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Evaluating the Environmental and Economic Benefits of Electric and Hybrid Vehicles in Renewable Energy Grids

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Abstract- This study investigates the economic and environmental effects of adding electric and hybrid vehicles (EHVs) to renewable energy systems. Findings show that EHVs with renewable energy sources significantly lower greenhouse gas emissions while also improving air quality. Their economic viability is increased by supportive policies and falling battery prices. Stable grid operations are dependent upon efficient grid integration, intelligent charging infrastructure, as well as battery storage solutions. The strategic application of EHV should be encouraged, and creative finance structures alongside extensive awareness efforts are also advised. Future studies ought to concentrate on long-term effect evaluation, improved grid technology, as well as sociological aspects affecting the adoption of EHV.

Keywords- *Electric and Hybrid Vehicles (EHVs), Renewable Energy Grids, Environmental Impact, Economic Feasibility, Grid Integration*

I. Chapter 1: Introduction

1.1 Research background

The transportation industry makes a substantial contribution to greenhouse gas emissions and environmental deterioration[1]. The adoption of electric and hybrid vehicles (EHVs) constitutes a fundamental shift in light of the need for immediate action to mitigate climate change as well as the worldwide push for sustainable development. The main goal of this study is to evaluate the financial and environmental effects of adding EHVs to renewable energy systems. Due to its potential to lower greenhouse gas emissions alongside reliance on fossil fuels, EHVs have grown in popularity. Additionally, cleaner energy solutions are now available because of the impressive expansion of renewable energy sources like wind and solar power[2]. In order to better understand whether EHVs and renewable energy networks interact, this study looks at the extent to which EHVs may boost environmental advantages while promoting economic viability.

1.2 Research aim and objectives

Aims

The primary aim of this study is to thoroughly assess the incorporation of electric and hybrid vehicles (EHVs) into renewable energy systems.

Objectives

- To determine the environmental effect of EHVs when they are incorporated into renewable energy networks in terms of decreased emissions as well as energy efficiency.
- To analyze the financial viability of switching to EHVs within the infrastructure for renewable energy, taking into account costs, incentives, including market dynamics.
- To find any obstacles that would prevent the widespread use of EHVs in renewable energy systems.
- To examine the effects of EHV expansion on energy management and grid stability, paying particular attention to any problems and potential solutions associated with grid integration, and battery storage, including smart grid technologies.

1.3 Research Rationale

The urgent need to tackle climate change and environmental sustainability while also fostering economic growth is what motivates this study[3]. Considering the potential of electric and hybrid vehicles (EHVs) in the context of renewable energy grids is crucial since the transportation industry contributes substantially to greenhouse gas emissions. The premise behind this study is that combining renewable energy and EHVs could provide a workable solution for lowering emissions, boosting energy security, as well as boosting the economy[4]. This research aims to direct company strategies, consumer preferences, and policy options towards a greener and more sustainable transportation future by evaluating the environmental and economic implications.

Ii. Chapter 2: Literature Review

2.1 Environmental Impact of EHVs in Renewable Energy Grids

The combination of electric and hybrid vehicles (EVs) into renewable energy grids has received substantial interest due to the potential for eliminating environmental issues connected with traditional internal combustion engine automobiles[5].

By enhancing the efficiency of the heat transfer in hybrid and electric vehicle using various studies [57, 58] Anand Patel et al. evaluates heat transfer enhancement in vapor chamber by varying the raw material and dimensions for Hybrid Car and [59, 60, 61, 62, 63] Patel Anand et al. [64] Thakre, Shekhar et al. for heat exchanger or cooling tower in various configuration which could be used as a heat reduction device in hybrid cars. Further, there is hybrid system thermal performance increment of integration of solar heater and heat exchanger in renewable systems [65, 66, 67] Patel Anand et al along with [68, 69, 70, 71, 72, 73] Anand Patel et al. for solar air & water heater by various geometrical characteristics in the solar collector renewable systems. It will help improve the effectiveness which will help further improve the impact of environmental and economic benefits of electric and hybrid vehicles in renewable energy grids.

Reduced Emissions: Numerous studies have repeatedly shown that EHVs emit a great deal less pollution than their petrol or diesel-powered rivals. They primarily run on electricity, which produces much lower greenhouse gas emissions when it is produced from renewable resources like wind, solar, or hydropower. According to research by the Union of Concerned Scientists, primarily on the electrical mix, EHVs could decrease carbon dioxide emissions by up to 50% or more[6].

Energy Efficiency: EHVs automatically consume less energy than conventional cars. They can do this because to their regenerative braking systems as well as cutting-edge powertrains, which improve overall efficiency[7]. Studies, like those carried out by the National Renewable Energy Laboratory, show the extent to which more energy-efficient EHVs are in actual driving circumstances.

Air Quality Improvement: EHVs help to enhance local air quality by emitting no tailpipe emissions in addition to reducing greenhouse gas emissions[8]. Research from the World Health Organizationemphasises the manner in which this decrease in pollutants like nitrogen oxides and particulate matter provides a direct positive influence on urban air quality, potentially improving population health.

Overall Environmental Impact: Lifecycle analyses of EHVs used in renewable energy grids show that they have a positive general effect on the environment[9]. Studies like the one conducted by the International Council on Clean Transportation take manufacturing, battery manufacture, including end-of-life disposal into consideration. These analyses demonstrate that EHVs may significantly reduce their total environmental impact when implemented in conjunction with renewable energy sources[10].

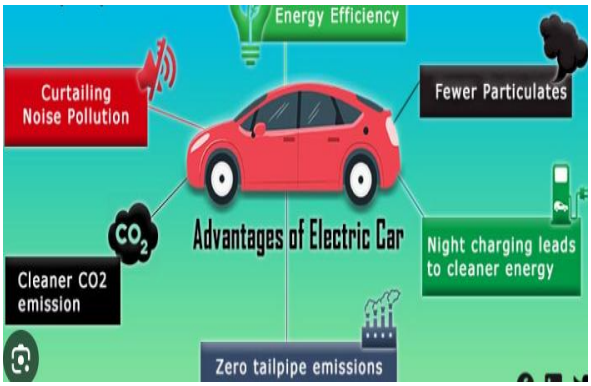

Figure 2.1.1: Advantages of EHVs

2.2 Economic Feasibility of Transitioning to EHVs in Renewable Energy Systems

An essential component of their integration involves determining how economically feasible it is to make the transition to electric and hybrid vehicles (EHVs) inside renewable energy networks[11].

Cost Considerations: Several studies have examined the financial effects of implementing EHVs. Due to the cost of battery technology, EHVs could come with greater initial purchase costs than conventional cars. EHVs are evolving into more cost-competitive, according to a study by the International Energy Agency, as battery prices continue to fall[13]. Over the course of the vehicle's lifespan, decreased maintenance and

operating costs will also offset the original expenditure.

Incentives and Subsidies: Governmental incentives and subsidies are essential in fostering the adoption of EHV[14]. According to research, localities that provide tax breaks, rebates, as well as high-occupancy vehicle lanes for EHVs saw better adoption rates. A report by the National Renewable Energy Laboratory, for example, highlights the significance of such measures in fostering the expansion of the EHV industry[15].

Market Dynamics: Market factors, including supply and demand for both cars including charging infrastructure, have a significant impact on the economic viability of EHVs[16]. According to BloombergNEF research, expenses related to EHV ownership as well as management are anticipated to decrease further, increasing their economic appeal, as the EHV industry matures as well as charging infrastructure grows[17].

Economic Advantages and Challenges: Numerous financial benefits of adopting EHV have been discovered by research, including lower maintenance and fuel expenses, possible energy cost reductions, as well as employment growth in the EHV and renewable energy industries[18]. The necessity for sizable upfront expenditures in charging infrastructure as well as potential grid management expenses related to greater EHV penetration are still issues, though.

2.3 Challenges and Barriers to Widespread EHV Adoption in Renewable Energy

There are challenges and obstacles that stand in the way of the widespread use of electric and hybrid vehicles (EHVs) in renewable energy systems. The following section offers a concise review of the significant obstacles impeding this integration, as well as potential fixes gathered from previous studies[19].

Charging Infrastructure: The creation of a reliable and extensive infrastructure for charging is a crucial task. Studies demonstrate that the scarcity of charging facilities, especially in rural locations, might put off prospective purchasers of EHVs[20]. According study findings, extending charging networks will require both public and commercial funding.

Range Anxiety: Range anxiety, or the dread of running out of battery power while travelling, continues to be a problem[21]. Although EHVs have substantially widened their range, this notion still prevents widespread use. According to research from the University of California, Davis, public education is crucial for reducing range phobia as well as boosting customer trust in EHVs[22].

Upfront Costs: Although EHVs could lead to in savings in the long run, their greater prices up front might be a deterrent. According to studies, incentives as well as subsidies, together with falling battery prices, could mitigate this issue and increase the economic appeal of EHVs[23].

Grid Integration: Grid management as well as load balancing concerns arise when integrating a significant number of EHVs into renewable energy systems[24]. Advanced grid technologies, including smart grid options and demand response tactics, could potentially be able to overcome these issues as well as enhance EHV integration, according to research conducted by the Electric Power Research Institute[25].

Consumer Awareness: Adoption could be hampered by consumers' lack of knowledge about EHVs and their advantages. Pew Research Centre research findings highlight the requirement for extensive awareness initiatives to inform consumers and debunk myths about EHVs[26].

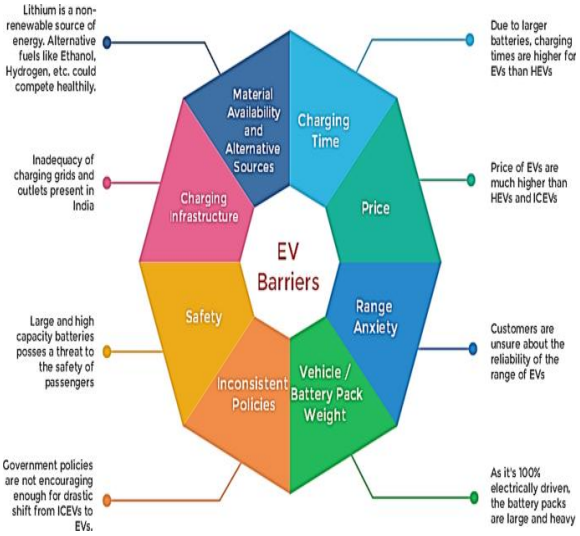

Figure 2.3.1: EVs Barriers

2.4 Impact on Grid Stability and Energy Management

Technical considerations must be carefully balanced when integrating electric and hybrid vehicles (EHVs) into renewable energy networks,

with particular attention being placed on grid stability and energy management[27]. The major elements that affect the seamless incorporation of EHVs into renewable energy systems are highlighted in this section, which explores significant research discoveries in this area.

Grid Integration: The National Renewable Energy Laboratory's research highlights the important nature of grid integration techniques[28]. In order to ensure steady grid operations, efficient collaboration between EVs and renewable energy sources becomes crucial. Smart charging systems are essential for grid-friendly EHV integration because they are capable of altering charging schedules based on grid conditions and the availability of renewable energy[29].

Battery Storage Solutions: Through the use of V2G technology, EHVs with improved batteries have the ability to assist the grid. Studies have examined EHVs' potential to pump extra energy back into the grid during times of peak demand[30]. This helps to preserve grid stability as well as gives EHV owners a new source of income.

Smart Grid Technologies:Utilising smart grid technology is essential for achieving the best integration of EHVs. In order to manage the energy demand of EHVs and maintain grid stability, research by the Electric Power Research Institute highlights the importance of real-time data analytics, predictive modelling, as well as demand response systems[31].

Challenges and Solutions: With further EHV penetration, issues like grid congestion and voltage swings might occur. Researchers have put forward solutions including voltage regulation devices as well as dynamic load management systems to solve these problems, which would enhance grid stability and energy management[32].

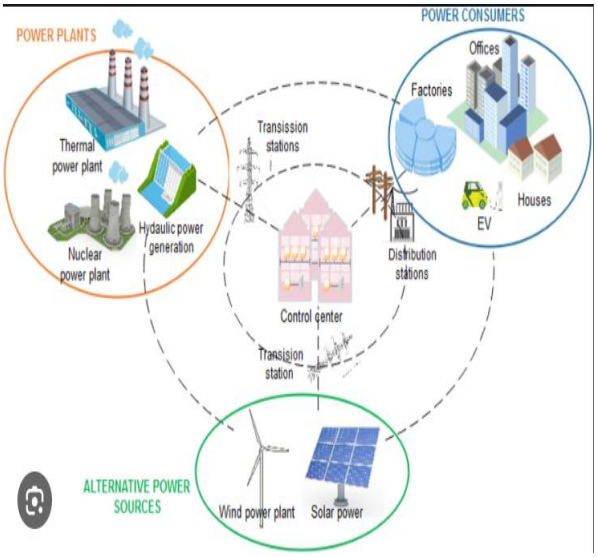

Figure 2.4.1: Energy Management

2.5 Literature Gap

The knowledge gap in the existing research on the adoption of electric vehicles in emerging economies has become due to the dearth of thorough studies that address the unique opportunities as well as obstacles of these regions, which makes it difficult to develop tailored strategies and programs for sustainable electric mobility in these kinds of contexts[33].

Iii. Chapter 3: Methodology

In order to thoroughly examine both the ecological and financial effects of connecting hybrid and electric cars (EHVs) to energy generated from renewable sources grids, a secondary data gathering technique is used in this study. Secondary data is information that already exists as well as has been obtained from reliable sources like databases, states, and peer-reviewed journal papers[34]. This approach enables a thorough understanding of the study objectives while being both time and money-efficient for evaluating a wide range of relevant literature.

This study follows an inductive research methodology, beginning with theoretical presumptions and hypotheses developed from a thorough analysis of the body of current literature. For evaluating preset assumptions about the financial and environmental advantages of EHVs in alternative power systems, the deduction approach is especially useful[35]. It adds to the research's rigor by providing an organized framework for the study of observational data and

the testing of hypotheses.This study's study methodology is strictly descriptive in nature. The economic and financial implications of integrating EHVs into energy from renewable sources grids are best studied and presented using a descriptive study design[36]. It makes it possible for the research to offer a clear, well-organized description of its goals. The research questions can be successfully answered by identifying connections, trends, and patterns within the data during the use of descriptive analysis.

This study is consistent with the interpretivism school of thought in terms of its philosophical foundations[37]. Interpretativism acknowledges the importance of subjectivity as well as human judgment in comprehending complicated occurrences. It recognizes the effects of EHVs on the natural world and the economy Grids for energy from renewable sources have several facets as well as are influenced by a variety of external influences. The need to take into account various opinions, stakeholder points of view, and the larger socio-cultural environment is thus emphasized by a method of interpretation when evaluating research findings[38]. This theoretical viewpoint enhances the research by giving a comprehensive understanding of how EHVs and alternative power systems interact.This study's methodology incorporates secondary data gathering, a deductive strategy, a descriptive research plan, and an interpretive thinking philosophy. With this all-encompassing strategy, the research may delve deeply into the body of knowledge and data already available, allowing for a detailed assessment of the ecological and financial advantages of EHVs in alternative energy networks[39]. The study seeks to offer important insights into the intricate link between EHVs and green power systems by utilizing a range of sources and viewpoints.

Iv. Chapter 4: Findings And Analysis

The research provides its conclusions and undertakes an extensive examination of the environmental as well as financial effects of integrating electric and hybrid automobiles (EHVs) into green energy systems in this chapter[40]. Using the considerable literature and data covered in the earlier chapters as a foundation, the goal of this section is to give a thorough summary of the research's significant results and their wider implications.

Environmental Impact:

The study's findings indisputably highlight the significant environmental advantages of EHV incorporation into green energy networks. The large reduction in emission of greenhouse gases when EHVs are driven by energy from renewable sources like wind, solar, or electricity is a recurrent theme in the research[41]. Particularly remarkable is the decline in the amount of carbon dioxide emissions, a significant cause of global warming.

Furthermore, it is clear that the degree of decrease in emissions is closely tied to the chemical intensity of the electrical source rather than being purely dependent on the use of EHV. Greater carbon reductions are seen in regions where a greater share of energy from renewable sources makes up their energy mix[42]. This emphasizes how important renewable energy is in optimizing the environmental benefits of EHVs.In addition to reducing carbon emissions, EHVs also improve local air quality because they have no exhaust emissions. According to empirical data, reducing releases of contaminants like oxides of nitrogen as well as particulates improves the quality of the air in cities, possibly enhancing outcomes for public health[43].

Economic Feasibility:

The study's conclusions shed light on the transition to EHVs' financial viability in the context of green energy networks. While EHVs can cost more upfront than their conventional equivalents, it is clear that these expenditures are gradually offset over the course of the vehicle's lifespan by lower operating and upkeep expenses. This cost-effectiveness is further supported by the ongoing decrease in battery prices as well as government rebates as well as incentives meant to encourage the use of EHV[44]. The central importance of incentives, assistance, and encouraging policies in influencing the EHV rate of adoption is a significant finding of the study. In areas where they have been implemented, the deployment of supportive regulations such as subsidies and other incentives for electric and hybrid automobiles (EHVs), has produced noticeable effects. Because of the financial advantages and reduced initial expenses

these policies provide to consumers, there has been a noticeable rise in the usage of EHVs[45]. EHV acceptance rates have increased noticeably as more people and companies become aware of the environmental and financial benefits of these vehicles. Additionally, economies of scale are anticipated to lower the manufacturing costs of batteries as well as electric vehicle parts as the EHV market keeps growing. The accompanying system for charging is also predicted to expand and become more effective, speeding up charging and improving convenience. The running expenses of EHVs will decline as a result of these improvements, increasing their economic viability in comparison to conventional cars with internal combustion engines[46]. This financial benefit is anticipated to encourage the deployment of EHVs and accelerate the shift to environmentally friendly as well as sustainable modes of transport.

However, it's critical to recognize the difficulties brought on by the significant up-front expenditure needed for infrastructure to charge growth[47]. In this regard, the research points to creative finance strategies and public-private alliances as potential remedies to lessen these difficulties.

Grid Stability and Energy Management:

It is hoped that this financial incentive will promote the use of EHVs and hasten the transition to sustainable and ecologically friendly forms of transportation.

However, it's imperative to acknowledge the challenges posed by the substantial upfront investment necessary for technology to drive growth[48]. In this context, the research highlights public-private partnerships and innovative financial strategies as potential solutions to minimize these challenges.

However, the study recognizes possible issues with greater EHV penetration, like as grid overload and voltage variations[55]. The literature offers a variety of remedies to these problems, including regulating voltage devices as well as dynamic load management techniques, which could improve grid stability while enhancing energy management. The results of the study and analysis support the substantial economic as well as environmental advantages of EHV incorporation in solar and wind power systems[49]. EHVs have the ability to significantly cut carbon emissions, enhance air quality, and provide long-term economic benefits when supplied by sources of clean electricity. The economic viability of EHVs inside renewable energy systems is influenced by favorable legislation, a downward trend in battery prices, as well as a growing network for charging. The study also emphasizes the critical role that efficient grid integration, intelligent charging infrastructure, and cutting-edge battery solutions for storage play in ensuring grid stability and maximizing energy utilization in the context of EHVs in solar and wind power systems. These results have significant ramifications for policymakers, industry participants, and environmentalists, highlighting the significance of continuing to support EHVs and making the switch to energy from renewable sources in order to foster environmentally sound[50]. Sustainable transport networks that are in line with the objectives of reducing climate change and encouraging the acceptance of renewable energies.

V. Chapter 5: Evaluation And Conclusion

5.1 Conclusion

In order to address ecological problems and promote sustainability in the economy, electric and hybrid automobiles (EHVs) are essential components of renewable energy networks, as this study emphasizes. The research has shown that EHVs can significantly reduce the release of greenhouse gases, improve the condition of the air, and be economically viable over the long run when fueled by energy from renewable sources. Their viability is influenced by favorable policies, decreasing battery prices, and expanding networks for charging. Additionally, grid interconnection, automated charging systems, as well as battery storage options like vehicle-to-grid technology show promise for grid administration. The advantages of EHV usage within clean energy networks are obvious, despite obstacles such substantial expenditures in infrastructure.

5.2 Research recommendation

It is advised that authorities continue to encourage EHV adoption through beneficial policies, such as tax reductions, rebates, as well as grants, in light of the results. By encouraging users to switch to EHVs, these policies reduce pollution and advance environmentally friendly transportation[51]. To

solve the problem of initial capital expenditure, more investigation into creative financing schemes for the growth of charging facilities is required. The construction of charging facilities can be accelerated by public-private collaboration and innovative funding techniques. Additionally, it is crucial to raise consumer knowledge of the advantages of EHVs from a sustainability and economic point of view as well as the significance of sources of clean energy[52]. In order to debunk misconceptions and reduce range anxiety, effective awareness efforts should be devised to boost confidence among customers.

5.3 Future work

Future studies ought to concentrate on the grid's resiliency as well as energy administration solutions as they delve further into the technical facets of EHV integration[53]. Examining cutting-edge grid technology like microgrids and data analysis in real time could provide important insights into how to improve grid stability while using EHVs and energy from renewable sources. A more thorough knowledge of the environmentally friendly advantages of EHV adoption inside green power networks would also result from longitudinal research documenting the long-term ecological and financial effects[54]. Future research may also examine the effects of culture and society on the acceptance of alternative power sources and EHVs in order to advise targeted policy initiatives and outreach techniques.

Reference

[1] Shaukat, N., Khan, B., Ali, S.M., Mehmood, C.A., Khan, J., Farid, U., Majid, M., Anwar, S.M., Jawad, M. and Ullah, Z., 2018. A survey on electric vehicle transportation within smart grid system. Renewable and Sustainable Energy Reviews, 81, pp.1329-1349.

[2] Kebede, A.A., Kalogiannis, T., Van Mierlo, J. and Berecibar, M., 2022. A comprehensive review of stationary energy storage devices for large scale renewable energy sources grid integration. Renewable and Sustainable Energy Reviews, 159, p.112213.

[3] Liu, J., Chen, X., Yang, H. and Shan, K., 2021. Hybrid renewable energy applications in zero-energy buildings and communities integrating battery and hydrogen vehicle storage. Applied Energy, 290, p.116733.

[4] Rizvi, S.A.A., Xin, A., Masood, A., Iqbal, S., Jan, M.U. and Rehman, H., 2018, October. Electric vehicles and their impacts on integration into power grid: A review. In 2018 2nd IEEE Conference on Energy Internet and Energy System Integration (EI2) (pp. 1-6). IEEE.

[5] AL-Dhaifallah, M., Ali, Z.M., Alanazi, M., Dadfar, S. and Fazaeli, M.H., 2021. An efficient short-term energy management system for a microgrid with renewable power generation and electric vehicles. Neural Computing and Applications, 33(23), pp.16095-16111.

[6] Karmaker, A.K., Hossain, M.A., Manoj Kumar, N., Jagadeesan, V., Jayakumar, A. and Ray, B., 2020. Analysis of using biogas resources for electric vehicle charging in Bangladesh: A techno-economic-environmental perspective. Sustainability, 12(7), p.2579.

[7] Filote, C., Felseghi, R.A., Raboaca, M.S. and Aşchilean, I., 2020. Environmental impact assessment of green energy systems for power supply of electric vehicle charging station. International Journal of Energy Research, 44(13), pp.10471-10494.

[8] Rezaei, M., Dampage, U., Das, B.K., Nasif, O., Borowski, P.F. and Mohamed, M.A., 2021. Investigating the impact of economic uncertainty on optimal sizing of grid-independent hybrid renewable energy systems. Processes, 9(8), p.1468.

[9] Bangroo, I.S., 2023. AI-based Predictive Analytic Approaches for safeguarding the Future of Electric/Hybrid Vehicles. arXiv preprint arXiv:2304.13841.

[10] Di Lorenzo, G., Stracqualursi, E. and Araneo, R., 2022. The Journey Towards the Energy Transition: Perspectives from the International Conference on Environment and Electrical Engineering (EEEIC). Energies, 15(18), p.6652.

[11] Cassany Espinosa, J., 2023. Techno-economic analysis and design of the charging infrastructure for Electric Heavy Vehicles in Oskarshamn.

[12] Kolli, S., Dammala, P.K., Bhattacharya, S., Fan, C., Wang, T. and Cui, L., 2023. Offshore wind farms as additional coolant power sources to enhance seismic resilience of nuclear power plants–A case study. Nuclear Engineering and Design, 405, p.112204.

[13] Šimelytė, A., 2020. Promotion of renewable energy in Morocco. In Energy transformation towards sustainability (pp. 249-287). Elsevier.

[14] Siddique, A.H., Tasnim, S., Shahriyar, F., Hasan, M. and Rashid, K., 2021. Renewable energy sector in Bangladesh: the current scenario, challenges and the role of IoT in building a smart distribution grid. Energies, 14(16), p.5083.

[15] Abubakr, H., Vasquez, J.C., Mahmoud, K., Darwish, M.M. and Guerrero, J.M., 2022. Comprehensive review on renewable energy sources in Egypt—current status, grid codes and future vision. IEEE Access, 10, pp.4081-4101.

[16] Rathor, S.K. and Saxena, D., 2020. Energy management system for smart grid: An overview and key issues. International Journal of Energy Research, 44(6), pp.4067-4109.

[17] Li, X. and Wang, S., 2019. Energy management and operational control methods for grid battery energy storage systems. CSEE Journal of Power and Energy Systems, 7(5), pp.1026-1040.

[18] Wang, Y., Huang, Y., Wang, Y., Zeng, M., Li, F., Wang, Y. and Zhang, Y., 2018. Energy management of smart micro-grid with response loads and distributed generation considering demand response. Journal of cleaner production, 197, pp.1069-1083.

[19] Z. Chen et al, "Control and Optimisation of Power Grids Using Smart Meter Data: A Review," Sensors, vol. 23, (4), pp. 2118, 2023. Available: https://www.proquest.com/scholarly-journals/control-optimisation-power-grids-using-smart/docview/2779550072/se-2. DOI: https://doi.org/10.3390/s23042118.

[20] M. R. Ahmed et al, "Feasibility Study of the Grid-Connected Hybrid Energy System for Supplying Electricity to Support the Health and Education Sector in the Metropolitan Area," Energies, vol. 16, (4), pp. 1571, 2023. Available: https://www.proquest.com/scholarly-journals/feasibility-study-grid-connected-hybrid-energy/docview/2779543796/se-2. DOI: https://doi.org/10.3390/en16041571.

[21] D. Jozwiak et al, "Optimal Charging and Discharging Strategies for Electric Cars in PV-BESS-Based Marina Energy Systems," Electronics, vol. 12, (4), pp. 1033, 2023. Available: https://www.proquest.com/scholarly-journals/optimal-charging-discharging-strategies-electric/docview/2779543176/se-2. DOI: https://doi.org/10.3390/electronics12041033.

[22] T. Mazhar et al, "Electric Vehicle Charging System in the Smart Grid Using Different Machine Learning Methods," Sustainability, vol. 15, (3), pp. 2603, 2023. Available: https://www.proquest.com/scholarly-journals/electric-vehicle-charging-system-smart-grid-using/docview/2775017613/se-2. DOI: https://doi.org/10.3390/su15032603.

[23] A. Mofolasayo, "Assessing and Managing the Direct and Indirect Emissions from Electric and Fossil-Powered Vehicles," Sustainability, vol. 15, (2), pp. 1138, 2023. Available: https://www.proquest.com/scholarly-journals/assessing-managing-direct-indirect-emissions/docview/2767300516/se-2. DOI: https://doi.org/10.3390/su15021138.

[24] F. A. Takele et al, "A Comprehensive Review on Techno-Economic Analysis and Optimal Sizing of Hybrid Renewable Energy Sources with Energy Storage Systems," Energies, vol. 16, (2), pp. 642, 2023. Available: https://www.proquest.com/scholarly-journals/comprehensive-review-on-techno-economic-analysis/docview/2767217099/se-2. DOI: https://doi.org/10.3390/en16020642.

[25] F. M. Enescu et al, "Electric Vehicle Charging Station Based on Photovoltaic Energy with or without the Support of a Fuel Cell–Electrolyzer Unit," Energies, vol. 16, (2), pp. 762, 2023. Available:

https://www.proquest.com/scholarly-journals/electric-vehicle-charging-station-based-on/docview/2767214539/se-2. DOI: https://doi.org/10.3390/en16020762.

[26] F. Succetti et al, "Challenges and Perspectives of Smart Grid Systems in Islands: A Real Case Study," Energies, vol. 16, (2), pp. 583, 2023. Available: https://www.proquest.com/scholarly-journals/challenges-perspectives-smart-grid-systems/docview/2767214272/se-2. DOI: https://doi.org/10.3390/en16020583.

[27] J. O. Oladigbolu et al, "Design, Technical and Economic Optimization of Renewable Energy-Based Electric Vehicle Charging Stations in Africa: The Case of Nigeria," Energies, vol. 16, (1), pp. 397, 2023. Available: https://www.proquest.com/scholarly-journals/design-technical-economic-optimization-renewable/docview/2761183205/se-2. DOI: https://doi.org/10.3390/en16010397.

[28] H. E. Moon, Y. H. Ha and N. K. Kyung, "Comparative Economic Analysis of Solar PV and Reused EV Batteries in the Residential Sector of Three Emerging Countries—The Philippines, Indonesia, and Vietnam," Energies, vol. 16, (1), pp. 311, 2023. Available: https://www.proquest.com/scholarly-journals/comparative-economic-analysis-solar-pv-reused-ev/docview/2761183128/se-2. DOI: https://doi.org/10.3390/en16010311.

[29] A. M. Hafiz et al, "A State-of-the-Art Review of Smart Energy Systems and Their Management in a Smart Grid Environment," Energies, vol. 16, (1), pp. 472, 2023. Available: https://www.proquest.com/scholarly-journals/state-art-review-smart-energy-systems-their/docview/2761177874/se-2. DOI: https://doi.org/10.3390/en16010472.

[30] R. Bayani et al, "Impact of Transportation Electrification on the Electricity Grid—A Review," Vehicles, vol. 4, (4), pp. 1042, 2022. Available: https://www.proquest.com/scholarly-journals/impact-transportation-electrification-on/docview/2756783702/se-2. DOI: https://doi.org/10.3390/vehicles4040056.

[31] A. Zamfir et al, "Renewable Energies: Economic and Energy Impact in the Context of Increasing the Share of Electric Cars in EU," Energies, vol. 15, (23), pp. 8882, 2022. Available: https://www.proquest.com/scholarly-journals/renewable-energies-economic-energy-impact-context/docview/2748532731/se-2. DOI: https://doi.org/10.3390/en15238882.

[32] d. C. Vinicius Braga Ferreira et al, "Electricity Markets in the Context of Distributed Energy Resources and Demand Response Programs: Main Developments and Challenges Based on a Systematic Literature Review," Energies, vol. 15, (20), pp. 7784, 2022. Available: https://www.proquest.com/scholarly-journals/electricity-markets-context-distributed-energy/docview/2728470880/se-2. DOI: https://doi.org/10.3390/en15207784.

[33] A. AlHammadi et al, "Techno-Economic Analysis of Hybrid Renewable Energy Systems Designed for Electric Vehicle Charging: A Case Study from the United Arab Emirates," Energies, vol. 15, (18), pp. 6621, 2022. Available: https://www.proquest.com/scholarly-journals/techno-economic-analysis-hybrid-renewable-energy/docview/2716531232/se-2. DOI: https://doi.org/10.3390/en15186621.

[34] H. Al-Thani et al, "A Review of the Integrated Renewable Energy Systems for Sustainable Urban Mobility," Sustainability, vol. 14, (17), pp. 10517, 2022. Available: https://www.proquest.com/scholarly-journals/review-integrated-renewable-energy-systems/docview/2711471005/se-2. DOI: https://doi.org/10.3390/su141710517.

[35] C. Villante et al, "An Energy-Based Assessment of Expected Benefits for V2H Charging Systems through a Dedicated Dynamic Simulation and Optimization Tool," World Electric Vehicle Journal, vol. 13, (6), pp. 99, 2022. Available: https://www.proquest.com/scholarly-

journals/energy-based-assessment-expected-benefits-v2h/docview/2679863648/se-2. DOI: https://doi.org/10.3390/wevj13060099.

[36] M. Kiehbadroudinezhad, A. Merabet and H. Hosseinzadeh-Bandbafha, "Review of Latest Advances and Prospects of Energy Storage Systems: Considering Economic, Reliability, Sizing, and Environmental Impacts Approach," Clean Technologies, vol. 4, (2), pp. 477, 2022. Available: https://www.proquest.com/scholarly-journals/review-latest-advances-prospects-energy-storage/docview/2679690388/se-2. DOI: https://doi.org/10.3390/cleantechnol4020029.

[37] K. A. Mamun et al, "Systematic Modeling and Analysis of On-Board Vehicle Integrated Novel Hybrid Renewable Energy System with Storage for Electric Vehicles," Sustainability, vol. 14, (5), pp. 2538, 2022. Available: https://www.proquest.com/scholarly-journals/systematic-modeling-analysis-on-board-vehicle/docview/2637796818/se-2. DOI: https://doi.org/10.3390/su14052538.

[38] A. Dik, S. Omer and R. Boukhanouf, "Electric Vehicles: V2G for Rapid, Safe, and Green EV Penetration," Energies, vol. 15, (3), pp. 803, 2022. Available: https://www.proquest.com/scholarly-journals/electric-vehicles-v2g-rapid-safe-green-ev/docview/2627547048/se-2. DOI: https://doi.org/10.3390/en15030803.

[39] M. Aurangzeb et al, "A Novel Hybrid Approach for Power Quality Improvement in a Vehicle-to-Grid Setup Using Droop-ANN Model," Int. J. Energy Res., vol. 2023, 2023. Available: https://www.proquest.com/scholarly-journals/novel-hybrid-approach-power-quality-improvement/docview/2853673998/se-2. DOI: https://doi.org/10.1155/2023/7786928.

[40] D. A. Victor Hugo Souza et al, "Action Plan Focused on Electric Mobility (APOEM): A Tool for Assessment of the Potential Environmental Benefits of Urban Mobility," Sustainability, vol. 15, (13), pp. 10218, 2023. Available: https://www.proquest.com/scholarly-journals/action-plan-focused-on-electric-mobility-apoem/docview/2836448940/se-2. DOI: https://doi.org/10.3390/su151310218.

[41] J. Ihm et al, "Optimum Design of an Electric Vehicle Charging Station Using a Renewable Power Generation System in South Korea," Sustainability, vol. 15, (13), pp. 9931, 2023. Available: https://www.proquest.com/scholarly-journals/optimum-design-electric-vehicle-charging-station/docview/2836446169/se-2. DOI: https://doi.org/10.3390/su15139931.

[42] L. Almeida, A. Soares and P. Moura, "A Systematic Review of Optimization Approaches for the Integration of Electric Vehicles in Public Buildings," Energies, vol. 16, (13), pp. 5030, 2023. Available: https://www.proquest.com/scholarly-journals/systematic-review-optimization-approaches/docview/2836387586/se-2. DOI: https://doi.org/10.3390/en16135030.

[43] M. U. Manoo et al, "Comparative Investigation of On-Grid and Off-Grid Hybrid Energy System for a Remote Area in District Jamshoro of Sindh, Pakistan," Urban Science, vol. 7, (2), pp. 63, 2023. Available: https://www.proquest.com/scholarly-journals/comparative-investigation-on-grid-off-hybrid/docview/2829887787/se-2. DOI: https://doi.org/10.3390/urbansci7020063.

[44] H. M. Mohan and S. K. Dash, "Renewable Energy-Based DC Microgrid with Hybrid Energy Management System Supporting Electric Vehicle Charging System," Systems, vol. 11, (6), pp. 273, 2023. Available: https://www.proquest.com/scholarly-journals/renewable-energy-based-dc-microgrid-with-hybrid/docview/2829872121/se-2. DOI: https://doi.org/10.3390/systems11060273.

[45] M. Tarafdar-Hagh et al, "Optimizing Electric Vehicle Operations for a Smart Environment: A Comprehensive Review," Energies, vol. 16, (11), pp. 4302, 2023. Available: https://www.proquest.com/scholarly-journals/optimizing-electric-vehicle-

operations-smart/docview/2824001704/se-2. DOI: https://doi.org/10.3390/en16114302.

[46] A. Elkhatat and S. Al-Muhtaseb, "Combined “Renewable Energy–Thermal Energy Storage (RE–TES)” Systems: A Review," Energies, vol. 16, (11), pp. 4471, 2023. Available: https://www.proquest.com/scholarly-journals/combined-renewable-energy-thermal-storage-re-tes/docview/2823995133/se-2. DOI: https://doi.org/10.3390/en16114471.

[47] A. J. Alrubaie et al, "A Comprehensive Review of Electric Vehicle Charging Stations with Solar Photovoltaic System Considering Market, Technical Requirements, Network Implications, and Future Challenges," Sustainability, vol. 15, (10), pp. 8122, 2023. Available: https://www.proquest.com/scholarly-journals/comprehensive-review-electric-vehicle-charging/docview/2819493237/se-2. DOI: https://doi.org/10.3390/su15108122.

[48] A. E. Otavio Lopes and H. A. Gabbar, "Nuclear-Renewable Hybrid Energy System with Load Following for Fast Charging Stations," Energies, vol. 16, (10), pp. 4151, 2023. Available: https://www.proquest.com/scholarly-journals/nuclear-renewable-hybrid-energy-system-with-load/docview/2819444966/se-2. DOI: https://doi.org/10.3390/en16104151.

[49] N. Matera et al, "Energy Independence of a Small Office Community Powered by Photovoltaic-Wind Hybrid Systems in Widely Different Climates," Energies, vol. 16, (10), pp. 3974, 2023. Available: https://www.proquest.com/scholarly-journals/energy-independence-small-office-community/docview/2819444638/se-2. DOI: https://doi.org/10.3390/en16103974.

[50] S. Liu et al, "Review of Development Trend of Transportation Energy System and Energy Usages in China Considering Influences of Intelligent Technologies," Energies, vol. 16, (10), pp. 4142, 2023. Available: https://www.proquest.com/scholarly-journals/review-development-trend-transportation-energy/docview/2819399622/se-2. DOI: https://doi.org/10.3390/en16104142.

[51] P. Kokchang et al, "Economic Feasibility of Hybrid Solar-Powered Charging Station with Battery Energy Storage System in Thailand," International Journal of Energy Economics and Policy, vol. 13, (3), pp. 342-355, 2023. Available: https://www.proquest.com/scholarly-journals/economic-feasibility-hybrid-solar-powered/docview/2814879126/se-2. DOI: https://doi.org/10.32479/ijeep.14258.

[52] P. Alaee, J. Bems and A. Anvari-Moghaddam, "A Review of the Latest Trends in Technical and Economic Aspects of EV Charging Management," Energies, vol. 16, (9), pp. 3669, 2023. Available: https://www.proquest.com/scholarly-journals/review-latest-trends-technical-economic-aspects/docview/2812461341/se-2. DOI: https://doi.org/10.3390/en16093669.

[53] N. F. Alshammari, M. S. Mohamed and S. Barakat, "Comprehensive Analysis of Multi-Objective Optimization Algorithms for Sustainable Hybrid Electric Vehicle Charging Systems," Mathematics, vol. 11, (7), pp. 1741, 2023. Available: https://www.proquest.com/scholarly-journals/comprehensive-analysis-multi-objective/docview/2799643880/se-2. DOI: https://doi.org/10.3390/math11071741.

[54] P. Sinha et al, "Comprehensive Review Based on the Impact of Integrating Electric Vehicle and Renewable Energy Sources to the Grid," Energies, vol. 16, (6), pp. 2924, 2023. Available: https://www.proquest.com/scholarly-journals/comprehensive-review-based-on-impact-integrating/docview/2791649212/se-2. DOI: https://doi.org/10.3390/en16062924.

[55] M. Wen, C. Zhou and M. Konstantin, "Deep Neural Network for Predicting Changing Market Demands in the Energy Sector for a Sustainable Economy," Energies, vol. 16, (5), pp. 2407, 2023. Available: https://www.proquest.com/scholarly-journals/deep-neural-network-predicting-changing-market/docview/2785195782/se-2. DOI: https://doi.org/10.3390/en16052407.

[56] Y. Zahraoui et al, "Market Mechanisms and Trading in Microgrid Local Electricity Markets: A Comprehensive Review," Energies, vol. 16, (5), pp. 2145, 2023. Available: https://www.proquest.com/scholarly-journals/market-mechanisms-trading-microgrid-local/docview/2785193958/se-2. DOI: https://doi.org/10.3390/en16052145.

[57] Patel, AK, & Zhao, W. "Heat Transfer Analysis of Graphite Foam Embedded Vapor Chamber for Cooling of Power Electronics in Electric Vehicles." Proceedings of the ASME 2017 Heat Transfer Summer Conference. Volume 1: Aerospace Heat Transfer; Computational Heat Transfer; Education; Environmental Heat Transfer; Fire and Combustion Systems; Gas Turbine Heat Transfer; Heat Transfer in Electronic Equipment; Heat Transfer in Energy Systems. Bellevue, Washington, USA. July 9–12, 2017. V001T09A003. ASME. https://doi.org/10.1115/HT2017-4731.

[58] Patel, Anand Kishorbhai. Investigation of a Novel Vapor Chamber for Efficient Heat Spreading and Removal for Power Electronics in Electric Vehicles, thesis, May 2017; Denton, Texas. (https://digital.library.unt.edu/ark:/67531/metadc984206/: accessed September 11, 2023), University of North Texas Libraries, UNT Digital Library, https://digital.library.unt.edu;.DOI: 10.13140/RG.2.2.28847.10402.17.

[59] Anand Patel, "Thermal Performance Investigation of Twisted Tube Heat Exchanger", International Journal of Science and Research (IJSR), Volume 12 Issue 6, June 2023, pp. 350-353, https://www.ijsr.net/getabstract.php?paperid=SR23524161312, DOI: 10.21275/SR23524161312

[60] Anand Patel. TheEffect of Moisture Recovery System on Performance of Cooling Tower. International Journal for Modern Trends in Science and Technology 2023, 9(07), pp. 78-83. https://doi.org/10.46501/IJMTST0907013.

[61] Patel, Anand "Performance Analysis of Helical Tube Heat Exchanger", TIJER - International Research Journal (www.tijer.org), ISSN:2349-9249, Vol.10, Issue 7, page no.946-950, July-2023, Available :http://www.tijer.org/papers/TIJER2307213.pdf.

[62] Patel, Anand. “EFFECT OF PITCH ON THERMAL PERFORMANCE SERPENTINE HEAT EXCHANGER.” INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING (IJRAME), vol. 11, no. 8, Aug. 2023, pp. 01–11. https://doi.org/10.5281/zenodo.8225457.

[63] Patel, Anand. “Advancements in Heat Exchanger Design for Waste Heat Recovery in Industrial Processes.” World Journal of Advanced Research and Reviews (WJARR), vol. 19, no. 03, Sept. 2023, pp. 137–52, doi:10.30574/wjarr.2023.19.3.1763.

[64] Thakre, Shekhar, Pandhare, Amar, Malwe, Prateek D., Gupta, Naveen, Kothare, Chandrakant, Magade, Pramod B., Patel, Anand, Meena, Radhey Shyam, Veza, Ibham, Natrayan L., and Panchal, Hitesh. "Heat transfer and pressure drop analysis of a microchannel heat sink using nanofluids for energy applications" Kerntechnik, 2023. https://doi.org/10.1515/kern-2023-0034.

[65] Patel, A (2023). ""Comparative analysis of solar heaters and heat exchangers in residential water heating"". International Journal of Science and Research Archive (IJSRA),09(02), 830–843. https://doi.org/10.30574/ijsra.2023.9.2.0689."

[66] Patel, A. (2023). Enhancing Heat Transfer Efficiency in Solar Thermal Systems Using Advanced Heat Exchangers. Multidisciplinary International Journal of Research and Development (MIJRD), 02(06), 31–51. https://www.mijrd.com/papers/v2/i6/MIJRDV2I60003.pdf.

[67] Patel, Anand "Optimizing the Efficiency of Solar Heater and Heat Exchanger Integration in Hybrid System", TIJER - International Research Journal (www.tijer.org), ISSN:2349-9249, Vol.10, Issue 8, page no.b270-b281,

August-2023, Available :http://www.tijer.org/papers/TIJER2308157.pdf.

[68] Patel, A. (2023f). Thermal Performance of Combine Solar Air Water Heater with Parabolic Absorber Plate. International Journal of All Research Education and Scientific Methods (IJARESM), 11(7), 2385–2391. http://www.ijaresm.com/uploaded_files/document_file/Anand_Patel3pFZ.pdf

[69] Patel, Anand. “Effect of W Rib Absorber Plate on Thermal Performance Solar Air Heater.” International Journal of Research in Engineering and Science (IJRES), vol. 11, no. 7, July 2023, pp. 407–412. Available: https://www.ijres.org/papers/Volume-11/Issue-7/1107407412.pdf

[70] Patel, Anand. "Performance Evaluation of Square Emboss Absorber Solar Water Heaters." International Journal For Multidisciplinary Research (IJFMR), Volume 5, Issue 4, July-August 2023. https://doi.org/10.36948/ijfmr.2023.v05i04.4917

[71] Anand Patel. (2023). Thermal Performance Analysis of Wire Mesh Solar Air Heater. Eduzone: International Peer Reviewed/Refereed Multidisciplinary Journal, 12(2), 91–96. Retrieved from https://www.eduzonejournal.com/index.php/eiprmj/article/view/389.

[72] Patel, A (2023). "Thermal performance analysis conical solar water heater". World Journal of Advanced Engineering Technology and Sciences (WJAETS), 9(2), 276–283. https://doi.org/10.30574/wjaets.2023.9.2.02286.

[73] Patel, Anand. “Experimental Evaluation of Twisted Tube Solar Water Heater.” International Journal of Engineering Research & Technology (IJERT), vol. 12, issue no. 7, IJERTV12IS070041, July 2023, pp. 30–34, https://www.ijert.org/research/experimental-evaluation-of-twisted-tube-solar-water-heater-IJERTV12IS070041.pdf.