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A STUDY ON SMART ENERGY MANAGEMENT SYSTEM FOR ELECTRIC VEHICLES

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Keywords

SEMS, Electric Vehicles, Smart Grid, EV charging, Energy Optimization, Intelligent transportation

Abstract

In this study, a detailed discussion about "Smart Energy management system for electric vehicles" has been made based on the relevant literature sources. From the efficient sources, the relevant data have been gathered significantly and the significant themes are chosen from the identified resources. The findings have been included in the table highlighting the potential benefits of SEMS on EVs. The data have been analysed based on the identified themes shaping the guidelines for further research on this topic.

1. INTRODUCTION

In the dynamic automobile market worldwide and with rising sustainability demand, electric vehicle sales are increasing with the pre-installed Smart Energy Management System (SEMS). SEMS is recognized for the optimization of energy for electric vehicles (EVs) and it works in balancing the demand of energy consumption on the energy grids ensuring cost-effective and efficient battery charging. This system is integrated with the Smart Grid system effectively while communicating with the energy resources and charging stations. In this research, a detailed study of SEMS and its integration with EVs has been conducted to find effective results. There have been studied various resources about this topic to conclude this research shaping future research in this field.

2. RESEARCH BACKGROUND

The SEMS system is effectively designed to maintain the efficient charging and discharging of hybrid vehicles. By connecting with the Smart Grid, this system enables the vehicle owner and energy provider companies to maintain effective scheduling of charging for the EVs. Various AI-enabled technologies, FL, and Blockchain technologies have been integrated into the system for efficient management of the system. With the existing challenges in implementing effective energy management systems into EVs, this system can be adapted to develop an intelligent energy-efficient system (Yang *et al.*, 2020). With the evolving transformation for intelligent transportation, there have been available different real-time information sources. Based on these data, this research paper will provide a deep review of the existing study about SEMS in EVs.

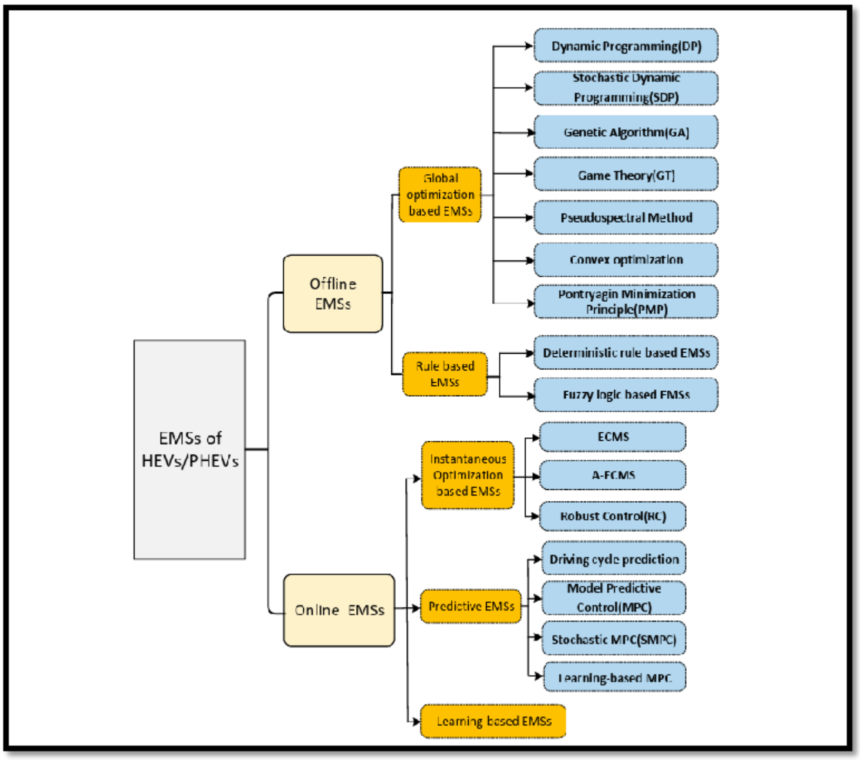

Figure 1: Efficient energy management strategies (Zhang *et al.*, 2020)

3. RESEARCH AIM

This research aims to develop and implement an effective SEMS in EVs addressing the potential implication of these technologies in terms of sustainability, cost efficiency, and overall performance.. the objective of the research is to evaluate the existing strategies for an effective SEMS and its benefits in EVs and to examine the impacts of SEMS on the utilization of renewable energy and smart EV technology grids. The research also has the objective to assess the potential challenges and user experience for the integration of SEMS into EVs and to recommend different mitigating strategies for this system integration providing future direction for this research.

4. RESEARCH METHOD

4.1 Systematic review

To conduct this research, various resources about this topic have been comprehensively studied and reviewed. From the efficient sources of research on this topic, the relevant information is collected to draw efficient findings. The existing literature including various industry reports, government schemes, and academic research has been evaluated to collect effective data based on SEMS and EVs (Zhang *et al.*, 2020). For systemic search strategies, relevant keywords are chosen so that they would match with relevant articles from various databases. As effective databases, Google Scholar and ProQuest have been used to gather information about this system. Moreover, the collected information has been sorted and reviewed based on the effective criteria of exclusion and inclusion eliminating the irrelevant topic. In the below table, most keywords are reflected along with the numbers of relevant articles by applying the Boolean operation.

Table 1: Database information and Boolean operation

Keyword		Keyword		Keyword	Search results
Energy Management System	AND	Electric Vehicles	AND	Energy Optimization	ProQuest- 168418
SEEMS	AND	Smart Grid Integration	OR	Renewable energy efficient	ProQuest- 948307
Sustainable Transportation	OR	Real-time SEMS integration	AND	Smart Electric Vehicles	ProQuest- 1659326
Energy performance	OR	Sustainable EVs	NOT	Traditional Combustion	ProQuest- 5368372

5. RESEARCH FINDINGS

The collected data have been analyzed effectively to consider it in this research study depending on the research methodology, research topic, and relevance. After sorting the relevant article and duplicate studies, the resources were analysed to record the findings of this research (Rathor & Saxena, 2020). From the identified research findings, the criteria for inclusion and exclusion along with their relevance are used to validate the findings. The following table highlights effective literature considerations based on different criteria.

Table 2: Search strategies for relevant data sources

Steps	Search results	Exclusion of resources and excluding reasons
Identification	Identified data resources: From the first database: (n=100) From the second database: (n=50)	For duplicate research articles (n=90)
Screening	Screened data resources (n=60)	Irrelevant keywords (n=30)
	Eligible data resources (n=10)	Data resources excluded for the irrelevance of information about the SEMS, energy optimization, EVs, and sustainability (n=20)
Final inclusion	Included resources in this study review (n=10)	

From the above table, it is clear that the irrelevant resources are excluded from this evaluation and finally 10 effective resources have been included in this study. Based on the considered keywords for this research, the data relevance criteria are followed. From the identified key resources, the below table reflects the key themes for this research with the relevant topic codes and subcodes.

Table 3: Identification of different themes based on the significant literature

Source	Codes	Sub-codes	Theme
Yang *et al.*, (2020) Zhang *et al.*,(2020) Lee & Choi (2020)	SEMS, EVs, Efficient Energy	Effective management strategy, Energy infrastructure, energy storage, EV charging	Effective energy management is the key to developing an intelligent transportation system.
Gong *et al.*, (2020) Mbungu *et al.*, (2020) Rathor & Saxena (2020)	Energy management, Smart grid	Microgrids, Energy management architecture, smart metering	A smart grid is the fundamental aspect of the effective management of energy.
Zand *et al.*, (2020) Li *et al.*, (2020) O'Dwyer *et al.*, (2020) Lan *et al.*, (2021)	EVs, Smart charging, Renewable energy, sustainability	Solar charging, Renewable energy resources, advanced technology integration, machine learning	Integration of energy managing tools and algorithms enables SEMS for EVs.

6. DATA ANALYSIS

6.1 Thematic Analysis

"Effective energy management is the key to developing an intelligent transportation system."

To address the worldwide energy fuel consumption challenges and greenhouse gas emissions, "Intelligent transportation system (ITS)" leverages technology utilization integrating renewable energy, promoting sustainability, and reducing the carbon footprint (O'Dwyer *et al.*, 2020). By building an efficient charging infrastructure and real-time data gathering, the energy sources could be effectively optimized within the dynamic landscape of EVs.

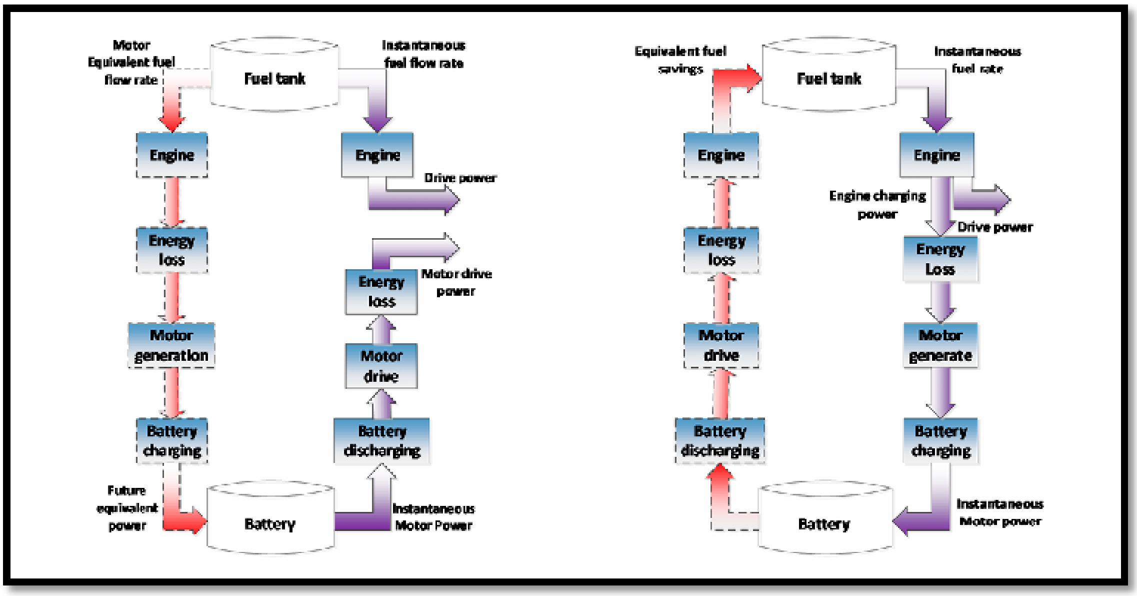

Figure 2: Energy optimization while discharging and charging (Zhang *et al.*, 2020)

"Smart grid is the fundamental aspect for effective management of energy."

Due to the implications of traditional grid systems in charging modified EVs, the Smart Grid evolves as efficient approach for establishing an effective SEMS. This system provides two-way communication, distributive energy integration, and enhanced control increasing the overall effectiveness of this system in the energy industry (Li *et al.*, 2020). Moreover, it is also beneficial for its cost-effectiveness, reliability, and sustainability with significant user experience.

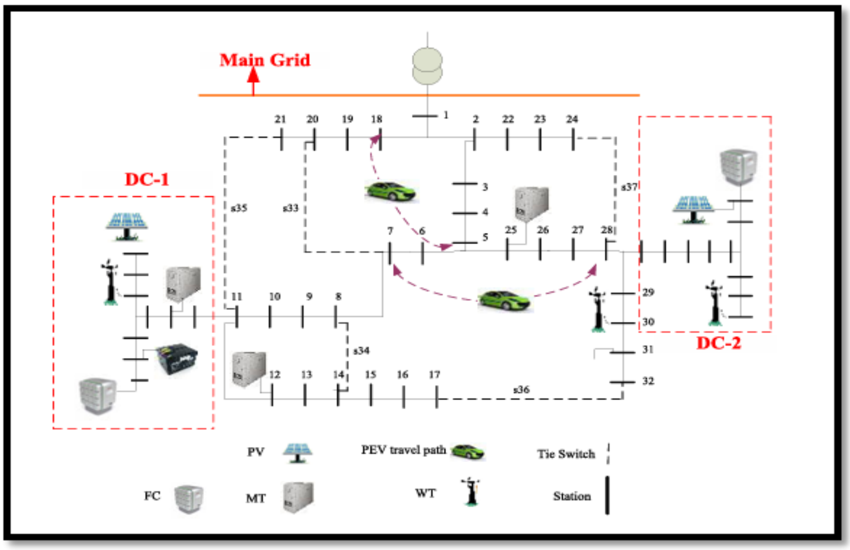

Figure 3: Structure of smart microgrid (Gong *et al.*, 2020)

"Integration of energy managing tools and algorithms enables SEMS for EVs."

EV presents significant challenges in the convenience of charging for users, integration of renewable energy, and grids. Effective data analytics, AI tools, and other significant smart charging tools could predict the future complications of EVs (Lee & Choi, 2020). It would further optimize the grid's stability, costs, and environmental sustainability.

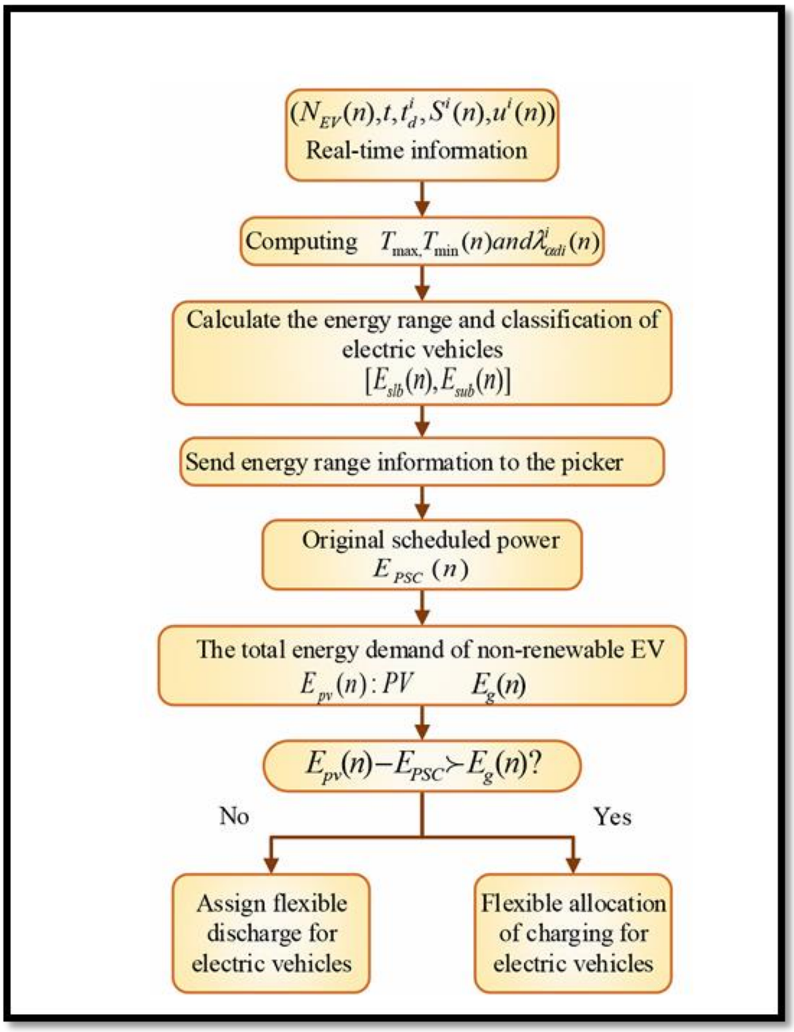

Figure 4: Effective algorithm for SEMS (Zand *et al.*, 2020)

7. CONCLUSION

It can be concluded that smart grid and technology integration are the key to the successful implementation of SEMS in EVs. Despite the underlying complications in installing these smart facilities, it offers a promising technology for future smart development.

8. LIMITATIONS OF THE STUDY

The limitation arises in gathering efficient resources for this topic from different databases. Moreover, the sorting of relevant articles to the topic is difficult within the landscape of evolving EV markets.

9. THE FUTURE SCOPE OF THIS RESEARCH

The significant research findings and results have shown the rising efficiency of energy resources contributing to future researchers for further development in this field. By focusing on smart charging facilities and microgrid system integration, the EV industry will achieve sustainability and environmental responsibility.

10. CONFLICT OF INTEREST: Nil

11.SOURCES OF FUNDING: This research work is not funded by any national and international government body or organization.

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