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# A Study on Smart Grid and Electrical Vehicle: Bird's View

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**Abstract**

This is about how Electrical Vehicles can contribute to grid stabilization, simulation-based research for smart charging, grid communication, block chain based technology for Electric Vehicles with the purpose of achieving the international environmental and sustainable goals. Smart grid and future electric vehicle is the most emerging issues that are integrating in the near future. 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 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.

**Keywords:** Smart charging, smart grids, electric vehicles, block chain and EV

## 1. Introduction

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. 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". 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 optimized 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".

## 2. History of Electrical Vehicles

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. Thomas Davenport developed the first electric motor in 1834. 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.

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 development will soon overtake gasoline power. John Good enough 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. Good enough 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.

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## 3. Electric Vehicles and Smart Grid

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.

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”.

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. 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.

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 renewable 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 renewable in such a grid.

**Charge Point Management:** The use of’ smart' charge points 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 Charge Point management options exists each of which offers different amounts of flexibility integration of electric vehicles will risk being not only as bottlenecks but also will ultimately find.

## 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 335000 km (other nations) (Czech Republic). When compared to the economical return, the environmental benefit is achieved over relatively short lengths of 30 000 km 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. 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. 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

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 (Norway) to 190 000 km (Poland). It is also demonstrated how economic and environmental benefits are influenced by mobility profile, with longer trip distance profiles providing greater benefits.

**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.

**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-contrives 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

## 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.

**i). 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. 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

a) To extract maximum power from solar PV; and
b) The design and control of a SEPIC DC-DC converter with MPPT to extract maximum power from solar PV.
c) Modeling and control of a voltage source converter and LCL filter to improve grid support and
d) Design and control of a bidirectional DC-DC converter with smart charging/discharging algorithm for V2G operation.

**ii). Integrating Electric Vehicle Communication in Smart Grids:** This paper 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 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 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.

**iii). Smart Charging:** This work 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. 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. In this paper, 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 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 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.

Comprehensive Management Strategy for Plug-in Hybrid Electric Vehicles using National Smart Metering: In this work, 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**

**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.

iv). **Block chain System in Electric Vehicle:** Block chain 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. 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**

i). 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.

ii). The blockchain platform includes the charge operators, electricity trading centers, and dispatching centers formed a consortium chain with multiparty participation.

iii). 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.

iv). 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.

v). 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.

vi). 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.

## 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. And also further Solar power is making rapid change to the power generation aspects and it is not harmful for the society and environment. By using electric vehicles we can save environment from the Air pollution and we can gift healthy environment to our future generations.

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