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Review Article

A Comprehensive Review on the Integration of Electric Vehicles for Sustainable Development

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In this article, the concept of an electric vehicle (EV) as a sustainable development (SD) is discussed, and the viability of the development of electric vehicles is assessed. This study broadens the conventional definition of sustainable development by incorporating and prioritizing crucial areas of technology, environment, and policy performance. The proposed review studies have summarized the elements that can promote the integration of electric vehicle technology. The innovation of the EV has just become a modern innovation. At the same time, some obstacles, such as policy and lower adoption, are resisting its goals. To overcome this situation, electric cars have to adopt some innovative approaches that can be another path to success. The review result shows that the proposal discusses the technological advancements of electric vehicles worldwide and paves the way for further improvements. The results also mentioned technological development to reduce emissions and help us understand the impact on the environment and health benefits. However, the summary would be advantageous to both scholars and policymakers, as there is a lack of integrative reviews that assess the global demand and development of EVs simultaneously and collectively. This review would provide insight for investors and policymakers to envisage electric mobility.

1. Introduction

Electric vehicles (EVs) have the potential to contribute to the decarbonization of transportation and the emergence of low-carbon cities due to the benefits of energy-efficient technology and low pollution. Thus, it has become one of the development trends of interest in the automotive industry [1, 2]. However, the EV industry's future success is highly reliant on technological innovation [3, 4]. Many countries, including Sweden, China, Malaysia, and Korea, have paid close attention to EV technology innovation and issued policies to encourage EV technological innovation [5–8]. Nowadays, technological innovation in the electric vehicle field of sustainable development is a significant topic.

The most important reason is that, at present, environmental issues are becoming increasingly serious. Vehicle exhaust gas emissions have become the most significant source of air pollution, particularly in densely populated areas. In order to overcome the environmental and energy crisis issues that conventional vehicles contribute to, hybrid electric vehicle (HEV) technology has been developed and applied over the past few years. HEV technologies provide a fuel economy improvement and enable HEVs to exhaust fewer emissions compared to conventional internal combustion engine vehicles (ICEVs), but HEVs cannot completely resolve the above-mentioned issues. Thus, vehicle technology has improved to produce pure electric vehicles (PEVs). As a result, PEV technology could reduce greenhouse gas (GHG) emissions and particulate matter ($PM_{2.5}$) air pollution as the world is suffering from dangerously high levels and poses a major environmental risk to human health [9]. Many studies have been conducted to reduce GHG emissions from vehicles. Without GHG standards, global CO_2 emissions from passenger vehicles would nearly double between 2000 and 2030 [10].

However, if current GHG standards are followed, global GHG emissions from passenger vehicles are expected to be slightly lower in 2030 than they were in 2000. Based on other research, currently implemented vehicle GHG emission standards will reduce 1.7 billion tons of CO_2 emissions from light duty vehicles (LDVs) in 2040, whereas CO_2 emissions from LDVs will be 5 billion tons in 2040 if GHG emission standards are not implemented [11]. Sen et al. have estimated the impact of GHG standards on the market share of electric vehicles (EV) because zero-emission vehicles are more likely to meet GHG standards, also known as the corporate average fuel economy (CAFE) [12].

The researchers from different countries used various methods to assess the environmental impact of EVs. Many researchers have discovered that electric vehicles (EVs) can help to reduce GHG emissions in a variety of ways [13–15]. For example, Hawkins et al. discovered that in Europe, EVs could offer a 10% to 24% reduction in global warming potential when compared to conventional diesel vehicles [16]. According to Onat et al., all-electric vehicle types could help to reduce global warming in Qatar [17]. Some scholars believe that electric vehicles may not help to reduce greenhouse gas emissions [18–20]. Some researchers deny the actual environmental benefits of EVs, owing to a lack of EV stock and the power utilized by EVs being insufficiently clean. For example, more than 70% of China's electric power is generated by burning coal or natural gas. The power production industry is well-known as a source of air pollutant emissions, including sulfur dioxide (SO_2) and nitrogen oxide (NO_X) emissions [21]. The source of electricity generation emits a large amount of greenhouse gases, which makes the popularity of EVs appear to be environmentally unfriendly [20, 22–24]. The electric vehicle contributes to global warming mitigation if the electricity generation system is powered by renewable and sustainable energy [25–27]. However, Khan et al. have discovered a comprehensive study on solar-powered electric vehicle charging systems [28]. As a result, from an environmental viewpoint, EVs remain a promising trend for decarbonizing transportation and can contribute to sustainable development [29].

The sustainable development framework is the most important model or framework to consider when developing new technology. Such frameworks take into account various aspects of development, such as social, economic, environmental, and technological factors. Furthermore, the development of international standards and codes, universal infrastructures, associated peripherals, and user-friendly software will be critical to the successful growth of EVs over the next decade [30]. Huge teams of researchers are working in these fields all over the world. Khalid et al. and their research team have enclosed a comprehensive review on advanced charging topologies and methodologies for electric vehicle batteries [31]. They focused on EV charging technologies regarding charging methods, control strategies, and power levels. Ahmad et al. developed an existing EV charging infrastructure and energy management system for smart microgrids [32]. The charging infrastructure of electric vehicles relays on the grid system, thus unscheduled EV connectivity with conventional grid systems leads to unreliable and interrupted power supply, which may lead to grid failure. Therefore, the smart city development and energy management systems could respond to the smart grid system, which includes renewable energy sources (RESs) and EVs, respectively. That research shows a good summary of the progress of EV charging infrastructure and the impact of EV charging on the grid, which, on the other hand, is critical for the growth of the EV market. However, several authors summarized EV charging infrastructure [33–35], EV integration into the smart grid [36], vehicle-to-grid (V2G) technology impact [37], battery swapping stations for electric vehicles [38], and EV and smart grid interaction [39] in various publications. But taking part in single approaches may not be suitable for EV adoption growth. There are several supporting strategies, such as environmental and health impact, policies to help EV technology improvement, and sustainable development worldwide.

To improve EV adoption growth towards sustainable improvement, this paper proposes an innovative approach for EV development to provide an important guideline with examples for developing and nondeveloping countries. Such approaches consider various aspects of development, such as technical, environmental, health, and policy. The study is summarized from the standpoint of sustainable development using electric vehicle technology and its impacts in different sectors. The technological development could not help to increase EV adoption. Thus, this review points to the technological improvement rates including such key dimensions as human, nature, and system factors. EV technology with future smart city development is the key factor for renewable energy system development, which could help to reduce the impact of EV integration on the grid. The smart grid structure with EV system impact has been discussed in this review. The following article summarizes EV policy, which is a significant contribution to recognizing the major improvements in EV use in different countries and necessary methods. The review summarized the EV adoption hypothesis, which could improve the sociodemographic and psychological characteristics. Nowadays, EV sharing and its benefits are hot topics, and electric vehicles are playing an essential role in environmental and infrastructure benefits. In this regard, the review went through the vehicle sharing mobility structure discussion. Lastly, the paper summarizes and explores some different methods and their advantages and disadvantages, which could continue the development of electric vehicle innovations with a sustainable energy management system. These discussions will give a general framework for increasing EV growth in the world.

The structure of this article is as follows: in the next section, we summarized the electric vehicle technology development approaches. Section 3 summarizes the CO_2 emission and reduction approaches with different countries' alternative fuel vehicle studies. Sections 4 and 5 show the EV's environmental and health impacts. Section 6 summarizes the electric vehicle policies and major improvements for EV development. Section 7 outlines the advantages and disadvantages of electric vehicles. In the last section, the study covers the conclusion and makes a recommendation.

2. Electric Vehicle Technology

Currently, the world is facing atmospheric changes and emissions of ozone-depleting substances [40, 41]. Most of the conventional vehicles carry substances that deplete the ozone layer. According to a declaration issued by the European Commission, transportation sector is responsible for a quarter of the total ozone layer depletion in the European Union (EU). One of the main ozone-depleting materials is CO_2 gas, and about 15% of CO_2 is emitted by light vehicles [42]. The revolution of electric vehicles has stirred up great interest from analysts, governments, and strategic designers in many countries. Today's electric vehicle (EV) technology stems from various types of individual achievements that divides the overall field of EV into several key areas [43]. Because of their low pollution level, EVs can promote low-carbon emission and present a model for decarbonization of transportation in automobile sector [1, 2, 44]. Nevertheless, future expansion of EVs depends on technological improvement to a great extent [3, 4]. Policymakers in many countries like Sweden, China, Malaysia, and South Korea are serious about developing strategies to support the new inventions in this field [5, 45].

Figure 1 shows the analysis of the estimated improvement index the estimation steps to improve the areas and subdomains, where PE is the hardware and EM is the electric motor.

There are various analytical models to appreciate the sustainable and unsustainable development of electric vehicles. An enhanced version of the HNS model (human, system, and nature) has been developed for mechanical steering of EV, which is then converted into NHS to show versatility from N to H and then converted to H to S. An idea of the relationship between people, nature, and systems is shown in Figure 2. As shown in Figure 2, each of the three representations is adjusted equally in accordance with their proposed model (NHS)—case (a) is more supportable than (b), and (b) is more practical and therefore better than case (c). In the proposed model, nature, human, and systems are considered independently (Figure 2), whereas humans depend on nature and nature will remain without people, and the structure depends on both humans and nature. As a rule, support infers a rational approach to limit negative environmental impacts trying to maintain harmony between all three components. The opinions of people and structures are discerned from a natural viewpoint [46].

There are three types of electric vehicles: hybrid electric vehicle (HEV), fuel cell electric vehicle (FCEV), and electric vehicle (EV). According to [47], all PHEVs in a municipal fleet can be divided into the following six categories, where vehicles in category 2 are modular electric vehicles that are operated by, at least, one electric motor using the energy stored in batteries.

(1) Electric bicycles and bicycles

(2) Street electric cars

(3) High-speed urban electric vehicles

(4) Low-speed electric cars

(5) Supercars

(6) Electric bus and electric truck

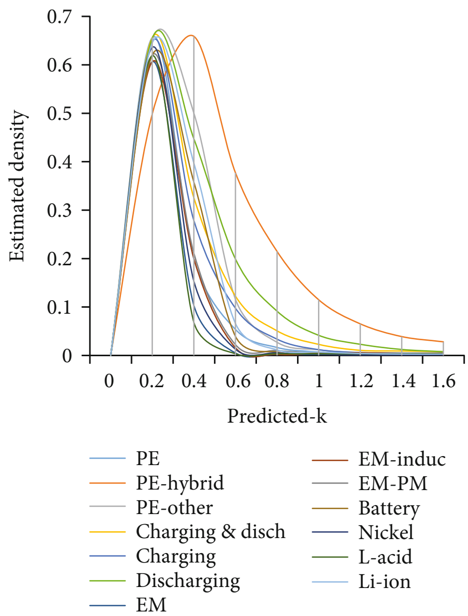
A model for relationship between EV and the grid is shown in Figure 3 [41, 48]. To overcome the low-voltage and high-load systems, it is recommended to connect or charge EVs to the grid at a specific time. However, EV technology advancement may not only increase EV adoption. There are several criteria needed for energy management methods and policies to give motivation to EV customers. A study using bilevel mathematical model to capture the decision-making processes of the transport agency and the travelers can serve as guidance for metropolitan transport agencies to establish specific locations and capacities for EV [49].

2.1. Flexible and Innovative System in the Vehicle. In near future, dynamic mobility between fully electric vehicles (EVs) and plug-in hybrid electric vehicle (PHEV)) will become an imperative choice for the smart grid area [50]. Hence, an energy management mechanism is desirable to endorse the link between household business taxes and fast car charging. One of the best choices required for flexible and unique utilities is EV [41, 51], the function and focus of which include strategy to ensure high response speed and transfer energy in two directions.

2.2. Future Development Model of Electric Vehicle Network (EVGI). Electric vehicles can be used not only as transportation but also as electrical loads (grid to vehicle (G2V)), the corresponding energy stock of grid (vehicle to grid (V2G)), the energy stock of various electric vehicles (vehicle to vehicle (V2V)), and the energy stock of buildings (vehicle to building (V2B)) functions system compliance center [52, 53]. In the field of vehicles, some of the latest innovations include proprietary long-distance power transmission (wireless power transfer (WPT)) [54], connected mobility (CM), autonomous or autonomous electric vehicles, and the economic saving and life power network of electric vehicles. Figure 4 shows a classification, and Figure 5 shows a recommended model for the future development of EVs and energy structures. This proposed structure includes renewable electricity and hydrogen generation for battery and fuel cell EVs. On the other hand, energy networking systems have been developed for energy utility, distribution, and transmission control systems, whereas EV is contributing as a utility and energy distributer.

2.3. Application of Renewable Energy. This section studies the impact of renewable energy systems in implementing EV. Knezović et al. [55] studied the opportunity and exertion of synchronizing sustainable energy sources (for example, based on wind and sun) to provide energy for battery charging and limiting greenhouse gas (GHG) emissions. PEV can charge electric vehicles in peak-off hour or when the renewable energy is available. 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 load and the maximum load. At the top time, supplementary energy is fed into the grid. From the literature, we found that primarily, the broader prospects of entire future grid system and network have been studied so far [41].

2.4. Smart Grid Structure. Smart grid is a multifaceted system connected to all grid networks. At present, the power grid network does not meet the flexibility required to facilitate EV



Domain & subdomain	Improvement (%)
PE	18.3
PE-hybrid	38.5
PE-other	15.8
EM	7.7
EM-PM	10.1
EM-Induction	9.4
Charging & dis	23.8
Discharging	28.6
Charging	21.9
Battery	11.7
Battery-lithium-ion	13.2
Battery-nickel	8.7
Battery-lead acid	5.1

Figure 1: The estimated technological improvement rates of domains and subdomains [43].

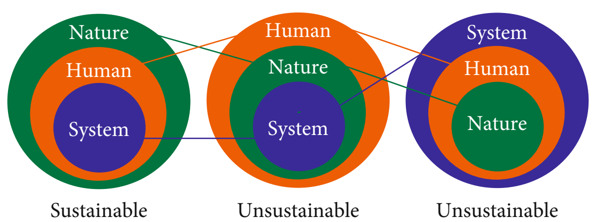


Figure 2: Models for human, structures, and nature (HNS): (a) sustainable and (b and c) unsustainable. Redrawn from this source [46].

charging. For the exhibition of all system screen characters for this application, various networks need to be effectually cliched, connected, and permitted. The following are the main components of planning a keen system [41, 52]:

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

(2) The structured grid model should support future growth

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

(4) Any system update program should be executed automatically

2.5. Impacts of EV Integration on the Grid. However, this section's information is important to observe the impacts of EV integration on the grid. We summarized the effects of mixing the EV grid, which can be divided into negative and positive. It is recommended that before connecting EV technology to the grid network, there will be significant heavy load problems. However, EV technology still needs to be synchronized to the national grid system. A short details are shown in Figure 6 [52].

2.5.1. Negative Effects. Electric cars are a wonderful test for energy suppliers. The unnecessary integration of electric vehicles into a decentralized system can affect the shape of the stack, the limits of the components of the transport frame, tension and repetitive accidents, injection of upper symphonies, a power failure, and financing stability.

2.5.2. Positive Effects. Although top-level EV access to the network can cause problems such as damage to the quality of the degradation, increasing maximum loads, and power recommendations, each of these problems can be resolved using executive power techniques, such as [37, 56, 57].

2.6. Approach Time to Charge the Battery to Reduce Negative Impacts. Synchronous loading is 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) (Figure 7(a)), are regarded as the parameters of this technology. In the independent state of charging, 55% of the battery charge is accomplished, and additionally, 45% is supplied during low use (10:00 p.m. to 7:00 a.m.). In express delivery, 75% of the EV battery charge ends when used less (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 an uncontrolled state of charge, 55% of the charging time of the battery is used during periods of low usage (10:00 p.m. to 7:00 a.m.), and the remaining 45% is between 7:00 a.m. and 10:00 p.m. [12].

A proposed charging schedule is shown in Figures 7(b) and 7(c). One of the primary difficulties with this strategy is that during periods of maximum energy consumption,

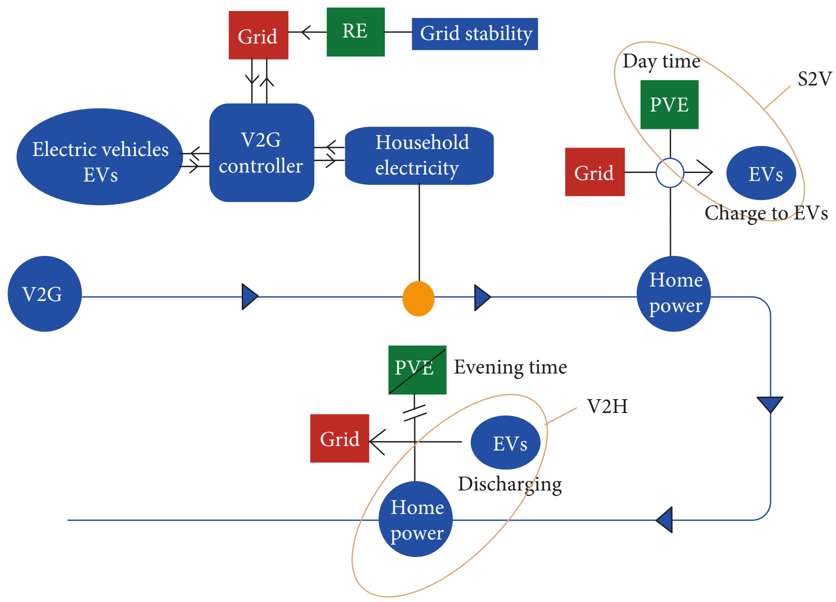


Figure 3: The relationship between electric vehicles and the grid.

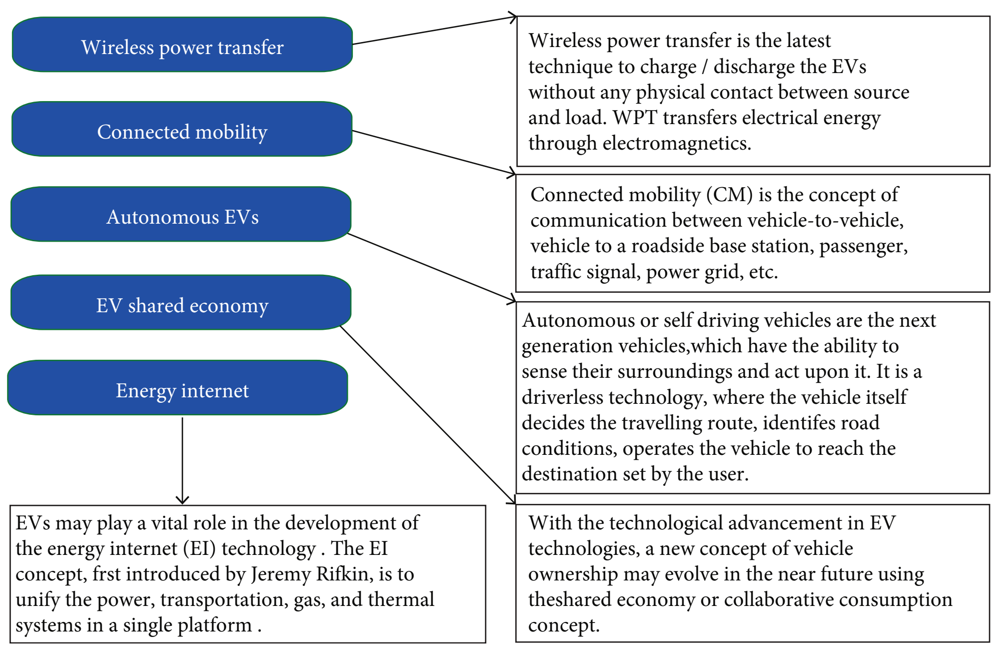


Figure 4: Classification of EV network.

the charging of connected EVs gets restricted. The following mode (controlled state of charge) is considered.

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.

3. CO_2 Emission and Reduction Approaches

Apart from the positive impact, we believe that EVs could be a suitable technological option for renewable energy sources. However, for sustainable development, EVs could contribute to the environmental impact. Synchronization between issues related to global temperature change and air pollution are vital for a cleaner transportation sector. The International Energy Agency (IEA) is taking measures to reduce carbon dioxide (CO_{2eq}), and many countries have adopted the introduction of EVs in the market as an important policy [59, 60].

Many observations focused on the development of electric vehicle advertisements in various departments and countries, such as in the United States, Iceland, Canada, and the Netherlands [61–64]. From 2012 to 2013, the development of cooperation between electric vehicles in the Scandinavian market was determined by measuring the possibility of using various forms

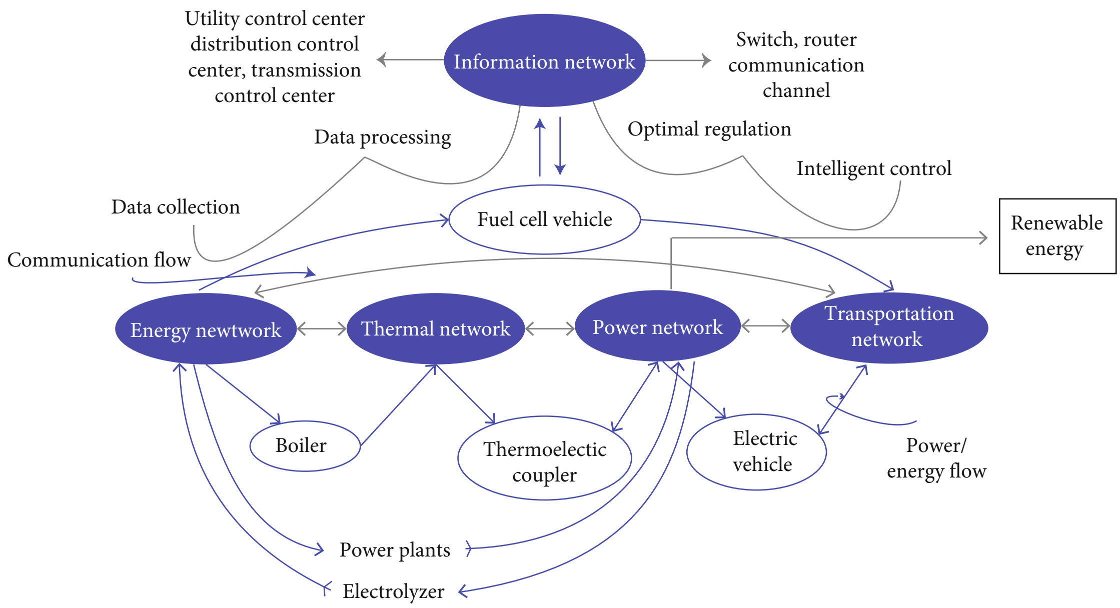


Figure 5: Structure of energy network. Redrawn from this source [52].

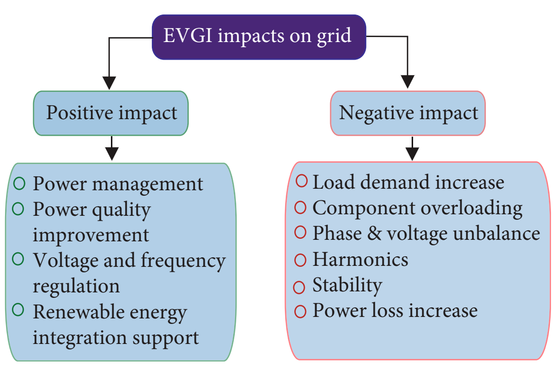


Figure 6: Negative and positive impacts of EV grid integration system. Redrawn from this source [52].

of financing to purchase electric vehicles [61]. The outcomes indicate that the decisive factors are the development of fuel and electric vehicle costs and the driving force behind the government. Many tests use virtual models to estimate the cost of emissions from electric vehicles. Therefore, further research on real information about electric vehicles is required [65]. Buyers of electric vehicles are required to use their local grid discharge as a guide for EV statistic, which is a dangerous deviation from atmospheric deviation due to different radiant forces in the area. Appropriate models for determining the age limit of electricity consumption and carbon dioxide emissions for electric vehicles take into account the explicit radiation factor of the energy service life, which is why it should be carried out on site [66].

As people pay more attention to environmental changes, more attention is being paid to reducing carbon dioxide emissions than ever before. Carbon dioxide from the automotive industry, in particular, accounts for 22.9% of global emissions [67]. More than 190 countries have created plans to carry out the exercises foreseen after 2020 as part of the Intended Nationally Determined Contribution (INDC) [68]. South Korea proposes to reduce the runoff of greenhouse gases (GHG) by 37% by 2030 as an INDC. They believe that this will be achieved by reducing carbon dioxide emissions in the family car sector by 30.8 million tons in terms of carbon dioxide, which equates to the target emission reduction of 11.1% [69]. In order to reduce greenhouse gas emissions from the automotive sector, the Korean government has reached an agreement to create and provide institutional assistance to the global green automotive industry [70]. Electric vehicles (EVs) and fuel cell electric vehicles (FCEVs) play an important role, especially in response to environmental concerns and future interest in cars. In light of these environmental and economic considerations, the Korean government has set targets for the elimination of electric vehicles and FCEVs and is looking for various methods of assistance [71, 72].

3.1. Different Country's Strategies for Alternative Fuel Vehicles (AFVs). Figure 8 shows different countries' strategies for alternative fuel vehicles (AFVs). We summarized the important studies and methodologies for AFVs' performance and contribution to reducing GHG emissions. Previous alternative fuel vehicle (AFV) surveys show that customer preferences for fuel type vary by country/region and inspection time. In addition, in many studies, the probability of making an AFV decision is less than that of an internal combustion engine. Especially considering the opening and charging time of the charging station and taking into account the various characteristics of various studies, with the current level of innovation, internal combustion engine vehicles (ICEV) are even better than AFV [72], but ICEVs produce more GHG emissions than AFV. However, based on environmental and health benefits, AFVs such as BEV and FCV technology could provide an alternative means for sustainable development. The problem of locating refueling stations in a transportation network via

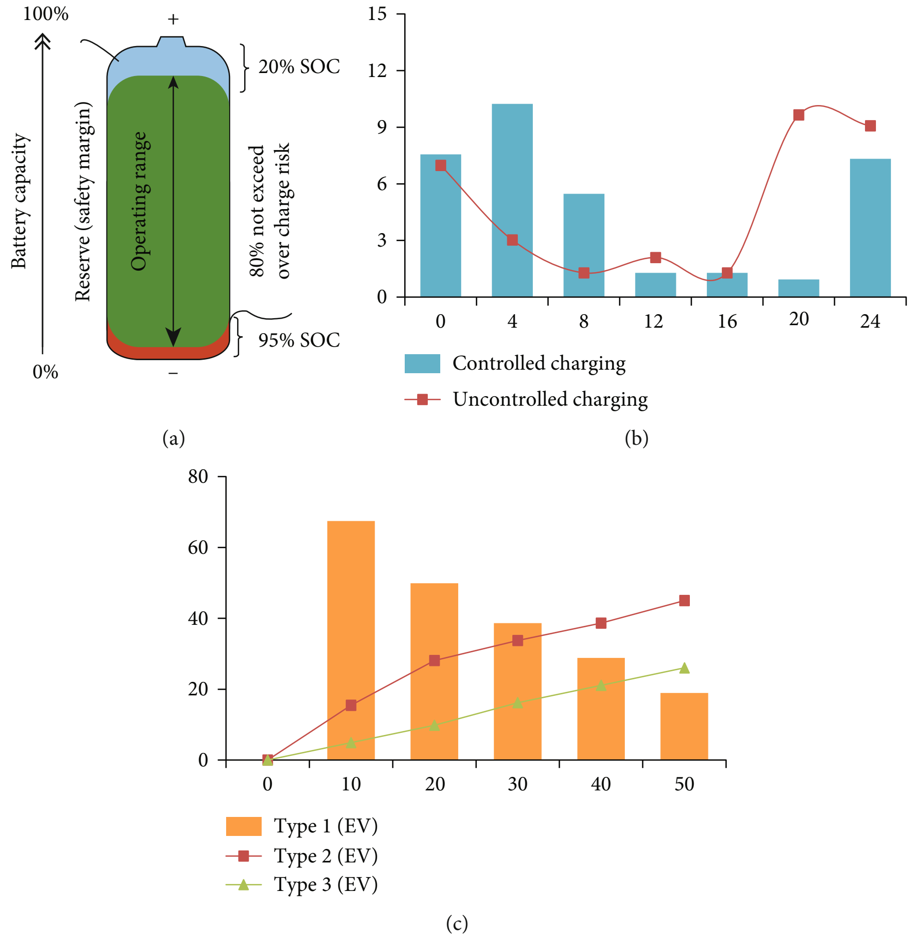


FIGURE 7: Charging schedule of EVs. Redrawn from this source [58]. (a) EV battery capacity. (b) Charging is limited during peak times. (c) Charging process is completed before 6 a.m.

mathematical programming has been carried out by [73]. The proposed model is applicable for several alternative fuel types and is particularly suitable for hydrogen fuel.

Various studies have shown that a clear energy structure in the United States is a key factor in AFV greenhouse gas emissions. To reduce the reduction of medium- and long-term AFV greenhouse gas emissions, some AFV assumptions need to be considered, as well as customer trends and mechanical innovations, as well as state regulatory mechanisms for energy consumption. It is recommended that we follow the different countries' AFV methodology to overcome the EV performance issues and use those technologies for sustainable development. Based on the life cycle assessments around the world, AFVs perform better than ICEVs. For example, in the European power mix, EVs can reduce GHG emissions by 10 to 20% compared to ICEVs. On the other hand, GHG emissions from hydrogen production are analyzed in the context of South Korea. They used well-to-wheel (WTW) approaches to reduce GHG emissions. However, since a large portion of the power sources around the world are fossil fuel based, EVs may not be effective in reducing GHG emissions. Thus, EV technology needs further improvement (i.e., fuel cell technology) and policy implications to achieve deep decarbonization from power to transportation sectors. In the following section, we provide some research and future prediction outcomes for EV development in the road transportation sector in South Korea and China.

3.2. CO_2 Emission and Reduction Scenario Approaches. This is a proposed assessment of carbon dioxide emissions and approaches of reducing the use of heavy-duty trucks under various conditions of emission acceptability in South Korean. Mechanically achievable carbon reduction levels apply to the following four situations: similar to business as usual (BAU), mild, normal, and aggressive conditions. In the estimation of CO_2 emissions, a simulation model based on the longitudinal component of the vehicle, the normal vehicle mileage, and the number of Korean vehicles has been used, as shown in Figure 9. According to BAU, 30.82 million tons of carbon dioxide will be produced by 2030 and carbon dioxide emissions will be cautious and sensitive and, as a rule, will decrease by 2.1%, 4%, and 5%, respectively. By 2040, the impact of these conditions will be reduced by 5.7%, 10.9%, and 15.8%, respectively. These results indicate that South Korea can reduce CO_2 emissions through strict improvement measures or CO_2 regulations for vehicles [74].

Here is another example. China is by far the best private electric car advertisement in the world and flexibly represents

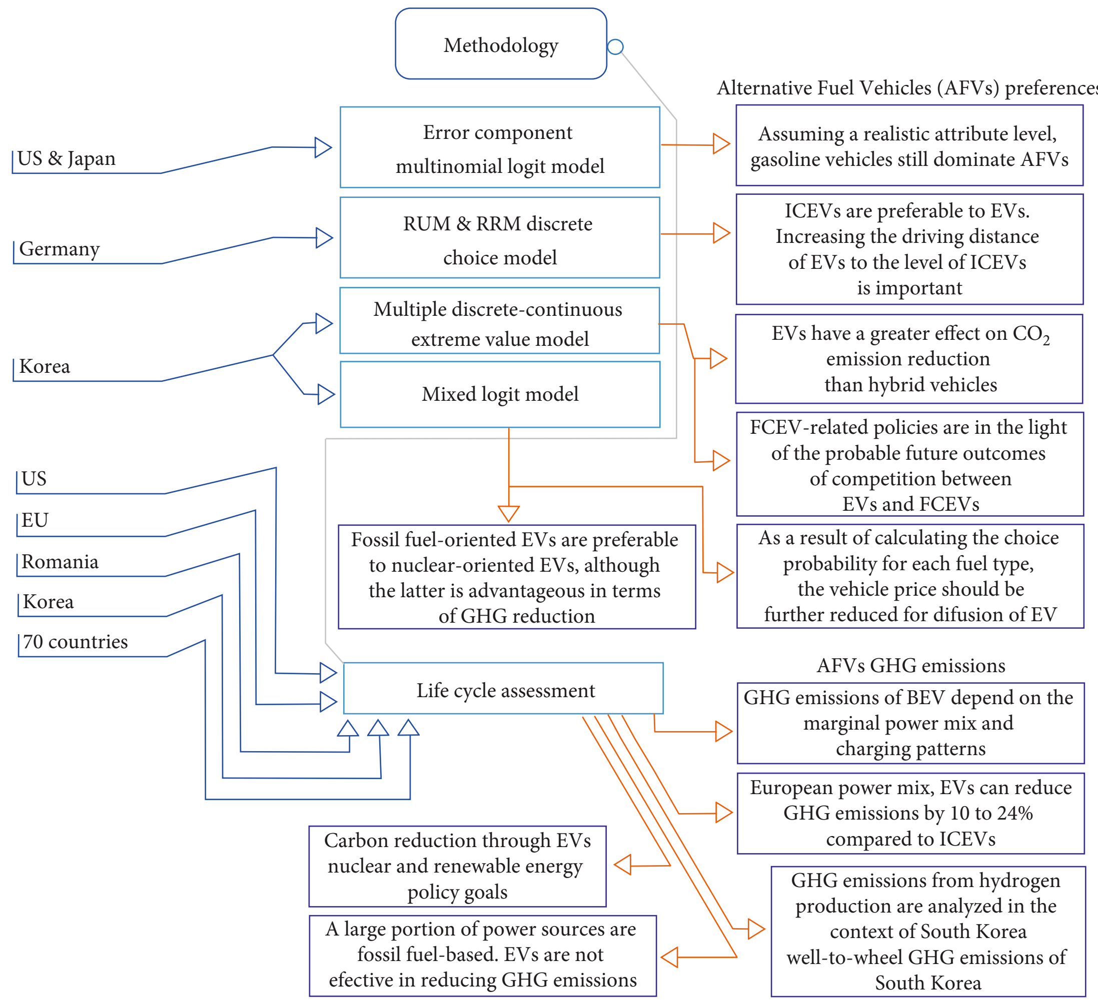


Figure 8: Summary of the relevant studies.

part of the world's private car in 2017. The China data research center of Automotive Technology & Research Center has maintained an extensive database of prices and quality. This data can be used to evaluate the environmental impact of the PEV in China [75].

Always indicate eVKT (vehicle kilometers travelled) of BEV and PHEV in 5 districts. From 2011 to 2017, BEV covered 12.5 billion kilometers in 5 regions. Beijing invested over 30% in all electronic quotas; Zhejiang, Guangdong, and Shandong accounted for around 20%; in Tianjin, it is less than 10%. From 2011 to 2017, 5.8 billion kilometers were spent in 5 regions. Shanghai represents 55% of the PHEV recommendations, Guangdong 32%, and less than 5% in the other three regions. Between 2011 and 2017, these five districts spanned a total of 1.83 billion kilometers. In 2017, PEVs accounted for 70.1% of the 9.7 billion kilometers guaranteed by battery-based EVs.

Figure 10 shows the absolute annual CO2R for BEV and PHEV, respectively. From 2011 to 2017, BEV carbon dioxide outflows in Beijing and Zhejiang declined. In any case, from 2011 to 2013, BEV went to Guangdong, from 2014 to Shandong and from 2012 to Tianjin, carbon emissions have increased, and the ICEV has also been limited. Although carbon emissions in Shandong and Tianjin are generally high, this increase in runoff is due to the generally low natural impact of destroyed vehicles in Guangdong.

In Shanghai, from 2011 to 2017, the outflow of carbon dioxide from PHEV continued to decline. Between 2011 and 2017, plug-in hybrid cars have grown steadily in Guangdong, Tianjin, and Shaanxi in the past 4 years (except 2016) and in 2017. It is unclear whether PHEV-CO_2 in region 5 has completely run out until 2015. The model is also explained by the general environmental impact of top models such as Guangdong, Tianjin, and Shaanxi, although the CO_2 emissions in Tianjin and Shaanxi are slightly higher. In 2017, the PEV produced 355,827 tons of carbon dioxide in five main locations. About 80% of this volume is provided by BEV and 20% by PHEV. In 2017, each BEV model emitted 606.6 kg of carbon dioxide, and each PHEV model emitted 350.9 kg of carbon dioxide. Although BEV and PHEV disposed of 472,806 tons and 139,018 tons of carbon dioxide from 2011 to 2017, respectively, the PEVs generally reduced 611,824 tons of carbon dioxide [76].

The above results show the performance of EVs and EV-related policy applications. That progress mainly depends on a country's policy and identifying the best technology to fit

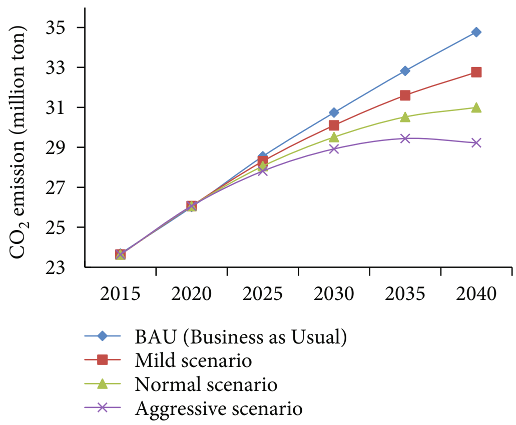


FIGURE 9: CO_2 emission reduction in South Korea [74].

into the market. However, underdeveloped countries should learn from EV growth countries' experience. A good EV policy could help to reduce GHG emissions and environmental and health impacts from the transportation sector. To support this powertrain electrification, China and India launched subnational level policies to inspire electric vehicle demand, local manufacturing, research and development (R&D), and infrastructure development. Therefore, technology and policy have a significant role in EV growth and adoption.

4. EV Environmental Impact

Since the introduction of the most advanced combustion engine in 1885, transportation has only been achieved through fossil-fueled vehicles. Today, vehicles account for 29% of global carbon dioxide emissions, while individual vehicles account for 10% [77]. In addition, by 2025, less than 5% of vehicles in the United States will correspond to corporate average fuel economy (CAFE) [78]. On the other hand, EU regulations stipulate that by 2020, the bound emissions of carbon dioxide must reach 95 g/km, which means that more than 95% of cars still do not agree with the standard [79]. As a result, the main contest is the amount of adoption for EVs versus clean electricity fueled. In 2009, a fascinating study was conducted, showing the advantages of PHEV and HEV vehicles in achieving emission targets and reducing fuel consumption compared to regular vehicles [80]. At this point, the restriction that restricts the use of electric vehicles as a standard rather than an exception seems to support hybrid electric vehicles. However, the environmental impact of HEV largely depends on its internal combustion engine "range extender" [81].

Another major disadvantage of simple fractional alternatives is that, despite many other options, they all produce nearby toxins such as some CO, NO_x, and PM. Contrary to the flow of carbon dioxide, these particles have local characteristics that affect air quality within 100 km [82]. Several sources indicate that this reduction in carbon dioxide emissions can reach 100%, while SO_x can be reduced by 75%, NO_x can be reduced by 69%, and PM_{10} can be reduced by 31% [83, 84]. In this regard, urban areas are exposed to another type of pollution: noise pollution. In all respects, a quiet EV can reduce the noise level by 3-5 dB (A) [85]. Nonetheless, some experts found this reduction to be a conflict advantage, especially due to helpless street customers [86], and emphasized the need for additional security measures.

The location of countless electric vehicles poses environmental problems associated with battery disassembly. Although it is currently impractical to use lithium batteries incompletely, lithium batteries contain hazardous components inherent in the toxicity of electronic equipment and must be properly disposed of. There are many reasons why lithium batteries are more difficult to predict and more expensive than lead-acid batteries. Initially, lithium batteries were equipped with a series of accessories, including $LiCoO_2$, $LiMn_2O_4$, $LiNiMnCoO_2$, $LiFePO_4$, $LiNiCoAlO_2$, and $Li4Ti5O_{12}$, which made the automatic reuse process difficult. In this case, the dynamic materials in the battery cells of Li particles are coated with metal foil powder, which needs to be separated during recycling. Lead-acid batteries are always made of a small number of large lead plates and are located in a single plastic case, but in most cases, many individual low-limit batteries and lithium particles are bundled in the module [87, 88].

4.1. Electric Vehicle Battery Recycling. From an environmental point of view, the rapid growth of the electric vehicle market will not cause a large number of lithium-ion batteries to expire. If they enter the recycling program or are improperly used, they will generate a lot of toxic waste. Stringer and Ma [89] found that due to the strengthening, the global electric vehicle load will reach 55,000 to 3.4 million from 2018 to 2025. These batteries are no longer suitable for electric vehicles. However, they have less than sufficient limits for certain fixed capacities (for example, storing energy on a private, modern, and basic scale). However, according to Nissan CEO Francisco Carranza [90], the price of EV battery materials that can be disposed of permanently is much lower than the price of fully used batteries. Since the used EV battery has enough energy to meet the less demanding tasks (such as RES energy storage), and since the use time can only be about 8–20 years [91], this will undoubtedly be reused again. This wise approach is called the second demonstration of using electric vehicle batteries, and some organizations have recommended it, for example, Nissan and Hyundai. Marra et al. [92] found that the ratings of batteries with potential for reuse are almost several times higher than the ratings of batteries that are increasingly suitable for recycling [93].

4.2. Electric Vehicle Effect on Electric Scaffolding. At the turn of the 20^{th} century, global temperature changes and environmental pollution issues became the main issues of general legislative issues, which led people to seek the choice of petroleum products functionally and may revive electric vehicles. At the same time, the rapid expansion of the state-supplied electricity supply can benefit both the land and the real test of the energy structure. Huang et al. [94], described that the emergence of electric vehicles will cause a "top-down" impact, which may lead to serious risks related to the power system, for example, in southern Norway in 2017 [95]. These risks include an increase in the short-circuit currents; the voltage level could no longer be between the standard limits; the power demand is higher and the lifespan of the equipment is affected.

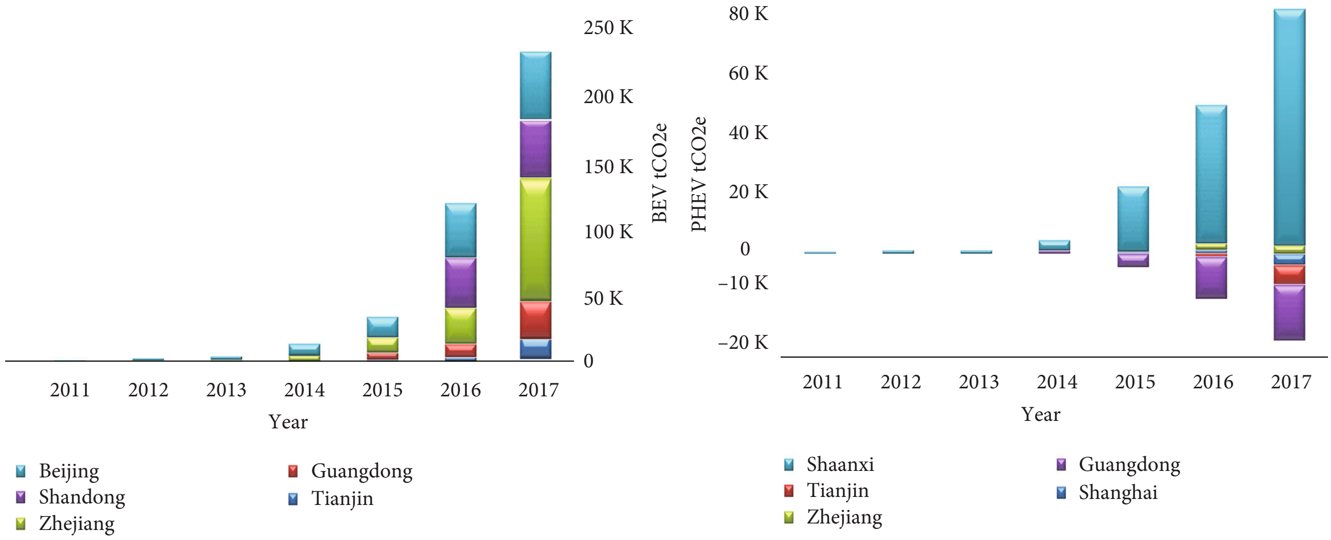


Figure 10: Top 5 BEV and PHEV CO_2 emission reduction in China [76].

However, the EV hosting capacity of the grid is good for a majority of the end-users, but the weakest power cable in the system will be overloaded at a 20% EV penetration level. The network tolerated an EV penetration of 50% with regard to the voltage levels at all end-users in Norway. Injecting reactive power at the location of an installed fast charger proved to significantly reduce the largest voltage deviations otherwise imposed by the charger [96]. Various scientists have raised comparable questions about these issues [97, 98].

5. Health Impact

Vehicle-driven innovations such as electric vehicles (EV), including hybrid electric vehicles (HEV), plug-in HEV (PHEV), and battery electric vehicles (BEV) have potential economic, environmental, and health benefits, but they need to recognize the impressive benefits of open EV reception. Anyway, in the United States, only a small percentage of electric vehicles need to investigate the behavior of the vehicle distribution in order to identify the current consumers of electric vehicles based on the attributes and settings of the electric vehicle while also considering competitive solutions, which are assembled fuel and diesel ordinary vehicles [99].

EVs powered by low-emitting electricity from natural gas, wind, water, or solar power can reduce environmental health impacts by 50% or more compared of ICEVs [100]. Considering the age of sustainable energy use, German electric vehicle emissions are 62-64% lower than traditional vehicles [65]. However, many scholars believe that the promotion of EVs in China cannot achieve energy savings or greenhouse gas reduction in most provinces due to their power structure [101]. Certain environmental benefits can only be realized in certain well-established or low-carbon regions [102]. Increasing the proportion of renewable energy, such as hydropower, wind, and solar power, in the power supply system can effectively reduce the negative environmental effects of EVs [27].

5.1. Well-to-Wheel Approach. The well-to-wheel analysis is a nonstandardized method to quantify the impact of transportation fuels and vehicles regarding energy and climate change. According to the life cycle concept, the US Department of Energy's Argonne National Laboratory has proposed a well-to-wheel (WTW) rating system for studying vehicle fuel consumption. Well-to-wheel is the first step in comparing the efficiency of different solutions towards greenhouse gas (GHG) emissions. Those GHG emissions are so crucial to mitigate because, simply put, they cause climate change. The subject of the assessment is the support of the vehicle's fuel base, which is divided into two stages: the level of fuel production (or from the well-to-tank, WTT) and the ignition level of the fuel (or from the fuel tank-to-wheel, TTW). The former includes the extraction, transportation, and conversion of fuel. The WTW method focuses on the life cycle of fuel consumed by the vehicles without describing the vehicle manufacture, scrapping, and recycling. Figure 11 shows the system boundary of the well-to-wheel approach structure [20].

Figure 12 shows an example of the EU energy mix in the transportation sector. Let us compare vehicles that are powered by gasoline, diesel, plug-in hybrid electric vehicles (PHEV), batteries, and compressed natural gas (CNG) [103].

There are some immediate assumptions from this simple example:

(i) On a TTW basis, electrified solutions offer the best performance. These are the emissions coming directly from the vehicle

(ii) Considering the current EU energy mix (106 g CO_2/MJ), the WTT CO_2 contribution from BEV is approximately double compared to conventional fuels. These are the emissions coming from the fuel or, in the case of electric vehicles, the electricity production

(iii) On a WTW basis, BEVs offer better performance thanks to the better efficiency of the powertrain

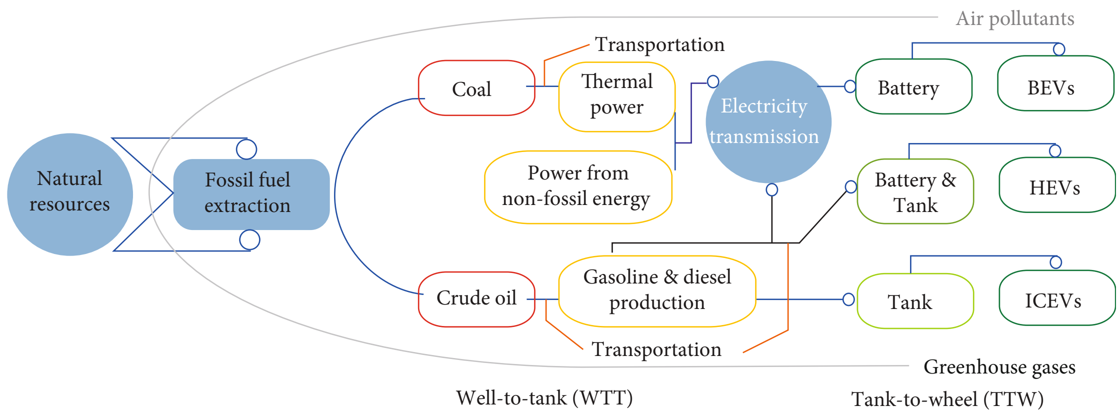


Figure 11: Well-to-wheel system bounder [20].

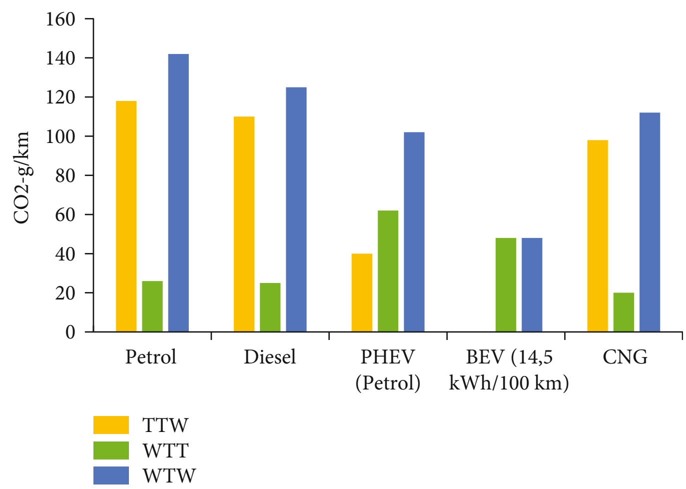


Figure 12: WTW emission comparison C-segment vehicle—WLTP [103].

5.2. EV and Health. Despite continuous innovation and improvement, the automotive industry continues to account for a quarter of the emissions of greenhouse gas substances (GHGs). Automobile emissions lead to a high concentration of air pollution, and many urban communities on the planet often do not meet the air quality indicators set by the World Health Organization (WHO) [104]. For many reasons, it is important to show off new energy vehicles in the global industry. Electric and hydrogen-powered vehicles offer many advantages for cities and urban areas, such as extremely low (hybrid electric cars with plug-in PHEV) to zero (electric cars with battery-BEV, electric cars with fuel cell-FCHEV, and hybrid fuel cell) tailpipe emissions, reduced noise, and the ability to enable new smart services [105–108].

Thus, the European Union (EU) is carefully and extensively studying the enforcement of a driving ban for diesel cars in other European and German cities [109, 110]. By doing so, policymakers want to reduce local emissions, such as nitrogen oxides, in order to mitigate natural and health problems [111, 112]. For example, in 2018, the German city of Stuttgart will impose restrictions on driving old diesel cars due to the higher nitric oxide content than in previous years [113, 114]. Furthermore, policymakers want to lower greenhouse gas emissions through alternative technologies, e.g., by using battery electric vehicles that are powered by sustainable energy sources to limit their environmental footprint. Since the road transport sector has generated 18% of the all greenhouse gas emissions over the past decade [115], an increased interest in alternative technologies such as battery electric vehicles (BEVs) could reduce such emissions [116].

6. EV Policy

Policy development for electric vehicles is an important factor for sustainable EV development. Most policy research has focused on plug-in electric vehicles (PEVs) in the short term, such as by (i) typically considering a wider range of evaluation criteria and (ii) setting PEV sales goals in the longer term (e.g., 2030 or 2040) [117]. Much evidence shows that the short-term method has played a key role in the supervision of PEV so far [118, 119]. Although some studies have shown that PEV and standard gasoline vehicles will eventually achieve equal costs (whether on the price tag or at any cost of ownership) [120, 121], various studies have shown

Table 1: Summary of key PEV supportive policies.

Policy demand focused	Description	Current PEV policy in Canada	"Strong" version
Financial incentives	Reduce the cost of PEVs and infrastructure (via grants, discounts, user fee exemptions, or tax breaks)	Financial incentives ranging from \$500 to \$14,000 per PEV in BC, QC, and across the country through 2020	Incentives of \$6,000 per PEV for 20 years across all provinces
High-occupancy vehicle (HOV) lane access	HOV lane access without restrictions for PEVs	PEVs in BC, ON, and QC have unrestricted access to the HOV lanes	Access to HOV lanes in all provinces that have them
Public charging	Allow charging while away from home	Current charger to gas station ratio unchanged over time	By 2025, the ratio of chargers to petrol stations will be 0.5 throughout all provinces
Building codes	Require charging access in new buildings	In BC, ON, and QC, charges are mandated by building codes	All provinces have adopted EV-ready building regulations
Carbon pricing	Increase in the cost of fuels that produce carbon emissions through cap and trade or a carbon tax	Existing carbon prices are in place in BC, AB, and QC; beginning in 2018, a federal price floor will be applied to all provinces	By 2030, the price of carbon reaches and remains at \$150
Supply-focused zero-emission vehicle (ZEV) mandate	Impose a minimum proportion of light-duty ZEV sales on manufacturers	Beginning in 2020, the QC ZEV obligation will increase to 22.5% credits by 2025	By 2040, a national ZEV requirement will have increased market share by 40%
Vehicle emission standard	Give light-duty cars a maximum amount of tailpipe emissions	By 2025, the fleet must meet an average CO_2e/km standard	By 2040, the fleet must emit 71 g CO_2e on average
Low-carbon fuel standard	Demand that fuel suppliers limit the amount of carbon in the fuels they sell and provide credits for the use of alternative fuels (such as electricity and hydrogen)	By 2030, national standards call for a 12.5% decrease in the carbon intensity of transportation energy compared to 2010	According to national standards, the carbon intensity of transportation energy must decrease by 45% by 2040 compared to 2010 levels and by 25% by 2030

Table 2: Policy on recycling and recycling technology for metal recovery from end-of-life batteries of EVs.

Country	Key content	Company	Recycling process	Reference
European Union	Create a system of collection and recycling for all types of batteries based on an extended producer responsibility system through the Battery Directive	GRS Batterien Batrec AG	Pyrometallurgy, mechanical separation, hydrometallurgy	[136–138]
Swiss		Eurodieuze Recupel	Pyrolysis, hydrometallugy, hydrometallurgy, mechanical separation, leaching, and refining	
France		SNAM	Crushing, pyrolysis, distillation, pyrometallurgy	
Spain		Pilagst	Mechanical separation, chemical treatment	
Belgium		Umicore	Hydrometallugy after pyrometallurgy	
Germany	The German Batteries Act requires all producers and importers of batteries and accumulators to collect end-of-life batteries	Accurec	Pyrolysis, hydrometallurgy	[138, 139]
USA	Universal waste regulations are used to manage the large number of batteries. The recycling of EV batteries at the end of their useful lives is not required by federal law, though. Several states recently outlawed the disposal of used EV batteries in landfills	Onto Retriev TOXCO	Cryogenic crushing, hydrometallurgy, pyrometallurgy, cryogenic crushing, hydrometallurgy	[138, 140]
Japan	Under the Law for the Promotion of Effective Utilization of Resources, manufacturers encourage resource collection and recycling on a voluntary basis (recycling batteries is not covered by any specific laws)	DOWA Sumitomo	Pyrometallurgy, hydrometallurgy, hydrometallugy after pyrometallurgy	[141, 142]
China	Interim Measures for the Management of Recycling and Utilizing Power Batteries for New Energy Vehicles were published in China (including design, production, and recycling responsibilities)	N/A	N/A	[143, 144]
Korea	After receiving a subsidy, the consumer must return the EV's dead battery. The recycling of EV battery end-of-life batteries is not, however, subject to any laws	SungEel Hitech Kobar	Hydrometallurgy	[145, 146]

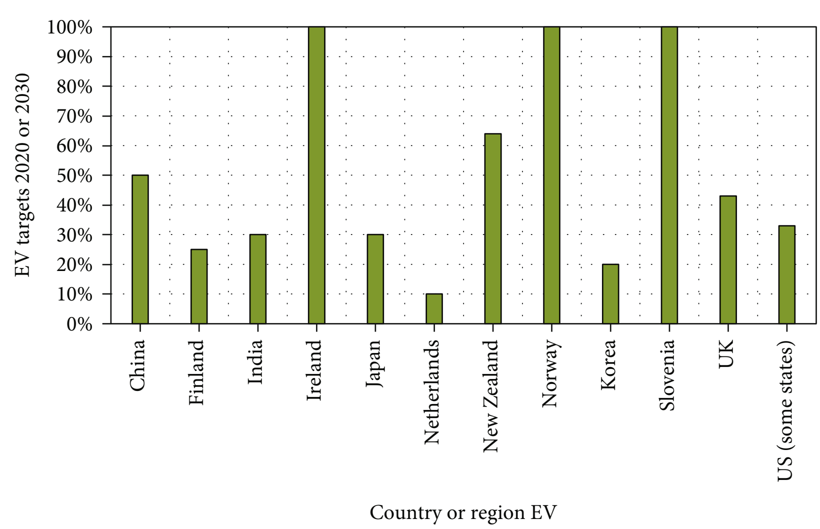


Figure 13: EV present and future targets by countries.

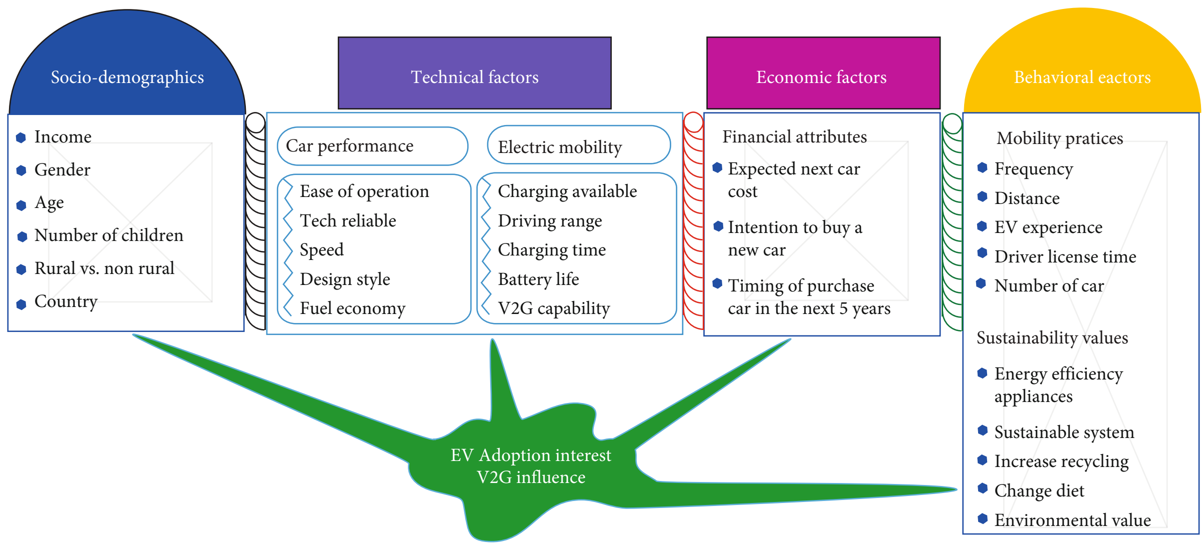


Figure 14: Conceptual framework for EV adoption and the influence of V2G [149].

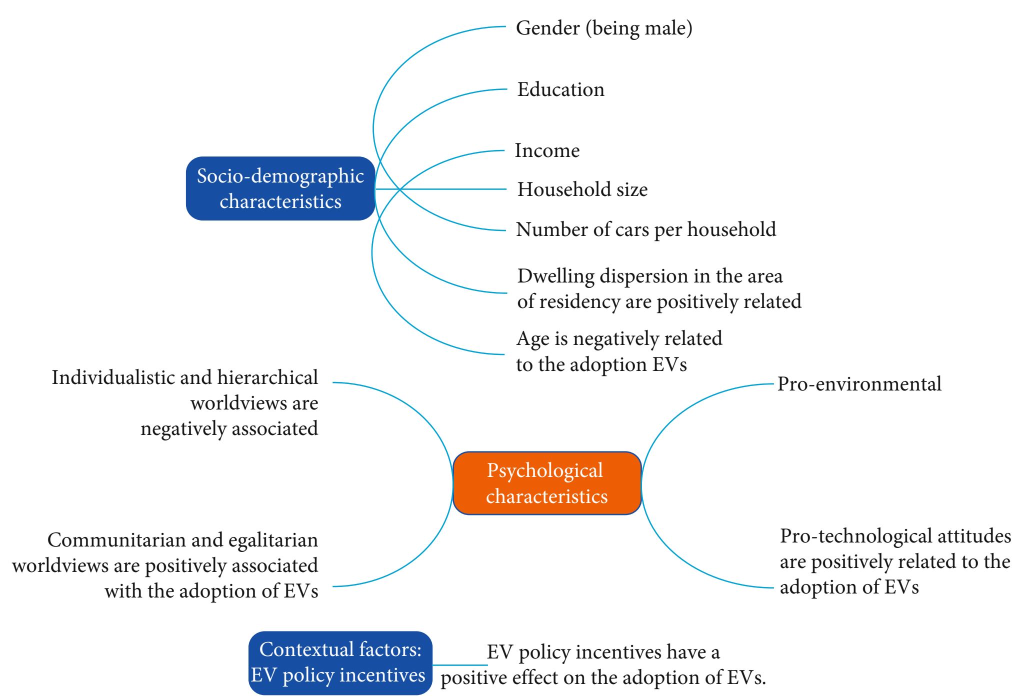


Figure 15: EV adoption hypothesis stature.

that this strategy will undoubtedly help to expand PEV transaction volume. In the coming decades [122, 123], for example, a Canadian study showed that despite ideally reducing battery costs, without expanding at least one stable PEV, the new industry-wide PEV cannot exceed 10% by 2030 [124]. However, the current vehicle market has already switched to new BEV technology and will soon go for FCEV. Most national policies around the world are focused on reducing road transport CO_2 emissions by shifting to high energy efficiency and low-carbon energy demand technologies. According to the International Renewable Energy Agency (IRENA), renewable energy policies must prioritize end-use sectors over power generation. Renewable heating and cooling require more policy attention, such as dedicated targets, technology mandates, financial incentives, generation-based incentives, and carbon or energy taxes [125]. EV and climate policy also push to utilize renewable energy in the transportation sector. To reduce more emissions from the road transport sector, the

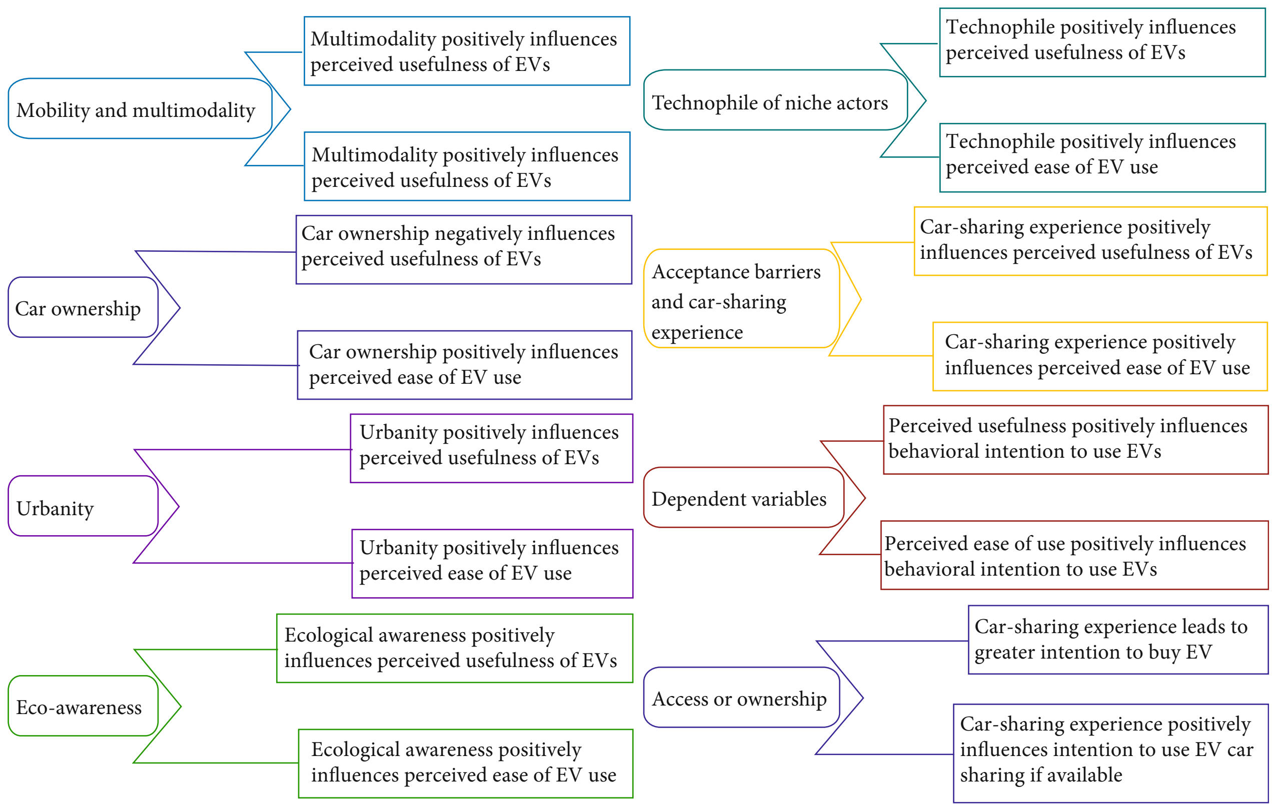


Figure 16: A mobility research framework.

subnational government has implemented several initiatives to stimulate the adoption of electric mobility in recent years [126].

6.1. Barriers to Adoption. PEV adoption is low in most regions due to a variety of demand and supply-side market barriers [127, 128]. Understanding these barriers is helpful for designing policies to encourage EV adoption. Previous studies have identified eight key types of PEV stabilization policies implemented in Canada and various sites, which can measure their impact on PEV adoption [129]. These policies can be predicted using core policies implemented globally and form the basis of most PEV strategies (e.g., [130, 131]). For a small part of the entire industry, different types of policies were deemed to have a negligible to small market share impact (e.g., voluntary programs) and/or a particularly uncertain impact (e.g., research and development support) [117, 132]. These eight "quantifiable" policies are described in Table 1, along with how they are currently being implemented in Canada and how they differ from a "strong" version that we summarized in this paper.

Table 1 shows an example, but it is true that EV adoption needs strong policy support to overcome its barriers to adoption. We can utilize the developed countries' EV policies (e.g., PEV policies) and their impacts to make reliable policies that could be linked to climate policies. However, EV policy is still experiencing challenges because consumers need time to adopt new technology. In this next section, we summarized some countries' EV policy improvements and future goals.

6.2. The Major Improvements of the 2018/19 Agreement Include the following Policies

(1) The EU has approved some excellent strategic tools. They include mileage standards for cars and trucks and the Clean Electric Vehicle Directive, which stipulates the public procurement of electric vehicles. The Energy Efficiency Directive specifies minimum requirements for load foundations in new and rebuilt structures

(2) In China, the progress of the agreement reviewed the speculative restrictions on the new ICE car manufacturing facility and brought forth a proposal to establish normal mileage for the passenger light-duty vehicle (PLDV) in 2025. The utilization of separate motivating inducements for vehicles depends on the quality of the battery (for example, a car loan and a zero-emission car loan under the new energy vehicle rules)

(3) In Japan, the adoption of an automatic method, which can be used by modern partners, means that the emissions of greenhouse gas (GHG) substances from vehicles (including sold vehicles) provided by car manufacturers to households account for 80% of the country (road vehicles account for 90%), through the combination of HEV, BEV, PHEV, and FCEV, to reduce emissions in 2050. The truck's performance principles have been revised, and an update on the vehicle's mileage has been announced

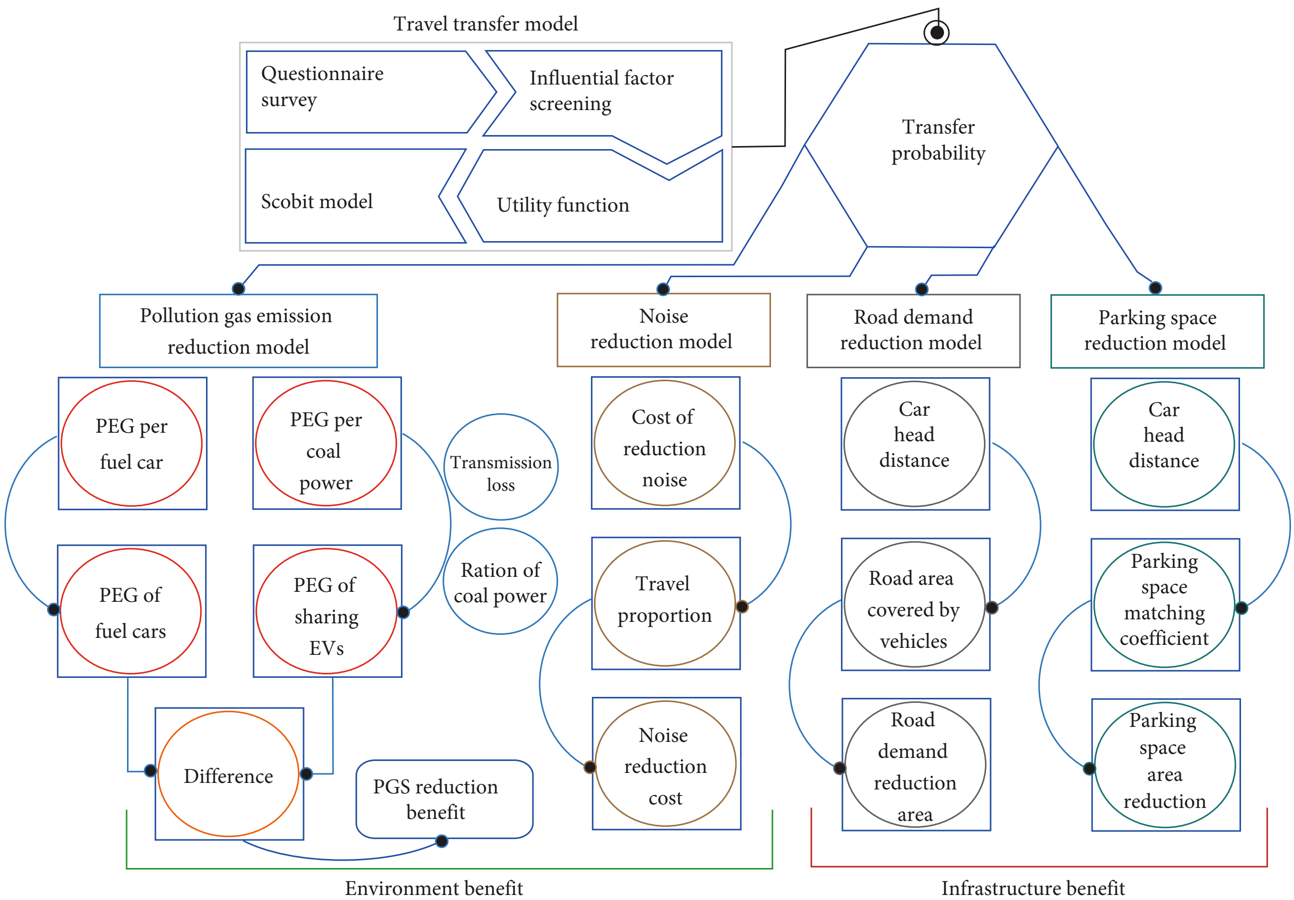


Figure 17: Travel transfer model [158].

(4) Canada has realized the dream of combining EVs with new methods. British Columbia announced the introduction of the world's most potent ZEV (zero-emission vehicle) team: by 2030, the share of the ZEV business will reach 30%, and by 2040, it will reach 100%. Canada's system is comparable to the ten US states where the ZEV team has been implemented

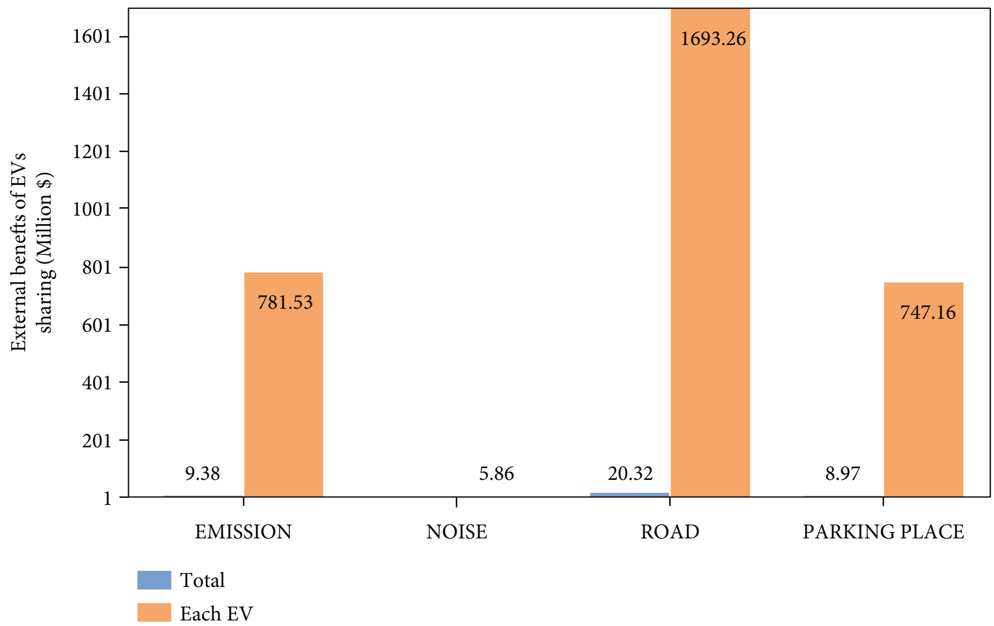
(5) India announced the second conspiracy period, "Faster Adoption and Manufacturing of Electric Vehicles in India" (FAME India). It reduced the price of electric vehicles by half, focusing on vehicles for open or general transportation (vehicles, rickshaws, and taxis) and private bicycles

(6) In South Korea, the level of national sponsorship for all low-carbon vehicle purchases increased from 32,000 in 2018 to 57,000 in 2019, and other strategic tools have been added, including public access, subsidies, and discounts on transportation security fees and reduced parking spaces. It is joined by an objective to support production volume of more than 10% of the capacity of all vehicles by 2022 and to use money-related help and progress to guarantee great manufacturing players

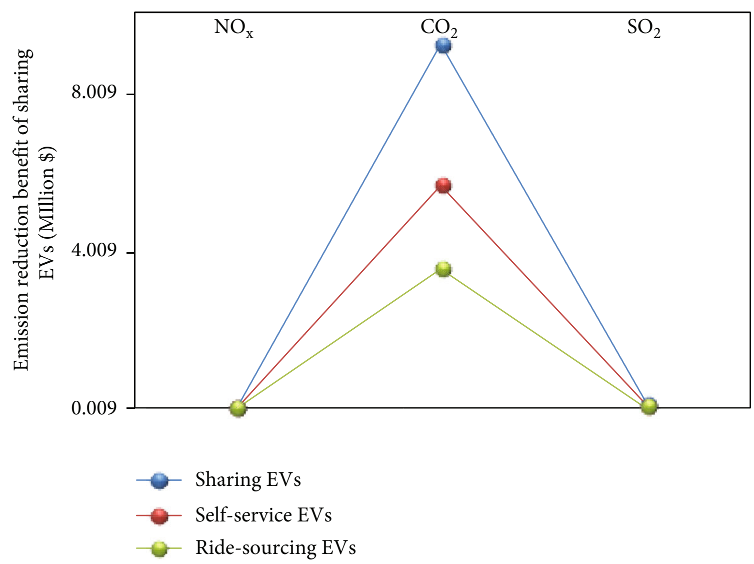
Strategic energy is also increasing in various countries. One of the most important aircraft types is Chile, which is one of the largest airlines in the world after China. Chile's goal is to rejuvenate 100% of its convertibles and 40% of its private cars by 2050. New Zealand also has high expectations and hopes to achieve a transition from a clean economy to zero emissions by 2050. New Zealand and Chile joined the Electric Vehicle Initiative (EVI) in 2018 [133].

6.3. Policy on Recycling of EV Battery by Countries. Battery-related research is also important to enhance EV adoption. This is part of waste management and needs a specific policy to encourage the expansion of the EV market. With the rise of the EV market, the global supply of EVs has recently increased significantly, as has the global market for EV batteries [134]. China, Japan, and Korea have a large market share of EV batteries and are essential countries for the development and production of EV batteries on a global scale. Because the top ten EV battery producers are from China, Japan, and Korea, they accounted for more than 80% of the EV battery supply in 2018 [135].

To maximize resource recovery and properly manage hazardous materials from end-of-life EV batteries and technology, recycling policies for EV batteries are being implemented in several countries, as shown in Table 2.



(a) External EV sharing benefits in Chongqing



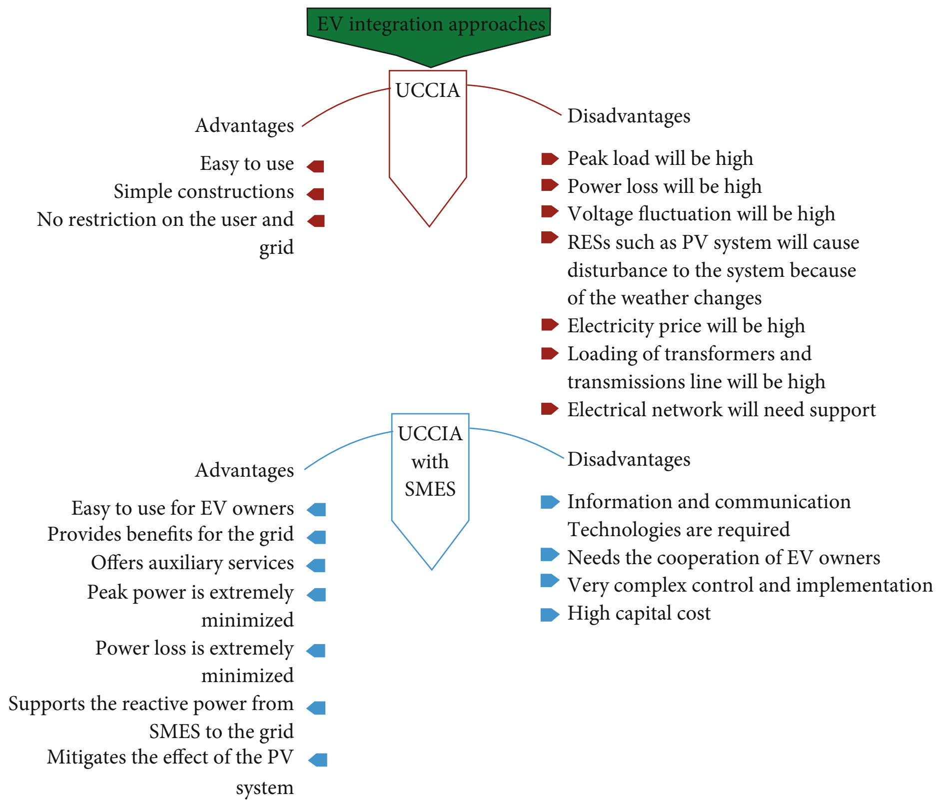
(b) Emission reduction benefit of sharing ENs

Figure 18: EV sharing benefits [158].

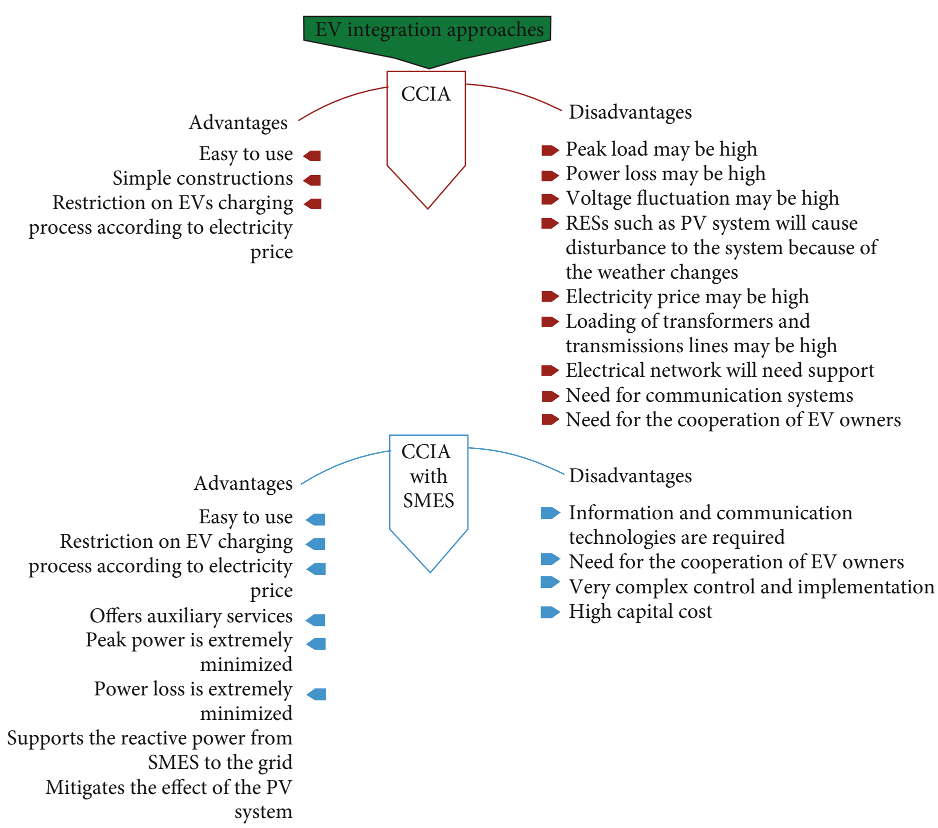
6.4. EV Adoption. EVs continue to penetrate the national market, and by the end of 2018, more than 5.1 million EVs had been produced [147]. Global stocks of EVs have mainly been concentrated in three regions: China accounts for about 45% of them, followed by Europe and the United States, which account for 24% and 22%, respectively [133]. In addition, European countries continue to travel relative to the entire fleet. More than 10%, of vehicles in Norway are electric vehicles (BEV or PHEV), followed by Iceland (3.3%), the Netherlands (1.9%), Sweden (1.6%), and China (1.1%) [148]. However, China has the most widespread advertising for EVs, and by the end of 2018, its national fleet increased by 1.1 million EVs [133]. This can be observed in the international EV targets for 2020 or 2030 in Figure 13.

The literary outcomes integrate the appeal of EV choices and the six components of the V2G influence. The text on the EV and (to a lesser extent) the evolving V2G employment classification typically emphasizes the importance of six dimensions, including the various parts of the user, conventional vehicles, and a supportive (and social) foundation for innovation. An overview of these indicators can be seen below. Figure 14 shows a multidimensional conceptual framework for EV adoption [149].

6.5. EV Adoption Hypothesis. The current study has reliably established that early users of EVs have the quality of social segmentation and can be clearly identified on the basis of potential users or non-EVs (i.e., buyers of ICE cars). Currently, the study

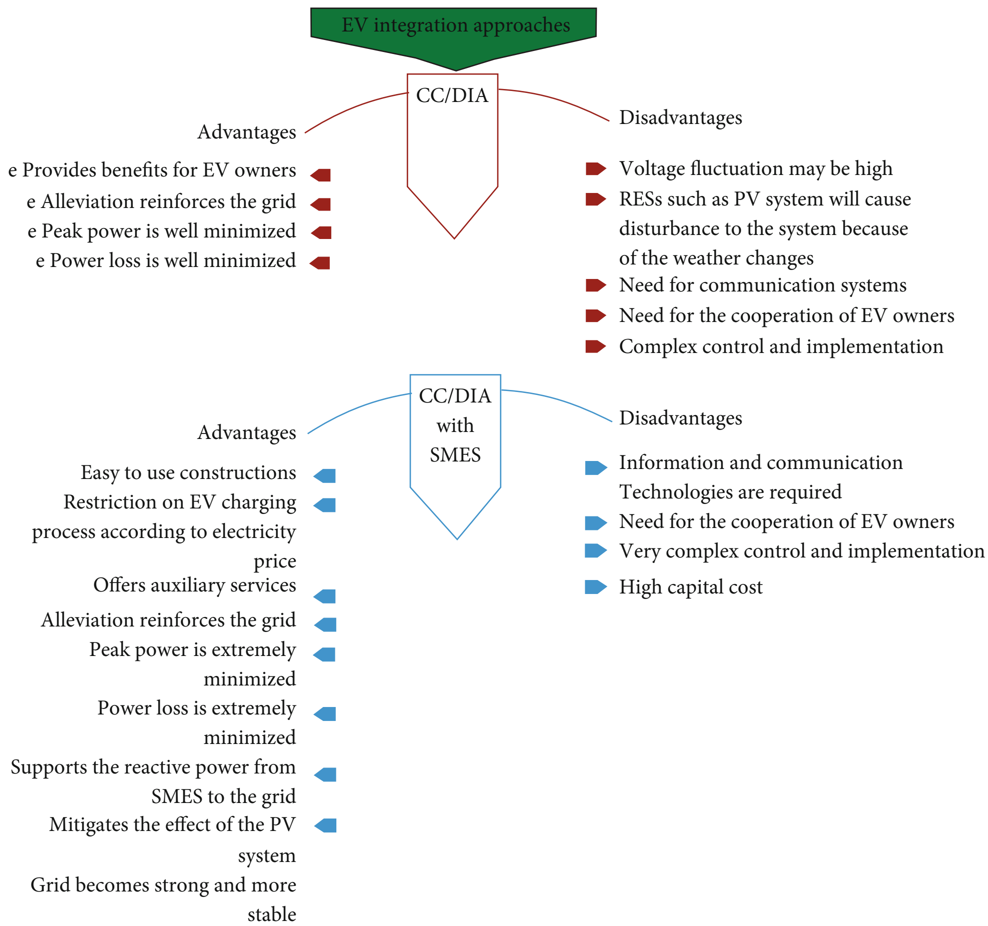


(a)



(b)

Figure 19: Continued.



(c)

Figure 19: Advantages and disadvantages of the EV integration approach.

assumes that regular or early users (depending on definition) usually (1) are profoundly trained [150], (2) have a higher income [151], (3) are young to middle-aged [152], (4) are part of a family with several cars [150, 153], (5) live in larger families [150], (6) are mostly men, and (7) live in small- and medium-sized cities [152]. Figure 15 shows a diagram of the EV adoption hypothesis.

The latest report by Nayum et al. [150] tested the importance of psychological factors as an indicator for buyers who buy increasingly environmentally attractive vehicles (e.g., electric cars). They expanded the comprehensive action determination model [154], which includes targeted, standardized, situational, and ongoing impacts on environmentally friendly behavior [64, 155].

6.6. EV Sharing. Given the dangers of climate change, the mobility sector must move towards sustainability. One way to reduce emissions while driving is to establish the use of electric vehicles (EVs). However, given the current market share in Germany, the expected regime change from traditional combustion to electric motors seems rather unlikely. This leads to the search for new options for dynamic market growth. Recent studies have shown that consumers lack sufficient knowledge and have a high level of uncertainty regarding electric vehicle technology. To overcome these barriers to acceptability, this study suggests that experience with car-sharing services—in particular electric car-sharing—can lead to broader adoption of electric car technology, which will lead to wider market penetration. Using the technology acceptance model, a quantitative study was conducted between users who share cars and those who do not to evaluate the impact of car-sharing experiences on the acceptance of EVs. In addition, five possible predictors for the adoption of EVs were tested: mobility, automotive ownership, urban areas, environmental awareness, and technology [156]. Figure 16 shows the car-sharing mobility structure.

6.7. Measuring Frame. According to Pigou's theory, external factors must be assimilated to reflect their real expense or value [157]. As a combination of new, environmentally friendly technologies and an innovative business model, the external effects of sharing electric cars should undoubtedly be studied in order to facilitate this further. Selecting appropriate indicators is a crucial step. The entire structure of the travel transfer model can be observed in Figure 17 [158].

Summarizing the above findings of this document by sharing travel measurements of EVs instead of urban ICVs reveals some interesting results. For example, in China, in Chongqing, 6.33% of urban residents might want to move their travel arrangements from ICVs to self-service EVs, while 4.26% of people want to choose EVs from ICVs. This conclusion means that self-service EVs are currently more popular on the market than self-service EVs. The potential market demand for EVs is 27,400, and the demand for EVs with a source code is 12,000. Based on the results, the external benefits of sharing EVs can be calculated (Figure 18(a)). The most significant benefit comes from the highway asset reserve and the benefit of parking. The benefits of reducing emissions are primarily related to reducing carbon dioxide emissions, as shown in Figure 18(b) [158].

7. Advantages and Disadvantages of Electric Vehicles

Recently, some analysts have uncovered the critical advances in EVs. Nordelöf et al. [159] written survey analyzes knowledge points based on the life cycle assessment as advantages of EVs and shows the continuous development of electric vehicle innovations, the constant progress in material production, and the age of performance the life cycle assessment EV test [159]. They found that many articles consider the energy source to be the driving force behind the EV results, but they also argued that many inspections could not undo this judgment, resulting in people having no rational information about the environmental impact of EV [160]. ICEV were compared to shortages in the concentration of GHG or EV. WHO conducted an important WTW study focusing on EVs [161]. Figure 19 shows a comparison of EV integration approaches [162, 163], where SMES is the superconducting magnetic energy storage, UCCIA is the uncontrolled charging integration approach, and CCIA is the controlled charging integration approach.

8. Conclusions and Recommendations

EVs can effectively promote the use of renewable energy and environmental pressures on ICE vehicles. This paper explores EV-related technology and major policy concerns to help make EV a sustainable development. The following conclusions are drawn.

(1) The estimation of EV technology improvement in this study indicates that the higher complexity of sustainable development leads to relatively slower EV adoption

(2) A possible implication for the policymakers encouraging EV development is to issue more incentive plans for innovations in the grid and electric vehicle relationship domains

(3) The technology trajectories of future development models have been proposed for EV wireless charging and energy networks. This could be a recommended model for the future development of EVs and energy structures. Moreover, power electronics for EV integration on the grid have negative impacts. The results in the paper prove that it is time to approach EV charging to reduce negative impacts

(4) The policymakers found that EVs might be a renewable energy contributor to reducing CO_2 emissions. However, EV sustainable development needs strong policy support, which has been proposed in our review paper. We summarized different countries' strategies, methods, and outcomes to give attention to EV sustainable development

Although this work provides insight and novel results and discussion about the technological and policy development of EV, there are still some limitations. For instance, depending on the application, there are two different types of EV. The car is one, and "the bus, truck, and lorry" are the others. Exploring and contrasting the technological developments in the domains of these two types is important from an application standpoint. We use the common method system to decompose the EVs filed in the work, even though it currently appears impossible to achieve sustainable development, but this work will provide a full package to understand barriers and necessary methods to solve them. Thus, this study provides a number of policy recommendation to address the increase of the EV adoption by showing EV uptake and promote the installation of charging stations or act to remove barriers and limitations.

(1) The provincial government provides incentives to EV users, such as cash rebates or subsidized loans, to help them offset the cost of the electrical vehicle supply equipment (EVSE) and its installation as well as the costs of the necessary building upgrades

(2) Provide financial assistance to landlords and strata councils with a requirement for a specific number of charging stations

(3) Municipal and provincial governments should develop and implement a program within the next ten years to encourage and provide financial support to strata councils and landlords who develop retrofit plans and upgrade the power distribution systems of their buildings to meet residents' future charging needs

(4) Avoid being overly conservative, which can result in the unnecessary oversizing of electrical equipment, and revise and update the regulatory requirements from codes and standards on a regular basis to reflect the most recent technological advancements

(5) To prevent future situations of unfairness and inequality among them, regulate the rights and responsibilities of EV users, building residents, strata councils, and landlords regarding the installation and use of charging stations within multiunit residential buildings (MURBs)

(6) Expand the current guidelines to offer precise direction and answers on technical and governance issues like defining ownership and charging infrastructure costs

(7) Develop a program or guideline to instruct and direct strata councils and landlords on how to create a long-term EV charging infrastructure plan that will

direct and dictate present and future charging infrastructure deployment in their building, the need for infrastructure upgrades, and governance and ownership considerations

Data Availability

Data can be available upon request to the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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