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Investigation about Electric Vehicle market and its future

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Abstract

This paper discusses about the proliferation in Electric Vehicle (EV) market and its future. Globally the researchers have started focusing towards EV, since financially unviable control of fuel price. The mobility of electric vehicle drive systems, market scenario, benefits, types of motor drives, EV types has been discussed initially. In addition the mitigation of acoustic noise and vibration through pulse width modulation (PWM) technique suitability has been discussed. The stumbling block in EV has been presented. The hydrogen based vehicle, wireless technology impact in EV and battery replacement with nanomaterails based solar cells a progressive analysis has been addressed.

Keywords: Electric Vehicle, PWM, Nanomaterials

I. Introduction

According to Economic times report, in 2019 top auto sector industries suffered a major dip in sales. The reason behind the current slowdown of market is due to overabundance of government policies regarding the emission, safety, registration and insurance along with fuel price hike [1]. The above mentioned reasons can be trounced with favorable mobility of Electric Vehicle Drive System (EVDS). Constructive benefits like tax rebate, subsidies have been approved by the government to promote the accessibility of EVDS. According to the report by mordor intelligence, the market growth of electric vehicle is predicted to reach 18-22% CAGR during 2019 to 2025 globally [2]. Recently, due to recent irreconcilable difference between USA and Iran, USA started attack against iran, which results greater economic crisis for iran. The manufacturer of crude oil, Iran is positioned as no.1 in production. Thus the fuel price hiked. All over the world the people have started thinking about the alternative source to limit the fuel cost. The European countries, china and USA started replacing with electric vehicle with a significant reach of 50% over the population of total vehicle. The government of india also looking forward to approve methanol mixed fuel as short term period, to minimize the fuel cost till the EV market attains its 100% sales commitment. Based on the recent market scenario, this paper presents the state of art for various random pulse width modulation scheme for power electronic converters and electric motors best suited for EVDS. An array of motor assembly is congregated to be utilized in EVDS system. According to Indian union budget 2019, to promote electric vehicle the government has approved two major contributions 1. Subsidy of 1.5 lakhs interest free loan for the purchase of EVs. 2. Lowered the GST rate from 12% to 5%. The main objective is to budge ahead with existing vehicle into electric vehicle [3].

However, the major research challenges for the manufacturer of EVDS are categorized in four group i) Electric Motor Design ii) PWM technique adopted to drive the system iii) Battery Storage capability iv) Charging Station accessibility [4]-[8]. Further from the above categorized group, according to survey the researcher's prioritizes there focus on first two groups which leads to meet the future energy efficient drive demand with lower total vehicle cost without degrading the other two group aspects.

Selection of EV motor based on the utility has been out looked with its imperative insights. Since in 1899, early evidence of hybrid electric vehicle was initiated by Porsche ---engineers. However in 1900, the electric motor and internal combustion engines equally attracted with significant characteristics. Due the limitation of charging station, battery backup duration, and hindered long journey, restricts the usage of EV penetration [9]-[11]. With intense availability of fuel stations and expanded version of road accessibility, the preferences were paved to IC engine development. After the commencement of Avoid-share (safety)-improve strategy, the sustainable system of transportation is prioritized to attain the efficient system, safety trip with highly efficient vehicle.

The concept of electric vehicle is not newer to this globe. The advanced development in semiconductors devices and controller topology has enabled the researchers to reconsider the mobility of replacing the IC Engine to electric motor [12]-[13]. The battery feasibility and reliable recharging requirement has been discussed for electric buses. Configuring multiple battery and practices of battery swap along its benefits has been analyzed. The energy consumption between conventional bus and electric buses are compared. From the analysis, based on load constraint the electric bus ensures reliable energy saving over the conventional [14].

The Fig. 1. shows the different types of electric motors utilized for EVs with their benefits and drawbacks.

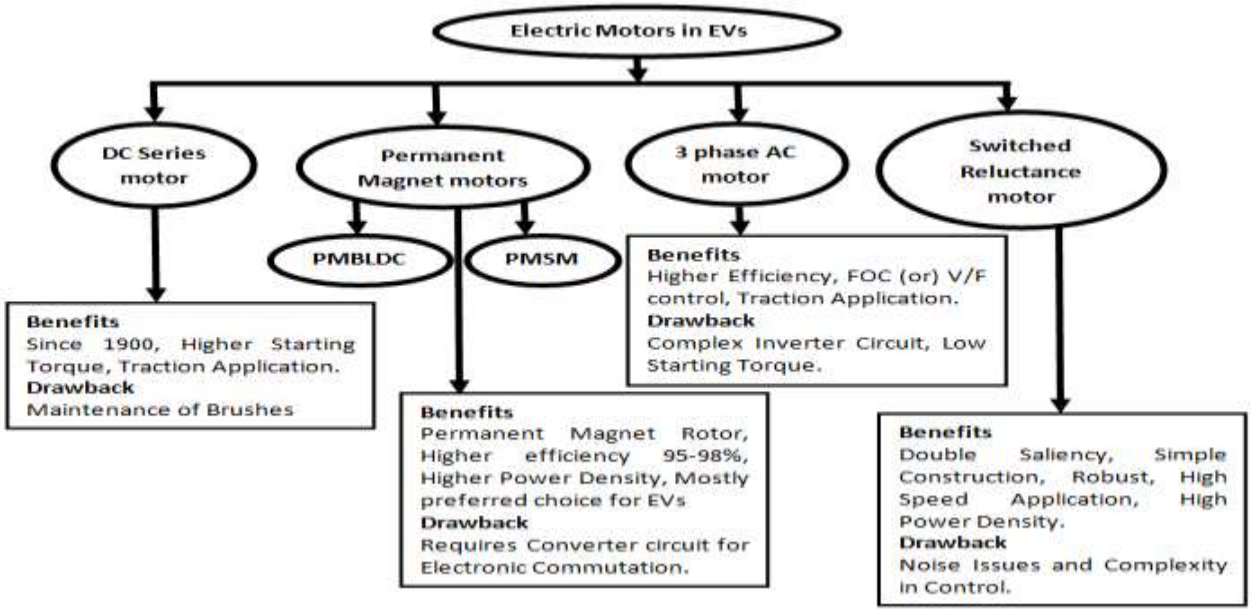

Fig. 1. Types of Electric Motors used for EV.

The Fig. 2 shows the different types of EVs with their benefits and drawbacks.

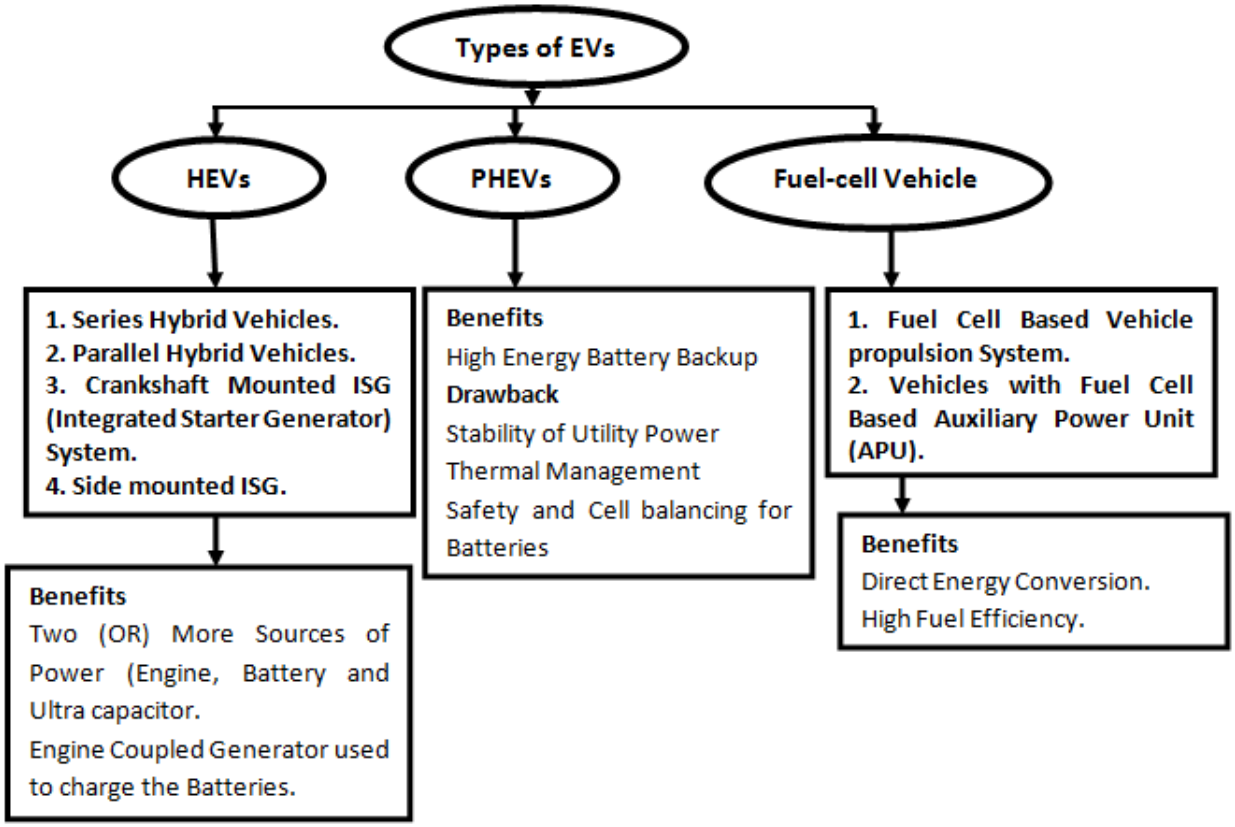

Fig. 2. Types of EVs

Since 1941, the awareness to mitigate the acoustic noise and mechanical vibration in electrical machines was identified as intensified issue. The acoustic noise, mechanical vibration in EVDS has been reported due to certain inadequacies such as improper machine design and pulse width modulation techniques which could lead to lower the demand of EVDS [15]-[16]. However, the introduction to permanent magnet materials perked up to minimize the noise issues. Permanent magnet machines (PMM) require converter as a driver circuit called electronics commutator. Hence a PWM based voltage source inverter is mandatory to supply current to PMM. Commercial inverters are usually switched with fixed switching frequency modulation schemes which results tonal noise being ejected from the motor [17]. Thus the PMM-EVDS generates high intensity noise called acoustic noise significantly increases with power rating of the motor. The various sources of noises such as magnetic, mechanical and aero-dynamical categories can be mitigated with proper care in designing the motor dimensions [18].

From the literature, many imperative methods with accurate mathematical analysis are applicable to mitigate the acoustic noise and vibration issues. But still the diversified search has been undergone to warrant promising strategies to accomplish the converter fed electric drives with significant improvement in acoustic noise reduction. However the real growing interests have bounded with the study on PWM schemes to drive the system as they offer better reliability and efficiency to practical approach of EVDS with the capability to solve acoustic noise and vibration problems [19]-[23]. Hence a Random pulse width modulation noteworthy approach has regained its popularity.

Since from the past 5 decades to till date, nearly 10775 IEEE intensive research publications on pulse width modulation techniques (which includes conference-8072, Journals-2587, Magzines-40, books-7). Ascendancy researchers intended to focus on the performance betterment of EVDS. More recently electrical drive system becoming predisposition because of its utility in electric vehicle applications.

a) RPWM Technique applicable to EV

In 1987, since the introduction of RPWM technique by trzynadlowshi had an opportunity to suppress the higher order harmonics. The RPWM technique belongs to non deterministic category, capable to control the leading frequency signal and spread the harmonics with random number carrier generation [20].

The implausible feature of accepting RPWM strategy in inverter drive ensures randomness introduced in the PWM wave shape can result the spreading of harmonics with significant magnitude such that it suppresses the higher magnitude harmonics in the harmonic spectrum.

A RPWM theory with its practical implementation view has been presented (Andrzej M. Trzynadlowski). The attention of RPWM review succinct the RPWM principles, effects of randomization, accessible RPWM techniques, issues in implementation of RPWM for EVDS.

RCPWM has been proposed for induction motor. The proposed RCPWM technique exploits multiple frequency triangular carriers. The proposed MCRCPWM technique effectively fine tunes the torque ripple, voltage harmonics suppression and current distortion level in induction motor [24].

Hybrid RPWM technique has been proposed for VSI to mitigate the PWM acoustic noise. The odd order and even order PWM frequency noise can be eliminated more efficiently with effective viability of both RPWM and proposed modified SVPWM. The proposed scheme has the ability to minimize the phase voltage and phase current harmonics efficiently compared to the conventional RPWM scheme [25].

Variable switching frequency PWM scheme has been proposed for induction motor drive to distribute the acoustic noise spectrum uniformly with limited current ripple. The experimental validation of VSFPWM scheme has been compared with conventional SVPWM, it is inferred that the proposed PWM scheme is pronounced choice to ensure better spread spectrum for both acoustic noise and current without disturbing the performance of other aspects of the system [26].

Fruitfulness of five RPWM schemes has been practiced with industrial and commercial regulating speed drives. The performance characterization of each RPWM scheme has been quantitatively validated [27]. Based on the observation, the random distribution of zero voltage vector (RZD-PWM) and random switching frequency (RSF-PWM) are the best appropriate options in achieving better performance in the real world engineering community applications. The five phase dual random space vector PWM has been proposed to five phase voltage source inverter. The random zero vector and switching frequency method are united in the proposed PWM strategy and the

performance parameters like higher order harmonic distribution range has been evaluated along with probability density function optimization [29].

The following table 1 shows the various RRWM schemes existing from literature.

Table 1 Different types of Random Modulation schemes

Random Modulation Scheme	Randomized Pulse Position Modulation (RPPM) Randomized Pulse Width Modulation (RPWM), □ Randomized Carrier Frequency Modulation with Fixed Duty ratio (RCFMFD), □ Randomized Carrier Frequency Modulation with Variable Duty ratio (RCFMVD), □ Randomized Duty ratio and an RPPM with Fixed Carrier Frequency (RDRPPMFCF), □ Randomized Carrier Frequency and an RPPM with Fixed Duty ratio (RCFRPPMFD), and □ Randomized Carrier Frequency and a Randomized Duty ratio, with RPPM (RRRM)	Random lead lag modulation Random Displacement of the Pulse Centre Modulation (RCDM) Random Phase shift Modulation (RPSM) Random Distribution of the Zero-Voltage Vector Modulation (RZDM) Separately randomized pulse position Modulation (SRPM) Variable delay Modulation (VDM) Asymmetric Carrier Modulation (ACM) Fractal-Based Modulation (FBM)

b) No to EV (Need to Promote Hydrogen based Vehicle to ensure sustainable future)

With greater awareness of general waste management through the Indian government initiated clean india project named ‘Swachta Abhiyan’, the general citizens are becoming increasingly aware of the concept of waste disposal and management. However, the population remains largely unaware of the concept of Electronic Waste or E-Waste. E-Waste, comprising of waste electronics/ electrical goods, have been steadily building up to become a substantial problem. In EV too, the usage of lithium batteries are unavoidable until the new technology batteries scheme is developed. Hence these types of lithium batteries dispose tremendously toxic waste (until proper care in disposing the batteries), will lead to pollute the natural air, ground water. Majority of lithium sources has acquired by china, Indian enthusiasm at each chance. Assaults India at each global discussion.

c) Hydrogen Based Vehicle: the Future

Due to the dependency of lithium from china (the main sources of batteries). The researchers from Japan, Germany and Australia started investment to develop a hydrogen based hybrid vehicle. Since it has indigenous, free from air and water pollution.

d) Future technology

Wireless power transfer system has been proposed for battery charging of electric vehicle [30].

e) Replacement of Battery to Solar cell (with search of Energy efficient Nanomaterials)

Since in1839, the first impact on photovoltaic effect was originated by Becquerel. Since then viable material research has undergone a long way.

Within the last 60 years, in a context of depletion of oil deposits and increasing pressure from global warming, solar cells have emerged to offer a credible alternative to fossil fuels, providing large amounts of renewable energy at affordable prices. PV systems already provide 1.7% of the gross electricity production in Organisation for Economic Co-operation and Development, while their contribution was negligible (below 0.01%) in 1990. According to International Energy Agency, photovoltaics (PV) is the energy technology with the fastest growth and should pass the 350-GW global installation in 2020.

In recent decades, individuals are indicating enthusiasm for finding a well-suited progressed nanomaterial for future energy preservation and storage applications. In such manner, combination of nanomaterials or nanostructures has recognized as a lot of significant for endeavors of next generation [31]. Due to its fabulous physical, substance, electronic, and optical properties, the useful nanomaterials can be possibly utilized in different innovative applications that include sun powered cells, batteries, catalysis, sedate conveyance, and waste water treatment [32]. Accordingly, the investigation of new progressed useful nanomaterial is particularly required for future sustainable power source applications. Figure 1 clearly depicts the function of nanomaterials.

As of late, the significance of these useful nanomaterials in sun powered cells and other sustainable power source innovation is quickly progressing because of its remarkable optical and electronic properties [33]. Notwithstanding this, the advantages of these practical nanomaterials in sun oriented cell field regions pursue:

- Mainly, it helps in decreasing the assembling cost and encourages to get high effectiveness in new age sun oriented cells.

- It broadly bestows to alter the customary and traditional wafer sun powered cells to semiconductor sun oriented cells with ease of creation and establishment.
- Solar cells can be created even at room temperature rather than making at high vacuum statement forms.

- The utilization of quantum spots and nanocomposites can be customized to reap more daylight over a wide scope of range which brings about high transformation effectiveness.
- Plasmonic nanomaterials likewise offering viable approaches to diminish the thickness of safeguard layers.

- Spectral tuning in quantum restricted materials, sharpening colors, and polymers give prevalent impact on optical band hole which serves to produce photon-created charge transporters [34]-[35].

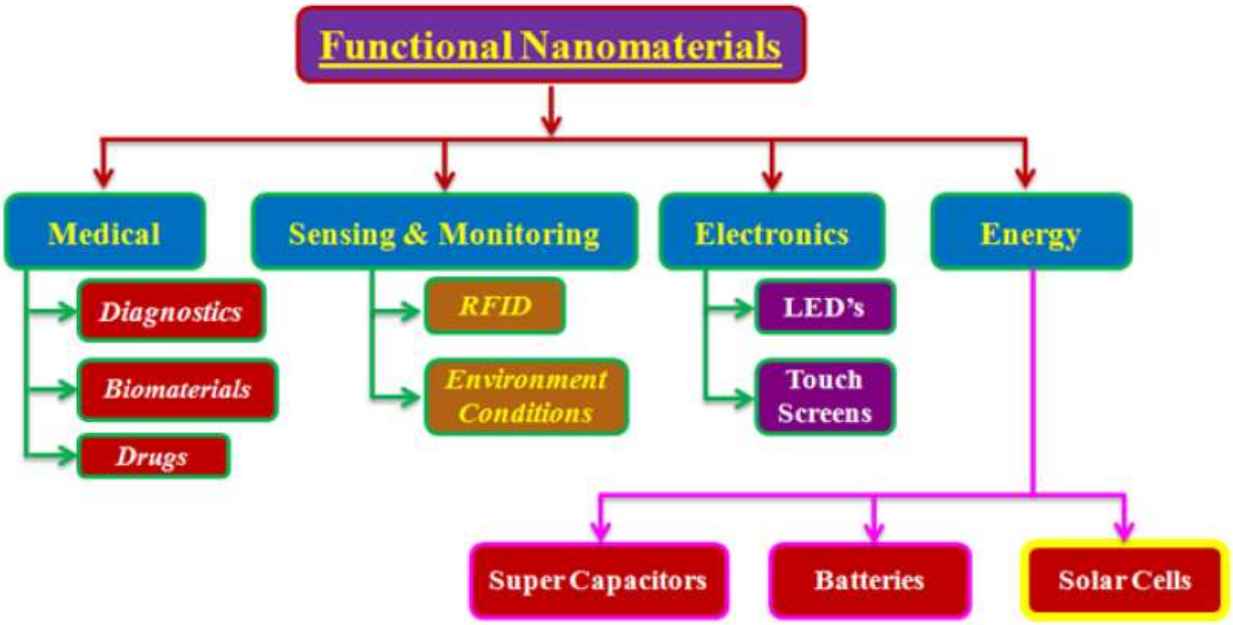

Figure 3 Nanomaterial Functions

Conclusion

Thus the Electric Vehicle (EV) market and its future have been investigated. The study reveals about the different types of motor utilized for EV, Different types of EV with their merits and demerits. In addition the study also proposes the random PWM schemes applicable of EV, drawbacks in EV, Hydrogen based vehicle and replacement of battery to solar cell in search of efficient energy storage materials.

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