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Integration of Renewable Energy Sources with Utility Connect Ev Charge

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ABSTRACT:
The idea of using Energy Sources with a Utility-Connected EV Charging System is really great. It is a way to charge electric vehicles in a sustainable way. This system uses panels and the utility grid to make sure there is always power available. The solar energy that is collected is. Regulated with the help of an LC circuit and capacitors. This helps to keep the voltage stable and reduces any power that is not needed. Special devices called MOSFETs are used to control the flow of power and make the system work better. There is also a stage that keeps the Renewable Energy Sources and the grid-connected load separate which makes the system safer. The energy that is collected is then sent to the EV charging unit, which makes it possible to charge the vehicles smoothly even when the conditions are not perfect. When there is not solar energy the system automatically switches to using the grid supply so the charging is not interrupted. This way of combining energy and the grid supply makes better use of energy reduces the need for fossil fuels and helps to make transportation eco-friendlier. The system that is proposed is not too expensive it can be made bigger if needed. It is suitable, for the modern smart grid and EV infrastructure. Renewable Energy Sources are a part of this system and they help to make it work well. Overall using Energy Sources with a Utility-Connected EV Charging System is a good idea that can help to make transportation more sustainable.

Keywords: Renewable Energy Integration, Electric Vehicle (EV) Charging, Solar Power System, Utility Grid Connection, MOSFET Switching, LC Filter Circuit, Energy Storage Capacitors, Electrical Isolation, Hybrid Power System, Smart Grid Technology

INTRODUCTION:

Energy demand is increasing rapidly due to the growing use of modern technologies such as electric vehicles (EVs), smart appliances, and automated systems in commercial buildings. These technologies improve comfort and efficiency, but they also lead to higher electricity consumption and increased stress on the power grid. This work is about making the schedule for using appliances and charging electric vehicles in a commercial building that is connected to the grid and also uses hybrid renewable energy systems and battery energy storage. It uses algorithms to lower energy costs and make the system work better while considering the limits of battery discharge. The study shows how important it is to have a schedule for managing energy demand and using renewable resources in the best way possible. This study is about managing energy in a way in micro grids that work together and use renewable energy. It talks about sharing power among micro grids that are connected to each other to make the system more stable and lower costs. The methods they suggest are meant to improve how distributed energy resources work together and make sure energy is delivered in a way. This work looks at off-grid and hybrid vehicle charging systems in detail focusing on using renewable energy sources. It discusses how the systems are set up how they are controlled and the challenges that come with charging vehicles in a sustainable way. The study highlights the things about hybrid systems, such as lowering dependence on the grid and promoting the use of clean energy. This study checks if it is possible to use wind energy systems with electric vehicle charging stations in a grid-connected environment. It looks at how well the system works how cost-effective it's how reliable it is under different environmental conditions showing that hybrid renewable systems can support electric vehicle infrastructure. This work presents a way to control hybrid electric vehicle charging stations using a model that predicts what will happen in the future. It focuses on making the system work efficiently lowering costs and keeping the system stable by predicting what the energy demand will be and adjusting the system accordingly. This study looks at ways to schedule energy use in buildings that use renewable energy sources and battery storage systems. It aims to make the system work efficiently and lower the peak demand by using smart optimization methods. The goal is to make energy consumption in buildings efficient and reliable, by using renewable energy sources and battery storage in the best way possible. This study looks at how electric vehicle charging affects the power grid. It tries to figure out what will happen to the power grid when a lot of people charge their vehicles at the same time. The study is about predicting what will happen to the power grid and finding ways to manage it. The study also talks about ways to charge electric vehicles, such as using a combination of different energy sources or charging vehicles when they are not connected to the power grid. It discusses the bad things about these different methods. The study says that using energy like solar or wind power is important, for making electric vehicle charging better for the environment and more efficient. Electric vehicle charging needs to be managed in a way to make sure it works well.

LITERATURE REVIEW

T. Boonraksa, N. Saeli, P. Boonraksa and B. Marungsri, "Metaheuristic-Based Optimal Scheduling of the Appliances and EV Charging in Grid-Connected Commercial Building Integrated with HRES and BESS Considering the BESS Discharge. The rapid growth of smart grids, renewable energy integration, and electric vehicles (EVs) has significantly increased the complexity of energy management systems.[1]. . - C. Leung, X. Zhu, H. Ding and. He, "Energy Management for Renewable Microgrid Cooperation: Theory and Algorithm," in IEEE Access, vol. 11, pp. The increasing integration of renewable energy resources into modern power systems has led to the development of microgrids as a key solution for decentralized energy generation and management. Microgrids consist of distributed energy resources, energy storage systems, and loads, operating either in grid-connected or islanded modes. Efficient energy management in such systems is essential to ensure reliability, cost-effectiveness, and sustainability. However, the intermittent nature of renewable energy sources introduces significant uncertainty in both generation and demand, making optimal scheduling a complex task [2]. G. Rituraj, G. R. C. Mouli and P. Bauer, "A Comprehensive Review on Off-Grid and Hybrid Charging Systems for Electric Vehicles,", The rapid growth of electric vehicles (EVs) has increased the demand for efficient and sustainable charging infrastructure. Conventional EV charging systems primarily depend on the utility grid; however, this approach faces challenges such as grid congestion, carbon emissions, and limited accessibility in remote areas. As a result, research has increasingly focused on alternative charging solutions, particularly off-grid and hybrid charging systems, to ensure reliable and environmentally friendly EV integration [3]. S. Singh, P. Chauhan and N. J. Singh, "Feasibility of Grid-connected Solar-wind Hybrid System with Electric Vehicle Charging Station," in Journal of Modern Power Systems and Clean Energy The integration of renewable energy sources with electric vehicle (EV) charging infrastructure has gained significant attention in recent years due to increasing energy demand, environmental concerns, and grid limitations. Conventional grid-based EV charging systems often lead to peak load issues and increased carbon emissions. As a result, hybrid renewable energy systems combining solar and wind resources have emerged as a promising solution for sustainable EV charging [4]. J. Cai, C. Chen, P. Liu and S. Duan, "Centralized control of parallel connected power conditioning system in electric vehicle charge-discharge and storage integration station," in Journal of Modern Power Systems and Clean Energy. Traditional EV charging stations typically operate independently without coordination between multiple converters or storage units. However, with the increasing scale of EV charging infrastructure, parallel operation of multiple PCS units has become necessary to meet high power demand and improve system reliability. In such configurations, effective control strategies are required to ensure proper load sharing, voltage regulation, and stable system operation [5]. E. González-Rivera, P. García-Triviño, R. Sarrias-Mena, J. P. Torreglosa, F. Jurado and L. M. Fernández-Ramírez, "Model Predictive Control-Based Optimized Operation of a Hybrid Charging Station for Electric Vehicles. Hybrid EV charging stations typically integrate photovoltaic (PV) systems, battery energy storage systems (BESS), and sometimes additional storage technologies such as hydrogen-based systems. These configurations enhance system reliability and reduce dependency on the grid. However, the variability of renewable energy sources introduces uncertainty in power generation, making real-time energy management a complex task. Efficient coordination among multiple energy sources is therefore essential for optimal system performance [6]. T. Boonraksa, N. Saeli, P. Boonraksa and B. Marungsri, "Metaheuristic-Based Optimal Scheduling of the Appliances and EV Charging in Grid-Connected Commercial Building Integrated with HRES and BESS Considering the BESS Discharge. The integration of EVs into power systems introduces additional challenges due to their stochastic charging behaviour and high energy demand. Uncoordinated EV charging can lead to increased peak loads, voltage fluctuations, and grid instability. Therefore, optimal scheduling of EV charging has become a critical research area. Various optimization techniques have been proposed to address this problem; however, due to the nonlinear and NP-hard nature of scheduling problems, metaheuristic algorithms are often preferred. These algorithms can efficiently handle complex constraints and large search spaces while providing near-optimal solutions within reasonable computational time [7]. S. Singh, P. Chauhan and N. J. Singh, "Feasibility of Grid-connected Solar-wind Hybrid System with Electric Vehicle Charging Station," in Journal of Modern Power Systems and Clean Energy. Grid-connected hybrid systems offer additional advantages compared to standalone systems by enabling bidirectional power exchange with the utility grid. This allows excess renewable energy to be exported to the grid and ensures continuous supply during periods of low renewable generation. Such configurations enhance system flexibility, reduce dependency on fossil fuels, and improve economic feasibility. However, efficient energy management and proper sizing of system components remain critical challenges [8]. G. Rituraj, G. R. C. Mouli and P. Bauer, "A Comprehensive Review On Off-Grid and Hybrid Charging Systems for Electric Vehicles. Hybrid charging systems combine grid-connected and off-grid capabilities, allowing flexible operation under different conditions. These systems can utilize renewable energy when available and draw power from the grid during periods of high demand or low renewable generation. This dual-mode operation improves reliability, reduces dependency on fossil fuels, and enhances overall system efficiency. Hybrid systems also enable bidirectional power flow, supporting advanced functionalities such as vehicle-to-grid (V2G) operations and energy trading [9]. S. Dias Vasconcelos et al., "Assessment of Electric Vehicles Charging Grid Impact via Predictive Indicator. The increasing adoption of electric vehicles (EVs) is exerting considerable pressure on existing electrical grids, particularly due to the high-power demand during peak charging periods. Uncoordinated or unmanaged EV charging can lead to grid congestion, voltage deviations, transformer overloading, and increased operational costs. Consequently, accurate assessment and prediction of grid impacts caused by EV charging are critical for maintaining grid stability and planning future energy infrastructure [10].

Methodology

EXISTING SYSTEM:

The vehicle charging systems that we have now get their power from the grid and also from things, like solar and wind energy. They use batteries to store energy so that the charging does not get interrupted. Most of these systems try to manage energy in a way by scheduling when to charge and when not to balancing the load and making sure everything runs smoothly. The problem is that a lot of these ideas are just tested on computers and do not really work when we try to use them in the real world with actual hardware and equipment. Electric vehicle charging systems need to be able to work in time and be connected to all the other parts of the system.

Disadvantages:

- Limited practical hardware implementation
- High dependence on simulations
- Complex control and management systems
- High cost of installation and maintenance
- Reliability issues due to renewable intermittency

PROPOSED SYSTEM: The proposed system, Integration of Renewable Energy Sources with Utility-Connected EV Charging, offers a viable and efficient alternative for long-term electric vehicle charging that combines solar energy with the utility grid. Solar panels serve as the major renewable energy source for the system, generating clean power. This energy is regulated via capacitors and an LC circuit to maintain voltage stability and reduce fluctuations. MOSFETs are used as high-speed switching devices to control and optimize power flow throughout the system, resulting in efficient energy conversion. An isolation stage is used to provide electrical safety between the renewable source, grid, and load, thereby safeguarding both the system and the user. The processed power is subsequently delivered to the EV charging device, allowing for consistent and uninterrupted functioning. The system is built to run in a hybrid mode, which prioritizes solar energy and uses the utility grid as a backup supply when generation is low. This lessens reliance on traditional energy sources while guaranteeing continuous EV charging. The suggested model is appropriate for real-world applications in smart grids and sustainable transportation systems because it prioritizes practical hardware implementation, effective power management, enhanced safety, and cost-effectiveness as compared to current systems.

Advantages:

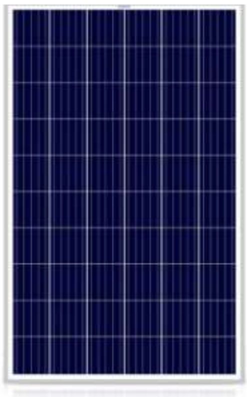
- Utilizes renewable energy, reducing dependence on conventional power sources
- Ensures continuous EV charging with hybrid (solar + grid) operation
- Improves overall energy efficiency through optimized power control
- Provides stable output using LC filtering and capacitors
- Enhances system safety with electrical isolation

- Reduces electricity cost by prioritizing solar energy usage
- Environmentally friendly and supports sustainable transportation

System Modules:

1. Solar panel
2. Mosfet
3. Capacitor
4. LC Circuit
5. Isolation Circuit
6. Utility Grid

SOLAR PANEL



The solar panel is the primary renewable energy source in the system. It converts sunlight into electrical energy using photovoltaic cells. This generated DC power is used to charge the EV or support the system, reducing dependence on the utility grid and promoting clean energy usage.

MOSFET

MOSFET (Metal Oxide Semiconductor Field Effect Transistor) acts as a high-speed electronic switch. It controls the flow of power between different stages of the system, ensuring efficient energy conversion and minimal power loss. It is widely used due to its fast switching and high efficiency.

CAPACITORS

Capacitors are used to store electrical energy temporarily and smooth out voltage fluctuations. In this system, they help in reducing ripple in the output and maintaining a stable voltage supply for efficient EV charging.

LC CIRCUIT (FILTER)

The LC circuit consists of an inductor (L) and a capacitor (C) connected together to filter unwanted noise and fluctuations in the electrical signal. It ensures a smooth and stable DC output by reducing harmonics and ripple from the power supply.

ISOLATION UNIT

The isolation unit provides electrical separation between different parts of the system, such as the solar source, grid, and load. It improves safety by preventing electrical shocks and protects sensitive components from faults and voltage surges.

LOAD (EV CHARGING UNIT)

The load in this system is the electric vehicle charging unit. It receives regulated and stable power from the system to charge the EV battery efficiently. The system ensures uninterrupted charging by switching between solar and grid supply based on availability.

UTILITY GRID

The utility grid acts as a backup power source. When solar energy is insufficient, the system automatically switches to grid supply to maintain continuous EV charging. This hybrid approach ensures reliability and consistent performance.

RESULT:

The installed system shows how well renewable energy sources can work with an EV charging station that is connected to the grid. The solar panels work well to make electricity, and LC circuits and capacitors control the output to make it stable and smooth. The MOSFET-based switching mechanism does a good job of controlling the flow of power, which reduces losses and makes the system more efficient. The system works well in all kinds of weather because it prioritizes solar energy and switches to the grid when there isn't enough solar power. This makes sure that EV charging doesn't stop. The isolation stage makes things safer by keeping both the system and users safe from electrical problems. The system produces stable voltage, uses energy efficiently, and runs all the time, which shows that it is good for real-time applications.

CONCLUSION

The proposed system successfully demonstrates a sustainable and efficient solution for EV charging by integrating renewable energy sources with the utility grid. By utilizing solar energy as the primary source and the grid as a backup, the system ensures continuous and reliable operation. The use of LC circuits, capacitors, and MOSFETs enhances power quality, efficiency, and control, while the isolation stage improves overall safety. This hybrid approach reduces dependence on fossil fuels, promotes clean energy usage, and supports eco-friendly transportation. The system is cost-effective, scalable, and suitable for modern smart grid applications. Overall, it proves to be a practical and forward-looking solution for meeting the growing demand for electric vehicle charging infrastructure in a sustainable manner.

Future scope:

- Integration of battery storage for efficient use of excess solar energy
- Implementation of AI-based energy management for better optimization
- Adoption of Vehicle-to-Grid (V2G) technology for grid support
- Development of fast-charging techniques for reduced charging time
- Use of IoT and mobile applications for real-time monitoring and control

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