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Hybrid Renewable Energy based Dual Power Electric Vehicle Charging Station

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***Abstract*: This paper introduces a Hybrid renewable energy based dual power electric vehicle charging station [EVCS]. This new perspective considers global challenges for energy demand while minimizing environmental impact. The prospective suggests a usage of a fuzzy inference system in MATLAB SIMULINK to manage power generation, EV power demand, charging periods, and existing charging rates to optimize real-time charging costs and renewable energy utilization. The output results obtained show cost reduction when compared to existing flat rate tariffs and other weekends and weekdays offers, furthermore this proposed idea shows a significant reduction in greenhouse effect and yields good profits for the owners of charging station.**

***Keywords*: electric vehicle charging station, fuzzy logic, renewable resources.**

1. Introduction

Electric vehicles (EVs) are fast emerging alternative to conventional fossil fuel combustion engine vehicles. To cut short the expanding needs of fossil fuels and in concern with the climate change and environmental pollution, EV's can be significant step towards reducing greenhouse gas emission. As the demand of EV's increases on road the need for electric vehicle charging station also increases, which should be more reliable, efficient, and environmentally conscious energy infra structure.

Hybrid renewable energy-based dual power electric vehicle charging stations (EVCSs) utilizes a combination of renewable energy source such as wind power along with biogas generation to charge electric vehicles. On Integrating the renewable energy sources in electric vehicle charging stations, automatically reduces the need of conventional fossil fuels and lowers the carbon emissions. But occasionally EV's pose challenges to the operation of charging stations due to intermittent nature of renewable energy generation and the variable charging demands. To answer these challenges and to optimize the utilization of renewable energy in EV charging, Energy Management System (EMS) plays a crucial role. An EMS is software and hardware system that monitors, controls, and optimizes energy flow among renewable energy, sources, energy storage system (ESS) and EV charging stations. This paper gives an idea of the role of EMS in hybrid renewable energy based EVCS. The dominance of energy management system in hybrid EVCS are,

1. Cost reduction
2. Environmental sustainability
3. Grid stability
4. Enhanced reliability

These charging stations utilize a combination of renewable energy sources, i.e., wind power and biogas along with grid electricity to charge electric vehicles. For sustainable transportation Hybrid renewable energy based dual power electrical vehicle charging stations shows many advantages and gives a promising solution.

2. Literature Review

As there is a shoot up in global electricity demand which has led to exploitation of fossil fuel resources and affecting the environment, resulting in global warming. Due to the increasing fossil fuel consumption, even the transportation industry contributes significantly to worldwide greenhouse gas (GHG) emissions. To overcome this issue electric vehicles will be best solution. Furthermore, the rapid implementation of EVs will be a cheaper mode of transportation, especially in developing countries but it is limited by the lack of charging stations. Therefore, to bridge the gap Hybrid renewable energy based dual power electrical vehicle charging station will be appropriate idea.

The proposed model has a part which uses,

Considered EV parameters	Contribution
EV battery SOC, parking duration and power availability	Proposed a fuzzy logic-based charging scheme for optimal power distribution to the EVs, reducing stress on the power grid.
EV demand, time of use	Reduces charging costs, satisfies EV demand, and avoids overloading, the time of use, critical peak price, and real-time pricing.
Charging reservation time, electricity price	Demonstrated an optimization scheme based on charging reservation time, derivation of charging reservation time, and electricity cost.

3. System Methodologies

A. Electric Vehicle Charging Station

In developing countries Electric vehicle charging stations are not sufficient. There are two types of charging stations exist i.e. public and private charging stations. The private charging stations have taken a higher charging rate. Fig. 1 shows a block

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diagram of an EVCS which comprises transformer, rectifier, and converter. Rectifier and converter make a charger which is used for EV charging.

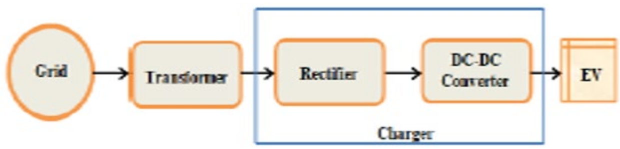

Fig. 1. Block diagram of Electric Vehicle Charging Station

B. Building a Fuzzy Inference System

Fuzzy inference is a method that interprets the values in the input vector and based on user defined rules, assigns values to the output vector. Using the GUI editors and viewers in the Fuzzy Logic Toolbox, you can build the rules set, define the membership functions, and analyze the behavior of a fuzzy inference system (FIS). The following editors and viewers are provided.

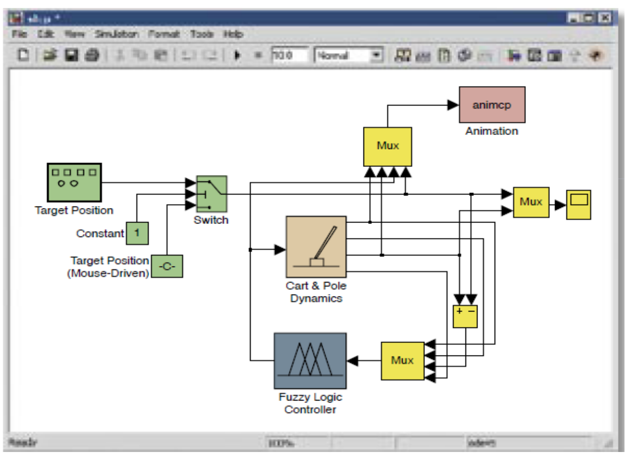

Fig. 2. Fuzzy interference system

Key features:

- Specialized GUIs for building fuzzy inference systems and viewing and analyzing results.
- Membership functions for creating fuzzy inference systems.
- Support for AND, OR, and NOT logic in user-defined rules.
- Standard Mamdani and Sugeno-type fuzzy inference systems.
- Automated membership function shaping through neuroadaptive and fuzzy clustering learning techniques.
- Ability to embed a fuzzy inference system in a Simulink model.
- Ability to generate embeddable C code or stand-alone executable fuzzy inference engines.

C. Wind Turbine

One of the fastest-growing renewable energy source in the country is wind energy. As India has vast coastline, wind plant in India is on shore and offshore. Choosing a location for a wind turbine is very important aspect. Wind's kinetic energy is collected from blades of wind turbines. Wind flows over the blades creating lift which causes the blades to turn. The blades are connected to a drive shaft that turns an electric generator, which produces electricity. As of 30 September 2022, wind energy in India has an overall installed power capacity of 41.666 GW. Wind energy in India has a huge potential to fulfill the country's power needs and boost the economy. The largest Wind Farm in India is the Muppandal Wind Farm in Tamil Nadu.

D. Biogas Generator

In biogas system there exists a biogas digester, Iron-chelate chamber, collector, and biogas fuelled generator. Biogas arises from the process of biodegradation of organic material under anaerobic conditions i.e. absence of oxygen. A major role is played by digester plant system as it determines the biogas composition and its properties. The cattle dung along with other substrates is constantly heated and stirred to ensure the homogeneity of gas. Floating gas holder type digester is used for biogas production. The gas thus produced is collected in the biogas balloon. Biogas acts as a promising alternative fuel, especially for gaseous fuelled engines. It consists of a varying proportion of CH_4 (methane) and CO_2 (carbon dioxide) and traces of H_2S (hydrogen sulphide), Ammonia (NH_3), H_2O (water vapour), etc. In which CH_4 (around 50%–70% of composition) is the most valuable component under the aspect of using it as a fuel for Internal Combustion (IC) engines.

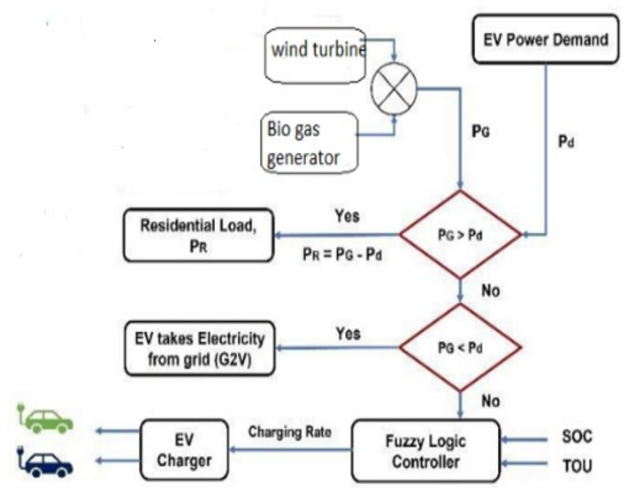

Fig. 3.

4. Conclusion

To meet the demand of current generation EV opens new avenues for research on renewable integration. This study aimed to design and developed an optimization algorithm for an EVCS using wind and biogas resources. The proposed approach also helps in reduction of GHG emissions and stress from the distribution grid. Based on power availability, EV power demand, charging period and existing tariff the fuzzy optimization algorithm optimizes the charging cost. It also helps in decreasing power quality problems during peak hours. This paper focuses on using wind and biogas resources in a hybrid mode for EV charging and developing an effective energy management system for EVCS.

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