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IMPACT OF PLUG-IN HEV ON POWER DISTRIBUTION SYSTEMCONSIDERING VEHICLE TO GRID TECHNOLOGY

B. Venkata Lakshmi,
Jntukno:20341A0208GMR
Institute of Technology
Rajam, Andhra Pradesh
India 532127
20341A0208@gmrit.edu.in

1. ABSTRACT:

This paper provides a thorough analysis of the possible technical effects of plug-in hybrid electric vehicles on electricity transmission and distribution systems. Various impacts of power quality on the power system are also presented in this review in a number of different ways. This review presents a thorough examination of electrical distribution networks' solutions for charging electric vehicles. We talk about the effects on power systems of the two charging aspects (coordinated/uncoordinated) and intelligent scheduling of charging. On the basis of technical, applicability, and configuration considerations, vehicle to grid technology is researched, developed, and assessed.

Keywords: *PHEV charging coordination, PHEV, powerloss, impacts on harmonics, voltage imbalance, transformer overloading, V2G technology, V2G modelling.*

2. INTRODUCTION:

Most nations have made significant efforts making an attempt to improve their economic and environmental statuses, especially being independent of oil consumption. Electric cars with plug-in hybrid engines (PHEV)are hopeful innovations that will reduce reliance as well as the overuse of oil. PHEVs have been made available due to their contributions to society in general, particularly in terms of reducing CO2 emissions and reducing consuming gasoline. PHEVs offer significant economic and environmental issues are supported. Large scale most nations with PHEV manufacturing the car industry has a significant impact on the power grid.in various areas, including power generation, peak and basic load requirement Uncontrolled PHEV charging results in the negative effects occur under peak load.V2G (Vehicle to Grid) technology utilisation, however combined with PHEVs could provide momentary grid with electricity, power system to supply PHEVs with electricity from the grid to offer solutions for unforeseen peak loads, these issues should be overcome. In order to supply power to the grid for PHEVs, a brand-new and developing V2G technology has been incorporated into the power system. Previous research showed that about 95% of the time, EVs were parked. As a result, extensive research has been done on the utilisation of idle energy storage systems from EVs to supply feedback power to the grid under the idea of V2G. V2G also provides other ancillary services to the grid, including peak power shaving, spinning reserve, and voltage and frequency controls (Ehsani et al., 2012).

The goal of on going study is to assess this unique technology. A growth in the number of PHEVs has a big impact. The current state of every nation's power sector; this discovery implies that a quick reaction to growing burdens that were abruptly revealed because of a great desire to hybrid electric vehicles (EVs) must be acquired, taking their substantial contribution most latest research consider the elements that the added weight of EVs has on the grid when recharging is taking place; these elements include charging habits, reducing energy costs, and driving battery life and patterns (Azadfar et al., 2015). The potential effects of PHEV distribution in the market are demonstrated in this review. The current study compares and contrasts all recent studies on the impact of PHEVs on the distribution grid in order to analyse the most common technical issues with PHEVs. Results could aid in long-term planning and offer future information on the potential integration of PHEVs into the national electricity system.

PHEV charging strategies: Prior to vehicle charging, distribution networks are significantly impacted by charging profiles .The levels of voltage are drastically changed when EVs are charged via the power grid. So it is necessary to research the strategy and control ways of charging EVs. To control EV charging duration and frequency, a variety of charging techniques could be taken into consideration.

- Controlled/coordinated charging
- Not-Controlled/un-coordinated
- Charging delayed charging
- Off-peak charging

There has not been a single impact research on PHEV charging can be used to represent or apply to any utility grid or country as a result of erratic PHEV charging characteristics of PHEV circuits in patterns and diversity from circuit to circuit. The absence of essential information, including charging habits and penetration levels, which might make things more unpredictable. Table 1 shows the different penetration levels of uncoordinated charging indifferent countries. Two main perspectives can represent the initiation and worsening of impacts on the distribution grid.

Table1:-Penetration level of uncoordinated charging in different countries:

Countries	EV level of penetration (%)	Peak load increment (%)	Reference
USA (Los Angeles)	5-20	3.03-12.47	Markel *et al*. (2009)
USA (California)	10-20	17-43	Shiau *et al*. (2009)
USA (New York)	50	10	Lopes Peas *et al*. (2009)
Portugal	11	14	Peças Lopes *et al*. (2009)
Western Australia	17-31	37-74	Galus *et al*. (2010)
Belgium	30	56	Clement-nyns *et al*. (2010)
United Kingdom	10-20	17.9-35.8	Qian *et al*. (2011)
Netherlands	30	54	Weiller (2011)

PHEV Charging coordination:

Based on the stated goal, coordination of PHEV charging is highly advised and must be put into practise. Different control architectures could be used to coordinate the charging of PHEVs.

- Centralized
- Hierarchical
- Decentralized

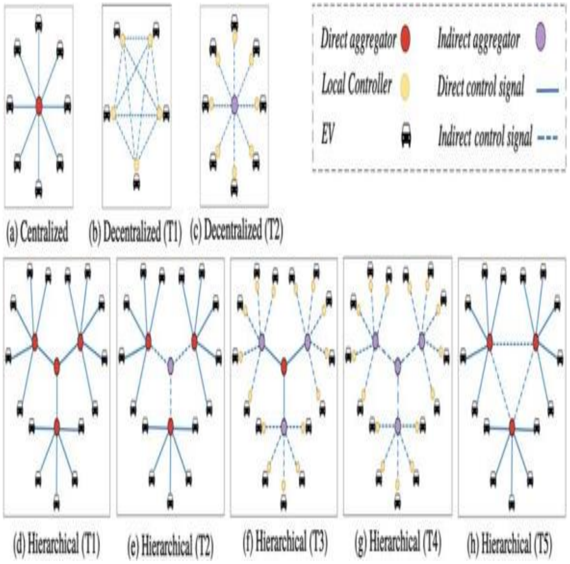

Fig.1: PHEV Charging coordination:- Centralized, Decentralized, Hierarchical.

Figure 1 provides a basic classification of the two charging coordination architectures under inclusion of the mixed hierarchical architecture.

Centralized charge control designs: These architectures were created using scheduling processes that take individual charging jobs' needs into account. In order to organise the total charging process, these paradigms frequently rely on scheduled, schedules that are transmitted by a central scheduling instance or assume a Direct Load Control (DLC) scheme, thereby obtaining specific technological limits (Gonzalez Vaya and Andersson, 2012).To enable precise planning with the central instance, however, centralised control systems call for a high level of knowledge (Li and Shahidehpour, 2015).

Hierarchical charge control designs:

Hierarchical coordinating processes can be a hybrid that combines elements of centralised and decentralised control paradigms. These processes include methods for centralised management and scheduling, but they only deal with issues unique to certain regions or components of the whole system.

Decentralized charging control designs:

Hierarchical coordinating processes can be a hybrid, combining parts of the centralised and decentralised control paradigms. This is illustrated by the architectures for hierarchical charging control. These procedures contain techniques for centralised planning and management, but they only address problems specific to particular geographical areas or system parts as a whole.

Electrical Power System (EPS) Effect of PHEV: Systems for generating, transmission, and distribution make up an electric grid. Power plants that produce electricity from a range of resources, including coal, gas, solar, and wind, make up the generation system.

Two factors primarily affect how PEV charging affects the electric grid as a whole.

- Level of PEV penetration
- Point in time and duration of PEV charging

Numerous studies have been conducted to assess the possible effects of extensive EV integration into the current power infrastructure. In the 1980s, research on EV grid integration first began. Heydt (1983) discovered that the peak load and EV charging demand are synchronised. The primary goal of this study was to estimate the potential effects on loads in various places when the penetration growth rate of EVs changes. Results indicated that EV charging situations that are not aligned with peak grid load occur, which has an impact on grid performance.

Power loss: If penetration levels fell below 10%, the Portuguese DS examined by Lopes et al. (2011) would encounter issues with voltage dips and power loss controls weren't used. When running simulations in PSS/E, the average driving distance was taken into account. To ensure accurate results, the charge time was computed using power consumption per day rather than battery size. Instead of charging every day, charging was done when it was thought that the battery was empty.By utilising two operational methodologies, Torquato et al. (2014) provided a thorough presentation of the impact assessment of EVs. The main effects of PHEV connection on the distribution network were voltage drop, increased losses, and cable overload.

Gray and Morsi carried out a prestigious study on the effects of PHEVs on the electrical distribution system's power quality.(2015). Additionally, Saberbari et al. (2014) assessed the effects of

PHEVs on Iran's distribution grid in terms of power loss and voltage drop. The findings highlighted the significance of having a coordinated plan for PHEVs, especially during peak hours, because without one, PHEVs would interfere with grid tactics, reduce voltage, and increase power losses. Baharin and Abdullah (2013) conducted a second study that examined the possible effects of widespread PHEV adoption in Malaysian residential areas. The effects of various PHEV penetration levels on a chosen residential network were identified and examined using geographic information system simulation tools. Upgrading cable size would greatly reduce power losses.

Impacts on harmonics: An unexpectedly high number of PEV charging during peak demand hours could change the overall home load curve and increase system losses, overload the wires and enhance the system's exposure to harmonics. Deilami et al. (2012) state that two PEV charging regimes were employed to investigate negative consequences. The situation of uncoordinated random charging showed the greatest bus-voltage deviation. However, in the case of scheduled coordinated charging, total power losses and THD for voltage were reduced. Furthermore, THD distortion was negligible and could be disregarded when PEV penetration was around 20%. Moses et al. (2011) showed that the nonlinear behaviour of PEV loads causes the current harmonics, which increase losses and heating, decrease efficiency, induce premature insulation failure, and winding failure. The potential consequences of the conventional distribution network and the random placement of each type of charger were assessed. Staats et al. (1998) suggested a statistical technique to determine how charging electric vehicle batteries affects harmonic voltage levels. The technique caused the voltage in the system nodes to exhibit entire harmonic distortion.

Hadley and Tsvetkova looked into the fundamental consequences of injecting PHEVs on the grid according on their characteristics (2009). According to Scott et al. (2007), who examined the economic implications of PHEVs being integrated into the US electric grid, off-peak power payments from PHEV owners are appealing and advantageous for electrical service providers and ratepayers.

voltage imbalance: When voltages, magnitude, and phase change, the impacts of the imbalance are categorised in three-phase systems (Committee et al., 2009).The major connection points and level of penetration for EVs are still unknown, and this element would cause a voltage imbalance in three-phase systems given the existing availability of single-phase EV chargers in residential networks. Numerous notable investigations on the effects of voltage imbalance have been done. To locate and ascertain PEV charging/discharging levels at low voltage distribution systems, Shahnia et al. (2011) primarily investigated and examined the voltage imbalance sensitivity and stochastic assessment. The distribution feeder end is where voltage imbalance levels are most severely affected. In a distribution network, voltage imbalance was actually measured by Meyer et al. in 2011.

Transformer overloading: Shao et al. (2009) investigated the potential effects of charging PHEVs on a typical distribution feeder in Blacksburg, Virginia. Two Chevrolet PHEVs and five homes were examined using two charging strategies: charging PHEVs at 6 p.m. and charging PHEVs during off-peak hours. The test found that the transformer load climbed to 68%/52% under the worst case scenario. The second one led to a somewhat lower percentage increase in transformer load—58%/52%—than the previous one. Farmer et al. (2010) addressed the effects of PHEVs on transformers and identified three possible outcomes in the event that PHEVs are implemented on a power system.

Because of the introduction of power electronics, the harmonics rose as a result of an increase in load and a subsequent rise in transformer temperature. Because of the flattening load attempts, this phenomena will cause the transformer bushings to wear out. Khamphanchai et al. (2014), among others, suggested a decentralised voltage control method to determine the potential influence of EV penetration on the load and voltage profiles in a distribution transformer. In this work, a distribution transformer's nodal voltage was controlled within an acceptable range to prevent load profile and transformer overload. The findings showed that EV penetration increased transformer load and decreased voltage beyond what was considered acceptable.

PHEV battery charger topologies limitations:

It must be stressed that the electronic components and control scheme are essential to the operation of the EV battery charger. Numerous research have suggested various circuit topologies and control schemes in conjunction with their designs during the past few years. The two different types of EV charging are as follows:

- Unidirectional charging
- Bi-directional charging

A diode rectifier serves as the first step of the first topology, which is regarded as being conventional. The local reactive power in this topology can make managing and controlling big loads less complicated. A bidirectional charger can also function in two distinct modes: vehicle to grid (V2G), also known as the discharging mode, and vehicle to vehicle (G2V), also known as the charging mode. Numerous scholars conducted in-depth studies on the potential effects of charging on the distribution network. Niazazari et al. (2014) enhanced the voltage profile and power factor.

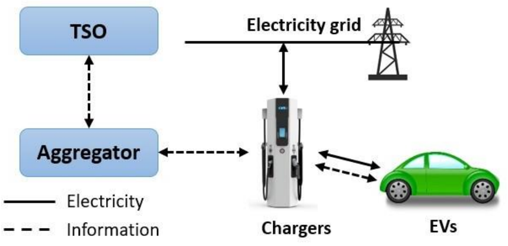

Fig.2:-Vehicle to grid concept.

Integration of V2G technology:

The distinctive feature of power flow in V2G vehicles is bi-directionality, which denotes that, as illustrated in Fig. 2, cars can either take electricity from the grid while charging or provide power to the grid during discharging. V2G might be a significant factor in increasing distributed generation during peak hours. Basically, with the present introduction of PHEVs into the transportation industry, V2G is critical to addressing the needs needed for integrating both PHEVs and V2G.The business models that permit slow charging of PHEVs, fast charging of EVs, and the establishment of battery swapping facilities for EVs are covered by more than half of the literature that is now available.

V2G modelling:

Other studies (Wu et al., 2011; Zhang et al., 2012) mainly concentrated on the effect of V2G on the distribution grid. Modeling and power system stability, particularly steady-state analysis, were highlighted by the effects. According to Zhang et al. (2012), intelligent solutions for charging and discharging PHEVs are exposed to reduce the power loss brought on by their widespread deployment into the electricity grid. However, Boulanger et al. (2011) strongly advised applying the market signal to boost off-peak charging and achieve the valley filling and peak shaving.

CONCLUSION:

As fossil fuel usage is decreased, it becomes more important to develop clean energy alternatives. Because of its significance in enhancing and improving economic and environmental qualities, the massive use of gasoline has become a significant concern and has been in the governments' top priority agenda and policies. According to Nemry and Brons, the market's penetration of PHEVs is predicted to reach up to 35% by 2020. (2010).

Accordingly, depending on the time and location when they are added, adopting large-scale PHEVs on the power grid could result in limitations and may overwhelm the electrical network. Therefore, generation adequacy, load diagram adjustments, and electrical grid robustness are some of the potential key technical challenges that PHEVs may cause. The majority of research agree on two points: first, the additional energy demand is not a significant issue because the energy required is negligible in comparison to the total energy use in most nations. The massive introduction of PEVs is secondarily constrained by the generation and transmission capacities. This restriction could be overcome by regulating the time of charging, either by regulation or by providing customers with incentives to alter the schedule of charging as best as possible. As a result, countries with low power use per capita would probably experience more of an influence on the EPS than countries with higher usage. The EPS and generation capacity are intended for lower consumption in nations with low energy usage, and the additional load from charging PEVs would represent a bigger percentage.

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