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A REVIEW ON GRID-CONNECTED SOLAR-WIND HYBRID SYSTEM FOR ELECTRICAL APPLICATION

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***Abstract*—**Recently, the smart grid has been paying more and more attention to renewable energy production and electric vehicles (EVs). In order to meet the electrical load demand in India, a grid-connected solar-wind hybrid system is presented in this study. The system also includes a charging station for electric vehicles. The proposed setup is subjected to an economic analysis in order to meet both the retail center's electrical load demand and the demand for EV charging. The cost of the energy that is purchased and then sold to the utility grid is taken into account while designing the suggested system, and the utility grid and other system components are guaranteed to exchange power. By utilising optimization techniques, the component is sized to achieve the lowest levelized cost of electricity (LCOE) while decreasing the probability of a power supply failure (LPSP). The efficient management of renewable energy generation and load needs is determined to be a key to designing a system that is both affordable and dependable. Particularly in poorer nations, the proposed approach would be useful in lessening reliance on the grid's heavy load.

***Keywords*—**Charging station, electric vehicle (EV), optimi- zation, solar photovoltaic (SPV) panels, wind turbine.

I .INTRODUCTION

The microgrid is an intriguing way to use more power, as it increases the efficiency of power supply and the quality of electricity consumed by various users [9][10]. The use of distributed renewable energy sources has expanded to lessen pollution, improve network dependability, and make it easier to electrify remote places [2]. In order to minimise carbon emissions, diversify energy sources, and revitalise local economies, particularly in poor nations, microgrids (MGs) powered by HRERs such solar arrays (PV) and wind turbine generators (WTGs) have recently attracted a lot of attention [11]. In order to improve operation efficiency, hybrid AC/DC MGs integrate the advantages of both AC and DC subgrids [14] and minimise conversion stages [15]

Because of this, hybrid MGs offer a promising alternative for either subpar poor distant populations [16] or even developed load centres that are isolated from primary utilities to meet their electrical needs [17]. In addition, constant population increase and rising load demand spurred aggressive strategies to ensure a sustainable and dependable power supply [18] via hybrid AC/DC autonomous MGs [19] whenever grid connection is not possible or is not cost-effective [20]. Though long-term supplemental energy storage systems (ESSs) can effectively suppress HRER irregularities [22] so that standalone MGs function as conventional power plants [23], MGs are still susceptible to notable voltage and/or frequency deviations due to climatic vagaries, such as changes in solar radiation and wind speed [21]. Hybrid energy storage systems (HESSs), which are distinguished not only by high power density but also by high energy density, are essential to handle rapid power changes and simultaneously ensure MG autonomy [24][3].

In the current electricity grid, EVs and plug-in hybrid EVs have grown significantly in recent years. An exciting and difficult study field is the integration of EVs in terms of economic analysis and power management in the renewable energy-based system. The control and power management of EVs in microgrid or grid-connected systems are the main research areas. One of the crucial considerations that must be made is an economic analysis that takes the power exchange with the grid into account. The growing use of EVs creates opportunities and difficulties for the current power infrastructure. The reliability, ACS, and a smooth power flow across the components are the three main factors to consider while developing a renewable energy-based system [1].

II. Literature Review

Sr. No.	Author/ citation []	Methodology	Features	Challenges
1.	Shakti Singh *et al.* [1]	Optimized microgrid controller	System that is reliable Affordable helps reduce dependency on the overworked grid	Grid dependency increases
2.	Bhargavi and Jayalakshmi [2]	Novel control strategy	• enticing possibility to boost effectiveness • a PEV charging device and the DC bus voltage can both be regulated	• Might cause the devices to share power improperly.
3	Sayed Abulanwar *et al.* [3]	Adaptive synergistic control strategy	• show a flawless exchange of the desired load power • reduce bus voltage disturbances brought on by large load variations • increases the robustness of the microgrid against parameter uncertainty	• taking into account predetermined parameters, which reduces system performance.
4.	Dina Emara *et al.* [4]	Coordinated control	• be functional in both normal and abnormal circumstances. • Greater adaptability and dependability	• Establishes a controlled DC voltage with reliable operation and few voltage spikes.
5	Pramod Bhat Nempu and Jayalakshmi [5]	Fuzzy logic and adaptive neuro-fuzzy inference system	• The battery system's voltage and power output transients are reduced	• There has been no discussion of the comparative analysis of FLC and ANFIS with PI regulators under dynamic system conditions.
6	Oladepo Olatunde *et al.* [6]	grid-connected load-following system with EV	• Improved power loss reduction • dynamic energy reserve • voltage regulation	due to the extensive system and high load demand, cannot operate effectively in an

				emergency
7	Asim Datta *et al.* [7]	Coordinated AC frequency vs DC voltage control (CFVC) scheme	• high robustness • capacity to tolerate a wide range of system loading	difficult to balance exploration and exploitation abilities
8	Peng Wang *et al.* [8]	stochastic scheduling approach	• it is conceivable to run hybrid microgrids that incorporate the high uncertainty of renewable energy sources. • dependable and consistent performance	• Plug-in electric vehicle use may have an impact on the security of hybrid microgrids.

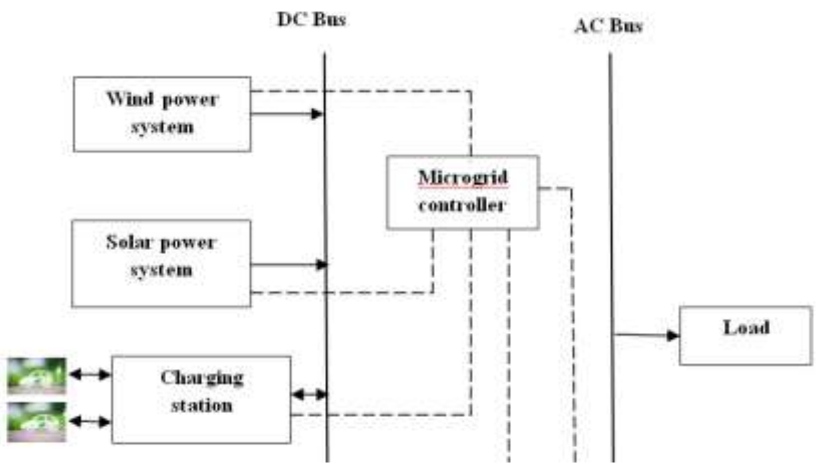
III. Methodology

The final goal of the research that is being presented is to carry out cost minimization when switching between AC and DC power microgrids. The suggested model includes an electric vehicle charging station, a hybrid AC/DC microgrid system, a wind power generation system, and a solar power generation unit. Wind turbines, SPV panels, and a charging station are connected to the DC bus, whilst the electrical load is connected to the AC bus. To convert AC into DC and vice versa, a dual converter is proposed. In a hybrid AC/DC system, as opposed to a single AC or DC system, power management is more important in terms of cost. As a result, the suggested research's goal of cost minimization is combined with a smooth power flow between the system's numerous components. To achieve the lowest levelized cost of electricity (LCOE) while minimising the loss of power supply probability (LPSP), the Aquila Marine optimization (AqMar) Algorithm is suggested [1]. The marine predator optimization algorithm (MPA) [25] and the aquila optimization algorithm (AOA) [26] have been integrated into the development of the proposed AqMar. Multiple energy sources make up the planned hybrid renewable energy system. Due of the numerous decision factors in this subject, complex optimization problems occur. The main goal of the suggested algorithm is to maximise converter, wind, and SPV capacity in order to satisfy the fitness functions of LCOE and LPSP. For the AC load and EV charging station to receive an uninterrupted power supply, this issue necessitates the identification of energy sources. Consequently, the optimization problem includes economic goals. Additionally, to find the best balance between LPSP and LCOE, long-term system performance must be calculated. The suggested AqMar algorithm reduces LCOE by dynamically searching for an ideal system configuration and keeping LPSP within specified bounds. As a result, an ideal power exchange between the utility grid and other system components is guaranteed.

TABLE I : SPECIFICATION AND COST OF SYSTEM COMPONENT

Sr. No.	Component	Parameter	Value
1.	SPV panel	Maximum power Pmax	100 W
		Maximum voltage Vmp	18 V
		Maximum power current Imp	5.56 A
		Open circuit voltage Voc	22.3 V
		Short-circuit current Isc	6.1 A
		Number of cells	36
		Nominal operation cell temperatur	45
		Capital cost and replacement cost	1084 $/kW
		O&M cost	5 $/year

		Life time	20 year
2.	Wind turbine	Rated power	1 kW
		Capital and replacement cost	1098 $/kW
		O&M cost	2 $/kW/year
		Cut-out speed Vco	20 m/s
		Cut-in speed Vcin	5 m/s
		Hub height	50 m
		Life time	20 year
3.	Others	DC bus voltage Vbus	120 V
		Project life N	20 year
		Interest rate i	6 %
4.	Converter	Rated power	1 kW
		Rectifier and invert efficiencies	90 %
		Capital and replacement cost	127 $/kW
		O&M cost	1 $/year
		Life time	20 year
5.	EV battery specification	Battery ampere-hour	210 Ah
		Battery type and variant	Lithiumion
		Number of modules	16
		Number of cells	48
		Battery energy capacity	5 kWh
		Maximum charging rate	0.5 kWh/h
		Maximum number of vehicles/bays	20



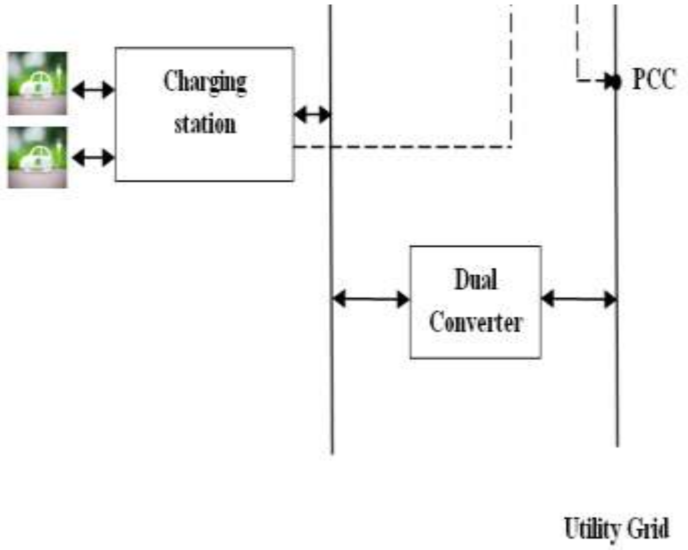


Figure 1. Schematic diagram of proposed system

IV.EXPECTED OUTCOMES

In MATLAB, the suggested model—which employs a hybrid AqMar optimizer—will be simulated before experimental testing and analysis are done. The proposed model is compared to numerous standardised models as part of the performance analysis of the work, and it is discovered to be superior in terms of cost and power loss.

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