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A Comprehensive Analysis of PID Based Electric Vehicle Model Design in Matlab 2015a Software

Sabeer Pinjari, Prof. Madhu Upadhyay
Department of Electrical Engineering,
NRI Institute of Technology and Research,
Bhopal, Madhya Pradesh

Abstract- The Solar powered plug-in electric vehicle is an economic vehicle with minimum maintenance. The main drawback of electric vehicles is the limitation of driving distance. By adding a solar PV module the vehicle battery can be charged while on drive. Here the mechanical parts like gearbox and differential are avoided. Direct drive to wheels allows efficient drive.

Keywords- BLDC, Solar PV.

I. INTRODUCTION

Over the past decade, developments in technology related to EVs have seen a rapid growth in reaction to the anticipated market demand for such vehicles. The high-density rechargeable battery packs of EVs are one of the most important components that directly impact the acceptance of electric mobility [1–3].

EVs are typically charged from the utility power grid through battery charging systems however other charging methods like charging directly from solar PV plants or wireless inductive charging also exist. Battery swapping is also a method for charging EVs wherein depleted vehicle batteries are replaced by pre-charged ones. In general, on-board chargers are mounted on the vehicle chassis whereas off-board chargers are kept external to the vehicle. Each power unit type has its own merits and demerits. Among all these power units, the DC-DC converter stage is more popular since it plays the important role of matching the charger rating with the required battery power requirement [6–8].

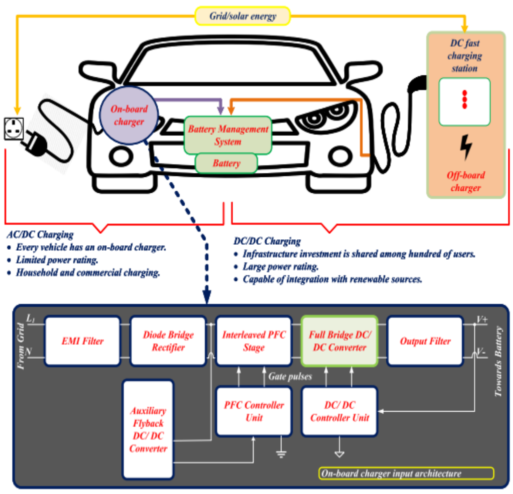

Fig 1. Charger rating with the required battery power requirement

The internal architecture comprises of two power conversion stages: AC-DC and DC-DC. The AC stage is responsible for improving the input power factor while the DC stage provides the suitable voltage and current in accordance with the battery profile [9]. Nowadays, the development of highly efficient and economic EV battery chargers is of high interest. Many EV charger configurations have been developed in the past decade in which the development of DC-DC converter stands out as a prominent development. This power conversion stage has made the converter capable to deliver power according to battery rating [10, 11].

II. RESEARCH MOTIVATION

In practice, EVs use rechargeable battery packs for powering the electric traction system. The batteries are recharged by using battery chargers that take power from the utility grid. It is an arduous task to work on a particular FBDC configuration inside an EV charger since these have a diverse nature. Among the available topological configurations, no specific configuration stands out for EV battery charging applications. Many aspects are considered for designing a particular topology, and some crucial aspects that are considered while justifying the merits of a FBDC are as follows:

- Power regulation of the converter according to battery charging characteristics.
- Ability to operate converter switches with soft-switching.
- Lesser voltage spikes across the isolation transformer poles and secondary rectifier diodes.
- Minimal losses during converter operation. On these lines, this thesis work aims to investigate the topological structures and hence, the topological refinements of DC-DC converters for improving the configuration and performance of the emerging converter configurations. As a specific contribution of this work, an auxiliary circuit based snubber-less configuration has been developed for a reliable operation of the converter. Accordingly, in build up to the description of the main contributions, converter circuits have been broadly classified into two categories:

auxiliary circuit based and snubber-based DC-DC converter configuration. Further, a not so exhaustive review, however covering the main topological variants pertaining to these selected converter topologies has been briefly presented.

To realize an EV paradigm shift, issues pertaining to EV adoption needs to be dealt. As stated in the earlier section, slow charging time, range anxiety, lack of public charging infrastructure, higher cost and capacity fading hinders the growth of EVs. The range anxiety and lack of charging infrastructure can be dealt by building convenient charging infrastructures. While charging time, cost and capacity fading can be managed by the advancement in battery and charger technology. Fast charging infrastructures are needed for long distance trips and during emergency condition. Therefore, it is expected that Fast Charging Stations (FCS) will increase in the near future.

Thus, proper investigation on the planning of FCS is needed. The planning of FCS is technically challenging since the operation of FCS will effect the operation of distribution and transportation system as well as the driving behaviour of EV users. The planning of FCS needs to be done with the consideration of charging demand distribution, traffic flow distribution, topology of distribution grid and road networks. To provide proper guidance for the planning of EV charging stations, forecasting of the EV charging demand is needed. Further, EV load characteristics are different from the conventional loads.

Therefore, behavioural characterization for power flow analysis is also important to accurately realize the operational parameters of distribution system. The FCS will add extra load to the power grid and may adversely affect its operation. Therefore, analysis of impact of FCS on power grid is also needed to provide information to the distribution engineers so that they can take decision in case of any system violations. Also, the integration of low carbon electricity generation like wind and solar can be both beneficial and detrimental for the power grid. Thus, impact assessment of both FCS and renewable sources is essential on the distribution system. Therefore, this research work attempts to address the major issues of load modelling, planning and impact analysis of FCS with renewables on the performance of distribution system.

III. CHALLENGES ASSOCIATED WITH EV ADOPTION

The adoption of EV is increasing over the years but the rate of growth is still small compared to the total vehicle population in the world. This is due to several issues like slow charging times, range anxiety, lack of charging infrastructure, higher cost of vehicles and degradation of battery life.

- Slow Charging Times EVs can take minutes to many hours depending on the battery capacity, vehicle type and charging infrastructure compared to the ICE vehicles which require only few minutes to refuel their gasoline reservoir. The time taken by the battery to charge through residential charging needs approximately 7 hours. Currently, the level of charging available are Level I, II and III [19] where level I and II are AC slow charging and level III is DC fast charging. Most of the EVs in the market come with Level I cordset where one side consists of standard SAE J1772 plug and the other is a standard household plug. These charging outlets are available at home, offices and commercial places. But Level I charging requires large charging time. The Level II charging requires installation of special chargers and potential upgrades. The time required by Level II charging is still in hours. Lastly, Level III charging is the fastest taking less than 30 minutes. However, they require installation in public areas and upgradation of power grid equipments may also be needed.
- Range Anxiety Range anxiety is when the EV user is worried about the depletion of complete battery energy before it reaches destination or the charging station. Majority of EVs have lithium ion chemistry-based batteries which provide shorter driving range in one charge compared to their equivalent ICE vehicles. The EVs at present can be divided into two subgroups: Plug-in Hybrid Electric Vehicle (PHEV) and Plug-in Electric Vehicle (PEV) [3]. The PHEVS has the combination of electric battery and combustion engine for the mobility.

IV. LITERATURE REVIEW

Abhinav Saxena et al. [1] The paper illustrates the control of an electric vehicle network driven by solar PV arrays. Utilizing both the incremental conductance (IC) approach and P&O method, the MPPT of a solar PV array is evaluated. The outputs of the solar PV array gets linked to an electric vehicle that once solar PV array has produced the peak amount of power. It is observed that a suitable level of voltage is measured for the charging of electric vehicles (EV) with minimum harmonics (THD).

Zia Ullah et al. [2] The integration of Electric Vehicles (EVs) and Photovoltaics (PVs) into the electric power distribution system is rising worldwide due to the environmental concerns and the rapid depletion of fossil fuels. However, the simultaneous integration of EVs and PVs in the power system poses challenges of uncertain power penetration, charging, and dynamic loading conditions, which requires a suitable control design and scheduling optimization to keep the modified electric system stable. This paper proposes a solar-based grid-tied charging station (SGTCS) that optimizes EV charging by enabling the scheduling technique resulting in maximum utilization of PV power.

Mali Satya Naga Krishna konijeti et al. [3] Electric car motors and power electronics have gotten a plenty of concerns recently, because to their rapid growth. DC and 3ϕ induction motors are two of the greatest well-studied electric vehicle (EV) motors. Developing countries, particularly with Brushless DC (BLDC) Motors, have developed their own solutions for EV (BLDC). Controlling the steady-state response and transient, settling time, overshoot, rise time, and other aspects of the 3ϕ BLDC motor is a difficult task. A break in control can make the system unstable and reduce the component's lifespan.

Nikhil Kumar et al. [4] The success of the electric vehicles (EVs) sector hinges on the deployment of fast charging electric vehicle charging station (EVCS). The inclusion of clean energy into EV charging stations poses both risks and opportunities. A viable and adequate capacity setup with appropriate planning of EVCS is favourable and crucial. This paper proposes a two-stage sustainable framework for joint allocation of fast charging EVCS, solar photo voltaic (PV) and battery energy storage system (BESS) with dynamic charging and discharging under coupled distribution and transportation network.

V. Kandasamy et al. [5] Electric vehicle (EV) emerging as an upcoming technology in both the sector of transportation and power. There are more benefits in terms of economic and environmental conditions. The most important factor in Electric Vehicle is charging station, which reduces green gas effect and environment pollution. This electric charging station is also known as Electric Vehicle Supply Equipment (EVSE).

Andrés Felipe Cortés Borray et al. [6] This paper introduces a linear programming (LP)-based optimisation method of charging electric vehicles (EVs) in a decentralised fashion. It exploits the available photovoltaic (PV) power to charge EV batteries while maintaining the low-voltage (LV) network within its operational limits. A new energy-bound model is implemented in order to meet the connected EVs energy requirements.

Priessner Alfonset al. [7] Although electric vehicle (EV) sales have recently been increasing, EVs can only contribute to mitigating climate change if the power they require is generated from renewable energy sources. Hence, a product bundle of EVs with photovoltaic (PV) solar panels in combination with battery storage (BS) for households could be instrumental in improving EV adoption rates and thus also their carbon footprint.

Yujuan Fang et al. [8] The research on renewable energy utilization has attracted much attention in recent years with the increasing awareness of sustainable development and environmental protection from the public. To promote the usage of solar power, a public-private partnership program is suggested which encourages investment companies to cooperate with residents by setting up rooftop solar panels and receiving payment from electric vehicle users. In order to analyze the willingness of each stakeholder participating in such a program, an evolutionary game model is established considering three populations.

Andrew K. Penning et al. [9] As consumer adoption and total energy consumption of electric vehicles continues to rapidly increase, it is important to develop comprehensive system modeling frameworks that consider the complex interactions of their mechanical, electrical, and thermal subsystems to guide component technology development. In this study, such a comprehensive system model of a generic long-range electric vehicle is developed and used specifically to assess the influence of cabin glass radiative properties on vehicle performance.

Xingchi Shen et al. [10] Electric vehicles, residential rooftop solar photovoltaics, and home battery storage contribute to a reliable, resilient, affordable, and clean power grid. To accelerate decarbonization, large-scale deployment of these distributed technologies will be indispensable but cause significant impacts on the power grid in the future.

Zachary Needell et al. [11] Battery electric vehicle (BEV) and photovoltaic (PV) electricity adoption increases in many climate change mitigation scenarios, yet large-scale deployment of these technologies, if left unmanaged, can raise electricity costs by increasing peak evening electricity demand and causing overgeneration of electricity during midday. Here we examine these risks and how they amplify or mitigate each other. We model hourly electricity demand under BEV and PV adoption in two United States cities.

Punyavathi Ramineni et al. [12] A super capacitor (SCap)/Battery combination leads to development of an efficient energy storage system (ESS). This combination further enhances the performance of the battery by reducing the burden, especially at peak load conditions. In this work, the Energy Management (EM) based model is developed and implemented to the basic solar power-based (SPB) electric vehicle (EV) model. In any type of EM model predicting the driver cycle of EV is one of the main obstacles.

Le Wen et al. [13] Joint deployment of solar photovoltaic (PV) systems and electric vehicles (EVs) offers a sustainable option for decarbonisation. However, the possible influence of solar PV on EV uptake within a spatial-temporal framework is often overlooked in the literature. Based on a unique dataset at a detailed spatial level in Auckland, New Zealand, this study explores the potential complementarity of EVs and solar PV using spatial negative binomial regression models.

Richard Opoku et al. [14] The increasing effect of climate change as a result of CO_2 emissions emanating from utilization of conventional energy resources is driving national and regional policies towards global energy transformation in all sectors, including the transportation sub-sector. Internal combustion engine vehicles (ICEV), which use fossil fuel are the main contributors of CO_2 emissions in the transport sub-sector. Grid-powered battery electric vehicles (BEV) and solar electric vehicles (SEV) have the potential to reduce emissions in the transportation sub-sector and are therefore being promoted in regions where solar radiation levels are appreciable.

Kah Yung Yap et al. [15] Solar energy offers the potential to support the battery electric vehicles (BEV) charging station, which promotes sustainability and low carbon emission. In view of the emerging needs of solar energy-powered BEV charging stations, this review intends to provide a critical technological viewpoint and perspective on the research gaps, current and future development of solar energy-powered BEV charging stations to fill the gap of the absence of review articles. The current technical limitations of solar energy-powered industrial BEV charging stations include the intermittency of solar energy with the needs of energy storage and the issues of carbon emission and maintenance of solar arrays.

V. CONCLUSIONS AND RECOMMENDATIONS

EVs can effectively promote the use of renewable energy and environmental pressures on ICE vehicles. This paper explores EV-related technology and major policy concerns to help make EV a sustainable development. The following conclusions are drawn.(1)The estimation of EV technology improvement in this study indicates that the higher complexity of sustainable development leads to relatively slower EV adoption(2)A possible implication for the policymakers encouraging EV development is to issue more incentive plans for innovations in the grid and electric vehicle relationship domains(3)The technology trajectories of future development models have been proposed for EV wireless charging and energy networks.

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

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