperature; an air-cooled medium technology can be applied, such as water or PCM (Phase Change Material). For more details, go to Akinlabi and Solyali [87].

(v) Develop new EV business and policy plans for customer's products and services about EVs.

(vi) Globally, EV acceptance still needs time. EV implementation can be improved by following some EV-accepted countries.

(vii) The information and communication should be more advance in EV smart cities with renewable energy development. To take the right plan, we need to collect more literature or online survey data, and the idea can generate from EV-developed countries.

Data Availability

All data used to support the findings of this study are included in the article.

Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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