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COMPARATIVE ANALYSIS OF EVS AND CONVENTIONAL VEHICLES FROM AN ECONOMIC PERSPECTIVE

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ABSTRACT

The automotive industry is marching towards cleaner energy in the impending future. The government to a large degree in the global market promotes the need for cleaner energy in order to reduce pollution. Automobiles contribute to an upper scale regarding the level of pollution in the environment. For cleaner energy in automobiles, the industry needs to be revolutionized in all needed ways to a massive extent. The industry has to move from the traditional internal combustion engine, for which the main sources of energy are nonrenewable sources, to alternative methods and sources of energy. The automotive industry is now focusing on electric vehicles, and more research is being highlighted by manufacturers to find solutions for the problems faced in the field of electrification. Therefore, to accomplish full electrification, there is a long way to go, and this requires a change in the existing infrastructure in addition to many innovations in the fields of infrastructure and grid connect connectivity a the economic impacts of electric vehicles in society. In this work, an analysis of the electric vehicle market with the economic impacts of electric vehicles is studied. We have a comparison of different parameters of the electrical vehicle and IC engine-based vehicles. This theme of the transformation of the automotive industry.

Keywords: Energy Management, Depth Of Discharge, EV Battery Management, Hybrid Electric Vehicle, Economic Impact.

I. INTRODUCTION

Definition

An electric vehicle (EVs) operates on an electric motor, instead of an internal-combustion engine that generates power by burning a mix of fuel and gases. Therefore, such as vehicles is en as a possible replacement for current-generation automobiles, in order to address the issue of rising pollution, global warming, depleting natural resources, etc. Though the concept of electric vehicles has been around for a long time, it has drawn a considerable amount of interest in the past decade amid a rising carbon footprint and other environmental impacts of fuel-based vehicles. Electric vehicles have low running costs as they have less moving parts for maintenance and are very environmentally friendly as they use little or no fossil fuels (petrol or diesel). While some EVs used lead acid or nickel metal hydride batteries, the standard for modern battery electric vehicles is now considered to be lithium-ion batteries as they have greater longevity and are excellent at retaining energy, with a self-discharge rate of just 5% per month. Despite this improved efficiency, there are still challenges with these batteries as they can experience thermal runaway, which have, for example, caused fires or explosions in the Tesla Model S, although efforts have been made to improve the safety of these batteries.

In India, the first concrete decision to incentivize electric vehicles was taken in 2010. According to a Rs 95-crore scheme approved by the Ministry of New and Renewable Energy (MNRE), the government announced a financial incentive for manufacturers of electric vehicles sold in India. The scheme, effective from November 2010, envisaged incentives of up to 20 percent on ex-factory prices of vehicles, subject to a maximum limit. However, the subsidy scheme was later withdrawn by the MNRE in March 2012.

In 2013, India unveiled the 'National Electric Mobility Mission Plan (NEMMP) 2020' to make a major shift to electric vehicles and to address the issues of national energy security, vehicular pollution, and growth of domestic manufacturing capabilities. Though the scheme was to offer subsidies and create supporting infrastructure for e-vehicles, the plan mostly remained on papepapeile presenting the Union Budget for 2015-16 in Parliament, then finance minister Arun Jaitley announced faster adoption and manufacturing of electric vehicles (FAME), with an initial outlay of Rs 75 crore. The scheme was announced with an aim to offer incentives for clean-fuel technology cars to boost their sales to up to 7 million vehicles by 2021.

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General Working of electric vehicles

Electric vehicles function by plugging into a charge point and taking electricity from the grid. They store the electricity in rechargeable batteries that power an electric motor, which turns the wheels. Electric vehicles accelerate faster than vehicles with traditional fuel engines – so they feel lighter to drive. All-electric vehicles, also referred to as battery electric vehicles (BEVs), use a battery pack to store the electrical energy that powers the motor. The batteries are charged by plugging the vehicle in to an electric power source. Although electricity production may contribute to air pollution, the U.S. Environmental Protection Agency categorizes all-electric vehicles as zero-emission vehicles because they produce no direct exhaust or tailpipe emissions.

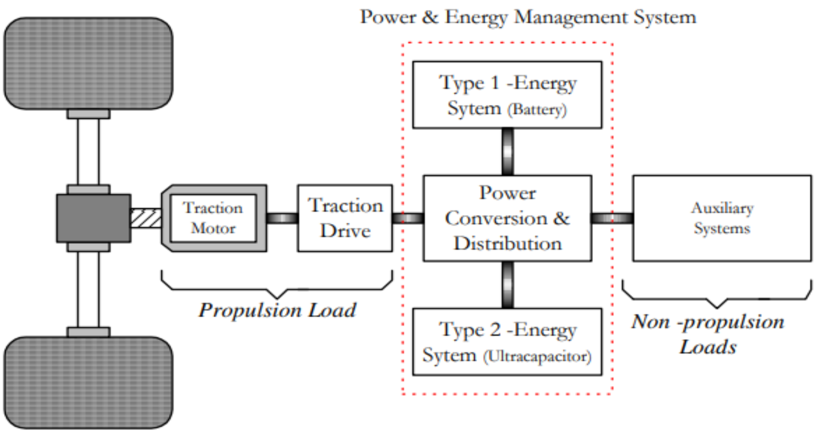

Fig. 1.1 EV drive train power system diagram

Both heavy-duty and light-duty all-electric vehicles are commercially available. BEVs are typically more expensive than similar conventional and hybrid vehicles, although some costs can be recovered through fuel savings, a federal tax credit, or state incentives.

Main components of EVs

Electric vehicles consist of electric motor that is powered by a battery pack. The main advantage of electric vehicles is that they emit zero emissions and are eco-friendly. They also do not consume any fossil fuels; hence use a sustainable form of energy for powering the car. The main components of electric vehicles are:

Traction battery pack: A traction battery pack is also known as an Electric vehicle battery (EVB). It powers the electric motors of an electric vehicle. The battery acts as an electrical storage system. It stores energy in the form DC current. The range will be higher with increasing kW of the battery. The life and operation of the battery depends on its design.

DC-DC Converter: The DC-DC converter distributes the output power that is coming from the battery to a required level. It also provides the voltage required to charge the auxiliary battery.

Power inverter: It converts DC power from the batteries to AC power. It also converts the AC current generated during regenerative braking into DC current. This is further used to recharge the batteries.

Charge Port: The charge port connects the electric vehicle to an external supply. It charges the battery pack. The charge port is sometimes located in the front or rear part of the vehicle

Onboard charger: Onboard charger is used to convert the AC supply received from the charge port to the DC supply. The onboard charger is located and installed inside the car. It monitors various battery characteristics and controls the current flowing inside the battery pack.

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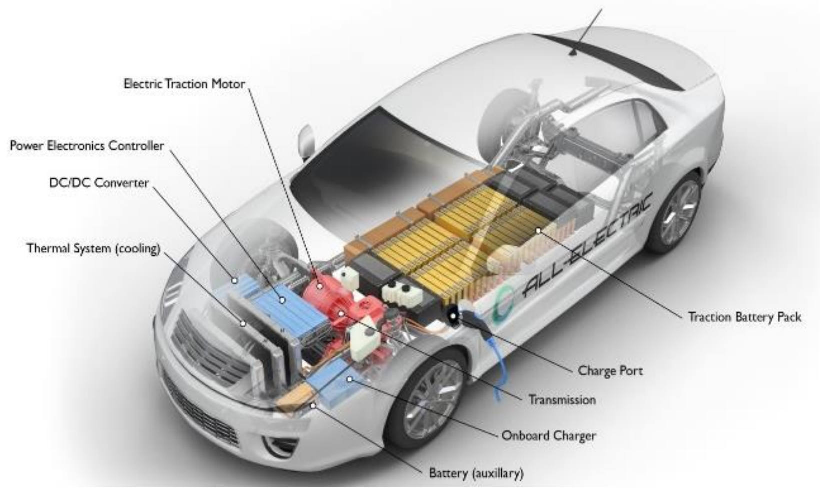

Fig. 1.2 Main components of EVs

Controller: Power electronics controller determines the working of an electric car. It performs the regulation of electrical energy from the batteries to the electric motors. The pedal set by the driver determines the speed of the car and the frequency of variation of voltage that is input to the motor. It also controls the torque produced.

Electric motor: Electric traction motor is the main component of an electric vehicle. The motor converts electrical energy into kinetic energy. This energy rotates the wheels. The electric motor is the main component that differentiates an electric car from conventional cars. An important feature of an electric motor is the regenerative braking mechanism. This mechanism slows down the vehicle by converting its kinetic energy into another form and storing it for future use. There are basically two types of motors DC and AC motors.

Auxiliary batteries: Auxiliary batteries are the source of electrical energy for the accessories in electric vehicles.

Thermal system (cooling): The thermal management system is responsible for maintaining an operating temperature for the main components of an electric vehicle such as an electric motor, controller, etc. It functions during charging as well to obtain maximum performance. It uses a combination of thermoelectric cooling, forced air cooling, and liquid cooling.

Transmission: It is used to transfer the mechanical power from the electric motor to the wheels, through a gearbox. The advantage of electric cars is that they do not require multi-speed transmissions. The transmission efficiency should be high to avoid power loss.

II. LITERATURE REVIEW

1. **Mohamed Iqubal, 1 Paul Sathiyan, 1 Albert Alexander Stonier [2022]-** Electric vehicles (EVs) have the potential to transform transportation and save the globe from impending disasters associated with global warming. In this article, first, the history of EVs is discussed followed by the different types of EVs, various motors in EVs, different storage systems, different power converters, controllers, PWM methods, chargers, and charging methods. By working with smart grids and facilitating the integration of renewable sources, the main technical aspects of each component have been outlined in terms of how they may contribute to the development of an environmentally friendly and more effective energy system. For mentioned sections could have a significant impact on designing and implementing highly efficient storage systems, modular converters, hybrid PWM methods, intelligent controllers, and effective charging systems with BMS in automobile applications. Furthermore, this review article can provide a clear understanding of various components of EVs to researchers and academia.

2. **Yirga Belay Muna and Cheng-Chien Kuo [2022]-** This paper focuses on the feasibility and techno-economic analysis of electric vehicle charging of PV/wind/diesel/battery hybrid energy systems with different battery technology, which is the first in Ethiopia, and includes PV and Wind power sources, different technology battery storage, diesel generator and, grid connection. The proposed methodology is discussed through the creation of a technical and economic tool for local stakeholders, authorizing them to identify the initial

requirements and feasibility conditions for PV/wind/diesel/battery hybrid energy system EV charging stations that lead to this hybrid system benefitting growth: the required space, the generated investment cost and an assessment of the infrastructure's environmental and technological character.

3. **Thananusak, T.; Punnakitikashem, P.; Tanthasith, S. [2020]-** This paper examined the development of charging stations in Thailand since 2015. First, we found that main players in the charging stations business in Thailand include oil and gas companies, electricity state enterprises, green energy companies, start-ups, and automotive companies. These companies spot the opportunities in the growing Thai EV market. Similar to China where the role of state enterprise and government is extensive in building the charging infrastructure, the Thai government has used many technology-push policies (e.g., tax-incentives for investors and pilot stations) to jump-start EV charging stations when the number of EV users in Thailand was still very low.

4. **Guo, J.; Zhang, X.; Gu, F.; Zhang, H.; Fan, Y.[2020]** This study employs the panel data regression (specified with FE model) to examine the effects of PM2.5 concentrations (denoting air pollution) on the sales of EVs, using a unique city-level panel data that includes monthly EV sales statistics from 20 major cities in China. The urban population, industrial output and dis-posable income per capita of the selected cities are used as controls. The data spanning from 1st May 2014 to 30th April 2018. Our empirical analysis shows that air pollution.

5. **Banol Arias, N.; Hashemi, S.; Andersen, P.B.; Traeholt, C.; Romero, R [2019] -** This paper presented a review of the recent literature focusing on distribution system services provided by EVs (EV-DSS). It was found that there is not an agreement regarding the classification of the services provided by EVs for DSOs (Distribution system operators), which could be because of the novelty of the concept at the distribution level; therefore, a new classification of EV-DSS was proposed, including three main categories: active power support, reactive power support, and renewable energy source (RES) integration support. A description of the services, basic formulations, and the main contributions of the reviewed papers were presented. This information provided an overview of the traditional methods and allowed us to identify weaknesses in the control strategies as a means to encourage exploring new ones, aligned with the current requirements for the realistic implementation of services from EVs for DSOs.

6. **Zeng, X.; Wang, J. [2019]** this Studies show that both the route information and human driving style have a great impact on vehicle energy consumption.

7. **Donald Kennedy & Simon P. Philbin [2019]-**Significant advances in battery technology are creating a viable market space for battery-powered passenger vehicles. Climate change and concerns over reliable supplies of hydrocarbons are aiding in the focus on electric vehicles. Consumers can be influenced by marketing and emotion resulting in behaviors that may not be in line with their stated objectives. Although sales of electric vehicles are accelerating, it may not be clear that purchasing an electric vehicle is advantageous from an economic or environmental perspective. A techno-economic analysis of electric vehicles comparing them against hybrids, gasoline, and diesel vehicles is presented. The results show that the complexity of electrical power supply, infrastructure requirements and full life cycle concerns show that electric vehicles have a place in the future but that ongoing improvements will be required for them to be clearly the best choice for a given situation.

8. **P.M.De Oliveira-De JesusaC. Henggeler Antunesb [2018]** this paper presents a new social welfare optimization model for the evaluation of smart grid cost recovery in competitive electricity markets. The key contribution of this work is the development of a market simulation model to determine if network revenues are enough to recover in the short-term the smart grid costs for different levels of applications. Specific applications as reactive power dispatch of renewable distributed generation and demand–response are explicitly considered.

9. **Kishore Naik Mude [2018]-**This paper explores the thorough review of battery charging infrastructure from wired connection to on-road wireless charging for an EV. The initial part of the paper deals with the wired charging and its power electronics infrastructure. The later portion deals with the wireless charging where both static and On-Road types are discussed. Furthermore, various aspects of wireless power transfer are also discussed. The Market scenario and future growth prospects are reviewed and presented in last section of the paper.

10. Cao, C.; Wang, L.; Chen, B [2016]- This paper presents an optimal PEV charging control method integrated with utility demand response (DR) signals to mitigate the impact of PEV charging to several aspects of a grid, including load surge, distribution accumulative voltage deviation, and transformer aging. To build a realistic PEV charging load model, the results of National Household Travel Survey (NHTS) have been analyzed and a stochastic PEV charging model has been defined based on survey results. The residential distribution grid contains 120 houses and is modeled in Grid LAB-D. Co-simulation is performed using Mat lab and Grid LAB-D to enable the optimal control algorithm in Mat lab to control PEV charging loads in the residential grid modeled in GridLAB-D. Simulation results demonstrate the effectiveness of the proposed optimal charging control method in mitigating the negative impacts of PEV charging on the residential grid.

III. METHODOLOGY

Comparative analysis of EVs and conventional vehicles: After a detailed literature survey, it is been observed that most of the research scholars had worked on minimizing the weight and battery cost of electric vehicles. And charging infrastructure, and cost minimization of an electric vehicle. Some have focused on optimizing the behavior of battery cost and economics of different electrical and existing ic engine-based vehicles. We have a comparison of different parameters of the electrical vehicle and IC engine-based vehicles.

a. Battery cost
b. Fuel economy
c. Vehicle Cost
d. CO_2 Emission

We have taken various parameters for electrical vehicles like Battery Capacity (Kwh), Drive Range (Km), Torque (Nm), Top Speed (Kmh), Fuel economy in km per ltr/km per kWh, CO2 emissions in gm/km Price in ₹(Lakh). The top model of Electrical vehicles and conventional IC engines in India are given below table:

Table no.1.1 model of Electrical vehicles and conventional IC engines in India which have compared

S. No	Battery electrical vehicles	Internal combustion engine
1	Tata Nexon	Tata Nexon
2	Hyundai Kona Electric	Hyundai Creta SX
3	MG ZS EV	MG Hector
4	Mahindra XUV400EV	Mahindra XUV

IV. RESULT

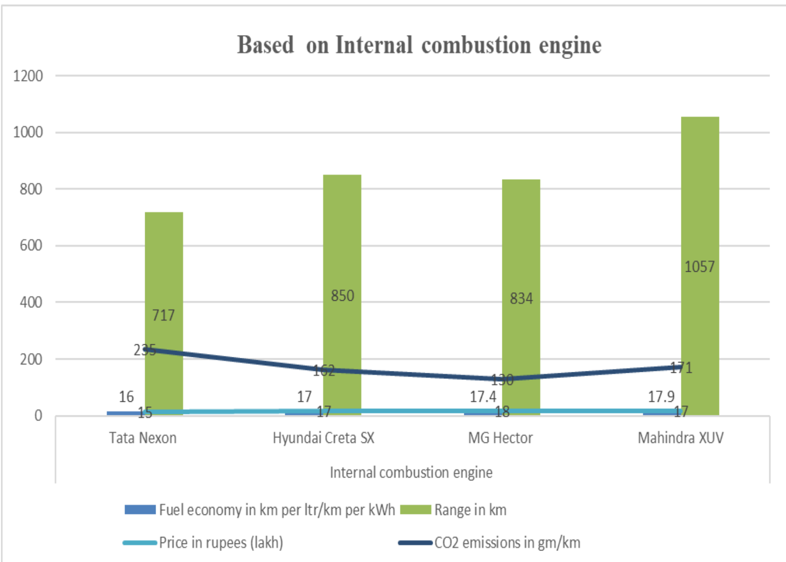

Fig.4.1 Based on Internal combustion engine

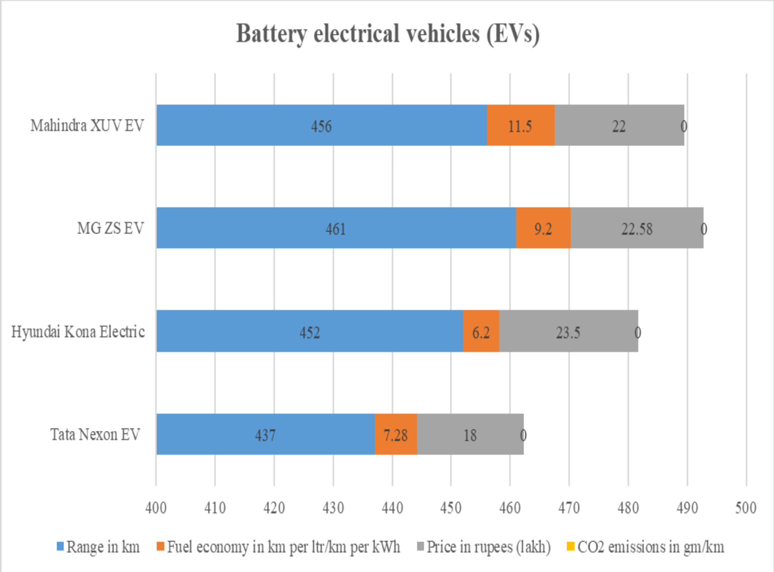

Fig.4.2 Battery electrical vehicles (EVs)

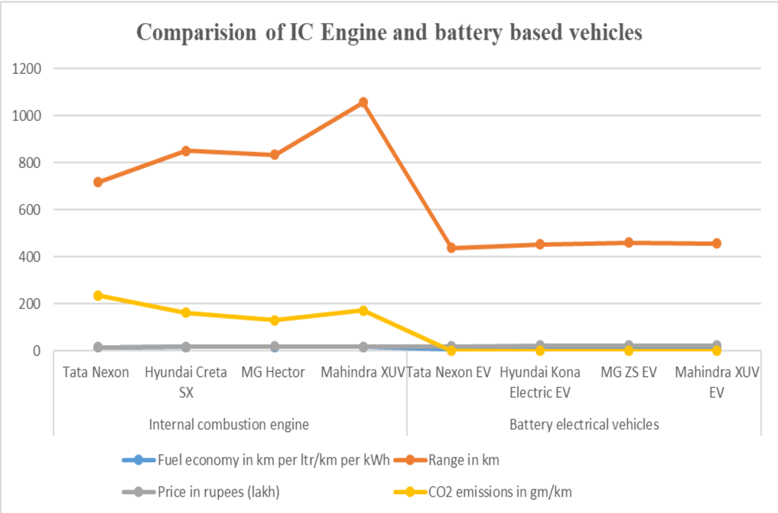

Fig.4.3 Comparison of IC Engine and battery based vehicles

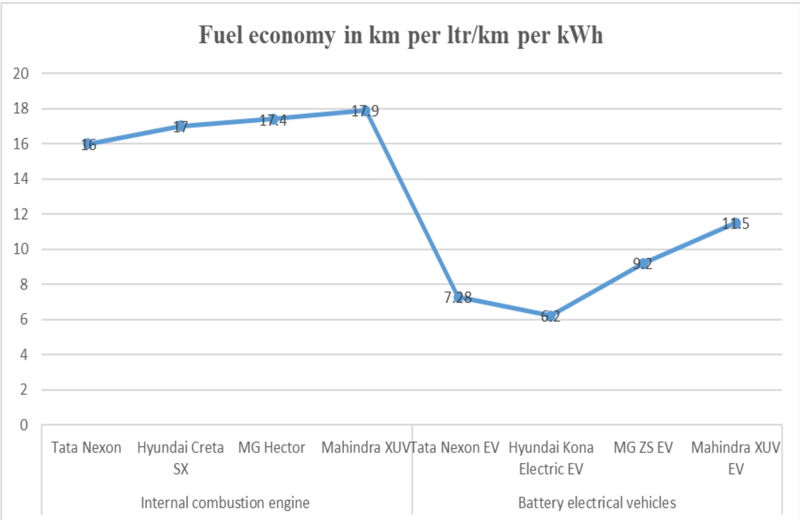

Fig.4.4 Fuel economy in km per ltr/km per kWh

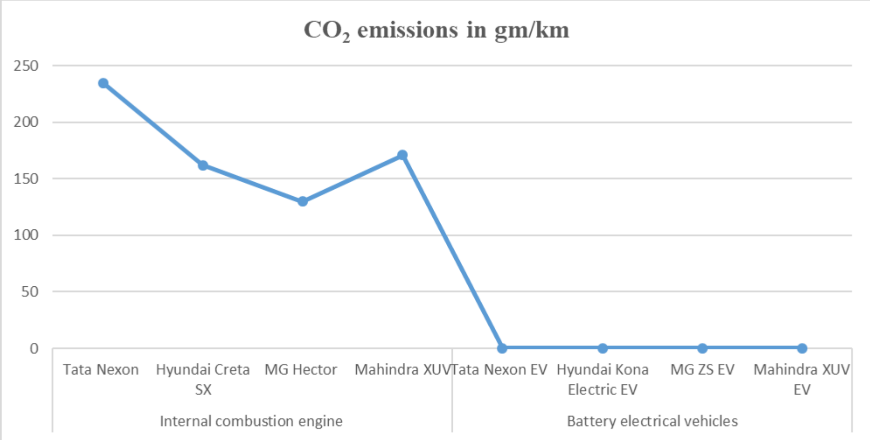

Fig.4.5 CO2 emissions in gm/km

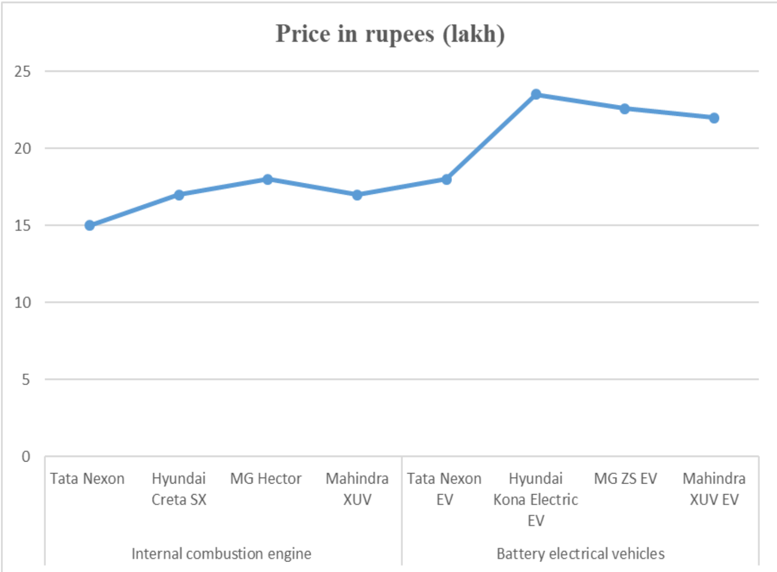

Fig.4.6 cost comparison

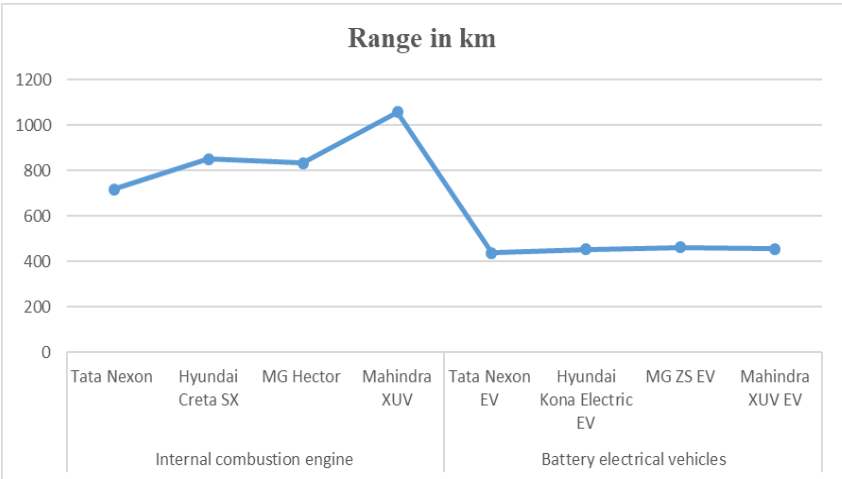

Fig.4.7 range in kilometer

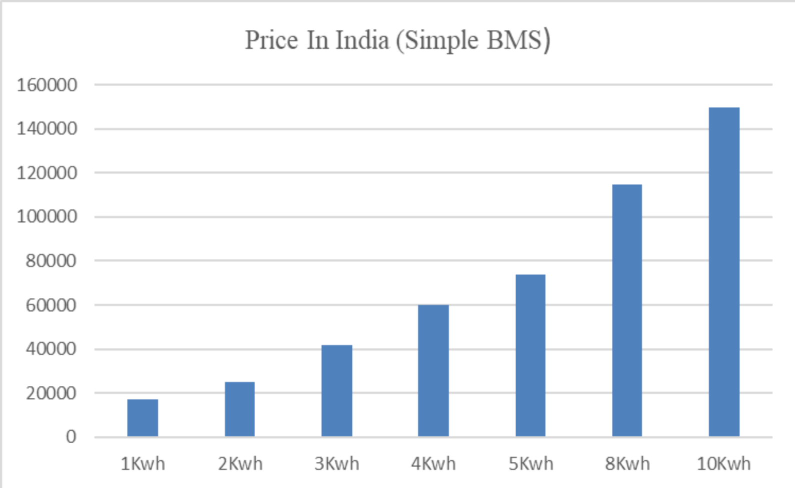

Fig.4.8 Price in India (Simple BMS)

V. CONCLUSION

The battery is the major cost component of EVs and makes it unaffordable, which is holding back the imminent transformation of the electric mobility system in India. India as a developing country must handle this transition carefully as the new set of automobiles that will lead the country towards development must be both economical and environment-friendly. Batteries are at center stage of this dichotomy. Batteries are complex in terms of their components and chemistry, integration into vehicles as well as end-of-life utility. The affordability of the batteries will play a key role in the smooth transition from a traditional fossil fuel-based system to an electric mobility system. This study attempts to identify cost reduction strategies. But all electric vehicles are best on the basis of environmental protection.

VI. FUTURE SCOPE

This dissertation has described a comprehensive and systematic framework to address and implement such a power and energy management system. To demonstrate this, the framework was implemented in the development of a test vehicle. In this research, an attempt has been made to provide a new perspective to the problem description of electric vehicle power and energy management. The battery is the major cost component of EVs and makes it unaffordable, which is holding back the imminent transition to an electric mobility system in India. India as a developing country must handle this transition cautiously as the new set of automobiles that drive the country towards development has to be both affordable and environmentally friendly. Batteries are at the center stage of this dichotomy. Batteries are complex in terms of their components and chemistries, integration in vehicles as well as end-of-life utility. The affordability of batteries will play an important role in the smooth transition from a conventional fossil fuel-based system to an electric mobility system. This study attempts to identify cost-reduction strategies

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