Electric Vehicles in Smart Grid

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Abstract – *Smart grid and future electric vehicle are two of the most emerging issues that are integrating in the near future. This paper presents a review of electrical vehicles and the novel proposals on how to smartly integrate it into the Smart Grid. Moving forward the future characteristic of a smart grid includes, flexibility being able to adapt to the changing needs that a system could require, clever and safe these are the values of the smart grid, efficient where minimizing new infrastructure for electrical grid is the aim, open to be integrated with renewable energies safely, and finally sustainable a key point to the future environment and sociable acceptance. Due to the world vision of smart grid, things are changing rapidly. With the increase numbers of EV's, new challenges are imposed to the grid, in terms of synergistic, continuous, dynamic, and stable integration of electric mobility problems. What was impossible to achieve back in history, eliminating Electrical Vehicles from the market due to its disadvantages is now possible via the Smart Grid integration. This paper is a review on how Electrical Vehicles can contribute to grid stabilization, simulation-based research for smart charging, grid communication, blockchain based technology for EV with the purpose of achieving the international environmental and sustainable goals.*

Key Words: Smart Grids, Electric Vehicles, smart charging, blockchain and EV, EV communication.

1.INTRODUCTION

A Smart Grid is defined as being an electricity network that enabled the flow of electricity on a two-way basis as well as data with the use of "digital Communications technology" thus enabling the detection, reaction and even the pro-act change in both usage and even multiple issues. It is prudent to note that smart grids usually have "self-healing capabilities" and therefore make it possible for electricity clients to become "active participants" [1].

Electric Vehicle are vehicles which are either fully or partially powered by electric power. In most cases, it is asserted that EV have low running costs because they have lesser moving parts to be maintained also because they are environmentally friendly due to the fact that they either use little or even no fossil fuels such as diesel or Petrol[2].

Smart grid technology provides the means to match up supply and demand at a local level. A critical part of a smart grid is to have forms of flexibility in the energy system. The millions of Electric Vehicles (EVs) predicted over the next few years offer flexible demand that could be optimised in order to deliver the smarter outcomes for electricity network operators and consumers. It is prudent to note that smart grids usually have "self-healing capabilities" and therefore make it possible for electricity clients to become "active participants"[3].

The Smart Grid is indeed the key towards smart Electrical Vehicle (EV) charging and is tasked with the responsibility of not only providing stability but also control that is needed in mitigating load impacts. In addition to that, the Smart Grid is also tasked with the responsibility of protecting components of distribution networks form ultimately being overloaded by the Electric Vehicles and thus eventually helping in ensuring that there is efficient use of electricity that is generated [4].

There are 4 types of electric vehicles namely the Plug-in Hybrid Electric Vehicle or the PHEV, Battery Electric Vehicle or BEV, the Hybrid Vehicle or HEV, and lastly the Hydrogen Fuel Cell [5]. Taking into account the diverse battery types, lithium-ion batteries represent the best-performing rechargeable battery technology due to their higher capacity and stand out with respect to other battery types because of being lighter, showing lower self-discharge, no memory effect, and higher number of charge/discharge cycles, among other advantages [6].

2. HISTORY OF ELECTRICAL VEHICLES

Thomas Davenport developed the first electric motor in 1834. Gaston Planté, a French physicist, invents the lead-acid battery in 1859. In the coming decades, other scientists, notably Planté, would improve on the invention. In 1884, renowned English inventor Thomas Parker, dubbed "Europe's Edison," produces the first commercially practical electric car. Unlike many of Parker's other inventions, such as electric trams, underground lights, and "Coalite," a smokeless fuel, the automobile receives little attention. Both Paris and New York launch fleets of electric taxi cabs in 1897. The electric automobile rose to prominence in the late 1900s as a viable alternative to steam cars, which can take up to 45 minutes to start in the morning, and gasoline cars, which require sophisticated gear shifting and must be cranked to start. As a result, electric automobiles are promoted as being particularly suited to women due to their lower physical demands. Moreover, a third of all cars on American roadways were electric by the turn of the century. However, the electric car's prominence will be short-lived, as technological developments will soon overtake gasoline power. John Goodenough and his colleagues at Oxford University devised the cobalt-oxide cathode, which is the heart of the lithium-ion battery, in 1980. Batteries made possible by this technology will power all kinds of consumer devices, as well as electric cars that can travel hundreds of kilometers on a single charge, in the decades ahead. Goodenough and two other researchers were awarded the Nobel Prize in Physics in 2019 for their contributions to the development and improvement of lithium-ion batteries.

Tesla introduces the Model S vehicle in 2009, with seating for up to seven people. Despite its premium vehicle costs, it will go on to become the fastest-selling electric car in history. Consumer Reports will hail it as the best car the publication has ever tested, yet reliability concerns will force the publication to withdraw its endorsement in 2019. By 2018, global electric car sales are expected to continue to rise at a rapid pace. However, all plug-in vehicles, including electric and plug-in hybrids, account for slightly over 2% of global passenger vehicle sales. China accounts for more than half of all electric vehicles sold worldwide, thanks to generous government subsidies [7].

3. EV AND SMART GRID

It is worth noting that in Smart Grid, PHEVs have the potential of curbing emissions as well as reduction of the transportation costs. Another vital and unique advantage that is associated with the PHEVs is their capability in integration of the “onboard energy storage” with the “power grid” which can ultimately help in improvement of efficiency as well as increasing reliability of the “power grid”. There are various types of technologies which are used or applied in a smart grid [3]. It is prudent to note that the use of electric vehicles across the world will play a significant contribution towards the Smart Grid in that they will make use of the vehicle to grid or V2G technologies that enables an easy access and connectivity with electric vehicles especially in distribution of grid for provision of demand responses [8].

It was noted that with the most recent oil leak in the Gulf of Mexico, the use of EVS with their great potential for both emissions reductions and gasoline savings are indeed generating immense political and consumer interests. However, it is further noted that owing to huge amounts of electricity that is required in order to charge the EVs, they are also resulted in generation of significant concerns among the utilities that are tasked with the supply of electricity on the smart grid (Tang et al. 2019) [9].

It is projected that the next 2 years are indeed expected to bring about an immense shift in electrification of the transport sector since approximately twenty automakers intend to introduce into the market plug-in hybrid electric vehicles and battery powered electric vehicles. There is therefore need for the relevant utilities to act now in the development of strategies for the integration of Electric vehicles. One of the most serious concerns is controlling when the electric vehicles charging stations or the EVSE will ultimately load to grid. This is because with millions of electric vehicles expected on the road in the nearest future, it is projected that a higher percentage or number of consumers are bound to instinctively have their EVs charged whenever they come home from their respective workplaces. [10]

This is prone to result in serious impacts of “peak demand” on the power grid. This is because “home charging stations” are typically known to draw an “electricity load” of about 6.6 Kilowatts translating to 240 volts and 30 amps.[8]

A single electric vehicle can thus double the peak load of a home while even low levels of Electric Vehicles adoption in a specific neighborhood is also capable of straining the prevailing power infrastructure. According to the “Electric Power Research Institute” or EPRI, it was suggested that if two clients based on a similar transformer instantly plugged in a charging station of 6.6 kW during peak times, then their charging loads together with prevailing loads may ultimately exceed emergence ratings of about 40% of the distribution transformers. [11]

It is prudent to note that due to the “robust or strong communication infrastructure” that is presented by the “Smart Grid”, it is possible for the utilities to monitor the charging stations remotely and even allow for their comprehensive management of their charging. In addition to that, utilities are also capable of troubleshooting any charging issues or problems without unnecessary “on-site service calls” and management when there is charging of the connected EVs. It is worth noting the “Smart Grid” plays a crucial role in Electric Vehicles since the utility back offices are capable of not only supporting and integrating but also optimizing the Electric Vehicle charge managements as part and parcel of an “Integrated Demand Side Management” or DSM operation [12].

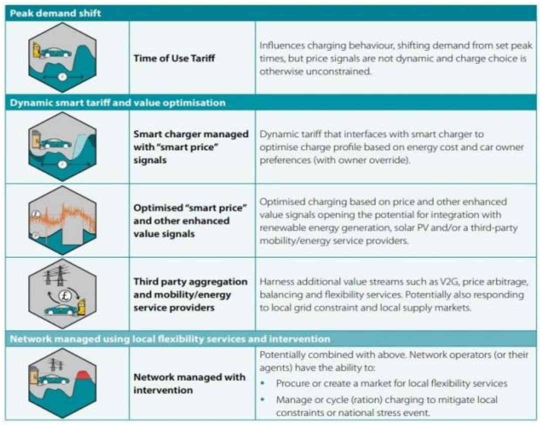
The approach requires or dictates that systems which both manage the EV charging and optimize them in conjunction with other viable Demand Responses or DR. it is also important to note that even though the use of Electric Vehicle integration is known to pose some serious challenges or problems, it ultimately helps in presentation of viable utilities with viable opportunities. Like for instance, it helps in planning how much utilities can be able to maximize their prevailing infrastructures, creation of closer relationships and networks with their customers, and even the leveraging of investments in order to enable an easier adoption or embracing of the EVs. As a result, those which do not effectively prepare for the effective integration of electric vehicles will risk being not only as bottlenecks but also will ultimately find themselves with potentials for issues to do with reliability and a grid that is highly overtaxed [13].

It is worth noting that evolution of the “smart grid” also comprises of electric vehicles and indeed, there are interesting possibilities that are attached to it. The smart grid involves the smart residential charging that implies to just plugging in one’s car after commuting. Rather, it involves smart charging which enables the times of charging to be shifted based on the grid loads as well as on the needs of the owner which can be based on the utility’s monetary incentives. That apart, the smart grid in electric vehicles also makes use of the Vehicle-to-Grid or the V2G which is a technology that helps in enabling connectivity of electric vehicles with the “distribution grid” thus helping in provision of demand services. This is done through returning electricity or power to grid or even through slowing down their rates of charging. [12]

The Vehicle-to-Home or the V2H involves provision of connection between a vehicle and the home of the owner thus ultimately helping in the provision of additional energy sources to such a home. The vision in this technology is that such a type of connection will help in provision of load shaving services especially during the peak hours and even as a major source of “back-up energies” in times of outages. The electric vehicles have an impact on the smart grid in that it also involves the renewables as well as storage integrations. This is true since if electric vehicles are part and parcel of the complex “new grid of distribution”, then they will also effectively integrate with the storage and even renewables in such a grid [10].

3.1 ChargePoint Management

The use of'smart' chargepoints that can broadcast and receive data as well as respond to external signals to adjust charging levels will be critical in regulating the impact on the power grid. Although most EV charging will take place at home or at work, spreading it out to other sites and at different times of day will help control the network's impact. Number of ChargePoint management options exist, each of which offers different amounts of flexibility as shown in Figure-1.



Peak demand shift		
	Time of Use Tariff	Influences charging behaviour, shifting demand from set peak times, but price signals are not dynamic and charge choice is otherwise unconstrained.
Dynamic smart tariff and value optimisation		
	Smart charger managed with “smart price” signals	Dynamic tariff that interfaces with smart charger to optimise charge profile based on energy cost and car owner preferences (with owner override).
	Optimised “smart price” and other enhanced value signals	Optimised charging based on price and other enhanced value signals opening the potential for integration with renewable energy generation, solar PV and/or a third-party mobility/energy service providers.
	Third party aggregation and mobility/energy service providers	Harness additional value streams such as V2G, price arbitrage, balancing and flexibility services. Potentially also responding to local grid constraint and local supply markets.
Network managed using local flexibility services and intervention		
	Network managed with intervention	Potentially combined with above. Network operators (or their agents) have the ability to: • Procure or create a market for local flexibility services • Manage or cycle (ration) charging to mitigate local constraints or national stress event.

Fig -1: Type of ChargePoint Management [14]

Overall, based on the local network conditions and consumer requirements, a combination of these tactics will be used. Electricity network operators (DSOs) will oversee ChargePoint management to ensure circuits stay within their limits. This will be accomplished by establishing local flexibility markets to manage network demand, or by intervening directly with charging, using a controller device on the ChargePoint and at the local substation in the short term, and possibly through smart meter communication infrastructure in the long term [14].

4. ELECTRICAL VEHICLES AND ENVIRONMENT

The growth of the EV market both in Europe and the rest of the World in last years, arose a relevant question: to what extent are electric vehicles eco-friendly and cost effective in comparison with internal combustion engine vehicles (ICEVs)? (C.M. Costa 2021) The economic payback is demonstrated to be quite variable in European countries. The economic payback can range from 2500 km (Portugal) and 335 000 km (other nations) (Czech Republic). When compared to the economical return, the environmental benefit is achieved over relatively short lengths of 30 000 km (Norway) to 190 000 km (Poland). It is also demonstrated how oeconomic and environmental benefits are influenced by mobility profile, with longer trip distance profiles providing greater benefits. To make EVs more competitive in the automobile market, it was determined that their prices must be reduced. Furthermore, it is critical to establish policies that help both the economy and the environment. Furthermore, adopting policies within the European Union to achieve a more equal reality throughout the different countries, with more leveled pricing and revenues, is critical to combining both economic and environmental benefits (incentives, fees and taxes).

Other methods, such as fuel cells (FC), have been used in automobiles in addition to lithium-ion batteries. Similar to batteries, FC hydrogen systems can immediately transform chemical energy into electrical energy. It has been demonstrated that in the event of a collision, fuel cell vehicles provide no greater risk than conventional automobiles, although more research is needed to confirm this.[14] When compared to electric vehicles, several limitations include the high cost of hydrogen production, the absence of appropriate supporting infrastructure, and the relationship between battery size and vehicle mass [15]. Thus, hydrogen FC can be an alternative for future clean energy for vehicle applications but its high cost (platinum catalysts), high flammability and storage difficulty hold back its massive implementation in the market [16].

EVs, including BEVs and PHEVs, have been gaining traction thanks to their ability to deliver multiple environmental, societal and health benefits. These include:

Energy efficiency: BEVs consume three to five times less energy than traditional ICEVs. This unrivaled energy efficiency could lead to a significant increase in private transportation, benefiting both the economy and the environment [17,18].

Environmental benefits: Air pollution issues can be addressed, particularly in metropolitan areas, where a high number of people are exposed to dangerous pollutants emitted by transportation vehicles, by using BEVs with zero tailpipe emissions in conjunction with an energy mix mostly based on renewable sources. Although this is an issue that affects all large cities around the world, it is especially important in China, where air pollution is responsible for approximately 1 million deaths per year [19]. Furthermore, when combined with a gradual increase in low-carbon energy generation, electric mobility can result in significant reductions in greenhouse gas emissions from road travel compared to ICEV [20].

Cost effective: With the narrowing of the acquisition costs between BEVs and ICEVs, BEVs represent potential savings in transportation, where BEVs can show a significantly lower running and maintenance costs. Nonetheless, this is highly dependent of the individual mobility profile, geographic location, and the BEV choice. Additionally, several governments provide acquisition and charging in- centives that contribute to the anticipation of the point where BEVs become economically advantageous when compared with ICEVs.

Noise reduction: BEVs are quieter than ICEV, contributing to reduce noise pollution which is an environmental advantage.

Grid stability: BEV have the potential to not only act as charge by draining electric power from the grid, but also to act as power source in events like a power outage. In this way, grid stability can be improved to the point where BEV can perform as energy buffer to face the dynamic evolution of power grid events. With this use, BEV can contribute to economic benefits once it replaces other stabilization devices such as power walls, eliminating the cost of the acquisition of these devices.

Energy security: Electric mobility boosts energy security as it reduces dependence on oil imports for many countries. Furthermore, electricity can be produced with a variety of sources and fuels, often generated domestically. Further, when these sources are renewable, there is a significant reduction of the environmental impact [21].

5.NOVEL SOLUTIONS TO GRID STABILIZATION

The following is to demonstrate different research using simulation, suggestions, models on how to develop the integration of electric vehicles in smart grid taking into consideration different aspects of the system.

5.1 Solar Photovoltaic Based Electrical Vehicles for Grid Support

The suggested solar PV-based EV charging system was constructed using the MATLAB/Simscape environment, and the findings show that it can charge the EV and provide grid support under changing irradiance and grid disturbances. A solar PV array with a single-ended primary-inductor converter (SEPIC) DC-DC converter, a bidirectional DC-DC converter for EV battery charging, and a three-level inverter with LCL filter for grid interface, as well as accompanying controllers, make up the charging system. Through a bidirectional DC-DC converter and controller, the SEPIC converter is regulated with a maximum power point tracking algorithm to extract maximum power from the solar PV array and charge the EV battery. The controllers are capable of providing continuous charging and grid support to improve grid performance in the face of disruptions and fluctuating PV generation. The charger also has V2G power transfer capabilities for active and reactive power assistance, as well as improving fault ride through capability for distribution grids with renewable energy sources [24].

Through vehicle to grid (V2G) and grid to vehicle (G2V) operation, solar PV-based EV charging infrastructure provides high-efficiency and reliable EV performance as well as ancillary services to the power system such as voltage and frequency regulation, peak shaving, and bidirectional power flow to maintain utility grid balance [22],[23].

V2G operation also functions as a controllable spinning reserve, which is possible with the smart grid. With the combined control implementation, a solar PV based smart EV charging system is presented to accomplish satisfying operation of various functions. The smart charger was created to charge the EV battery with solar PV power while also improving grid support through V2G operation. In comparison to other DC-DC converters, a single-ended primary-inductor converter (SEPIC) is chosen to connect the PV array to the DC-link because of its efficient voltage regulation, low ripple current, and minimal electrical stress on the system components. Separate power converters with algorithm designs to EV charging and feed EV electricity to the grid connect the EV battery, solar PV array, and power grid via a DC-link. To improve the power quality of the system, an LCL filter is included to improve the power factor and decrease harmonics. The key contributions of this study are I the design and control of a SEPIC DC-DC converter with MPPT to extract maximum power from solar PV; and (ii) the design and control of a SEPIC DC-DC converter with MPPT to extract maximum power from solar PV. (ii) Modeling and control of a voltage source converter and LCL filter to improve grid support and (iii) Design and control of a bidirectional DC-DC converter with smart charging/discharging algorithm for V2G operation [24].

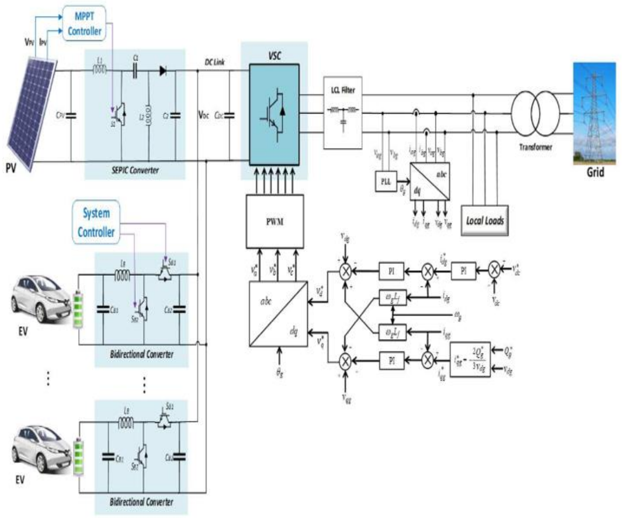


Figure -2. System Configuration of solar PV based EV charging system [24]

In the MATLAB/Simscape environment, the solar PV based EV charging system with accompanying power converter and controllers of Fig.2 is simulated. Various irradiance, temperature, and grid disturbances were used in the simulation. A solar PV-based EV charging system with V2G operation for grid support is presented in this research. Under fluctuating irradiance and temperature, the SEPIC DC-DC converter is managed via MPPT to extract maximum power. The PV-based EV charging system can use a bidirectional DC-DC converter to charge or discharge the EV battery depending on PV power supply and grid demand. With minor changes, the controllers function adequately during both charging and discharging. Extensive simulation results with all specified control objectives have been used to verify the proposed charging mechanism. The given results further confirmed that the developed controllers could handle the system power flow under a variety of transients and battery charge/discharge currents under all test scenarios. Under fluctuating grid voltage, the inverter controller assures V2G functioning to provide grid support. This design decreases cost and circuit complexity while preserving PV array efficiency and providing continuous charging to the grid with active and reactive power support. Control objectives. [24]

5.2 Integrating Electric Vehicle Communication in Smart Grids

This paper [25] discusses how EV's can significantly affect the electrical grid with uncontrollable charging which in result poses a challenge to the grid operator. To proceed the authors of this journal are offering a developed research and analysis test system according to the ISO/IEC 15118 standard show casing the result of its functionality in an electrical network. This research develops a test system to study the functionality of the EV communication protocol with the network components in real-time. For the realization of technical communication, a model-based approach in terms of universal applicability is pursued. A real-time simulation in RT-Lab is the basis for the entire test system. An automated battery model communicates in parallel with a charging controller box (CCB) and a server. The server exchanges information with the charge management to control the charging process. The CCB contains information to start or to stop the real charge process. The effect of intelligent bidirectional communication on the electrical network is analyzed and evaluated by a real- time simulation with real measured data. The results are summarized in Figure -3. Solar power and load profiles are the model's input data. The charging of the electric vehicle is dependent on the charging management's hourly updated input. The PV generation is considered first. Figure -3. depicts the output of the PV system, households, and electric vehicles after 24 hours of regulation and charge management. When there is a lot of PV generation, the EV is charged with a lot of electricity. When the PV power is low, about 14 o'clock, the EV is only charged with 4,7 kW. These findings contrast sharply with those obtained when an electric vehicle is charged in an unregulated manner. If numerous EVs charge at full power for several hours, the grid may experience frequent outages. The findings suggest that intelligent bidirectional communication based on the ISO/ICE 15118 protocol improves the electrical grid's resilience.

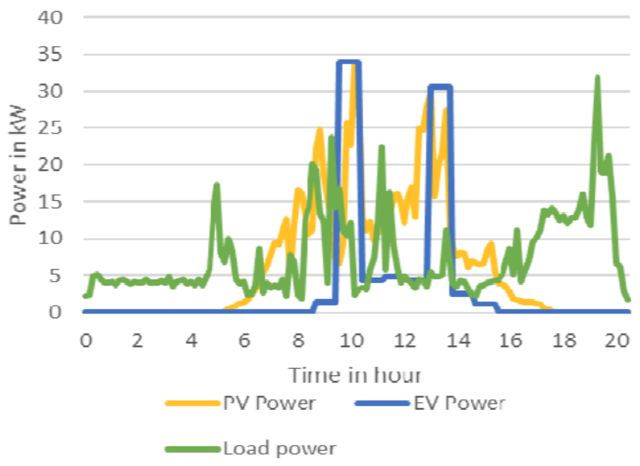


Figure -3. Power Grid components (PV,Load,EV)[25]

The charging of EVs may be modeled based on information interchange with the CS and therefore with charge management, thanks to the system's built-in automation. In the real-time simulator OPAL-RT, the represented battery behaves as an EVCC. It communicates with the server to share energy-related data, as well as with the CCB to control real-time charging. The test system was reviewed, as well as the integration of this communication standard into a smart grid. The chosen simulated power supply is a single-phase low voltage grid with four PV plants, ten residences, and one electric vehicle (EV), all of which communicate with a charge management system that has been created. The PV plant input production profiles are based on genuine measured data from an established PV plant at Bielefeld University of Applied Sciences. The impact of bidirectional communication between the EV and the CS was investigated using this simulation. The battery model communicates with the server and the CCB after the simulation begins. Every hour, until the charging process is complete, energy-related data is exchanged. The findings illustrate how bidirectional intelligent communication between EV and CS can help with Smart Grid power balancing. The modeling of electric vehicle charging based on this test system will make future EV simulations more realistic and conform to the ISO/IEC 15118 standard. In addition, as part of the Fit2Load project, the automatic system will be integrated into the simulation, allowing the charging of several EVs to be modeled according to the ISO/IEC 15118 standard. [25]

5.3 Smart Charging

This work [26] offers a new Smart Charging Scheduling Algorithm (SCS-Algorithm) for charging solutions in a smart grid (SG) system by coordinating several plug-in hybrid electric vehicles (PHEVs). Voltage strains, smart grid performance degradations, and overloads that occur in distribution networks with a high number of PHEV charging events are causing concern among utilities. On newly emerging SG, haphazard and unorganized PHEV charging can result in significant power losses, stability difficulties, and blackouts. As a result, a smart charging strategy is proposed and developed for charging coordination of PHEVs (e.g., every 30 minutes) to minimize total daily charging cost by incorporating Grid to Vehicle (G2V) and Vehicle to Grid (V2G) technology in parking lots, controlled by various aggregators, to minimize total daily charging cost. To identify the ideal value of charging cost and charging schedule, an optimization technique is linked with SCSA. Two test cases are used to validate our work, and SCSA is used to check the algorithm's resilience and consistency using a non-parametric Wilcoxon Signed Rank test (WSRT).

Two test cases are used to validate the feasibility of the work and to determine the ideal charging cost when G2V and V2G technology are used simultaneously. In test case 1, 30 PHEVs are used with a 9:1 ratio of PHEV-30 to BEV, but in test case 2, 30 vehicles are used with a 5:4:1 ratio of PHEV-30, PHEV-40, and BEVs in the parking lot. In this research, a unique SCS-Algorithm is proposed, with stochastic initialization of various attributes and optimization techniques, to determine the optimal scheduling of numerous PHEVs while taking into account practical restrictions and determining the optimal overall daily cost. Both techniques are included in this algorithm, G2V and V2G. A novel concept for zero-energy car transactions has been introduced. After obtaining the ideal cost and strategy, it can be inferred that EVs with larger battery capacity can participate more in V2G mode during higher tariff rates, but EVs with smaller battery capacity may occasionally operate in G2V mode instead of V2G mode in the same scenario. Furthermore, because there is greater participation in V2G operations in test case 2, the overall daily charging cost is lower than in test case 1, which is ideal. Finally, the consistency of the SCS-Algorithm is evaluated using WSRT, and it is found that this algorithm is robust enough to give consistent results [26].

In this paper [27], they propose optimal charging architecture between a smart home and a plug-in electrical vehicle. This solution architecture is expected to optimize energy and power sharing between a plug-in electrical vehicle and a home with minimal costs with demand variability. It also reflects battery energy storage system's state of charge to make flat demand response schedule. A suggestion for an ideal charging design for a smart home and a plug-in electric vehicle is proposed in this research. With demand fluctuation, this solution design is projected to maximize energy and power sharing between a plug-in electric vehicle and a residence with minimal expenses. It also reflects the state of charge of the battery energy storage system in order to provide a flat demand response schedule. A smart charging method and architecture for plug-in electric automobiles and smart houses is included. It is possible to create an optimal charging system for plug-in electric automobiles in the smart grid using this architecture. The proposed design is cost and energy efficient for a plug-in electric vehicle's optimal charging and energy-sharing algorithm. At the smart house or building, it can also take into account cost functions and restrictions like dynamic price, demand response, and battery state-of-charge. This architecture and technology can efficiently control the battery energy storage system. Enough energy transmitted by electricity and renewable energy sources can be stored in the smart home or building's battery energy storage system (BESS) for later use.

Another published paper [28] discusses the Progression of smart Metering infrastructure for electric vehicle charging stations. It Describes public charging point development with smart metering to guide the user, which can precisely monitor the transfer of electric energy when the problem occurs auto shutdowns, when charging is done to describe the level, stops the charging process which ensures saving of energy which can be further utilized to measure the electrical energy while charging process, kwh meter with accuracy up to 0.5 watts is used in the charging station. For data processing, a microprocessor is used which will show the data on the 15-inch screen for user information. Smart Card enables purchasing process to complete the charge cycle. The focus of this paper [28] is on the evolution of charging infrastructures. It also includes the necessity for charging point infrastructure as well as the diversity of features and standards that can be accommodated. Levels 1 to 3 are best for charging with varying charging times. Level 3 denotes rapid charging. Level 1 is used for both residential and commercial applications that require high charging and long-term security. While level 2 charging is an improvement over level 1 charging in terms of charging time and safety. In the future, there will be opportunities to shorten charging times and make use of batteries that are less expensive, have greater storage capacity, and demand moderate safety when charging.

Comprehensive Management Strategy for Plug-in Hybrid Electric Vehicles using National Smart Metering: In this work [29], a complete management strategy (CMS) for plug-in hybrid electric vehicles (PHEV) is developed, based on Iran's national smart metering program (FAHAM). The proposed plan also takes into account PHEV charging management and billing solutions. To shift the charging load of PHEVs and maximize load factor, an optimization method is used.

AMI provides system operators and users with the knowledge they need to make informed decisions, as well as the power to carry out those decisions that they are currently unable to carry out. An optimization proposed model was solved using mixed integer linear programming (MILP) solver CPLEX under GAMS on a PENTIUM IV, 2.6 GHz processor with 4 GB of RAM. The charging load of PHEVs is shifted through optimization to achieve the following objective function: maximum load factor. In order to analyze the robustness of the CMS, the problem has been addressed in two scenarios: [29]

Scenario 1: There is no control on the charging procedure of the PHEVs. Scenario 2: The charging procedure of PHEVs is managed by the distribution system operator in order to maximize the load factor and flatten the load profile of the feeder.

Results has shown that in scenario 1 the uncontrolled charging demand of PVEV's can cause difficult situations for distribution feeders by overloading it. Meanwhile scenario 2 controlled charging through FAHAM infrastructure and CMS strategy, the load profile of the feeder is flattened. Using controlled charging results in a higher load factor, which can be viewed as a major opportunity for the system operator to produce a far more efficient system using FAHAM infrastructure.

A complete management approach for Iran is offered, based on the country's national smart metering scheme. The proposed technique aids the system operator in improving the overall efficiency of the system. The charging was carried out during the hours with lower loading, while the charging demand was reduced during the hours with higher loading. The adoption of FAHAM infrastructure for controlling PHEV charging has removed the risk of an increase in electricity demand during the network's peak load, according to simulation results.[29]

Another paper [30] suggested smart meter integration for better control over devices that includes electric vehicle. In a Smart Home, a new smart meter has been proposed for regulating devices and making efficient use of power. The necessity for a more dependable meter to prevent problems and lower monthly expenses prompted the development of a Smart Meter. This Smart Meter is useful since it reduces the likelihood of a power outage in a Smart House. If a device fails, it is automatically taken off service without disrupting the rest of the Smart Home's devices. It also aids in the reduction of the monthly bill. It automatically supplies energy to the Smart Home from the utility with the lowest rate at the time. If such a system is built in a home, it will increase reliability while also providing the possibility to save money.

5.4 Blockchain System in Electric Vehicle

Blockchain technology is known for being used in the financial service, but little did we know it is also being used in Securely sharing medical information, Logistics, and supply chain tracking, data storage, etc. Blockchain is a technology integrated distributed data storage, peer-to-peer transmission, consensus mechanisms, encryption algorithms and other computer technologies, which collectively maintain a reliable database through a decentralized and trusted approach. [31]

This paper [32] introduced a developed block-chain-based renewable energy tracing method for tracking EV charging consumption depending on the kind and source of renewable energy. It has built the mutual trust and resource sharing platform: "renewable energy tracing for EV charging" using the technical features and advantages of block-chain. By utilizing block-chain technology, the platform connected Beijing Power Trading, Qinghai Power Dispatch, Smart Internet of Vehicles Platform, local power operators, and EV charging users; introduced the tracking and matching mechanism of renewable energy products for EV charging orders; and established the infrastructure for the formation of EV renewable energy consumption certification by utilizing smart contracts, which formed the basis digital certification of EV renewable energy consumption. The method that has been considered, for renewable energy tracing is the following:

1.Using an architecture design of blockchain technology tracing renewable energy for electrical Vehicle charging platform. connecting the power trading center and users charging app e-charging, which provides a technical foundation for EV users to engage in the dissipation of clean energy while also improving the charging experience and sense of participation.

2.The blockchain platform includes the charge operators, electricity trading centers, and dispatching centers formed a consortium chain with multiparty participation. Customized the creation of partition consensus, privacy protection, smart contracts, and other features to give common access to the blockchain and other services for consortium chain participants, based on the consortium chain's operation mechanism and business requirements.

3.Data uplink and smart contract development, includes the design blockchain transmission services and interface standards to realize data uplink of power trading centers, dispatch curves, charge orders, and other related information, such as renewable power trading contracts, contract announcement numbers, originators, receivers, power types, and dispatch curves. Simultaneously, a smart contract program is being built to automatically generate Green Pass for each renewable energy charging request, and to realize the generation and circulation of Green Pass.

4.Renewable energy tracking management system developed on the basis of the Smart Vehicle Networking Platform. It can get renewable energy transaction data as well as dispatching curve data. The user order matching mechanism and the characteristic curve algorithm were created. In addition, the system provides Green Pass with full life cycle maintenance. Green power contract management, green power dispatch management, green power inventory management, green power order matching management, Green Pass management, and other functions are among the primary responsibilities. Simultaneously, the app offers features such as displaying Green Pass on the blockchain and checking Green Pass on the blockchain.

5.An app is considered in this method that includes online renewable energy selection, Green Pass management, charging report, and other features are given for charging users on the basis of e-charge APP 3.0 in order to promote user engagement and experience. To provide green power configuration and usage bias settings, develop a green power charge traceability module. The traceability of user charging orders is realized through interaction with the underlying block-chain platform, green power tracing, and other systems, and at the same time, the blockchain link port provides users with Green Pass inquiries and regularly generates green power charging reports, enhancing the user's sense of participation and honor.

6.A visualization for the block chain information was created also that display interface based on the block-chain platform, which includes real-time displays of green power transactions, green power usage, Green Pass, and other related data. Simultaneously, supplied essential blockchain visualization information, such as block height, Green Pass, and other worldwide statistics data, while leveraging the blockchain's immutability to give trustworthy data endorsement for the display material.

Another paper [33] has discussed how the P2P energy market represented by electric vehicles will receive more and more attention. Therefore, a design that combines the blockchain technology and electric vehicles will be discussed within this paper. From the standpoint of feature matching, the blockchain's advantage is found to be complimentary to the demand for electric vehicle charging and generation transactions. The authors suggest that simultaneously, the trading system must be changed to allow the platform owner to fix prices in order to optimize their own interests. The shared economic model can be used by the electric car blockchain platform to incorporate a large number of scattered distributed power sources on the demand side into the charging transaction. It also assures that users of electric vehicle charging stations can publish personal data in real time on the same platform in order to sell and buy the electricity they need. And it doesn't matter if it's in the apartment, a public space, or a private parking lot. The grid company's platform on the platform may ensure that both the seller and the other seller can compete freely in B2C and P2P trading modes, and that distributed power is absorbed efficiently and in real time.

6. CONCLUSION

The world is steadily moving forward with renewable energy, within a smart grid solution. The evolution of the "smart grid" includes electric vehicles, and there are some intriguing possibilities associated with them. Smart residential charging, which entails simply plugging in one's automobile after commuting, is part of the smart grid system. Smart charging, on the other hand, allows charging times to be changed based on grid loads as well as the demands of the owner, which can be based on the utility's monetary incentives. Electrical vehicles might be the solution for many obstacles that the grid might face from renewable energy resources. The solutions that have been offered whether it's a solar photovoltaic based electrical vehicle for Grid Support, integrating EV's in smart grid system using ISO/IEC 15118 protocol, Smart Charging, or block-chain technology being used for grid and electric vehicle support these demonstrate how the EV's can contribute to the environment and Grid stabilization.

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