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An Overview of Electric Vehicles

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ABSTRACT: Electrifying transportation is a potential strategy for addressing climate change. The introduction of electric vehicles to the market has had a major effect on a variety of sectors, particularly the power grid. Various regulations have been adopted to encourage the deployment of electric vehicles, and the upward trend in electric car adoption in recent years has been encouraging. Electric car powertrain, battery, and charger technology have all advanced in recent years, allowing for a broader use of electric vehicles. Despite the environmental and financial advantages, charging electric cars has a detrimental effect on current network operations. To address this problem, appropriate charge management methods may be used. Furthermore, integrating electric vehicles with the smart grid may open up a slew of possibilities, particularly in terms of vehicle-to-grid technology and as a solution to the renewable energy intermittency problem. This paper examines the most recent advancements in electric car technology, as well as the implications of electric vehicle adoption and prospects.

KEYWORDS: Climate change , Charging , Battery , Electric vehichle , Greenhouse gas.

1.INTRODUCTION

Greenhouse gas (GHG) emissions are an unwelcome consequence of burning fossil fuels for electricity. The severity of climate change as a result of GHG emissions has reached a dangerous level, as shown by current global warming and the melting of huge icebergs. To reduce the increasing effects of climate change, immediate preventative measures and climate policies are required. In response to this, the International Energy Agency (IEA) has developed future energy system scenarios that aim to keep global average temperatures below two degrees Celsius by 2050 If no measures are made to address this issue, GHG emissions are expected to quadruple by 2050.

In 2009, the transportation sector was responsible for one-quarter of all energy-related GHG emissions. Efforts are being made to decrease emissions from the transportation industry in a variety of ways[1]. The emphasis is on developing alternative fuels and incorporating clean technology elements into cars in order to decrease GHG emissions while simultaneously improving vehicle performance. Electrifying transportation is a viable strategy with many advantages[2]. Electric vehicles (EVs) have the potential to provide energy security by diversifying energy sources, spur economic development by establishing new sophisticated sectors, and, most significantly, preserve the environment by reducing tailpipe emissions. Because of the use of more efficient power trains and electric motors, EVs outperform internal combustion engine vehicles (ICEVs)[3].

Governments all around the globe are adopting various initiatives, laws, and programs to encourage the use of electric vehicles. Incentives to lower the cost of electric vehicles, the construction of charging infrastructure, and increased public knowledge of the advantages of electric vehicles are just a few of the steps done to promote EVs. The efforts seem to be paying off, as EVs begin to acquire popular acceptability. The worldwide EV stock was above 180,000 at the end of 2012, according to the Global EV Outlook produced by the Electric Vehicle Initiative (EVI) and the International Energy Agency (IEA). This enables EVs to account for 0.02 percent of the worldwide car fleet while still allowing for further research and development. Continuous EV technology development is a critical element in improving EV performance and ensuring its competitiveness[4]. The development of powertrain, battery, and charging infrastructure technologies, for example, has been prioritized. Varied power train topologies, including as series, parallel, and series-parallel configurations, are developed throughout the EV development process to suit various needs[4].

Due to the utilization of a highly efficient electric motor, these power train designs may increase fuel efficiency and vehicle driving range. Similarly, battery technology has progressed from lead-acid to nickel-based to ZEBRA battery to lithium-based kinds in order to provide a storage technology with high energy density, high power density, low weight, low cost, safety, and durability. Metal-air batteries have been the subject of research because they have a high energy density of up to 1700 Wh/kg and can compete with the performance of a traditional internal combustion engine vehicle. To address the problem of range anxiety among EV drivers, charging infrastructure that offers high charging power, such as direct current (DC) rapid charging stations, is progressively being used to replace slow chargers. Studies are being conducted to assess the effect of EV adoption, with an emphasis on the economic, environmental, and technological problems that affect the power system, which will be thoroughly e. The economic effect of electric vehicles is largely reliant on the generation mix utilized to charge them [5].

Because electric vehicles depend on energy from the power grid to operate, the cost of power production has a significant impact on the cost of EV ownership. The economic effect of EV deployment may be assessed from both the power grid and the perspective of EV owners. For the increased EV load demand, the power grid will require more generating capacity, while EV owners will have to pay the high initial purchase cost of an EV at this time. EV deployment, on the other hand, may be lucrative for both the power grid and EV owners if coordinated charging, energy trading, and different electricity pricing policies are implemented. The effect of EV adoption on the environment is debatable[6]. The apparent remark is that electric vehicles emit no tailpipe emissions, making them clean and environmentally friendly. EVs, on the other hand, utilize energy produced by the power grid, which emits GHGs throughout the generating process. As a result, the environmental effect of EV use is dependent on the power source. Renewable energy has been more popular in recent years, making electric vehicles (EVs) more environmentally benign than traditional ICEVs. Concerns regarding the detrimental effects of EV charging on the power grid have arisen as a result of their connectivity to the power grid to get charges. Harmonics, system losses, voltage drop, phase imbalance, increased power demand, equipment overloading, and stability concerns are among the expected challenges related with EV charging, according to a thorough review of the literature[7].

1.1 History And Current Status of EVs:

From the eighteenth century to the present, electric vehicles have seen significant modifications. It's shocking to discover that electric vehicles were previously the preferred mode of transportation[7]. The discovery of the electric motor aided the development of electric cars. Robert Anderson developed the first prototype electric-powered vehicle between 1832 and 1839, which was powered by non-rechargeable primary cells. Following that, several electric-powered carriage prototypes were developed, but due to the absence of an efficient electric motor and a viable rechargeable battery, none of them were appropriate for practical development. The direct current (DC) electric motor and rechargeable battery underwent a series of changes between 1856 and 1881[8].

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Werner Siemens, Antonio Pacinotti, and Zénobe Gramme received the most of the credit for developing a high-efficiency DC electric motor. In addition, Gaston Planté developed the first workable rechargeable lead-acid battery in 1859, which Camille Alphonse Faure refined into a commercial device about 1881 . The development of DC electric motors and rechargeable batteries has given the EV sector a significant boost. In New York City, for example, an electric taxi was the first commercial EV to hit the market in 1897. In only three years, electric cars (EVs) accounted for 28% of all road vehicles and were the preferred mode of transportation . After a decade, though, EVs faced a significant hurdle. Henry Ford introduced gasoline-powered cars, such as the Ford Model T, to the market in 1908. Charles Kettering's development of the electric starter in 1912 eliminated the need for a manual crank to start gasoline-powered automobiles. Furthermore, because of the low cost of fuel, gasoline-powered cars have a cheaper operating cost than EVs. EVs, on the other hand, could only drive a small distance and had a limited number of charging stations. Because of all of these reasons, gasoline-powered cars have gained widespread acceptability, whereas electric vehicles have declined in popularity.

There were no electric vehicles on the road in 1935[5]. A few decades later, the problem of gasoline-powered car pollution, as well as rising oil prices, reignited interest in EVs. Governments have taken legislative measures to decrease air pollution and encourage the development of electric and hybrid cars. California's Zero Emission Vehicle Mandate of 1990 was one of these governmental measures, requiring two percent and ten percent of all cars to have no emissions by 1998 and 2003, respectively. Many manufacturers are working to develop hybrid cars. The EV1 vehicle was manufactured and leased by General Motors in 1996 . The next year, Toyota released the Prius, the world's first commercial hybrid electric vehicle (HEV), in Japan, with 18,000 units sold in the first year of manufacturing. As the price of oil continued to rise, more manufacturers committed to vehicle electrification. Battery electric cars (BEVs) and plug-in hybrid electric vehicles (PHEVs), such as the Nissan Leaf, Mitsubishi i-MiEV, Chevrolet Volt, and Tesla Model S, have been available on the market since 2010. According to the EVI and IEA's Worldwide EV Outlook, the global EV stock was over 180,000 by the end of 2012. The present state of electric vehicles throughout the globe. Table 1 shows the EV stock and quantity of Electric Vehicle Supply Equipment (EVSE) deployed in each country in 2012, as well as the national EV goal.

BEVs, PHEVs, and fuel cell electric cars are all considered EVs in this sense. Non-residential slow and fast chargers are referred to as EVSE. The United States has the most electric vehicles on the road, accounting for more than 70,000 units, or 38% of the worldwide EV total. More than 15,000 EVSE devices have been deployed. Japan is the world's second-largest EV market, accounting for 24% of worldwide EV sales. European nations account for about 11% of the entire worldwide EV stock. Countries all around the globe have set ambitious national EV targets that must be met in the near future. To achieve the goal, several policies and measures have been implemented, such as EV purchase cost subsidies and the construction of charging infrastructure. The National Automotive Policy in Malaysia encourages the use of electric vehicles and the development of associated infrastructure. Green Tech Malaysia has been tasked by Malaysia's Ministry of Energy, Green Technology, and Water to create a plan for EV adoption. In 2011, an EV pilot project, the Fleet Program Test Vehicle (FTV), was implemented in Putrajaya and Cyberjaya, as one of the measures done. The FTV implementation will guarantee that a complete EV roadmap is provided and that EVs are promoted to the general public.

The Mitsubishi i-MiEV and Nissan Leaf were the first two electric vehicles to enter the Malaysian market in 2013. For the convenience of EV vehicles, public charging stations have also been built. For example, EV charging stations were installed in Bangsar Shopping Centre, Suria Kuala Lumpur Convention Centre, Lot 10 Shopping Centre, and Petronas Solaris in Serdang by First Energy Network. Sync R&D has launched a project called Electric Bus 1 Malaysia (EB1M) to promote the use of electric propulsion in public transportation. By 2020, the aim is to have 2000 electric buses on Malaysian highways

1.2 EVs Technology:

Before attaining current prominence, Vs went through a number of technical advancements. In order to compete with the dominating ICEVs and to expand EV adoption, EV technology must continue to evolve. Improved technologies, particularly the powertrain, battery, and charging infrastructure, have been prioritized. As a result, these components undergo significant changes throughout the EV development process. Power train designs are available in a variety of configurations, including series, parallel, and series-parallel. Similarly, battery technology has progressed from lead-acid to nickel-based to ZEBRA battery to lithium-based. There are also many possible battery types, such as the metal-air battery, which has an energy density similar to that of a normal internal combustion engine vehicle. Fast charging infrastructure has recently been introduced to the market to address the issue of traditional slow chargers' lengthy recharge times.

- *Power train*: Hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and battery electric vehicles are the three kinds of powertrain EVs that may be classified based on the vehicle hybridization ratio (BEVs). HEVs use a mix of an internal combustion engine and an electric motor to drive themselves. External energy sources, such as the power grid, are not compatible with HEVs. The battery is charged either by the built-in internal combustion engine or by regenerative braking, which recovers energy. This process slows down a hybrid electric vehicle by converting its kinetic energy to chemical energy, which may then be stored in a battery for later use. PHEVs are similar to HEVs but have additional characteristics such as bigger battery packs and the ability to be recharged from the grid. BEVs, on the other hand, run entirely on battery power.
- *Battery*: The battery is the heart of an electric vehicle and one of the two propulsion systems used by HEVs and PHEVs. In the meantime, it is the only source of propulsion for BEVs. Current EV battery technology has certain limitations, which is a barrier to broader EV adoption. The present EV battery has a poor energy density, which has a direct impact on the EV's potential all-electric range.
- *Charger*: The battery packs in PHEV and BEV may be recharged externally from the electrical grid through the charging equipment. The EV battery charging procedure necessitates the use of a charger since the power grid source is alternating current (AC) while the battery is direct current (DC). The EV charger is intended to convert AC electricity from the grid to a DC power level appropriate for charging EV batteries. An EV charger is often built as an AC/DC converter or rectifier to do this job. For improved energy conversion, an extra DC/DC converter is incorporated in the design of certain EV chargers, such as the rapid charging station. Electric car chargers may be placed both on and off the vehicle. To minimize the weight of an electric vehicle, on-board chargers are often built to be tiny. It also has a low power rating, thus it's best for sluggish charging. Off-board EV chargers, on the other hand, are installed at specific places to enable rapid charging.

- *Requirements for charging*: The Society of Automotive Engineers (SAE), the Worldwide Electromechanical Commission (IEC), and the CHAdeMO EV standards are among the recognized international standards for EV charging [21]. The standards are issued by the nations with the greatest electric vehicle stocks at the moment, which are the United States, the European Union, and Japan.

1.3 Impacts of EV deployment:

The effects of EV adoption have been the subject of much study. The three main effects of the EV rollout are being focused on: economic impact, environmental impact, and influence on the power system. In the sections following, the key results from these three categories will be explored in depth.

- Economic consequences; The economic effect of EV deployment may be assessed from two perspectives: from the standpoint of the electrical grid and from the perspective of EV owners. Electric vehicles (EVs) are extra loads that must be connected into the electrical system to obtain charging. Due to the higher fuel required for greater power production, system costs will rise to deal with the huge extra EV demands. In order to provide these EV demands, there are also higher power losses during the power transmission across the power grid. This scenario, however, may be drastically altered by properly managing EV charging. Controlled electric vehicle charging may save up to 60% on system costs. Integration of renewable energy resources, especially wind energy, into the power system reduces costs even further. Environmental effect Electric vehicles (EVs) are said to be green and environmentally benign since they emit no exhaust emissions. EVs, on the other hand, charge their batteries using energy produced from the power grid, which emits greenhouse gases. A measure termed "wells-to-wheels emissions" is used to compare the emissions levels of EVs with traditional ICEVs. Wells-to-wheels emissions include emissions from a vehicle's full life cycle, including the energy and materials needed to power it as well as direct tailpipe emissions. EVs have the lowest wells-to-wheels emissions, according to several studies.
- *Impact on the electrical grid*: Concerns regarding the impact of EV charging on the electrical grid have arisen as a result of EV adoption. Large EV fleets connecting to the power grid to receive charging may have severe consequences for the power grid, including as harmonics, system losses, voltage drop, phase imbalance, increased power consumption, equipment overloading, and stability problems. The potential effects are further complicated by the various charging rates and dynamic behavior of electric vehicles. As a result, the amount of relevant literature has lately grown. Various research on the grid effect of EV charging are included in this section[9].
- *Implications for the load profile*: Several studies have been conducted to look at the effect of electric vehicle adoption on grid load profiles. This impact analysis takes into account power networks from all around the globe[10]. For example, investigates the effect of electric vehicles on the hourly load profile in the United States. The findings indicate that allowing EV owners to charge their vehicles anywhere at any time would increase the demand during peak hours and late afternoon peak, which correspond to the time of arrival at work and home after work, respectively. To avoid an increase in peak demand, research [85] proposes a delayed charging control.
- *Consequences for system components*: large fleets of electric vehicles charging from the grid require a massive quantity of electricity being transferred from power plants

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to these loads. This scenario may put a strain on current system components, which may not be built to handle the increased EV demands. Overloading power system components like transformers and cables may be a significant barrier to broader EV adoption. On this topic, many investigations have been conducted, and the major literature is presented below.

- *Impact on voltage profile and phase imbalance*: The voltage loss and voltage variation on the EV connecting point will be caused by EV charging from the power grid. As a result, huge EV charging fleets may cause the network voltage to exceed the safe regulatory voltage limits. Phase imbalance, which is caused by single-phase AC charging, is another effect of EV charging on the electrical system. uses the Monte Carlo simulation technique to assess the impact of EV charging on system voltage variation. Uncoordinated charging and vehicle-to-grid charging are the two EV charging methods used. According to Chinese power grid regulations, voltage variations of up to 7% on the 10 kV power system are permissible. In the case of uncoordinated EV charging, an EV penetration rate of 60% or greater will result in many network voltages exceeding the voltage variation tolerance of 7%. When V2G mode is used, all network voltages are kept below permissible limits, and EV penetration rates of up to 90% are achieved. V2G mode can accomplish load leveling and generates a lower voltage differential between peak and off-peak demands, which is why it's used. Similarly, according to, an EV penetration rate of 50% or greater causes network voltages to exceed the voltage variation tolerance of 7%. All network voltages are within acceptable voltage limits after using the smart charging method.

2.DISCUSSION

The environment and the electrical grid may both benefit from the adoption of electric vehicles. EVs are cleaner for the environment than traditional internal combustion engine cars since they emit no tailpipe emissions. From the standpoint of the electrical grid, EV adoption offers many benefits to the smart grid, including V2G technology and the facilitation of RES integration. The V2G interaction with RES in the smart grid has been shown in extensive literature to offer economic and environmental benefits, as well as a variety of services and regulations to the power system. Nonetheless, numerous obstacles, difficulties, and restrictions must be addressed before EV deployment can be effective. Electric vehicle technology are still in their infancy. Despite significant advancements in recent decades, today's lithium-based EV battery has a low energy density, a short life cycle, and a high initial cost. Some battery technologies have the potential to provide better performance, but they are currently in the experimental stage. Furthermore, using an electric vehicle battery with V2G technology would increase the number of EV charging and discharging cycles, hastening battery deterioration. As a result, additional research is needed to enhance the technical and economic performance of electric vehicle batteries.

3.CONCLUSION

This study examines the present state, effects, and possibilities of electric vehicle adoption, as well as the most recent advancements in EV technology. The worldwide EV prognosis seems to be extremely positive, with over 180,000 EVs in hand by the end of 2012. Implementation of an incentive-based strategy to reduce the cost of EV purchases, the development of charging infrastructure, and greater public knowledge of environmental issues are all facilitators for expanded EV adoption. The development of electric vehicle technology has received a lot of attention. To accomplish particular goals, various power train combinations, new battery technologies, and different charger converter topologies are J.Y. Yong et al. / Renewable and

Sustainable Energy Reviews 49 (2015) 365–385 381 presented. The effects of EV deployment on the environment, economy, and power grid are also outlined in the study. EV adoption may have severe effects on the electricity grid if appropriate EV charging management is not implemented. Aside from the difficulties, EV adoption has the potential to offer numerous benefits to the smart grid, such as vehicle-to-grid technologies and support for the integration of renewable energy resources.

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