IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.53

Volume 4, Issue 8, April 2024

Photovoltaic Actuated EVs: Induction Motor Triumphs, Paving Sustainable Path in Transportation Revolution

Vinay Anand[1], Himanshu Sharma[2], Bhagwan Shree Ram[3], Dharmendra Kumar Dubey[4]

Lovely Professional University, Phagwara, Punjab, India[1,2]

Babu Banarsi Das University, Lucknow, Uttar Pradesh India[1]

Nalanda College of Engineering, Nalanda, Bihar, India[3]

Shree Dhanvantary College of Engineering and Technology, Kim East, Gujrat, India[4]

himanshu.23441@lpu.co.in and vinayanand77@gmail.com

Abstract: *This comprehensive review explores the incorporation of renewable energy sources, particularly solar energy, in electric vehicles (EVs) through induction motors. It emphasizes the importance of sustainable transportation and the potential of solar power in meeting EV energy demands. The study employs a rigorous methodology involving theoretical analysis, simulation studies, and practical experiments to compare induction motors with brushless direct current (BLDC) motors in photovoltaic-actuated applications. Theoretical assessments delve into motor characteristics, while simulations analyze performance under various conditions. Practical experiments with a photovoltaic-actuated prototype validate theoretical and simulation results. The research concludes that induction motors outperform BLDC motors in photovoltaic-actuated EVs, offering higher efficiency, reliability, and adaptability to solar variations. They also feature reduced complexity and superior torque capabilities. These findings have significant implications for advancing solar-energized EVs, promoting sustainability and reliability in propulsion technology. The study's insights benefit researchers, practitioners, and policymakers seeking to enhance photovoltaic-actuated EV efficiency. It advocates for the widespread adoption of induction motors, contributing to a more sustainable and resilient future for photovoltaic-actuated transportation.*

Keywords: Brushless DC Motor; Electric Vehicle; Induction Motor; Photovoltaic; Transportation

I. INTRODUCTION

This review article explores the integration of renewable sources of energy whereas wind power and solar power are the future of power generation systems [1], here solar energy is usedin electric vehicles (EVs), specifically focusing on propulsion using induction motors[2]. Emphasizing the role of solar power which is a better option as a non-conventional energy source[3], in sustainable transportation, the study conducts a comparative analysis, spotlighting the advantages of induction motors over widely used brushless direct current (BLDC) motors in photovoltaic-actuatedEVs[4]. Methodologically, the research combines theoretical assessments, simulation studies, and practical experiments. Theoretical foundations dissect the characteristics of both motor types, while simulations scrutinize their performance under diverse conditions. Practical experiments with a photovoltaic actuated prototype featuring an induction motor validate theoretical and simulation insights.In different sectors, the use of an induction motor as a load to operate as a prime mover reduces the power factor by 80% to 85%[5]. Key findings demonstrate the superior performance of induction motors in photovoltaic actuated applications, showcasing enhanced efficiency, robustness, and adaptability to varying solar conditions[4]. The analysis underscores benefits like reduced complexity, heightened reliability, and superior torque capabilities, positioning the induction motor as a more fitting choice for solar-energized EVs[6]. These results have substantial implications for advancing photovoltaic-actuated electric vehicles, signaling a promising propulsion technology shift for increased sustainability and reliability. The research contributes to renewable energy discourse in transportation, offering insights for researchers, practitioners, and policymakers aiming to boost the efficiency of photovoltaic-actuatedEVs. In conclusion, the study advocates widespread induction motor adoption in

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 8, April 2024

solar-energized electric vehicles, fostering a more sustainable and resilient future for photovoltaic-actuated transportation. The authors of this article present an introduction of the article with a brief about the history of electric vehicles in **Section 1** whereas **Section 2** describes the Methodology used in this article. The literaturereviewed in **Section 3** and **Section 4** describes in detail the Comparative analysis of Induction motors and BLDC motors. In contrast, some of the research gaps identified described in **Section 5** and **Section 6** elaborates on the mathematical model for PV-actuated EV. In the end,**Section 7** concludes with the benefits of the article and future scope.

1.1. History

Electric vehicles (EVs) have a rich history that spans more than a century. The idea of using electric power for transportation dates back to the 19th century, but it wasn't until the late 20th and early 21st centuries that electric vehicles gained significant traction[4]. Here's a brief overview:

Early Development (19th Century)

- The concept of electric vehicles emerged in the 19th century alongside the development of electric motors and batteries.
- In the 1820s, Hungarian engineer Ányos Jedlik created a small-scale model of a vehicle powered by a simple electric motor.
- Thomas Davenport, an American inventor, built a small electrically powered carriage in 1834.

First Practical Electric Vehicle (Late 19th Century)

- Thomas Parker, a British inventor, is credited with building the first practical electric vehicle in the 1880s. It used non-rechargeable batteries.

Early 20th Century

- Electric vehicles gained popularity in the early 20th century, especially for short-distance urban transportation.
- Detroit Electric Vehicle Company produced electric vehicles from 1907 to 1939, and they were favored by well-known personalities like Thomas Edison and Henry Ford's wife, Clara Ford.

Decline and Resurgence (Mid-20th Century)

- The rise of internal combustion engine vehicles and the discovery of cheap oil led to a decline in electric vehicle popularity.
- Interest in electric vehicles resurged in the late 20th century due to concerns about environmental pollution and energy security.

Modern Era (21st Century)

- Advances in battery technology, environmental awareness, and government incentives have fuelled the resurgence of electric vehicles.
- Companies like Tesla, founded by Elon Musk, played a crucial role in popularizing high-performance electric vehicles.As for solar electric vehicles:

Solar Electric Vehicles[7]

- Solar electric vehicles integrate photovoltaic (PV) cells to harness sunlight and convert it into electricity to supplement the vehicle's power.
- The concept of photovoltaic actuated vehicles has been explored for decades, but practical implementations faced challenges due to the limited surface area for solar panels and the efficiency of solar conversion technology.
- In recent years, there have been developments in solar vehicle technology, with some experimental and prototype vehicles incorporating solar panels into their design to extend the range or increase efficiency.

In conclusion, the history of electric vehicles is marked by periods of enthusiasm, decline, and resurgence. The choice between induction motors and brushless DC motors depends on various factors, including efficiency, complexity, and performance requirements. Solar electric vehicles represent an exciting frontier in sustainable transportation, albeit with ongoing technological challenges.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 8, April 2024

II. METHODOLOGY

A comprehensive methodology that combines theoretical assessments, simulation studies, and practical experiments strengthens the credibility of research. By employing a multifaceted approach, ensure a robust analysis of induction motors in photovoltaic actuated applications[8]. A proposed PV-actuated IM- EV is shown in Figure 1.

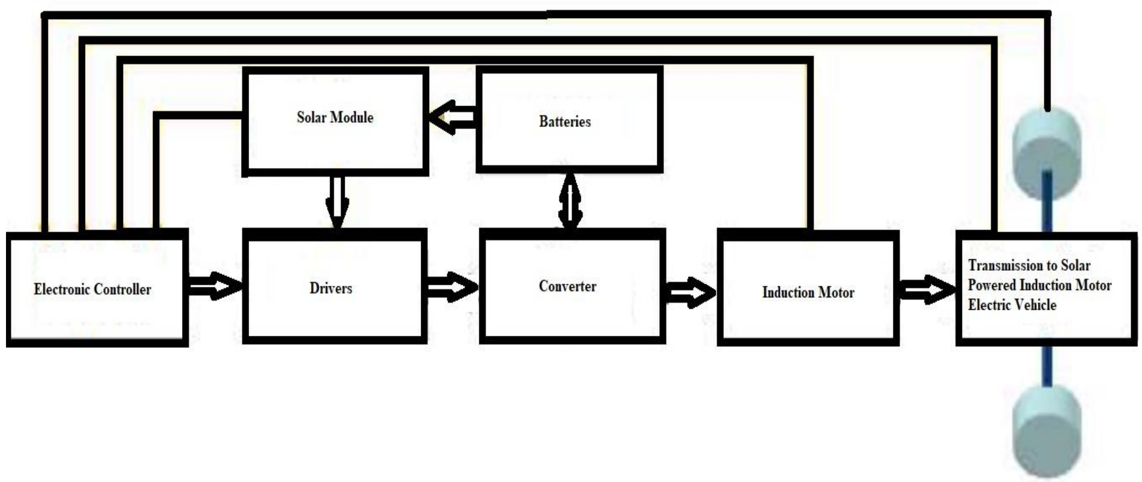

Figure 1-Proposed Photovoltaic actuated Induction Motor Driven Electric Vehicle system[9]

III. LITERATURE REVIEW

The need for sustainable transportation has led to a surge in interest in the integration of solar energy into electric vehicles (EVs) in recent times[10]. The application of induction motors (IM) in photovoltaic actuated electric vehicles (EVs) is examined in this review, which provides a thorough examination of the theoretical, simulated, and practical aspects. According to a survey of the researcher's literature, which can be used to understand the current state of the research on induction motor applications in solar vehicles, non-conventional energy is predicted to rank among the most important sources of electrical energy in the years to come. If solar energy is to generate a significant portion of the world's electricity, it must overcome certain technological and financial obstacles. Since India is a developing nation with a relatively low population density[11], there is a need to consider new ideas[12] and conduct studies and research in the field of sources of renewable energy. These sources could be cost-effective if supply and demand are taken into account, as few people in India are aware of alternative sources of energy and how to use them concerning their actual needs.Currently, transportation accounts for 23% of CO2 emissions, of which 72% are transported by street vehicles[13]. One global challenge is reducing CO2 emissions to stop global warming. By 2040, electricity will make up nearly 25% of all energy consumed; the power sector is required to pave the way for a decarbonized energy system; potential solar energy received by the earth in an hour can meet all energy needs for a year; and many scientists are developing photovoltaic electrical energy these days simply because electrical energy is essential to domestic, industrial, agricultural, and nearly every other aspect of life on Earth for various purposes[14]. A photovoltaic actuated electric vehicle is simply an electrical vehicle that runs on solar energy converted to electrical energy, which is then converted from DC to AC using an inverter circuit; the electric vehicle is based on an induction motor[15].In the current period, electric vehicles (EVs) are essential due to the need to reduce reliance on fossil fuels and take proactive measures to create a transportation system with low carbon emissions[16]. EVs are semiconductor devices. Alexander-Edmund Becquerel conducted the first study on the photovoltaic effect in 1839[17]. Single-crystalline Three main types of solar modules are used to convert solar energy into electrical energy: poly-crystalline, amorphous-crystalline, and mono-crystalline. Mono-crystalline modules are highly efficient but less common to purchase due to their high cost, while amorphous-crystalline modules are the least expensive of the three but less effective[18]. A portion of the developments were discovered to increase productivity. From an investigative standpoint, scientists have long made exciting promises, such as developing an electric vehicle with no emissions.To provide cleaner power going forward, less diesel is used in horticulture[19]. The truck, which is equipped with batteries that are fueled and charged by photovoltaic panels, is used for horticultural exercises in isolated hilly zones[20]. On the other hand, a lot of EVs are being developed to compete in different PV-actuated vehicle races throughout the globe to test and evaluate the latest mechanical advancements and their potential to design zero-emission vehicles[21]. This is all about being convinced by an Indian race known as the "Electric Solar Vehicle Championship" that features PV-actuated vehicles[13]. For professionals, academicians, and students, the ESVC Electric Solar Vehicle Championship is a Design & Manufacturing competition. The Indian government's MNRE has recommended. Through the use of an MPPT charge regulator, the vehicle is driven by a PV-actuated PV module that extracts additional force from a battery supply[22]. A changeover switch limits the engine and receives electricity from PV-actuated modules and batteries separately.

IV. COMPARATIVE PERFORMANCE ANALYSIS OF IM AND BLDC

Let's compare induction motors (IM) and brushless DC motors (BLDC) for electric vehiclesshown in Table 1 for propulsion applications[23]. It's important to note that both motor types have their advantages and disadvantages, and the choice depends on specific application requirements[24].

Table 1-Compare the motors for electric vehicle propulsion applications[25]

S.N.	Type	Brushless DC	PM	Switched Reluctance	Polyphase Induction Type
1	Current	AC	DC	AC	AC
2	FAMILY	Synchronous excited PM	Separately excited	Synchronous unexcited	Induction Slip ring squirrel cage
3	Power To Rotor	PM	DC	Induced	Induced
4	Power to Stator	Pulsed DC	PM	Pulse DC	AC
5	Overall cost	High	Medium	Medium	Medium
6	Efficiency	Outstanding torque and speed, fast responses, long life	High starting torque	Low inertia so that specific applications only	High efficiency
7	Maintenance required	Low	Brushes wear	Low	Low
8	Overall Efficiency	High	High	Less PMDC	High
9	Application	HEVs, EVs, and ICVs	HEVs, EVs, and ICVs	ICVs	HEVs, EVs, and ICVs
10	Example	Peugeot Citroen/ Berlingo (psa) (France	Nissan/ Tino, Honda/Insight (Japan), Toyota Prius (Japan), etc	Holden/ECOmmodore (Australia)	Renault/Kangoo (France), Chevrolet/ Silverado (USA), etc

Induction Motor (IM)[5]

Advantages

- Robust and reliable: Induction motors have fewer moving parts and are known for their durability.
- Lower cost: Typically, induction motors are less expensive to manufacture than their brushless counterparts.
- Suitable for high-power applications: Induction motors are well-suited for high-power applications, making them a common choice in electric vehicles.

Disadvantages

- Lower efficiency at partial loads: IMs may have lower efficiency when operating at partial loads compared to some other motor types.
- Limited speed control: Induction motors have limited speed control capabilities compared to brushless motors.

Brushless Direct Current (BLDC) Motor

Advantages

- Higher efficiency: BLDC motors generally have higher efficiency than induction motors, especially at partial loads.
- Better speed control: BLDC motors offer precise speed control, making them suitable for applications where variable speed is crucial.
- Higher power density: BLDC motors can be more compact and have a higher power-to-weight ratio.

Disadvantages

- More complex control: The electronic control of BLDC motors can be more complex, requiring additional components like sensors and dedicated controllers.
- Higher cost: Generally, BLDC motors are more expensive to manufacture than induction motors.
- Mathematical Data

Efficiency

- Induction motors typically have an efficiency ranging from 85% to 95%, while BLDC motors can achieve efficiencies above 90%, especially at partial loads.[26]

Cost

- Induction motors are generally more cost-effective, while BLDC motors tend to be more expensive due to their sophisticated control systems.

Induction Motor vs. Brushless DC Motor[27]

- Both induction motors and brushless DC motors are used in electric vehicles for propulsion.
- Induction motors are known for their robustness and simplicity, and they don't require brushes. However, they may require more complex control systems.
- Brushless DC motors offer higher efficiency, and precise control, and are often favored for electric vehicles due to their power density and performance.

V. GAPS IN THE RESEARCH

Intermittent Solar Energy Availability[28]

- Solar energy availability can be intermittent, depending on factors like weather conditions and time of day. Inconsistent sunlight may result in varying power inputs to the EV, affecting the overall performance and range.

Energy Storage Limitations[29]

- The efficiency of solar-energized EVs relies on energy storage systems, typically batteries. Challenges related to battery technology, such as limited energy density and lifespan, may impact the overall effectiveness of solar integration.

Space Constraints for Solar Panels[22]

- The available surface area on an electric vehicle for solar panels is limited. Designing an efficient solar panel arrangement without compromising the aesthetics or aerodynamics of the vehicle poses a significant challenge.

Conversion Efficiency of Solar to Electric Power[30]

- The conversion efficiency of solar energy to electric power, considering factors like the efficiency of photovoltaic cells and power electronics, can affect the overall effectiveness of the solar-energized propulsion system.

Weight Considerations[7]

- Integrating solar panels and associated components adds weight to the vehicle. Striking a balance between incorporating solar technology and minimizing weight to maintain vehicle efficiency is a complex challenge.

Cost and Affordability[31]

- Solar technologies, especially high-efficiency solar panels, can be expensive. Balancing the costs of integrating solar components with the overall affordability of electric vehicles is a challenge in promoting widespread adoption.

Technological Integration and System Complexity[32]

- The integration of solar propulsion systems with electric vehicles requires sophisticated technologies and control systems. Managing the complexity of these integrated systems while ensuring user-friendly operation poses a challenge.

Regulatory and Infrastructure Challenges[32]

- The adoption of solar-energized EVs may face regulatory hurdles and require infrastructure developments. Establishing standards, regulations, and charging infrastructure that support solar-integrated electric vehicles is a challenge.

VI. MATHEMATICAL MODELING OF A PV-ACTUATED ELECTRIC VEHICLE

Mathematical modeling of a photovoltaic-actuated electric vehicle system involves creating equations and relationships that describe the various components and processes involved in converting solar energy into electric power to drive a vehicle[33]. Here's an overview of the key elements that can be included in such a mathematical model:

Solar Panels: Solar panels convert sunlight into electrical energy. Their output power can be modeled using the following equation:

$$Ppanel = Apanel * G * \eta panel \qquad (1)$$

Where $P\,panel$ is the power output of the solar panel, $Apanel$is the area of the panel, $G$is the solar irradiance (incoming solar power per unit area), and $\eta panel$is the efficiency of the panel.

Battery Storage: The electrical energy generated by the solar panels can be stored in a battery for later use. The battery can be represented using a state-of-charge (SOC) model, which describes the energy capacity as a function of time:

$$dSOC/dt = (Ppanel - Pload) / Cbatt \quad (2)$$

Where$dSOC/dt$ is the rate of change of the state of charge, $Ppanel$ is the power generated by the solar panel, $Pload$is the power consumed by the vehicle and other loads, and Cbatt is the battery capacity.

Electric Motor and Drive System: The electric motor converts electrical energy stored in the battery into mechanical energy to propel the vehicle. The power delivered by the motor can be modeled as:

$$P\_motor = Pload + Paux \qquad (3)$$

WhereP_load is the power required to overcome vehicle resistance and accelerate, and $Paux$is the power consumed by auxiliary systems (e.g., air conditioning)

Vehicle Dynamics: The motion of the vehicle can be described using basic physics equations, such as Newton's second law, which relates the net force on the vehicle to its acceleration:

$$Fnet = m * a \qquad (4)$$

Where$Fnet$ is the net force acting on the vehicle, m is the vehicle mass, and ais the acceleration.

VII. CONCLUSION

In conclusion, this review underscores the pivotal role of induction motors in the integration of solar energy into electric vehicles (EVs). The comparative analysis has demonstrated the superiority of induction motors over brushless direct current (BLDC) motors in the context of photovoltaic-actuatedEVs[27]. The comprehensive methodology, comprising theoretical assessments, simulation studies, and practical experiments, provided robust evidence supporting the suitability of induction motors for solar-energized propulsion applications.

The findings reveal that induction motors exhibit heightened efficiency, robustness, and adaptability to varying solar conditions. These advantages position the induction motor as a more fitting choice for photovoltaic actuatedEVs, offering reduced complexity, enhanced reliability, and superior torque capabilities. This research contributes significantly to the ongoing discourse on renewable energy integration in transportation, offering valuable insights for researchers, practitioners, and policymakers.

The challenges identified in the integration of solar energy into EVs highlight the multifaceted nature of this endeavor. However, the strategies proposed to overcome these challenges provide a roadmap for future research, development, and implementation. Advanced energy storage systems, efficient solar panel technologies, innovative design approaches, and optimized power electronics are key elements that can collectively enhance the feasibility and effectiveness of solar-energized EVs.

As the world moves toward a more sustainable and resilient future, the adoption of photovoltaic-actuatedEVs becomes increasingly critical. This study advocates for the widespread adoption of induction motors in solar-energized electric vehicles, emphasizing the potential for a transformative shift in propulsion technology. By addressing challenges and providing viable solutions, this research contributes to the acceleration of photovoltaic-actuated transportation, aligning with global initiatives for a greener and more sustainable mobility landscape

REFERENCES

[1] V. Anand, “Power Generation on Highway by Harnessing Wind Power,” Int. J. Innov. Technol. Explor. Eng., vol. 8, no. 12S, pp. 330–331, 2019, doi: 10.35940/ijitee.l1085.10812s19.

[2] M. Waseem, A. F. Sherwani, and M. Suhaib, “Integration of solar energy in electrical, hybrid, autonomous vehicles: a technological review,” SN Appl. Sci., vol. 1, no. 11, 2019, doi: 10.1007/s42452-019-1458-4.

[3] V. Anand, “Optimal Placement of Distributed Generation System to Improve Power Quality,” Int. J. Innov. Technol. Explor. Eng., vol. 8, no. 12S, pp. 151–154, 2019, doi: 10.35940/ijitee.l1046.10812s19.

[4] H. H. El-zohri, M. Aref, A. Ahmed, and K. Sayed, “Enhancing Real-Time Control of Brushless DC Motors for More Electric Aircraft,” 2023, doi: 10.20944/preprints202310.1234.v1.

[5] V. Anand, “Correctness in Power Factor of Induction Motor by using Active Filters,” Int. J. Innov. Technol. Explor. Eng., vol. 8, no. 12S, pp. 148–150, 2019, doi: 10.35940/ijitee.l1045.10812s19.

[6] Z. Yang, F. Shang, I. P. Brown, and M. Krishnamurthy, “Comparative study of interior permanent magnet, induction, and switched reluctance motor drives for EV and HEV applications,” IEEE Trans. Transp. Electrif., vol. 1, no. 3, pp. 245–254, 2015, doi: 10.1109/TTE.2015.2470092.

[7] B. Kretchmer and M. Lahey, “Solar Powered Electric Vehicle,” 2017.

[8] P. Bhatt, H. Mehar, and M. Sahajwani, “Electrical Motors for Electric Vehicle – A Comparative Study,” SSRN Electron. J., 2019, doi: 10.2139/ssrn.3364887.

[9] V. Anand, “Photovoltaic actuated induction motor for driving electric vehicle,” Int. J. Eng. Adv. Technol., vol. 8, no. 6 Special Issue 3, pp. 1612–1614, Sep. 2019, doi: 10.35940/ijeat.F1298.0986S319.

[10] V. Anand, “A STUDY OF REGULATORY AND TECHNOLOGICAL CONSIDERATIONS OF WASTE MANAGEMENT OF ELECTRIC VEHICLE BATTERIES,” vol. 3, no. 1, pp. 29–35, 2023.

[11] V. Anand, “IOT Based Fault Detection of Underground Cables through Node MCU Module,” 2020 Int. Conf. Comput. Sci. Eng. Appl. ICCSEA 2020, 2020, doi: 10.1109/ICCSEA49143.2020.9132893.

[12] S. Sachan and P. Prakash, “Regional Sustainability Charging infrastructure planning for electric vehicle in India : Present status and future challenges,” Reg. Sustain., vol. 3, no. 4, pp. 335–345, 2022, doi: 10.1016/j.regsus.2022.11.008.

[13] M. Premkumar, R. V. Krishna, and R. Sowmya, "DESIGN , ANALYSIS AND FABRICATION OF SOLAR PV POWERED," vol. 8, no. 1, pp. 1255–1270, 2018.

[14] D. F. de Souza, F. A. M. Salotti, I. L. Sauer, H. Tatizawa, A. T. de Almeida, and A. G. Kanashiro, "A Performance Evaluation of Three - Phase Induction Electric Motors between 1945 and 2020," Energies, vol. 15, no. 6, pp. 1 - 31, 2022, doi: 10.3390/en15062002.

[15] M. Nirmala, K. Malarvizhi, and G. Thenmozhi, "Solar PV based Electric Vehicle," no. 2, pp. 276–280, 2018.

[16] D. Hao et al., "Solar energy harvesting technologies for PV self-powered applications: A comprehensive review," Renew. Energy, vol. 188, no. February, pp. 678–697, 2022, doi: 10.1016/j.renene.2022.02.066.

[17] G. Esmaili, L. Xu, D. G. Kasten, and S. A. Sebo, "APPLICATION OF ADVANCED POWER ELECTRONICS IN RENEWABLE ENERGY SOURCES AND HYBRID GENERATING SYSTEMS," 2006.

[18] N. Boaretto et al., "Lithium solid-state batteries: State-of-the-art and challenges for materials, interfaces and processing," J. Power Sources, vol. 502, no. November 2020, 2021, doi: 10.1016/j.jpowsour.2021.229919.

[19] S. Goel, R. Sharma, and A. K. Rathore, "A review on barrier and challenges of electric vehicle in India and vehicle to grid optimisation," Transp. Eng., vol. 4, no. January, 2021, doi: 10.1016/j.treng.2021.100057.

[20] P. Chakraborty et al., "Addressing the range anxiety of battery electric vehicles with charging en route," Sci. Rep., vol. 12, no. 1, pp. 1–15, 2022, doi: 10.1038/s41598-022-08942-2.

[21] G. E. M. Abro, S. A. B. M. Zulkifli, K. Kumar, N. El Ouanjli, V. S. Asirvadam, and M. A. Mossa, "Technology , Propulsion , Power Interfaces , and Vehicle and Connected Electric Vehicles," Energies, vol. 16, p. 2925, 2023.

[22] A. R. Bhatti et al., "Photovoltaics and opportunistic electric vehicle charging in the power system – a case study on a Swedish distribution grid," Energy, vol. 399, no. August 2018, pp. 500–522, 2019, doi: 10.1049/iet-rpg.2018.5082.

[23] S. Sharifan, S. Ebrahimi, A. Oraee, and H. Oraee, "Performance comparison between brushless PM and induction motors for hybrid electric vehicle applications," pp. 719–724, 2016, doi: 10.1109/optim.2015.7492473.

[24] Y. Kassem, H. Gokcekus, and A. Aljatlawe, "Utilization of Solar Energy for Electric Vehicle Charging and the Energy Consumption of Residential Buildings in Northern Cyprus: A Case Study," Eng. Technol. Appl. Sci. Res., vol. 13, no. 5, pp. 11598–11607, 2023, doi: 10.48084/etasr.6142.

[25] V. Anand, "Performance of Induction Motor and BLDC Motor and Design of Induction Motor driven Solar Electric Vehicle (IM-SEV)," Int. J. Adv. Res. Sci. Commun. Technol., vol. 6, no. 1, pp. 1046–1053, 2021, doi: 10.48175/568.

[26] V. Anand, "Optimized PV-based induction motor drive for electric vehicle system with bidirectional converter : modeling and analysis," 2024.

[27] V. Anand, H. Sharma, B. S. Ram, and D. K. Dubey, "Performance of Induction Motor and BLDC Motor and Design of Induction Motor driven Solar Electric Vehicle (IM-SEV)," vol. 10, no. 3, pp. 22–23, 2023, doi: 10.48175/568.

[28] H. Khreis and M. J. Nieuwenhuijsen, "Traffic-related air pollution and childhood asthma: Recent advances and remaining gaps in the exposure assessment methods," Int. J. Environ. Res. Public Health, vol. 14, no. 3, pp. 1–19, 2017, doi: 10.3390/ijerph14030312.

[29] O. Sadeghian, A. Oshnoei, B. Mohammadi-ivatloo, V. Vahidinasab, and A. Anvari-Moghaddam, "A comprehensive review on electric vehicles smart charging: Solutions, strategies, technologies, and challenges," J. Energy Storage, vol. 54, pp. 1–44, 2022, doi: 10.1016/j.est.2022.105241.

[30] M. Awais, M. Anees, and N. Zaffar, "Solar assisted , enhanced efficiency , induction motor EV drive with soft phase conversion".

[31] S. Wappelhorst, D. Hall, M. Nicholas, and N. Ltsey, "Analyzing Policies To Grow the Electric Vehicle Market in European Cities," ICCT White Pap., no. February, pp. 1–43, 2020, [Online]. Available: https://theicct.org/sites/default/files/publications/EV_city_policies_white_paper_fv_20200224.pdf

[32] M. Ibrahim, V. Rjabtšikov, and R. Gilbert, "Overview of Digital Twin Platforms for EV Applications," Sensors, vol. 23, no. 3, 2023, doi: 10.3390/s23031414.

[33] T. I. Of, I. M.- Driven, H. Sharma, and B. S. Ram, "Journal of optoelectronics laser," vol. 41, no. 10, pp. 615–629, 2022.