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A Comprehensive Study of Electric Vehicle Charging Systems: Charging Methods, Infrastructure Availability, and Solar PV–Wind–Grid Hybrid Energy Integration.

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Abstract
The mass proliferation of electric vehicles (EVs) is a new force in sustainable transport as a means to decarbonize transport fuel consumption, but at the same time to also bring renewables electricity to this application. However, charging stations availability, charging performance and accessibility and energy source are essential points affecting the effectiveness of the EV adoption. A systematic learning about EV charging system has been discussed in this mini project, EVs major charging methods, charging level, EVs basic charging system architecture and requirements of EV charging systems and integration with solar PV, Wind and grid energy have been discussed. The "combination" of hybrid, as a concept, has been well thought through to the level of associations it can have with RETIO, and ongoing lines of charging as supported by the grid. This simple energy-management strategy produces the charging demand and supply (renewable generation) by the following decision variables: charging demand, renewable generation, battery state of charge and grid constraints. Charging power, energy of batteries and the renewable energy contribution and power balance equations are shown and selected. Illustrative profiles are developed to represent the potential complementary generation from solar and wind energy sources which can work to keep residents off the grid. The problem with hybrid charging is that, in addition to being an electrical design issue, it is an infrastructure, a control, a protection and energy-management issue, and it is the latter of which the study emphasizes. Battery storage, smart charging, vehicle to grid operation, forecasting and optimization are all additions within the proposed framework that are adaptive...
Keywords : Electric vehicle charging, Electric vehicle charging infrastructure, on-grid solar PV power, renewable wind power, grid connectivity, hybrid energy system.

Introduction

The transition from internal-combustion vehicles to electric mobility creates a direct connection between transportation and the electrical power system [1]. Unlike conventional refueling, EV charging can occur at homes, workplaces, public locations, fleet depots, and highway charging stations. The charging process therefore has to be considered together with power availability, charging duration, equipment rating, user demand, and network constraints [2].
Availability can be viewed in many ways – including checking for the availability of charge stations. Factors include, but are not limited to, location, compatibility of connectors, operating conditions, queues, charging power and operating hours and accessibility and amounts of electrical capacity [3]. A large number of charging points in a charging station combined with a limited or non-existent numbers of charging points suitable for a specific vehicle, does not necessarily indicate that the charging station is practically available for the vehicle [4]. The hybrid architecture coupling that you require is either AC or DC. DC coupled option converts and regulates renewable energy, renewable electricity (before bringing onto common DC bus), and is plugged into EV charger. Based on the selection of the system rating, storage capacity, protection concept and charger design, the topology will be determined.

Objectives of the Study:

To explain what charging an electric car is and its principle charging types.

To gain an understanding of the different charging rates, how much accessories can charge, and how they can be charged (slow, normal, fast, high-power charging).
Write down key information and information resources of an EV charging station.
To research charging systems for homes, work sites, public sites, commercial properties and on highway sites.
To learn about Solar PV, Wind and how to integrate smart charging with the Grid for EV charging.
To develop a simple model of EV charging for energy-management/power-balance.
To analyze the impact of the renewable availability and EV demand on the charging operation as well as the grid limits, and the battery state of charge.

EV Charging Infrastructure:
Equipment and infrastructure to safely and conveniently connect an EV to an energy supply. Incoming Utility, Transformer or Switchboard, Protection Devices, Energy Meters, Charging Equipment, Communication Interface, Cables & Connectors, Parking Spaces, Signage, Supervisory Lighting & Software: Complete installation [5].

Main Infrastructure Elements [6]:
Electrical supply & distribution equipment: supply electricity to charging points.
Protection and isolation for safety enhancement by circuit breakers, RCD, Surge protection, Earthing and Emergency isolation.
EV supply equipment (EVSE): supplies electricity to the vehicle and controls the electrical connection to the vehicle.
Data recording: Energy, User sessions, charging status, operation information etc over communication, metering.
Parking bays and management of cables, protection from weather elements, lighting and accessibility and signage.
Energy-management system: minimizes the total electricity demand and arranges renewable generation and electricity from the power-grid.

2. Literature Review

For the general research topics of EVs, everything from charger topology, charger standards, to battery characteristics, charging times, power quality and communications and charging infrastructure planning [7]. The only method that is commonly used is AC charging, in which the function, often called “on-board charger”, is usually part of the car in the form of an integrated system and the bulk of AC to DC conversion is performed in the charging station and is called “DC fast charging”. These will depend on which charging speed you want, electricity problem size and your automobile model and rate. The 2nd strand of research relating to charging is the planning of charging infrastructure [8]. Appropriate placement of the charging station will need to take the following into account: size of the transformer, the loading of the feeder, transformer protection, space required for the charging station, ease of access for charging users and anticipated demand for charging at the location. Now as for the distribution network, the high-power charging can give rise to demands at individual points which can be managed [9].
Another sense of "direction" in this dimension is the introduction of renewable energies. Solar PV is perfect to charge during the day and wind power may be able to assist during low or non-solar charging times [10]. There is back-up power available (via grid connection) when renewables produce less electricity. In association with a suitable energy-management strategy, it could be used optimally to use the energy and provide reliability in charging.
A comprehensive analysis of energy path energy from energy production station to EV battery (via only charger) should be done. In this project, there are therefore three facets technology for charging the cars, provision of charging stations and hybrid energy supply which are combined in one mini project [11]. This should be directed towards demonstrating how such can be analyzed together in a simple manner with the use of simple electrical equations, a system diagram and typical operation profiles

3. Proposed Methodology for Energy-Management Strategy

The method proposed is in four steps i.e. charging demand, renewable energy sources estimation, electricity grid capacity estimation, energy sources power command selection and estimation [12]. The objective is to deliver good renewable energy usage if not a well poised experience for EVs charging. The proposed methodology flowchart defined for electric vehicle charging systems in fig.1.

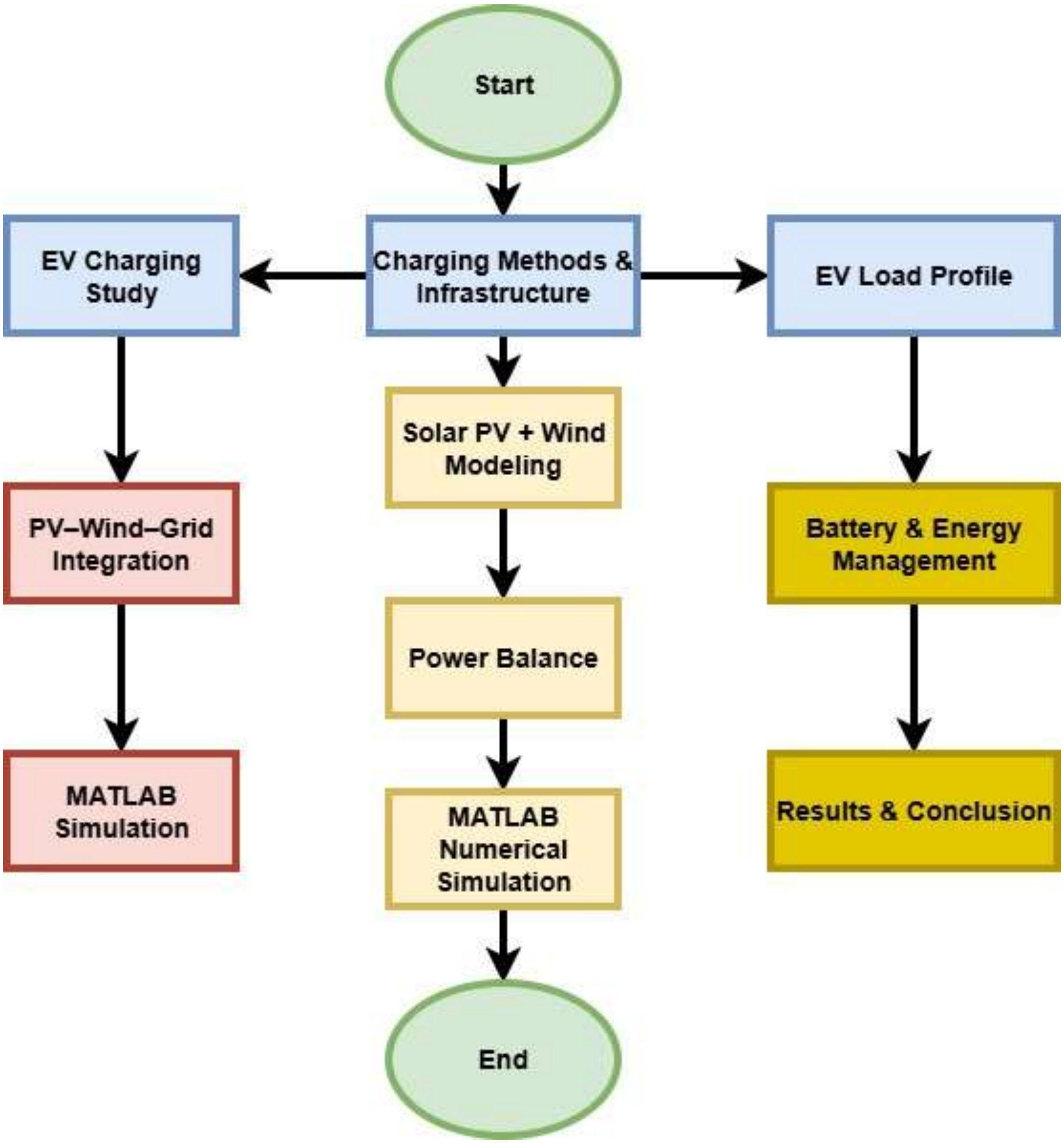

Fig. 1 Flowchart for Electric Vehicle Charging Systems

A useful EV charging study should answer practical questions such as: what charging method is appropriate for a particular vehicle, where should charging stations be installed, how much power is required, and how can renewable energy be used without compromising reliability? These questions motivate the hybrid Solar PV–Wind–Grid approach examined in this project.

$P = V\,I\,cos\varphi$ (1)

where P is charging power, V is voltage, I is current, and $\cos\varphi$ is the power factor for an AC charging arrangement. For DC charging, the delivered electrical power can be approximated by $P = VI$, subject to converter and battery limits. Basic electrical relationship used to describe charging power.

The charging power factors of the EVs are the charger rating, power supply voltage, current limit, battery acceptance (and charger efficiency). An expression that relates energy is severely simplified -

$E\_ch = P\_ch \times t\_ch$ (2)

where the charging energy is E_ch, charging average power is P_ch and charging time is t_ch. When efficiency added on is considered it is evident that more electrical energy is being extracted from the source than being stored in the battery.

$E\_grid = E\_batt / \eta\_ch$ (3)

State of charge (SOC) is indicative of an indication in the amount of energy that can be drawn from a battery. A simplified approach to energy update of battery is introduced (see fig.2):

$SOC(t+\Delta t) = SOC(t) + \eta\_ch\ P\_ch\ \Delta t / E\_batt, max$ (4)

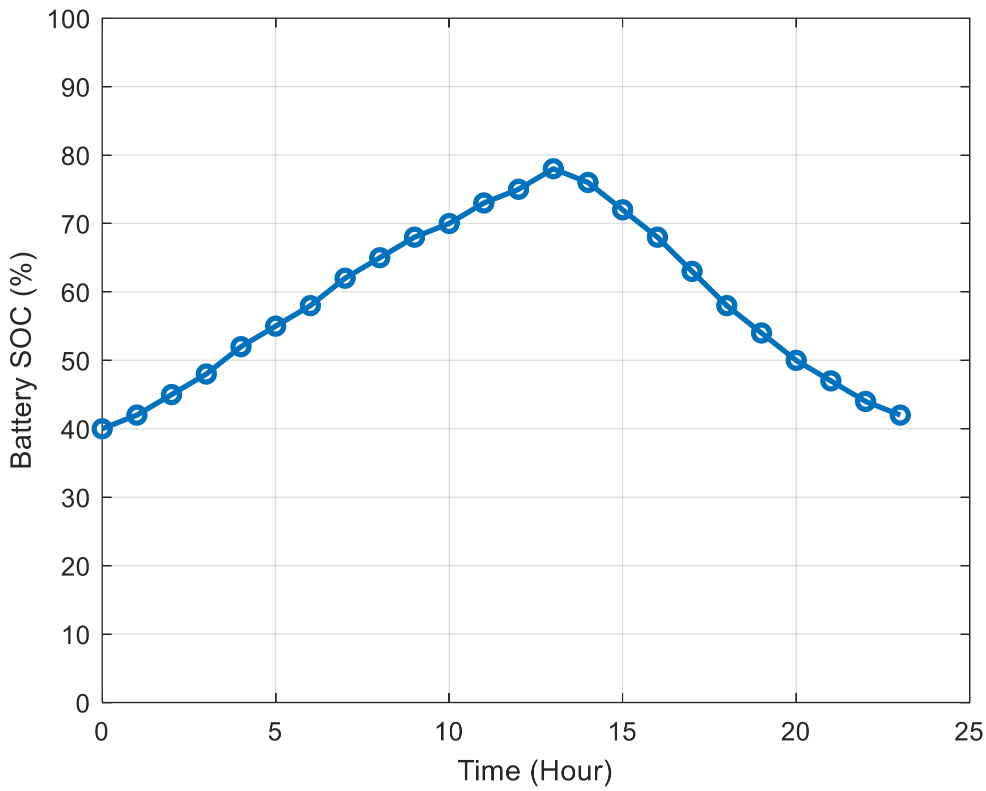

Fig.2 Battery State of Charge

If it is necessary to have a discharge/bidirectional operation, the sign convention and efficiency can vary. Also, actual real battery models are taken into account in case of voltage-, temperature-, charging-limits-, battery-degradation and battery-management-system-restrictions.

An operating profile complementary to the Solar PV network generation was used with wind network generation [13]. Generally, solar generation is proportional to daylight hours, and wind generation can be generated either during and after the day, and can be dependent on the weather. If it is possible to connect to the grid, then the difference can be compensated by the power/instability drawn from grid connections and power/instability can be released from grid connections if the production is surplus.

$P\_PV(t) = G(t)\ A\ \eta\_PV$ (5)

Solar Irradiance G(t), effective PV area A and Overall PV conversion efficiency n_PV are the values that define the value of the value of G(t). In actual practice, the following effects impact on the output: temperature effect, inverter efficiency, shading, dust and orientation and maximum power point tracking.

$P\_W(t) = 1/2\ \rho\ A\ C\_p\ v(t)^3\ \eta\_W$ (6)

As can be seen in this equation, here equation factors for air density (ρ), swept area (A), power coefficient (C_p) and wind speed ($v(t)$) enter as well as the conversion efficiency (η_W). The impact of the wind output with the weather is very significant in the cube wind speed effect on weather model.

$$P_{PV} + P_W + P_{grid} + P_{batt} = P_{EV} + P_{loss} \quad (7)$$

This is a reference number to the point on power balance equation. This can be to a positive or to a negative charge. So, there is a supervisory controller (SC) to limit the settling of an EV's consumption in the limits of the source and the grid. Based on the initial and target SOC, the amount of energy that can be specified per the EV can be estimated. The optimum energy needs are: The battery's maximum capacity ($E_{batt, max}$) and State of Charge (SOC) are used to calculate the E_{req} using equation:

$$E_{req} = \text{maximum capacity } (E_{batt, max}) + SOC \quad (8)$$

If renewable charging priority is set, priorities using PV solar power for charging.
Utilize wind power, if available, and does not impact system constraints.
Use grid power as backup, when there is no Renewable generation.
Reduce charging outside of the grid/station capacity.
When renewable energy is produced store it as electricity, and use it if there is a required deficiency.
A Constrained command is a charger reference, e.g.,

$$P_{EV}^* = \min (P_{EV, requested}, P_{EV,max}, P_{available}) \quad (9)$$

That is, it considers the constraints due to renewables sources and the electrical grid; the power after the renewable and grid constraints are applied is called $P_{available}$. For advanced systems this can be replaced by an optimization method, model based predictive control and/or demand response algorithm.
Charging efficiency is influenced by power-electronic conversion losses, cable losses, auxiliary loads, battery temperature, and battery-management limits. For a simplified analysis, an overall charging efficiency η_{ch} can be used to relate supply-side energy to stored battery energy.

$$\eta_{ch} = E_{batt} / E_{supply} \quad (10)$$

The control that accompanies it should have safety protection functions so that it does not switch high-speed between the sources, overload, voltage fluctuation and charging commands that are higher than the voltage of the vehicle/station.

$$f_{RE} = E_{RE} / E_{EV} \quad (11)$$

In which E_{RE} is energy delivered by renewables during the time interval considered and E_{EV} is the total energy delivered to EVs. To gain an insight into the potential offered by comparing woody plants to various scheme of charging or set-up. Availability may be expressed as a fraction of the time the availability is available and meets the criteria for good condition of service of a charging point.

$$A_{ch} = T_{available} / T_{total} \quad (12)$$

However, the availability value is not directly correlated to a low waiting time but does mean a high availability value in the event of a failure. Thus, also utilization, length of the queue, charging time and the type of the connectors are relevant.
If more than one EV is plugged in, charging at the station, the demand at the charging station is the sum of the charging demands of the EVs. Charging load can be spread out by decreasing the power requirement of each charging station and/or decreasing the time the charging station is utilized for charging to reduce the charging power requirement to a specified power level.

$$P_{station} = \Sigma P_{EV,i} \le P_{limit} \quad (13)$$

4. Charging Methods: Comparison and Selection

The major distinctions between charge schemes are how the power is converted, the speed at which it takes to charge the battery, the need for communication and the use [14]. AC can be used for longer periods of time parking wise as there's no limit on the distances that vehicles can be driven and it can be wired for a couple hours. The biggest users of energy delivery will have to be refueled quickly via DC energy. The comparison of EV charging methods illustrated in fig.3 and table 1, also such as charging aspects in table 2, charging cases in table 3.

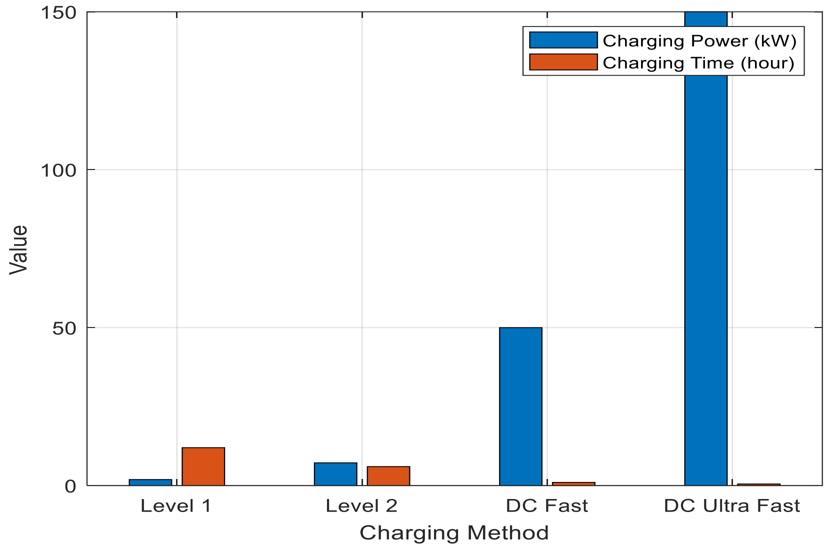

Fig.3 Comparison of EV Charging Methods

Table 1 Charging Methods

Method	Typical Power	Main Feature	Typical Use
AC slow	Low	Longer charging time	Home / overnight
AC normal	Moderate	Convenient routine charging	Home / workplace
DC fast	High	Shorter charging time	Public / highway
High-power DC	Very high	Rapid energy replenishment	Highway / fleet

Table 2 Charging Aspects

Aspect	AC Slow	AC Normal	DC Fast	High-Power DC
Power level	Low	Moderate	High	Very high
Charging time	Long	Medium	Short	Very short
Converter location	Mostly onboard	Mostly onboard	Station	Station
Best suited for	Overnight	Routine use	Public stops	Highway/fleet
Infrastructure impact	Lower	Moderate	Higher	Highest

Selection Factors

Vehicle capacity and charging power, at which they will accept it, and battery size.
Charging behavior of users and time users wish to park for.
Capability of Electric Power on-site in the U.S.
Whether the charging points be required during the same period or different time intervals will depend on the requirement of the number of charging points.
Cost of equipment, installation, maintenance and electric changes.
Communication, Payment, Monitoring and Smart Charging need.
Availability of renewable generation and desired contribution of renewables.

Table 3 Charging cases

Case	Source Condition	Charging Action	Expected Result
Daytime surplus	PV > EV demand	Charge EV; optional storage charging	High renewable utilization
Moderate renewable	PV + wind < EV demand	Renewables + grid	Continuous charging
Low renewable	PV + wind low	Grid-dominant charging	Reliability maintained
Grid-constrained	Demand > grid limit	Reduce/shift charging	Peak demand controlled

Two important characteristics of the hybrid system can be identified: First, the use of renewable energy, and second, the flexibility of the operation. Energy: Priority 17 Renewable: Energy savings for the grid will be done for energy when available [15]. Making use of grid support will not affect charging disruptions due to the variability of renewables. In fig.4, the 24-hour EV charging demand calculated from data. Also EV charging infrastructure availability are defined in fig.5.

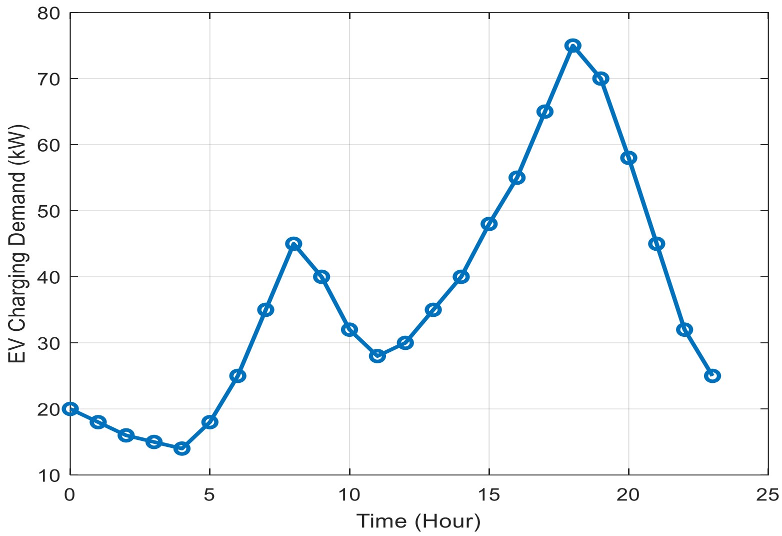

Fig. 4 24-Hour EV Charging Demand

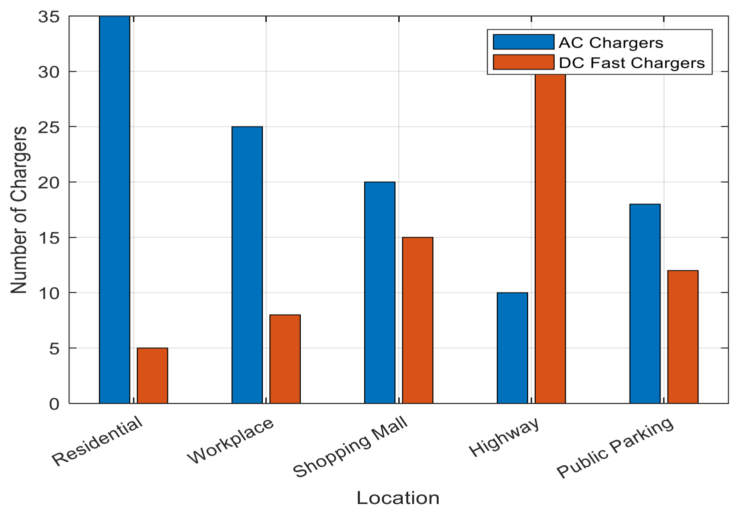

Fig.5 EV Charging Infrastructure Availability5. Results and Analysis

The illustrative hybrid profile indicates that there is the potential for solar generation to make a significant contribution on the day, and wind generation has more even contribution [16]. If the production of renewables decreases the rest of the EVs' energy needs are credited to the power grid to be supplied by conventional power plants. Renewables will be a percentage based on the variety of renewables, charging system, size of station and controls. The comparison of EV Demand, Solar PV and Wind Power is obtained in fig.6, the solar PV was reached maximum.

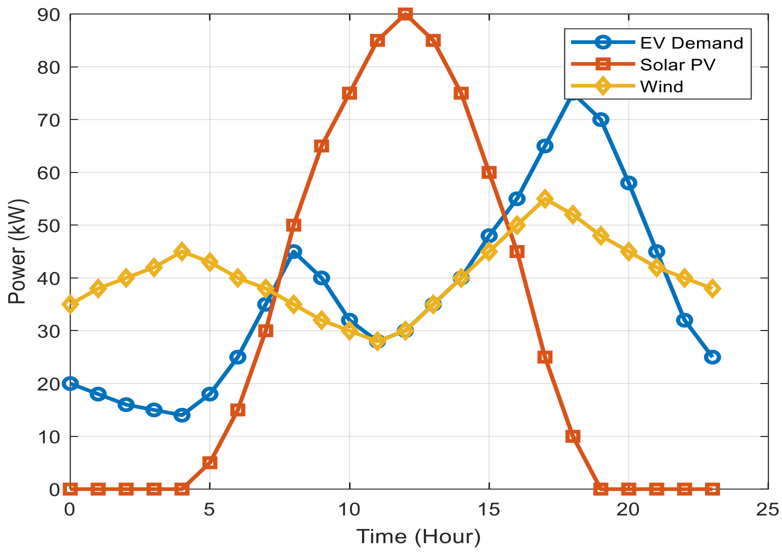

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Fig.6 EV Dem, andSolar PV and Wind Power

Charger demand, rather than a specific number of chargers, is more critical to consider when creating a feasible charging network. The dwell time to be allowed for residential charging may be more than that required on the highway and the power may be less. They are extremes which do not occur in workplace and commercial premises. Forecasts for predicted number of EVs/Predicted number of charging hours/day. To determine the highest takeover capacity of simultaneous charging [17]. Check transformer capacity, feeder capacity and protection/connection capacity. Evaluate parking facility, number of cables needed for parking access, safety of parking access and access/entry. Establish the renewable energy resources were available, and space available for roof/land. Establish Communication, Monitoring, Billing and Maintenance needs. Think large, don't design electrically and find it is limiting. The comparison of PV-Wind-Grid Hybrid EV Charging System is obtained in fig.7, the solar PV was reached maximum.

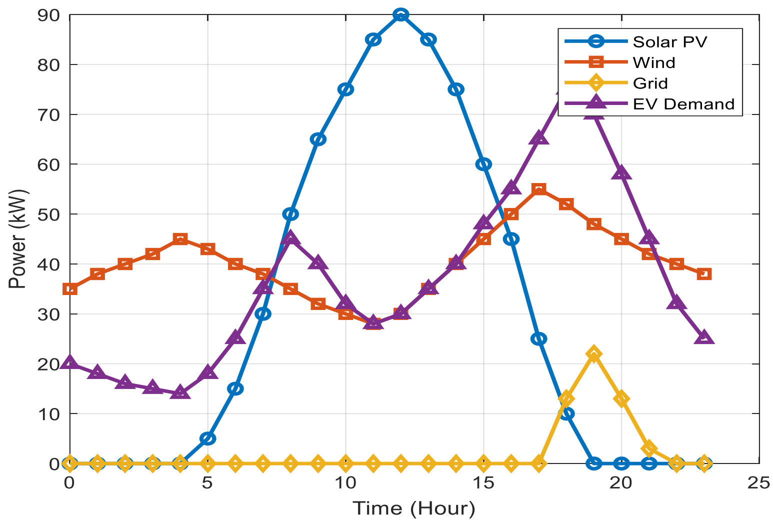

Fig.7 PV-Wind-Grid Hybrid EV Charging System

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It is an extremely straightforward constraint, but one of particular importance for hybrid stations as the capacity of the grid is fixed and renewables generation varies with time. The use of some of the applications, and associated practical advantages are discussed.
This is not offered any longer for home charging. Home charging is best suited for a long parking opportunity. The charging can be with grid power during the evening/night and some charging energy can be obtained from a rooftop PV system during daylight hours [18]. Through smart scheduling, charging can be scheduled outside peak hours when there is additional sun and/or the electric energy needed for the home does not need to be charged by the battery. The PV-Wind-Grid Hybrid Energy Supply was calculated form the data in fig.8, it is showing the reality of the energy systems.

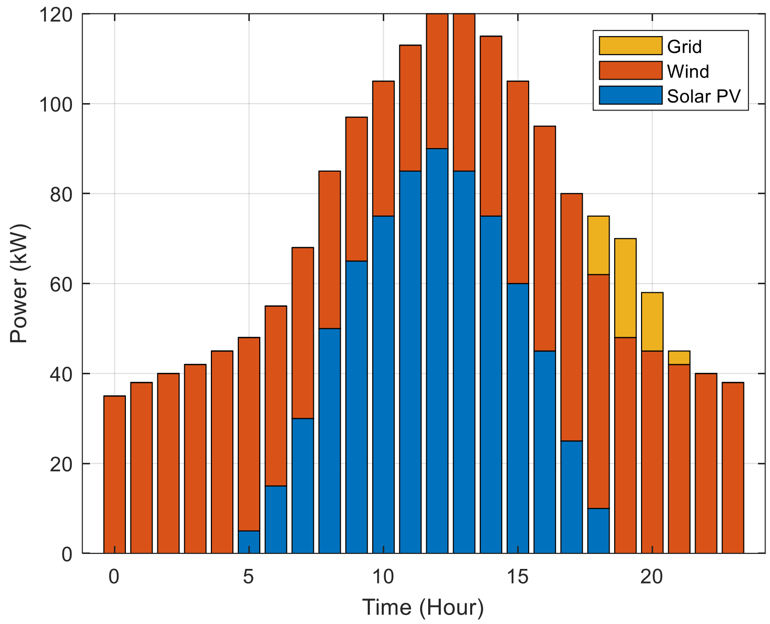

Fig.8 PV-Wind-Grid Hybrid Energy Supply

It is possible to provide charging at workplace(s) and/or at a commercial establishment to align with the building's use of energy. Solar PV can be used to supply energy during the day and demand for building energy use and EV charging can be controlled and limited to the point of use [19].
Electric fleets, and at highway stations are looking for more electricity and more robust electrical systems. Electric power supply capacity to charging stations for EVs should be increased as well as improvement of electric power infrastructures. A hybrid implemented based on a renewable system will reduce the use of the grid energy, Storage can be used to compensate for the renewable energy which is less over a short period of time or schools with consumption spikes.

Environmental and Energy Benefits

Development of Renewable fueled transport.
Increase utilization of solar power for heat & cool Control Electric Power charging.
Improved use of local supply of solar (and wind) power.
Greater resiliency with coordinated multiple energy sources.
Flexible future battery storage option and bi-directional charging platform.

Technical Challenges

Solar and Wind energy are variable because.
Great peak power requirement of fast chargers.
Power quality and harmonics, voltage protection and voltage regulation.
V2V vehicle-to-vehicle, vehicle-to-charger and vehicle-to-energy-management communications and interoperability.
Correct Identification of Battery Loss and Understanding of Battery limits at various temperature.

Cost of renewable resources (renewable generation), cost of power electronic equipment and space requirement. The operating profiles and equations used for this mini project are simplified and are only for conceptual analysis purposes. However, what can be carried out as part of this is a comparative study; which involves a practical validation of PV output, Wind output, charging load, power output and SoC (station battery state of charge) output variables with the measured output variables. Various weather conditions, charging plans etc. should be tested prior to deciding upon performance. The comprehensive EV charging with PV-Wind-Grid Hybrid Energy analyzed in fig.9, the total renewable is reached maximum.

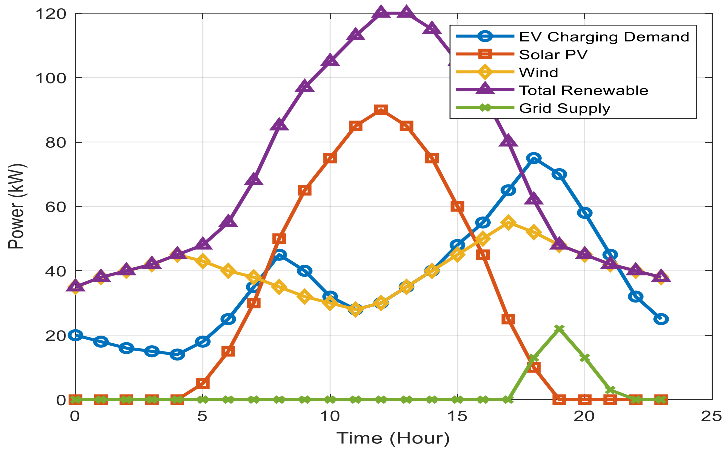

Fig.9 Comprehensive EV Charging with PV-Wind-Grid Hybrid Energy

This is especially the case for charging efficiency, battery capacity, renewable capacity availability (wind speed), grid limit, renewables capacity arrival time (wind) and users' arrival time (solar irradiance) and patterns. Hence, if charging demand occurs when the renewable energy is not available, then a reduced benefit from the investment in the renewable capacity can be achieved.

The Solar and Wind models are generic i.e. not to represent any specific location. It is not based on a representative user charging data but using charging illustrative profile data for charging demand. The same applies to the thermal behavior, battery degradation/detailed electrochemical-behavior is not modelled. This mini project doesn't address the detail standards and communication, protection and Utility Interconnection requirements for chargers. The hybrid controller is not optimized for cost and/or lifetime, and is based on rules. Space and practical availability will naturally be impacted by area and data sources should be updated locally. The charging system illustrated on Solar PV, Wind and Grid Power in fig.10.

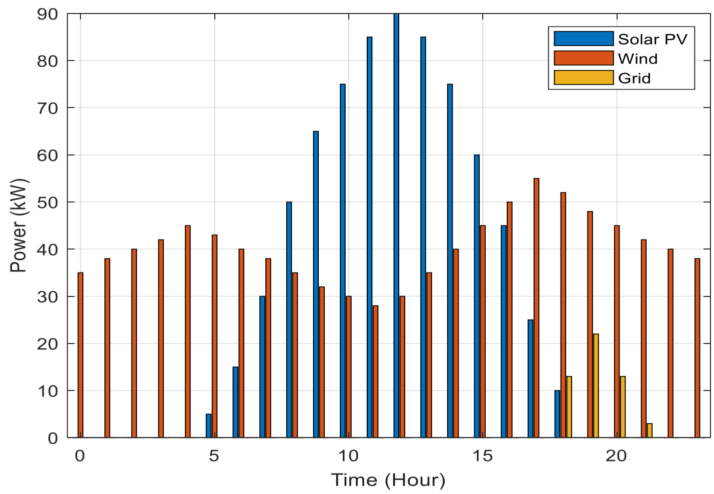

Fig. 10 Solar PV, Wind and Grid Power

7. Conclusion

Not only was the study of electric vehicles an important development in the field of electric mobility, but an integrated approach of charging methods, charging infrastructure/energy supply was a mini project as well. Depending on the dwell time, an AC charging system could be used, and based on the electrical capacity (corresponding with several times the energy transfers) a DC charging system could be used. Other than the number of charging stations, the following should be examined when considering charging infrastructure: charging station power rating, availability, charging station compatibility, power station capacity and user demand.

The amount of coordination and interconnectivity between different energy technologies which are needed to ensure stable charging of EVs can be appreciated from the conceptual PV–Wind–Grid Model. Variable solar power generation can be complemented by wind power and a reliable back-up from the grid can be provided by the grid during the daytime, at times when the solar PV can be a significant supply. A simple power-balance energy-management model has been included, as a sample model for more complex models...

References

1. Acharige, S. S. G., Haque, M. E., Arif, M. T., Hosseinzadeh, N., Hasan, K. N., & Oo, A. M. T. (2023). Review of electric vehicle charging technologies, standards, architectures, and converter configurations. IEEE Access, 11, 41218–41255.
2. Ali, M. U., Zafar, A., Nengroo, S. H., Hussain, S., Alvi, M. J., & Kim, H. (2019). Towards a smarter battery management system for electric vehicle applications: A Critical Review of Lithium-Ion Battery State of Charge Estimation. Energies, 12(3), 446. https://doi.org/10.3390/en12030446
3. Alkawsi, G., Baashar, Y., U, D. A., Alkahtani, A. A., & Tiong, S. K. (2021). Review of Renewable Energy-Based Charging Infrastructure for Electric Vehicles. Applied Sciences, 11(9), 3847. https://doi.org/10.3390/app11093847
4. Chakraborty, S., Vu, H., Hasan, M. M., Tran, D., Baghdadi, M. E., & Hegazy, O. (2019). DC-DC converter topologies for electric vehicles, plug-in hybrid electric vehicles and fast charging stations: state of the art and future trends. Energies, 12(8), 1569. https://doi.org/10.3390/en12081569
5. Goel, S., Sharma, R., & Rathore, A. K. (2021). A review on barrier and challenges of electric vehicle in India and vehicle to grid optimisation. Transportation Engineering, 4, 100057. https://doi.org/10.1016/j.treng.2021.100057
6. Hao, D., Qi, L., Tairab, A. M., Ahmed, A., Azam, A., Luo, D., Pan, Y., Zhang, Z., & Yan, J. (2022). Solar energy harvesting technologies for PV self-powered applications: A comprehensive review. Renewable Energy, 188, 678–697. https://doi.org/10.1016/j.renene.2022.02.066
7. Karmaker, A. K., Hossain, M. A., Pota, H. R., Onen, A., & Jung, J. (2023). Energy Management system for hybrid Renewable Energy-Based Electric Vehicle charging Station. IEEE Access, 11, 27793–27805. https://doi.org/10.1109/access.2023.3259232
8. Khalid, M. R., Khan, I. A., Hameed, S., Asghar, M. S. J., & Ro, J. (2021). A comprehensive review on structural topologies, power levels, energy storage systems, and standards for electric vehicle charging stations and their impacts on grid. IEEE Access, 9, 128069–128094. https://doi.org/10.1109/access.2021.3112189
9. Mahesh, A., Chokkalingam, B., & Mihet-Popa, L. (2021). Inductive Wireless Power Transfer Charging for Electric Vehicles–A Review. IEEE Access, 9, 137667–137713. https://doi.org/10.1109/access.2021.3116678
10. Panchal, C., Stegen, S., & Lu, J. (2018). Review of static and dynamic wireless electric vehicle charging system. Engineering Science and Technology an International Journal, 21(5), 922–937. https://doi.org/10.1016/j.jestch.2018.06.015
11. Rajendran, G., Vaithilingam, C. A., Misron, N., Naidu, K., & Ahmed, M. R. (2021). A comprehensive review on system architecture and international standards for electric vehicle charging stations. Journal of Energy Storage, 42, 103099. https://doi.org/10.1016/j.est.2021.103099

12. Roy, P., He, J., Zhao, T., & Singh, Y. V. (2022). Recent Advances of Wind-Solar Hybrid Renewable Energy Systems for Power Generation: A review. IEEE Open Journal of the Industrial Electronics Society, 3, 81–104. https://doi.org/10.1109/ojies.2022.3144093
13. Sadeghian, O., Oshnoei, A., Mohammadi-Ivatloo, B., Vahidinasab, V., & Anvari-Moghaddam, A. (2022). A comprehensive review on electric vehicles smart charging: Solutions, strategies, technologies, and challenges. Journal of Energy Storage, 54, 105241. https://doi.org/10.1016/j.est.2022.105241
14. Safayatullah, M., Elrais, M. T., Ghosh, S., Rezaii, R., & Batarseh, I. (2022). A comprehensive review of power converter topologies and control methods for electric vehicle fast charging applications. IEEE Access, 10, 40753–40793. https://doi.org/10.1109/access.2022.3166935
15. Sanguesa, J. A., Torres-Sanz, V., Garrido, P., Martinez, F. J., & Marquez-Barja, J. M. (2021). A review on Electric Vehicles: Technologies and challenges. Smart Cities, 4(1), 372–404. https://doi.org/10.3390/smartcities4010022
16. Shafiullah, M., Ahmed, S. D., & Al-Sulaiman, F. A. (2022). Grid Integration Challenges and Solution Strategies for Solar PV Systems: A review. IEEE Access, 10, 52233–52257. https://doi.org/10.1109/access.2022.3174555
17. Tran, D., Vafaeipour, M., Baghdadi, M. E., Barrero, R., Van Mierlo, J., & Hegazy, O. (2019). Thorough state-of-the-art analysis of electric and hybrid vehicle powertrains: Topologies and integrated energy management strategies. Renewable and Sustainable Energy Reviews, 119, 109596. https://doi.org/10.1016/j.rser.2019.109596
18. Unterluggauer, T., Rich, J., Andersen, P. B., & Hashemi, S. (2022). Electric vehicle charging infrastructure planning for integrated transportation and power distribution networks: A review. eTransportation, 12, 100163. https://doi.org/10.1016/j.etran.2022.100163
19. Zeng, X., Li, M., El-Hady, D. A., Alshitari, W., Al-Bogami, A. S., Lu, J., & Amine, K. (2019). Commercialization of lithium battery technologies for electric vehicles. Advanced Energy Materials, 9(27). https://doi.org/10.1002/aenm.201900161

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