FOREX Publication
Open Access | Rapid and quality publishing
International Journal of
Electrical and Electronics Research (IJEER)
Research Article | Volume 12, Issue 2 | Pages 345-351 | e-ISSN: 2347-470X

Green Power EV Charging Station Design and Analysis for Electric Vehicles

Vinoth John Prakash S[1], Mano Raja Paul M[2], Kannan S[3], Ann Rufus A[4] and Bhuvanesh A[5]

[1]*Department of Electrical and Electronics Engineering, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai, Tamil Nadu, India, vjp.tiglfg@gmail.com*
[2]*Department of Electrical and Electronics Engineering, Nehru Institute of Engineering and Technology, Coimbatore, Tamil Nadu, manorajapaul06@gmail.com*
[3]*Department of Electrical and Electronics Engineering, Ramco Institute of Technology, Rajapalayam, Tamil Nadu, India, kannan@ritrjpm.ac.in*
[4]*Department of Electrical and Electronics Engineering, SCAD College of Engineering and Technology, Tirunelveli, Tamil Nadu, India, annrufus@gmail.com*
[5]*Department of Electrical and Electronics Engineering, PSN College of Engineering and Technology, Tirunelveli, Tamil Nadu, India, bhuvanesh.ananthan@gmail.com*

***Correspondence:** Vinoth John Prakash S, **E-mail:** vjp.tiglfg@gmail.com

ABSTRACT- The primary goal of this research is to design on electric vehicle charging station with less emission in Chennai due to an increase in electric vehicles. The wind and solar are common renewable energy sources which produces green power. These renewable sources can also be implemented with diesel generator and grid connection to run the Electric Vehicle (EV) charging station. This research also focuses on the cost of energy and the total cost of the system for different sources to operate EV charging station. The sources to operate an EV charging station in various period of time to charge the vehicle are analyzed. The sensitivity analysis like derating of solar also done to examine the status of different parameters in entire system with low cost. The design of low-cost system for Electric Vehicle charging station will be a useful implementation to Chennai city for charge various EV vehicles. The result shows that the price of energy and total cost of the system are 0.176 $/kWh and $ 363,094 respectively for entire system which considers to charge different EV bike and EV car through EV charging station. The simulation for this research work is carried out in HOMER Grid software.

Keywords: EV charging station, Solar, Wind, Total cost, Battery.

ARTICLE INFORMATION
Author(s): Vinoth John Prakash S, Mano Raja Paul M, Kannan S, Ann Rufus A and Bhuvanesh A;
Received: 09/11/23; **Accepted**: 13/03/24; **Published**: 30/04/24;
E- ISSN: 2347-470X;
Paper Id: IJEER231024;
Citation: 10.37391/IJEER.120203
Webpage-link:
https://ijeer.forexjournal.co.in/archive/volume-12/ijeer-120203.html

crossref member
CROSSREF.ORG THE CITATION LINKING BACKBONE

Publisher's Note: FOREX Publication stays neutral with regard to jurisdictional claims in Published maps and institutional affiliations.

1. INTRODUCTION

Electric Vehicles are important in current research since they are future. The main goal of using electric vehicle is to avoid surrounding emission which is produced in petrol/diesel vehicles. The lack of resource is Electric Vehicle (EV) charging station. This EV charging station is not available everywhere like petrol bunks. More number of electric vehicles is not possible to charge at a particular period of time in any area with less hours of charging. In this research, the EV charging station is investigated in Chennai, India. The number of EV's is charged at a time with low cost. Usually, the grid is used for charging the vehicle through EV charging station but, in this research, renewable sources (solar and wind) also included to charge electric vehicles. The diesel generator is also used in hybrid power system when there is no output in renewable source due to climate condition. The EV charging station operated with diesel generator to overcome the effect of power shortage [1] The HOMER grid software is used to optimize the EV charging station with low cost [2]. The objective of this research work is to conduct a suitable design of charging station for electric vehicle with low cost and emission free environment. The novelty of this work is that the charging station design is done with renewable sources in Chennai for supplying power and sensitive variation of various derating of solar is conducted. The energy efficiency issue is due to usage of solar panel with dust particle and shading effect. The solar panel with dust particle will have less output. This proposed simulation has solar panel with better efficiency. The renewable operated electric vehicle station gives emission free environment. The main contribution of this paper is that the real time solar radiation and wind data are considered to optimize the hybrid renewable system-based EV charging station with low cost and less emission. For optimizing the system components, HOMER grid is used.

2. LITERATURE SURVEY

The Qatar is powered with renewable based electric vehicle charging station which estimates the cost of energy to and

International Journal of
Electrical and Electronics Research (IJEER)
Research Article | Volume 12, Issue 2 | Pages 345-351 | e-ISSN: 2347-470X

electrical values of hybrid power system [3]. The microgrid is designed for EV powered application which is utilized with energy storage technique [4]. The electric vehicle is charged with hybrid renewable source and this charging station operates 15 hours in a day by charging 10 EV vehicles [5]. The optimal sizing also performed in calculating hybrid power source EV charging station results. The quality of power is addressed and it can be applicable for small change in variation of load. The result also shows that the microgrid is suitable with better performance for fault in the system [6]. The diesel generator operated with solar and battery with suitable planning and validation process [7]. The effect of emission is avoided due to implementation of renewable in Maldives. The different strategies are compared and the result shows that the load following strategy produces less carbon emission than other strategies [8]. The future source of energy focussing on renewable sources all over the globe especially in remote areas. The total price of hybrid renewable system is higher than the centralized power production to the Island area. The construction cost of the centralized power production is higher than the hybrid renewable system. So, the non-conventional source has low cost of each unit energy [9]. The high capacity microgrid system is developed in Thailand using DIgSILENT software. The hydro, solar, generator and battery are rated more than 1 MW capacity [10]. The feasibility, stability of renewable system provides reliable power supply for remote location [11]. The reactive power and active power response for load following dispatch strategy which is best strategy in optimization process. The frequency and voltage variation and stability study of hybrid microgrid system are analyzed [12-17]. The active power and frequency of wind, solar and generator and emission (CO_2) discharges are analyzed in Islanded area of microgrid system [18]. The response of bus voltage, cost and power flow in Maldives are analyzed [19]. The system is simulated with low cost of energy 0.02 $/kWh when connected to grid supply. The microgrid is designed with various protection scheme for various kind of faults in the system [20]. The lifetime cost and cost of reliability is evaluated based on unmet load in microgrid system [21]. The result shows that the microgrid has low lifetime cost in optimization process. The fuel cell is used in microgrid for charging electric vehicles [22]. The future trends for optimization in remote areas are discussed with energy management system [23]. The microgid power flow method is necessary to understand the AC and DC power flow in the system [24]. The renewable based microgrid system for supplying power is highlighted [25-27]. The microgrid is designed in rural area for development with low cost [28].

3. BLOCK DIAGRAM DESCRIPTION

Figure 1 illustrate the structure of EV charging hybrid sources. The following are the power which is produced to satisfy the EV charging station and AC primary load. The various sources are solar energy, wind energy, grid, diesel generator. The lithium-ion battery is used in DC bus as bi-directional device. The converter is used for proper functioning of hybrid system with low cost. Whenever the AC to DC or vice versa transmission required, this converter is used to fulfil the EV charging station and load.

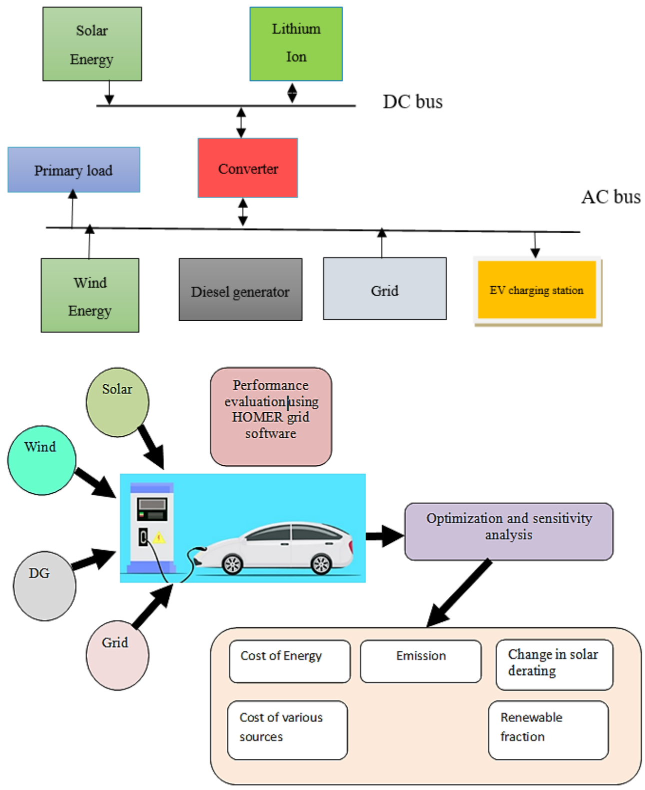

Figure 1: Structure of EV charging hybrid sources

4. METHODOLOGY

Table 1. Specification of Electric Vehicle

EV's	Quantity of EV	Max. charging power per EV (kW)	Average charging time (min)
EV Car	30	120	260
EV bike	70	30	260

Table 1 shows the specification of Electric vehicle. The number of chargers considered is 20. The charging power considered is 12 kW. The electric vehicle is visited one time during 6 a.m. and between 11 a.m. to 3 p.m. The electric vehicle is visited 2 times on 7 a.m. and 9 a.m. and 3 times on 8 a.m. The average energy for charging EV's is 258 kWh/day. The EV car and bike are distributed with 30% and 70% respectively.

The *figure 2* shows the proposed HOMER grid methodology. The inputs like cost of components, wind speed and solar radiation need to give HOMER grid. Then sensitivity and optimization are performed to determine the total cost and cost of energy.

Figure 3 shows the daily profile data of electrical load demand for EV charging station. To power electric vehicles in charging station, control room which requires fans, tube lights which operating during entire hours in a day. The load power varies from 1 kW to 1.5 kW of load in a day.

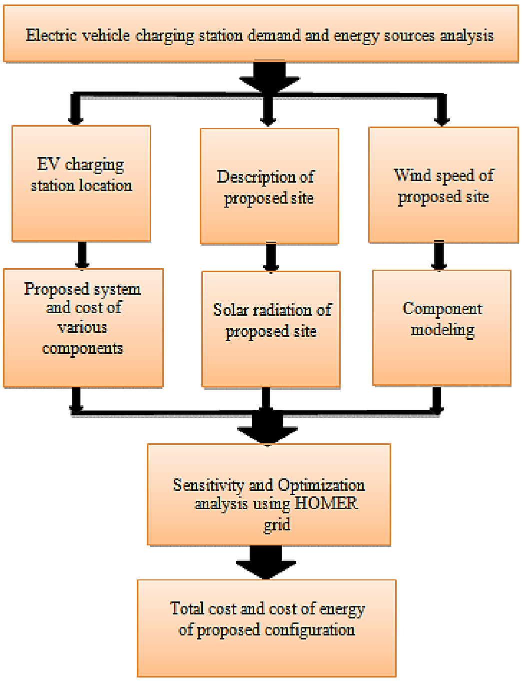

Figure 2: Proposed HOMER grid methodology

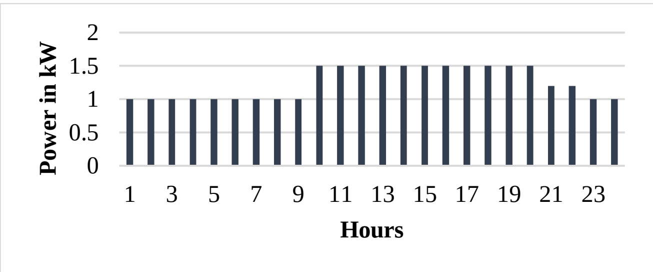

Figure 3: Electric load (Daily profile)

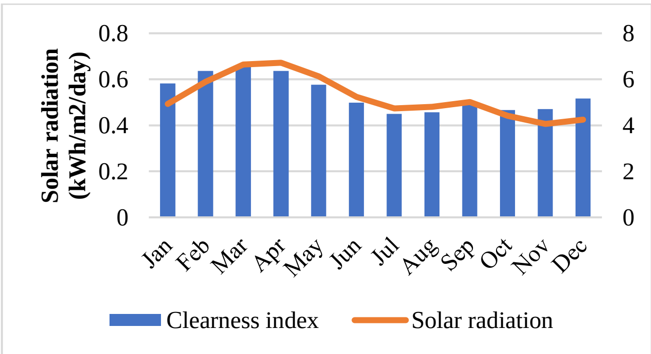

Figure 4: Solar radiation of Chennai in a year

Figure 4 shows the average solar radiation of Chennai in a year. The average solar radiation is highest during the month of April, which is 6.72 kWh/m2/day. The average solar radiation in Chennai is 5.23 kWh/m2/day. The average clearness index variation for each month in a year varies.

Figure 5 shows the average wind speed of Chennai in a year. The average wind speed is highest during the month of June, which is 6.31 m/s. The overall average wind speed in Chennai is 5.51 m/s. The average wind speed in Chennai is only 4.53 m/s during October month.

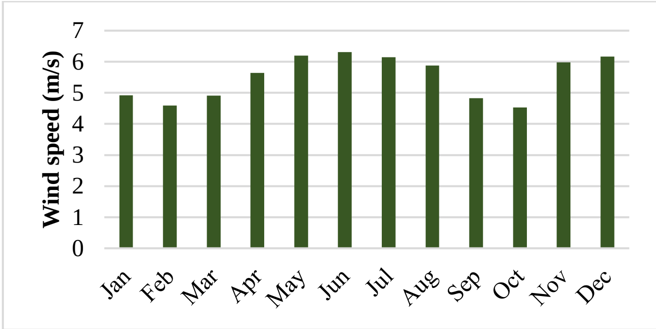

Figure 5: Wind speed of Chennai in a year

The objective of this research based on EV charging station is given in *equation (1),*

$$\text{Min cost} = \text{Min (TC)} \quad (1)$$

where, TC is the total cost which is to be minimized for charging Electric vehicle through various sources. The wind turbine output 'WTO' be contingent mainly on speed of wind and it is evaluated by the following *equation (2),*

$$\text{WTO} = \left(\frac{s^3\ \rho_{air}}{2}\right) * s_a C \text{ in watts} \quad (2)$$

where, s is Chennai wind speed in m/s, ρ_{air} is air density, S_a is swept area of rotor WT in m^2 and C is power coefficient of WT. The capital, replacement and O&M cost for 1 kW wind turbine are $ 3200, $ 3200 and $ 100 respectively.

The solar panel produces power and it is represented mathematically as shown in *equation (3),*

$$\text{SO} = [\emptyset\ (\text{TP} - \text{TS}) + 1]\ \text{DF} * \text{PR} * \text{R}\left(\frac{1}{\text{S}}\right) \quad (3)$$

where, Ø is solar coefficient in %/°C, 'R' is the radiation of solar in kW/m^2, *S* is the standard radiation in kW/m^2, DF is derating factor, *PR* is the rated PV power in kW, *TP* is PV temperature in °C and *TS* is the PV standard temperature. The capital, replacement and O&M cost for 1 kW solar are $ 650, $ 650 and 15 $/year respectively. The converter which processes the different conversion from AC and DC and it is mathematically represented in *equation (4),*

$$P_o(t) = P_i(t) * \eta_c \quad (4)$$

where, $P_i(t)$ and $P_o(t)$ are the input and output of converter and η_c is converter efficiency. The capital, replacement and O&M cost for converter are $ 290, $ 290 and $ 0 respectively.

The battery capacity 'B_C'is evaluated using the *equation (5),*

$$B_C = \frac{b_a * L}{C * \eta_b * DOD} \quad (5)$$

where, C is the battery capacity, b_a is autonomy of battery, L is the EV vehicle charging and electric load, DOD is discharging depth of battery and η_b is efficiency of battery. The capital, replacement and O&M cost for 1 kWh battery are $ 150, $ 150

FOREX Publication
Open Access | Rapid and quality publishing
International Journal of
Electrical and Electronics Research (IJEER)
Research Article | Volume 12, Issue 2 | Pages 345-351 | e-ISSN: 2347-470X

and 10 $/year respectively. The consumption of fuel in DG is from *equation (6).*

$$F(t)=I_C*Pr+ I_S *P_O(t) \quad (6)$$

where I_S is the fuel curve slope, I_C is the intercept coefficient, P_r is the rated power of DG and $P_O(t)$ is the real power of DG. The capital, replacement and O&M cost for 1 kW generator are $ 250, $ 250 and 0.010 $/kWh. The total cost 'TC' is represented by *equation (7).*

$$TC = C_{a,T}\left(\frac{1}{RF_{capacity}(r_i,l)}\right) \quad (7)$$

where, $C_{annual,\ T}$ is the annualized cost in $, $RF_{Capacity}$ is the capital recovery factor, r_i is discount rate and l are 25 years lifetime. The cost of energy 'COE' is the ratio of annualized cost '$C_{a,\ T}$' to the sum of EV charging and electric load 'L' as given in *equation (8).*

$$LEC = \frac{C_{al,T}}{\sum_{t=1}^{8760} L(t)} \quad (8)$$

5. SIMULATION RESULTS

5.1 Optimization result of hybrid system

Table 2. Result analysis of EV charging station

Session per year	Annual energy served (kWh)	Energy per session (kWh)	Session per day	Peak power (kW)
1825	94,128	51.6	5	83.8

Table 2 shows the result analysis of EV charging station. The number of sessions per year is 1825 with 51.6 kWh energy per session. Maximum power obtained from the EV charger to charge vehicles is 83.8 kW which is on 17th August. Based on the EV charging vehicle values, the renewables, DG and grid gives power at low cost.

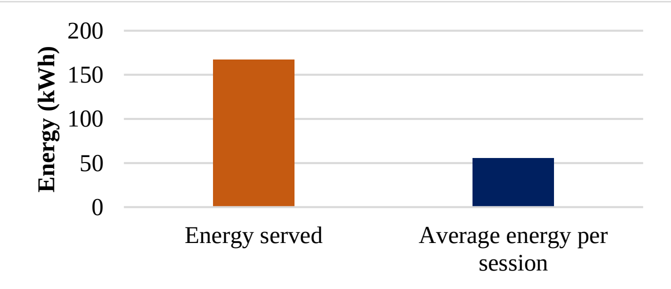

Figure 6: Result analysis of EV charging station on 7th February

Figure 6 shows the result analysis of EV charging station on 7th February. The number of sessions on this day is 3 and total charging time for 3 sessions is 13.93 hrs. The total energy served and average energy per session are 167 kWh and 55.7 kWh respectively. For each and every day, the energy served to electric vehicle will change based on the power demand of electric vehicle.

Table 3. Cost for various solar derating in hybrid model

PV Derating (%)	DF	Total cost ($)	Cost of Energy ($/ kWh)
80	DF1	370,525	0.186
82	DF2	366,790	0.181
85	DF3	363,094	0.176

Table 3 shows the cost for various solar derating in hybrid model. The cost of energy is 0.176 $/kWh when solar derating is 85% which is low compared to 80% and 82% solar derating. So, the results of 85% solar derating are considered as best case and optimization results analysed based on 85% solar derating.

Table 4 shows the optimization results of EV charging station-based hybrid system. The capacity of different components in the system is evaluated. The suitable power required from different renewables during particular period of time based on climate condition and diesel generator and grid to charge the electric vehicle required for each day is shown in Table.4. The solar is used in larger capacity in this system as 107,834 kWh/year for charging electric vehicle when it requires.

Table 4. Optimization result of hybrid system

System parameters	Values	System parameters	Values
PV capacity	78 kW	Battery capacity	95 kWh
PV Production	107,834 kWh/yr	Autonomy	142 hrs
WT capacity	24 kW	Energy sold from grid	55919 kWh/yr
WT Production	44201 kWh/yr	Energy purchased from grid	1481 kWh/yr
DG capacity	250 kW	Converter	56.7 kW
DG production	8000 kWh	Renewable Fraction	94.4%

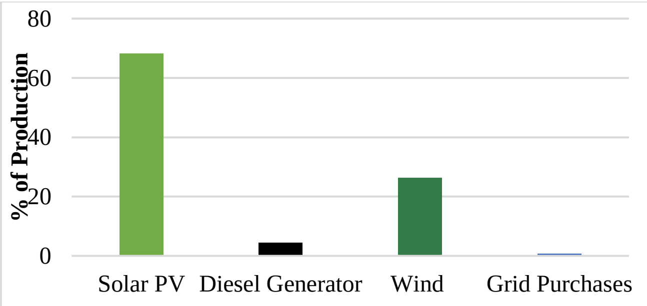

Figure 7: % of Production from various sources

Figure 7 shows the production of electricity from dissimilar sources of power. The solar and wind are frequently used in generation power to supply power to various electric vehicle (Car and bike) and load power. The power shortage is overcome by implementing diesel generator and purchasing power from grid. The solar power generated 114125 kWh in a year which is higher power source used to power electric vehicles. The wind, diesel generator and grid purchases are 44,201 kWh, 7562 kWh and 1321 kWh in a year. This diesel generator produces 61,252 kg/year CO_2 emission.

FOREX Publication
Open Access | Rapid and quality publishing

International Journal of
Electrical and Electronics Research (IJEER)
Research Article | Volume 12, Issue 2 | Pages 345-351 | e-ISSN: 2347-470X

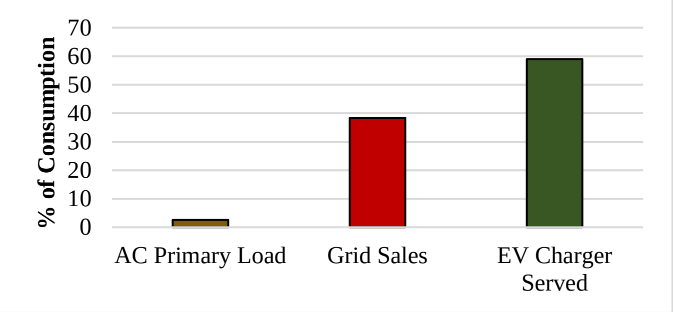

Figure 8: % of Consumption

Figure 8 shows the consumption of AC load, grid sales and EV charger served. Based on the demand of various vehicles in Chennai, the power is supplied from source to EV charging station in a year. The excess power is fed to the grid for saving cost. The highest consumption is from EV charging station of 94,128 kWh/year with 59% of total consumption.

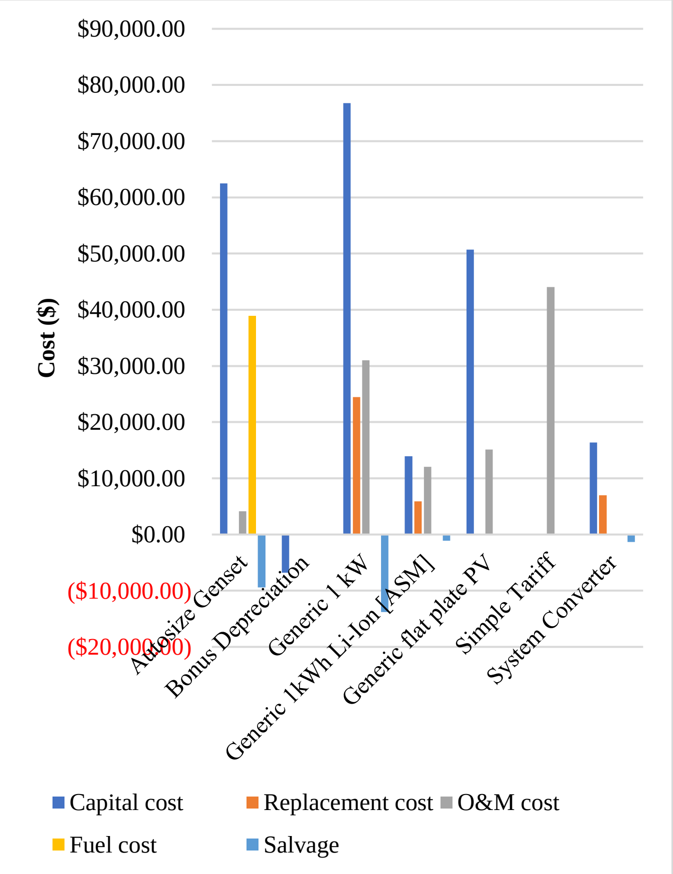

Figure 9: Cost for various sources in hybrid system

Figure 9 shows the different cost parameters for various hybrid sources in EV charging station model. The generic 1 kW wind system has more capital cost compared to DG, solar and converter. Similarly, replacement cost of wind system also more compared to other sources. Since, the lifetime of wind turbine is only 20 years, it should be replaced for 25 years lifetime project. The salvage cost is the additional income which is more in battery due to less lifetime.

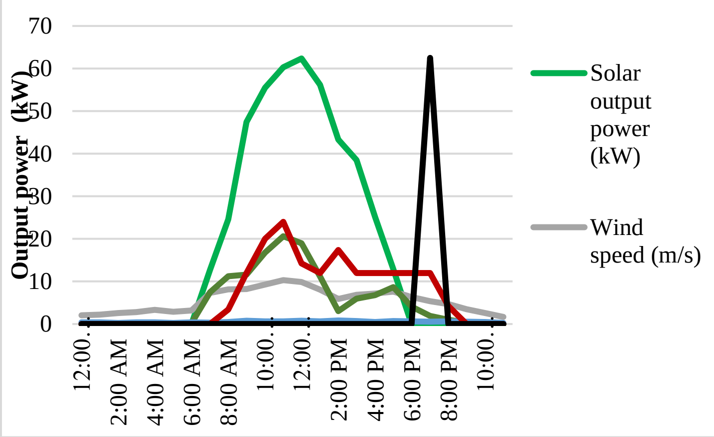

Figure 10: Energy balance for EV charging station & load

Figure 10 shows the energy balance for EV charging station and load. The EV charging station is the primary load, which is to be satisfied. The EV car and bike are charged through various sources from EV charging station. This energy balance graph is drawn for 7th February. To supply power to the EV vehicles, the solar used during 7 a.m. and 5 p.m. Wind power also supports to give power to EV chargers during this time. The maximum wind speed flow in this day is 10.31 m/s at 11.00 a.m. and wind turbine produces 20.62 kW power. Mainly wind power supports the AC load during 12.00 a.m. to 6 a.m. The demand for EV charging station starts between 8 a.m. and 8 p.m. The diesel generator produces power at 7 p.m. of 62.5 kW to supply power to the Electric vehicle. The excess power can be given to battery and if required power sold from grid through converter. The excess power can be used from battery when all renewable fails. The average wind speed on this day is 5.49 m/s in which wind turbine power produces 0 kW at minimum wind speed of 1.67 m/s.

5.2 Sensitivity analysis

Figure 11 shows the change in total cost (TC) and solar production for various derating factor. The derating factor is adjusted from 80% (DF1), 82% (DF2) and 85% (DF3) to analyze the performance of solar energy production based on cost in EV charging based hybrid power system. The TC reduces from $ 370525 to $ 363094 when increasing derating factor of solar. The solar energy production increases from 107834 kWh/year to 114125 kWh/year while increasing derating factor of solar.

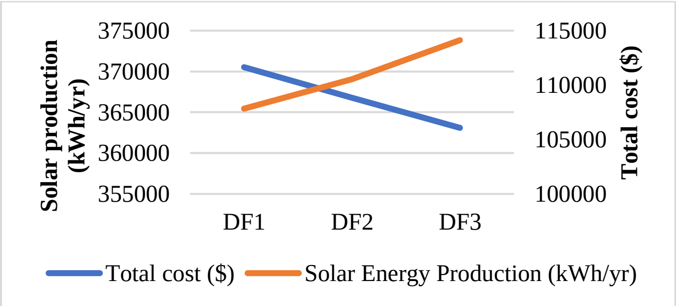

Figure 11: Change in cost and solar production for various derating factor

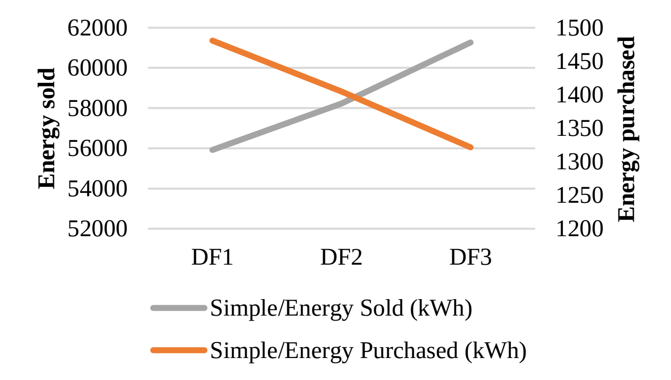

Figure 12: Change in energy sold and purchased from grid for various derating factor

Figure 12 shows the change in energy solar and purchased from grid for different derating factor of solar. The grid is also connected in hybrid system to supply power to EV charger when required. When solar derating increases then energy sold from grid increases from 55919 kWh/year to 61267 kWh/year. Similarly, when solar derating increases, then the energy purchased from grid drops from 1480 kWh/year to 1321 kWh/year. The *table 5* shows the comparison of proposed results with existing system. The proposed result shows that the cost of energy and emission is less compared to existing system. The renewable fraction is more in the proposed system.

Table 5. Comparison of results with existing system

Parameters	Existing system	Proposed system	Reference
Cost of Energy ($/kWhr)	0.27 $/kWh	0.176 $/kWh	[29]
Emission	459,370 kg/yr	61,252 kg/year	[30]
Renewable fraction (%)	87.9%	94.4%	[31]

6. CONCLUSIONS

The electric vehicle charging station is designed using renewable sources with diesel generator at low cost. Due to increase in Electric Vehicle in Chennai, India, the suitable charging station design is necessary and which has to be installed with low cost and less emission. This research highlights the importance of renewable sources necessary of electric vehicle charging station necessity, derating of solar with variation in cost parameter and involvement of wind energy system for charging electric vehicle. The grid is also used in hybrid system to sold and purchase power with reasonable cost. The sensitive results show that for different solar derating, the energy sold and purchase from grid are also discussed. The solar derating varies as 80%, 82% and 85%. The proposed EV charging station produces 83.8 kW peak power for the corresponding electric vehicle charging demand. The optimal sizing result shows that the solar and wind capacity are 78 kW and 24 kW respectively. The proposed design has the cost of energy and the total cost as 0.176 $/kWh and $ 363,094 respectively. The renewable fraction for this electric vehicle charging station with hybrid sources is 94.4%, which shows that the proposed system will produce maximum green energy to supply electrical power to the vehicle.

7. ACKNOWLEDGMENTS

The author would like to express his heartfelt gratitude to the supervisor for his guidance and unwavering support during this research for his guidance and support.

REFERENCES

[1] Aldhanhani, T., Al-Durra, A., El-Saadany, E.F. (2017). Optimal design of electric vehicle charging stations integrated with renewable DG. In 2017 IEEE Innovative Smart Grid Technologies-Asia (ISGT-Asia), IEEE, 1-6.
[2] Ghatak, A., Alfred, R.B., Singh, R.R. (2021). Optimization for Electric Vehicle Charging Station using Homer Grid. In 2021 Innovations in Power and Advanced Computing Technologies (i-PACT), 1-7.
[3] Al Wahedi, A., Bicer, Y. (2022). Techno-economic optimization of novel stand-alone renewables-based electric vehicle charging stations in Qatar. Energy, 243, 123008.
[4] Boonrach, N., Janjamraj, N., Bhumkittipich, K. (2021). Optimal Energy Storage System in Residential Micro-Grid for EV Charging Station Penetration. In 2021 International Conference on Power, Energy and Innovations (ICPEI). IEEE, 37-40.
[5] Oladigbolu, J.O., Mujeeb, A., Al-Turki, Y.A., Rushdi, A.M. (2022). A Doubly-Green Stand-alone Electric Vehicle Charging Station: An Overview and a Comprehensive Feasibility Study February. IEEE Access.
[6] Rathore, V., Kanwar, N. (2020). Modelling and analysis of autonomous microgrid using DIgSILENT software. In AIP Conference Proceedings, 2294(1), 040014.
[7] Jiménez, J.B., Córdoba, A., Escobar, E., Pantoja, A., Caicedo, E.F. (2022). Optimal sizing of a grid-connected microgrid and operation validation using HOMER Pro and DIgSILENT. Scientia et Technica, 27, (1), 28-34.
[8] Ishraque, M.F., Rahman, A., Shezan, S.A., Shafiullah, G.M. (2022). Operation and Assessment of a Microgrid for Maldives: Islanded and Grid-Tied Mode. Sustainability, 14(23), 15504.
[9] Terzić, L., Ramović, A., Merzić, A., Bosović, A., Musić, M. (2019). Analysis of the implementation of microgrid: case study of wide-area Bjelimići. SN Applied Sciences, 1(1), 33.
[10] Zhu, X., Premrudeepreechacharn, S., Kasirawat, T., Madtharad, C. Design and development of first MW-level microgrid in Thailand.
[11] Hossen, M.D., Islam, M.F., Ishraque, M.F., Shezan, S.A., Arifuzzaman, S.M. (2022). Design and implementation of a hybrid solar-wind-biomass renewable energy system considering meteorological conditions with the power system performances. International journal of photoenergy.
[12] Xu, X., Mitra, J., Wang, T., Mu, L. (2014). Evaluation of operational reliability of a microgrid using a short-term outage model. IEEE Transactions on Power Systems, 29(5), 2238-2247.
[13] Shezan, S.A. (2019). Optimization and assessment of an off-grid photovoltaic–diesel–battery hybrid sustainable energy system for remote residential applications. Environmental Progress & Sustainable Energy, 38(6), e13340.
[14] Mathew, P., Madichetty, S., Mishra, S. (2019). A multilevel distributed hybrid control scheme for islanded DC microgrids. IEEE Systems Journal, 13(4), 4200-4207.
[15] Melath, G., Rangarajan, S., Agarwal, V. (2019). A novel control scheme for enhancing the transient performance of an islanded hybrid AC–DC microgrid. IEEE Transactions on Power Electronics, 34(10), 9644-9654.
[16] Ali, H., Magdy, G., Li, B., Shabib, G., Elbaset, A.A., Xu, D., Mitani, Y. (2019). A new frequency control strategy in an islanded microgrid using virtual inertia control-based coefficient diagram method. IEEE Access, 7, 16979-16990.
[17] Arefin, S.S., Das, N. (2017). Optimized hybrid wind-diesel energy system with feasibility analysis. Technology and Economics of Smart Grids and Sustainable Energy, 2, 1-8.
[18] Shezan, S.A., Ishraque, M.F., Muyeen, S.M., Arifuzzaman, S.M., Paul, L.C., Das, S.K., Sarker, S.K. (2022). Effective dispatch strategies assortment according to the effect of the operation for an islanded hybrid microgrid. Energy Conversion and Management: X, 4, 100192.
[19] Ishraque, M.F., Rahman, A., Shezan, S.A., Muyeen, S.M. (2022). Grid Connected Microgrid Optimization and Control for a Coastal Island in the Indian Ocean. Sustainability, 14(24/), 16697.

[20] Mirsaeidi, S., Said, D.M., Mustafa, M.W., Habibuddin, M.H., Ghaffari, K. (2015). Design and testing of a centralized protection scheme for micro-grids. Journal of Central South University, 22, 3876-3887.
[21] Yan, B., Luh, P.B., Warner, G., Zhang, P. (2017). Operation and design optimization of microgrids with renewables. IEEE Transactions on automation science and engineering, 14(2), 573-585.
[22] Hai, T., Zhou, J., Khaki, M. (2023). Optimal Planning and Design of Integrated Energy Systems in a Microgrid Incorporating Electric Vehicles and Fuel Cell System. J. Power Sources, 561, 232694.
[23] Raya-Armenta, J.M., Bazmohammadi, N., Avina-Cervantes, J.G., Sáez, D., Vasquez, J.C., Guerrero, J.M. (2021). Energy Management System Optimization in Islanded Microgrids: An Overview and Future Trends. Renew. Sustain. Energy Rev., 149, 111327.
[24] Ilyushin, P., Volnyi, V., Suslov, K., Filippov, S. (2023). State-of-the-Art Literature Review of Power Flow Control Methods for Low-Voltage AC and AC-DC Microgrids. Energies, 16, 3153.
[25] Shan, Y., Ma, L., Yu, X. (2023). Hierarchical Control and Economic Optimization of Microgrids Considering the Randomness of Power Generation and Load Demand. Energies, 16(14), 5503.
[26] Khlifi, F., Cherif, H., Belhadj, J. (2021). Environmental and Economic Optimization and Sizing of a Micro-Grid with Battery Storage for an Industrial Application. Energies, 14, 5913.
[27] Park, W.H., Abunima, H., Glick, M.B., Kim, Y.S. (2021). Energy Curtailment Scheduling MILP Formulation for an Islanded Microgrid with High Penetration of Renewable Energy. Energies, 14, 6038.
[28] Tarife, R., Nakanishi, Y., Chen, Y., Zhou, Y., Estoperez, N., Tahud, A. (2022). Optimization of Hybrid Renewable Energy Microgrid for Rural Agricultural Area in Southern Philippines. Energies, 15(6), 2251.
[29] Zhang, Y., Yan, S., Yin, W., Wu, C., Ye, J., Wu, Y., Liu, L. (2023). HOMER-Based Multi-Scenario Collaborative Planning for Grid-Connected PV-Storage Microgrids with Electric Vehicles. Processes, 11(8), 2408.
[30] Yoon, S-G., Kang, S-G. (2017). Economic Microgrid Planning Algorithm with Electric Vehicle Charging Demands. Energies, 10(10), 1487.
[31] DJELLOULI, A., LAKDJA, F., HAFFAF, A., MEZIANE, R. (2023). Optimization of microgrids on/off-grid to the electrification of residential load in Saida, Algeria. Przeglad Elektrotechniczny, 99(5).