Journal of Current Research in Engineering and Science
JCRES
Bi-Annual Online Journal (ISSN : 2581 - 611X)

Volume7-Issue1, January 2024

Paper: 52

ANALYSIS OF ENERGY MANAGEMENT AND PROPULSION SYSTEMS IN ELECTRIC VEHICLE

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Abstract

Several types of propulsion motors, energy storage systems, and the incorporation of cutting-edge power conversion technologies are driving the development of electric vehicle technologies. The primary factors that will determine the improvement of the propulsion system in EVs include vehicle range, cost of the vehicle, battery pack replacement cost, battery pack life, rapid and simple recharging. The majority of propulsion system development will focus on battery solutions, with the exception of vehicle cost. The charging system of electrical should be robust and reliable as the usage is increasing day by day. Significant efforts were made to address the fuel shortages and pollution issues. Several analysis were done using the different charging scenarios. It is noted that power demand is increased by 17.9% through EV penetration 10%. The lower emissions and operational costs are due to the variation in primary global consumer demand. The price of battery technology, battery longevity, the quantity of charging stations, and charging time are some of the issues with electrification. Electric vehicle's energy management and propulsion optimization are achieved in an efficient way using machine learning and deep learning algorithms.

Keywords: Electric vehicle technology, Vehicle Propulsion system, Soft Computing technique, Battery Energy Storage systems, On-board charger, Energy Management.

I. INTRODUCTION

The efficient and reliable charging for electric vehicles with power electronics converters are achieved by electrifying the transport sector. The robust propulsion control and Energy storage systems will incorporate advanced power conversion technologies for continuous charging of the battery hence performing energy management efficiently during peak demand periods. The distance covered by the electric vehicle will be increased by utilizing the optimized energy stored and energy management control. The modeling of charger through various stages of voltage and current level control also battery charging can be done for providing propulsion torque. Torque propulsion control will be performed with high frequency charge control pattern. The efficiency can be boosted by considering the present state of the electricity grid, vehicle's battery level and help in improving the charging process through which the optimized energy can be obtained. Soft computing approaches can be used to create the conductive charging protocols for hybrid electric vehicles employed using ANN logic [1]. Energy recovery is the key to enhance the driving range of pure electric vehicles. The peak demand management can be done by analysis of different scenario of demand. Battery energy storage system for continuous charging as well as discharging is maintained. To offer control parameters for the vehicle, the dynamic programming optimizes the front-rear motor braking torques as well as the front and rear wheel cylinder pressures.

According to the recent surveys some issues like electric vehicle driving range, charging time and higher upfront cost were found in the existing Electric vehicles [2]. The eco-friendly electric vehicle will solve most of the above mentioned issues, if built in charging system while moving and halt is used. A complete renewable system based continuous charging of the battery in the electric vehicle can be used for energy management. Additional electric charging can be done using solar and wheel power generation for proposing optimized energy. Soft dash board-control for the analysis using soft computing technique for energy management can be done.

II. COMPARATIVE ANALYSIS

Youssef Nait Malek et al [1] forecasted speed system grounded on the Long Short- Term Memory (LSTM). This technique forces the addition of new gates to the traditional recurrent neural network, dramatically improving control over gradient inflow and long-term dependence preservation. The first one, the forget gate, shows how much information the LSTM cell will be able to forget. The following is the memory gate, which enables controlling data modification and storage in cell memory. The third one is the output gate, which determines the outcome given by each cell based on its state and the data that has been stored. The dataset used for the LSTM model training includes real-world urban travel patterns that were gathered via a traffic simulator. For the purpose of speed forecasting, models are created for both the uni-variate and multivariate environments. The simulation results show that the multivariate model performs better than the uni-variate model for both shortand long-term forecasting.

The first technique to estimate an electric vehicle's driving path using its energy consumption time series was introduced by Liuwang Kang et al [2] and is known as the Battery Energy-based Path Inference Attacks (Bepath). This method evaluates various states of the EV, such as its vehicle speed, air conditioning, and intersection turn state, to identify the driving path. The main components of this approach are the identification of energy consumption sources, the estimation of appliance states, and the inference of the vehicle's path. To identify energy consumption sources, GSP was used. According to the testing findings, Bepath can deduce the path and estimate appliance states for 50% of trips with a distance error of 0.5 km. Other approaches, however, can only estimate the path with a distance error of 0.5 km for 26% of journeys using data on vehicle speed from insurance companies.

Salman Habib et al [3] investigated the rapid growth in power converter topology for EV charging process. The essential elements, difficulties with various power converters, and future developments in EV charging systems are noted. In particular, both front-end and back-end converter setups are thoroughly reviewed. Soft switching approaches used in both isolated and non-isolated topologies are categorised and studied in light of the corresponding problems. Bridgeless interleaved boost converters are a different topology that combines bridgeless and interleaved topologies. The interleaving idea and lack of the boost diode rectifier give these converters higher efficiency and lower EMI. The examination of the front- and back-end topologies of the AC/AC and AC/DC converters is presented, together with the accompanying drawbacks and advantages.

The implementation challenges and drivers of connected, automated, shared, and electric (CASE) vehicle use, as well as potential solutions, were thoroughly examined by AMIRSAMAN MAHDAVIAN et al. [4]. The methods for energy efficiency are divided into two categories. The first category consists of longitudinal vehicle dynamics-related EV models. The second one includes longitudinal vehicle dynamics and electric motor dynamics for EV cars. In the first group, energy consumption is determined by integrating it over time, while in the second group, it is calculated by comparing the effectiveness of the regenerative and driving energies. A widely used classification system for AVs, initially approved by the NHTSA has five categories, from no automation to all automation, as of 2013. An industry perspective on AVs is provided by SAE International, which also classifies them into six levels. Smart information management is made possible by connected vehicle (CV) technology, which is crucial to achieving zero emissions. Battery technology's high price, low battery life, long charging times, and lack of charging ports are determined to be the key criticisms of fleet electrification.

Wei Wang et. al. [5] has proposed a technique utilizing vehicle-to-grid (V2G) devices to reduce the variability in large-scale wind power. They use the wavelet packet decomposition approach to determine the necessary electric vehicle EV, super-capacitor, and desired grid-connected wind power. They also developed an energy management model for EVs, incorporating a knapsack problem to assess requirements for an EV fleet. Using dynamic programming, they developed a dispatch plan for EVs and wind power. To maximize the benefits of V2G systems, they employed a scheduling model that balances supply and demand, known as the Dispatch model and approach method. In their study, a single EV had a 35 kWh capacity and 6.6 kW of charging power and -6.6 kW of discharging power. 90% of the capacity was used for charging and discharging. In contrast to EVs in dispatch action for discharging, which did not switch to charging within 1.5 hours, EVs in dispatch action for charging did not do so within an hour, according to their research. In order to dispatch electricity, EVs needed to have a state of charge (SOC) greater than 0.4, and those with an initial SOC below 0.4 needed to be charged right away. The lowest SOC for consumers' trip demand was discovered to be 0.8, whereas the maximum SOC was set at 1.The parameters analyzed for EV travel are presented in Table I.

Table I
Parameters of EV Travel

Time	EVs	Initial SOC	Arrival time	Depart time
8:30–06:00	600	N (0.65, 0.1)	N (9.3, 0.15)	N (17.5, 0.25)
06:00–8:30 (2nd day)	700	N (0.4, 0.1)	N (18.5, 1.2)	N (7.5, 0.2)

After many simulations, satisfactory weight coefficients of 0.1, 1.5, and 0.001 have been discovered, which can balance the dispatching potential and concentrate on the dispatch flexibility of EVs.

Figure 1(a) demonstrates the 5-minute sampling interval's total of the signals from the WPD to the penultimate branch over the course of one day. The demanded amount when EVs are used to suppress the previous is shown in Fig. 1(b). It is found that only considering wind and solar curtailment will decrease economic benefits.

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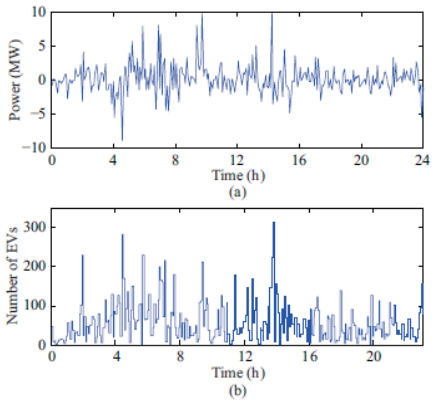

Figure 1. Demand analysis of the for EVs.

Abhishek Gaurav et al [6] worked on the design interfacing system between EV and EVSE (Electric vehicle supply equipment) as per automotive industry standard and to design prototype of 3.45 kw on-board charger. Li-ion batteries may be charged, which are utilized to provide propulsion thrust. By several charger phases, voltage and current levels are controlled, making them desirable for charging.. When a charging plug is attached to an EV, IEC standards apply to the EVSE side, and ISO protocols offer features. When the car is prepared for charging, it will automatically communicate with the EVSE to alert the driver, and once charging is complete, it will alert the driver to pay the bill. The different states of charging through the Charging control pilot are analyzed and it is explained in the Table 2. IEC 61851 standards can be used to interface between EVs and EVSEs, and once that is done, the ISO 15118 standard should offer the feature of automated charging.

Table 2
Electric Vehicle Service Equipment States

State designation	V EVSE (DC)	V Vehicle (DC)	EVSE States
S1	12	0	The supply grid and EV connection is not complete.
S2	9	9	Electric grid is connected to EV, however grid is not ready to give energy.
S3	9	9	Electric vehicles (EVs) are not yet prepared to accept electricity from the electric grid.
S4	6	6	Ventilation is not required after the EV is connected and ready to receive power from the grid.
S5	3	3	Ventilation is necessary for an EV that is connected and ready to accept electricity.
S6	0	0	EVSE detached from the vehicle**.**
S7	-12	-12	Other EVSE problem

In their study, Nan Chen et al [8] has out a thorough investigation into the deployment and management of Electric Vehicle Networks (EVN) with a focus on energy flow, data communication, and computation. The survey also reviewed the EVN management framework and the deployment of EV aggregators (AG) that provide energy and information infrastructure for the EVN. To ensure efficient resource allocation in the multi-dimensional heterogeneous Satellite Access Gateway (SAG) environment, the authors suggested modeling different trajectories of satellites and HAP/LAP using potential methods such as the mobility model of mobile ad hoc networks random waypoint. However, one challenging problem in estimating EV traffic patterns is the absence of EV data in various traffic scenarios. The study also highlighted the importance of proper resource allocation and deployment for timely data transfer to meet the demands of emerging communication technologies such as SAG and 5G.

Pier Giuseppe Anselma et. al. in their study [9] investigated the impact of temperature distribution on the projected lifespan of cells in a battery pack. The study employed data on temperature and C-rate profiles of three cells from a high voltage battery pack used in a plug-in hybrid electric vehicle during a driving mission. The results showed that, as a result of the temperature distribution in the battery pack, the hottest cell's anticipated lifespan may be as little as 61% less than that of the pack's coolest cell. Another assumption was made, which considered a temperature distribution that changes over time, but with uniformity between the cells in the battery pack. High voltage cells in hybrid electric vehicles can operate at different temperatures. A throughput-based cell ageing model was employed in the analysis. The results showed a decline of up to 38.8% in battery performance, in terms of useful life, when either the hottest or the coldest cell was considered.

In their study, M. S. Hossain et al [10] explored electric vehicles as a means of sustainable development by emphasizing the critical aspects of technology, environment, and policy performance. The research identified the essential components that could facilitate the integration of electric vehicle technology. According to the research, adopting GHG emission regulations for automobiles would result in a 1.7 billion tons decrease in Light-duty vehicle (LDV) CO2 emissions by 2040.

P.Sujidha et al [11] proposed a method of utilizing solar energy and wind energy to power vehicles. For the required voltage, the PV Module can be connected in parallel or series, but this topology is expensive, so power converters and batteries are used to mitigate this drawback. The electrical charge from the PV panel and wind turbine is combined and directed to the output terminals, which produce low voltage. This study considered DC motor, AC motor, and Brushless DC motor, and a 1.3hp, 48V BLDC motor was chosen. To ensure safety, a disc brake was mounted on the chassis. To store the energy and power the motor, Li-ion batteries with a capacity of 34 Ah were used. Li-ion batteries with a 20 Amp capacity were also employed because they could be fully charged 800 times before needing to be replaced. The system consists of four 50 watt per panel solar panels, a wind turbine with variable speed, and a permanent magnet synchronous generator. The Maximum Power Point (MPP) tracking system allows for maximum speed under maximum rotor speed. The microcontroller drives the hybrid model. Both line-dependent and line-independent systems are possible. Since the line-dependent system employs an inverter to send energy directly to the demand, it does not require batteries for energy storage. When the sun's beam is weak, this line system is also employed. Batteries or accumulators are needed by the line-independent system to provide energy when it is needed. The proposed prototype captures solar energy through solar panels and wind energy through a fan induced on it. This study suggests that vehicles powered with solar energy and wind energy are more effective than fuel vehicles.

Alan Millner et. al. [12] has identified three ways to improve the economics of plug-in hybrid electric vehicles. They first propose adding location data to the energy management algorithm of the car in order to enable predictive control and lower fuel consumption by foretelling the approaching route and necessary energy. Second, they suggest using the battery when the car is parked to balance out brief spikes in the electricity demand for commercial-scale facilities and lower demand fees. Lastly, they highlight the importance of maximizing battery cycle life to avoid high replacement costs. The study confirms that these strategies are compatible with long battery life, especially when using lithium-ion batteries. Also, employing PHEVs might cut CO2 emissions by 0.5 billion tons annually, or 8%. The authors contend that keeping the battery Status of Charge (SOC) at 80% throughout extended periods of parking (such as workdays and overnights) can improve the economics even more.

In their study, Rui Jing et. al. [13] suggested an optimization tool for simulating the future supply chains and formulating plans for reusing used EV batteries in decentralized energy systems. Their proposed model includes a profit-allocation model for the supply chain and a design optimization model for the DES sector to maximize the overall profit of the chain while ensuring fair profit distribution between the areas of EV, DES, disassembly, and recycling (D&R). The findings showed that while the D&R sector attained its maximum trend, the EV and DES sectors dominated the supply chain profit share, accounting for 45% and 49%, respectively.

In a study by Timo Lehtola et. al. [14], it was discovered that time, temperature, and state of charge are factors that affect calendar aging in EV batteries. The battery cycle ageing model was connected to driving information, measurement information, and vehicle-to-grid activities, and it was shown that timing charging can aid in extending the battery's naturally reducing lifetime. Even though employing EV batteries for V2G operations can strengthen the reliability of the power grid and the propulsion of EVs, it also accelerates battery deterioration. While assessing battery cycle ageing, it's crucial to take into account the SoC of the battery, which measures the amount of electrical charge in the EV battery cell. A battery cycle ageing model is used in the study to link all the methodologies, including measurements, cycle life models, daily driving patterns, estimates of lifetime and driving distance, and V2G operations. Charge ceilings based on travel distance must also be considered. In order to keep the battery cells within an ideal charging range, the V2G cycles were built to use just 5% of battery energy, and the battery charge level was sustained at an average SoC of 50%. This work is significant because it shows that battery management, rather than relying exclusively on battery chemistry advancements, can increase the lifetime of EV batteries. The author therefore asserts that battery cells are appropriate for high-capacity EV applications.

Pengtao Yang et al. [15] developed a system for multi-sensor, multi-vehicle localization and motion tracking in autonomous vehicles equipped with inertial measurement units (IMU). To increase localization and tracking precision and stability, data from onboard sensors in the vehicle and other ITS equipment, such roadside units, are used by the algorithm (RSU). The suggested framework can be implemented using several methods for local filters and is universal and functional with all kinds of sensors. The latency during information sharing via V2V communication lines, significant practical considerations were also made during cooperative localization and motion tracking. Kalman Filtering based Local Filter algorithm and Cooperative Localization of EVs were employed. The study took into account different road scenarios where the simulations confirmed that co-operation among multiple sensors can significantly improve the accuracy of localization and tracking, with low cost and high efficiency, particularly when RSUs are available. Furthermore, intelligent infrastructure in intelligent transportation systems such as RSUs can be used to further enhance the performance of cooperative localization and mobility tracking.

JUNJIANG ZHANG et. al. [16] incorporated included electro-hydraulic braking system's dynamic properties into their research. They used the adaptive cubic exponential approach to predict the vehicle's speed and braking force. The improvement of wheel cylinder pressures and motor braking torques was carried out by considering the vehicle restrictions, road restrictions, and brake laws. They contrasted this unique predictive control strategy with the optimum and multi-stage stop force distribution approaches to gauge its performance. The results showed that, compared to the optimal brake force distribution with multiple stages techniques, the energy recovery efficiency under gradual braking conditions rose by 1.55% and 6.40%, respectively.

An ANN controller was utilized by Rakesh Kumar Phanden et al [19] in the implementation of a bidirectional charger to the grid. The charger operates in two conversion states, namely using a universal bridge to convert AC to DC, followed by a buck-boost converter to convert DC to DC. The ANN controller has two outputs; though the second regulates the current supplied to the Buck-Boost converter for charging, the first regulates the voltage level across the rectifier between the grid and DC-link capacitor. The study revealed that the ANN-based approach is a realistic and affordable option for three-phase high-power applications that is compatible for any battery voltage and current.

In their study, Jun NI et al [22] improved the performance and adaptability of the structure architecture of an XBW electric vehicle by using the control configured vehicle (CCV) principle. To increase the closed-loop stability of the vehicle's lateral dynamics, they used a yaw control system. Four in-hub-motor driving subsystems employing the FWIA approach and a high voltage battery pack weighing 160 kg were installed to the method to electrify the process. To put the all-wheel-independent steer technology into practice, four steer servomotors weighing 4kg were also added. To put the all-wheel-independent steer technology into practice, four steer servomotors weighing 4kg were also added. In addition, a top platform weighing 110 kg, a robot weighing 20 kg, and six rotorcrafts totaling 3 kg were installed with the help of the vehicle rotorcraft robot cooperative control. The input signal for the necessary steer angle was provided by previously built software in the ECU. The UGC's GPS/INS was used to gather motion states and position states, such as yaw velocity, side slip angle, and C.G. displacement. The investigations made use of the Ackermann mode, which doubled the adaptable of the C.G arrangement. Using step steer and sine steer input, the yaw controller was tested on the XBW UGV, and the findings showed it can enhance the vehicle's handling stability and transient handling performance.

A three-level CLLC resonant converter intended for off-board EV charging was proposed by Yang Xuan et al. [24]. This converter is appropriate for EVs with a wide voltage range, from 200 V to 700 V. A 3.5 kW hardware prototype was built to confirm its viability.

The effective power converters were analyzed by B. Venkatesh Reddy et al [26]. It has been discovered that SEPIC, Cuk converters, Zeta for solar-powered EV charging, Luo converters for high-power EVs, and Vienna for both on-board and off-board off-grid EV charging stations may all be used for low-power electric vehicles.

An Android app developed by Arunkumar A et al. [27] can communicate with a vehicle's on-board diagnostics and display vehicle parameters. With the Parameter-ID, the software recognizes the vehicle parameters (PID). A few of the characteristics that the app may read are rpm, predicted engine load, absolute throttle, after malfunction indication lamp (MIL) distance, battery voltage, and coolant temperature. The ELM327 connector is used to connect the driver to the On-board Diagnostics (OBD). It is possible to employ interfaces like Bluetooth, USB, and Wi-Fi. The mode and Parameter-ID (PID) can be entered by users, and the device will append the header automatically. Vehicle parameters can be read by ELM327 and shown on a smartphone. Similar to a real vehicle, the CAPL script is written and delivers the response to the ELM327 device.

According to Haoran Zhang et. al. [28], the Age-related declines in the number of people engaging in high-electricity-density activities cause a 14% rise in the gap between peak charging demand and valley due to changes in driving behavior. In order to address potential issues brought on by ageing, it is advised that a comprehensive and quantitative management solution be developed for the growth of PVs and the smart charging market. The ageing population will have an impact on future dynamic-load profiles in terms of both magnitude and shape. Using a bottom-up methodology, the hourly profiles of 20 daily activities were combined into five major categories—sleep, movement, work and schoolwork, in-home activity, and personal activity—to develop the urban daily calendar. The study found that significant changes in urban charging load will occur as a result of ageing. According to the modeling, with a higher participation

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percentage from this group, the load factor in future energy plans might rise from 57.5% to 60%.

In their research, Wenzhou Lu et al [32] suggested the use of a compensation network to enhance the transmitting efficiency and achieve a constant current and voltage output. In order to assess the composite compensation network, an analogous circuit model was used as a guide. It was possible to estimate the ideal duty cycles for both converters based on the realization of CC/CV output. To meet the CC/CV requirement for charging lithium batteries, S-S and LCL-S compensation networks were utilized.

III. ANALYSIS RESULTS

With the comparative analysis of various methods implemented using advanced logic for controlling the Electric Vehicle it is noted that Fig 2 will be the futuristic approach for the energy management [10].

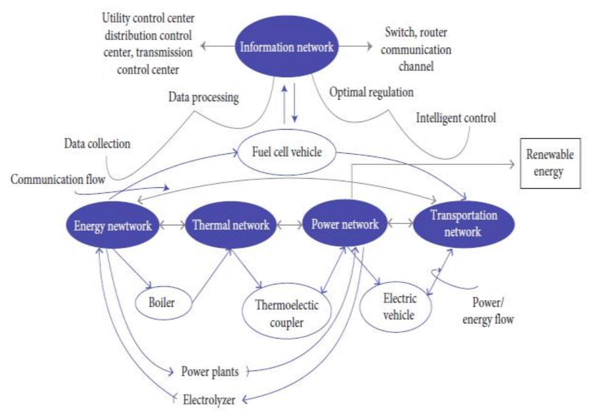

Fig 2: Structure of energy network

The charging load profile gets changed based on the ageing transition in the urban charging [29]. It is analyzed that 40% of people will adopt PEV based on this case.

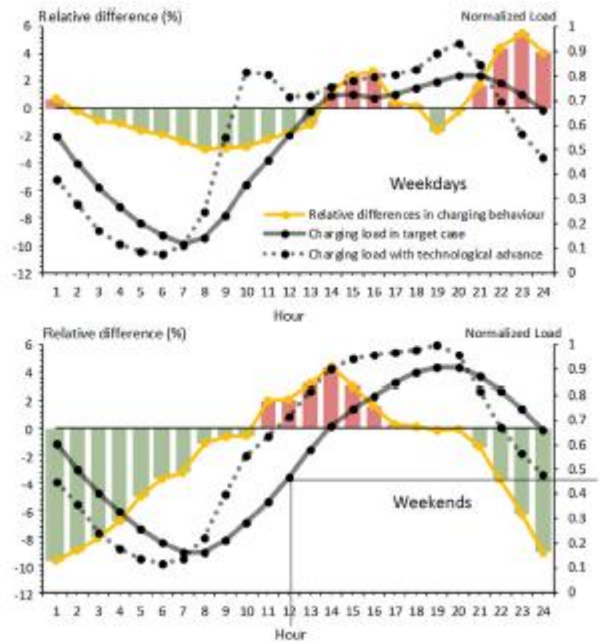

Fig 3: Future EV's charging changes

IV. CONCLUSION

The EVs are being accelerated by the car industry through extensive EV manufacturing plans. Namely, the automotive sector contributes 22.9% of the world's carbon dioxide emissions. South Korea plans to reduce greenhouse gas runoff to 37% by 2030 as part of its Intended Nationally Determined Contribution. The International Energy Agency (IEA) is taking enough action to minimize carbon dioxide emissions. Business As Usual (BAU) anticipates that by 2030, emissions will be low and total 30.82 million tons of carbon dioxide possible. The effect of these circumstances will lessen by 5.7% by 2040. Less than 5% of US vehicles will achieve corporate average fuel economy by 2025. India revealed the second phase of the conspiracy, titled "Faster Adoption and Production of Electric Vehicles in India" (FAME India). Increasing the lifespan of batteries is the answer to cutting costs because batteries are expensive. The lifespan of battery cells can be increased if the battery charge is maintained at roughly 50%. The cycle life of the investigated cells can be optimized by simulating them with various variables using efficient algorithm. Battery ageing models will be created in the future to estimate lifetime and cost.

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