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Environmental, Techno-Economic Feasibility Analysis of Grid-Connected Photovoltaic Power Plants in Subtropical Region

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Abstract: The design of distributed generation (DG) systems for a wide range of grid-connected and off-grid applications is made simpler with HOMER. Due to limited access to technological, social, and environmental constraints as well as a lack of energy consumption in power generation, it is difficult to acquire an effective photovoltaic array for residential use in Sudan. A high-quality architectural design is required for a model of a solar-powered, low-energy home that meets Sudanese social and economic standards. Method The charge advantage analysis of a hybrid system was examined and evaluated using the value for each kilowatt of grid-connected systems or the utility grid using the HOMER software. The reproduction results have been introduced as the most proficient and practical technique for accomplishing different home counts.

Keywords: Utilizing, HOMER, Techno-economic, Sustainable, Urban.

1. Introduction:

Solar photovoltaic panels (PV) are facing multiple challenges in the Region of subtropical weather based environment. These challenges including policy, costs & technology issues. With the growth of the needs in the energy sector of the Region of subtropical area, Grid Connected Photo Voltaic (GCPV) model scheme may helping to reduce demand under the peak load & offering an energy resource alternates. Grid-connected Photo Voltaic (GCPV) model scheme has two types of classifications; with battery- storage bank & without battery- storage bank, the Ist have the critical loads supply power advantage when the grid utility faces condition of power outages. Both schemes utilizing inverters effectively as a elements of crucial importance that may not goes under negligence. Inverters most in have applications in system connected to grid that are carrying a very high efficiency, for maintaining stable relations with the distribution system of power segment. The connection point in the Photo voltaic based generator & utility may having distoration of minor amount that could may leading to effects significantly serious. Distortion of these type may either causes by the instability of the grids, or the Photo voltaic supply fluctuation in the output or in the system losses [1]. The inverter function is not only converter action as Alternating Current to Direct Current power but also synchronizing the Photo voltaic output in phase & frequency along with the grid. Finally, function of providing protection by the inverters in charge of separation of the panels Photo voltaic systems from the grid of utility side, switches are helping as fuse on both the sides, and disconnect as large amount of occurs of the instability [2].In the case also when the shortages are frequent in the utility side, a system of standalone-grid- hybrid connected model must be applied. This is serving surety to the load as the occurrence of the shortage. Other type of classification definition for grid-connected utility interactive system [3]. In such type of cases, energy sold to utility in excess, but if the loading is not met then the system is fed by utility. The system connected to gird may not capable of satisfying the load demand entirely as per applications it is intending for serving, in such situations it may utilize to only offset costs of the electricity. This may be very beneficial for reduction of the costing of application of operating situation [4]. Have the system that also helping to reduction of the bills to avoid the companies under utility surcharging in duration of demand in peak hours. Dual meter based such system is important in tracking the performance of the system of GCPV model. System model of GCPV may help for setting as in a setup of plant or integrated building. The later, have the advantage to save its costs & space not included in the mounting structure to Photo Voltaic system, connection to the grid, roof, which all are necessary either way for every building. As under the plant mode, more costs may require in the investors. More researches is conducting for establishing high ratio of performance for systems model of GCPV along the factors like efficiency in overall, costs of life cycle, energy cost , energy, period of payback etc.

2. Related Work:

[1] Ali H.A. Al-Waeli, K. Sopian, Hussein A. Kazem, Miqdam T. Chaichan,(2017)

In the last four decades, attention in greater amount has been paid to Photo voltaic systems due to their advantages comparing with solar thermal systems or PV alone. This paper is aiming for studying aspects of various of PV systems through the literature in existing in order of highlighting key points as work of future in this field as well as different techniques illustration using under systems of such type. Additionally, reviewed PV systems in terms of electrical and thermal views side. Furthe, the analysis of thermal solar

systems, various applications of system such as water, air, water/air, material PCM phase change and systems of Nanofluid are summarized.

[2] McEvoy, T., , A., Markvart & Castaner, L. (2003)
This paper presenting a view of applications of PV systems since the initiation of the United States Program of National Photovoltaic in 1985. Applications based experiences with these are summarized & drawn some conclusions. Implications for research for future, development in technology & experiments bsased application are drawn from the experiences based analysis. [22]

[3] Sopian, K., Al-Waeli, A. H., Chaichan, Hasan, H. A., M. T., Kazem, H. A., & Al-Shamani, A. N. (2017).
The properties of thermophysical behavioir of nanofluid composing of water and SiC nanoparticles without using of surfactant coolant for a Photovoltaic/Thermal system is investigated. It is observed that the addition of 5 percent by weight of these nanoparticles to water causing an increase in the fluid density resulting by up to 0.0082% and a viscosity increase by up to 1.8%. Moreover, the conductivity of thermal medium is showing enhancement by up to 9 percent for the temperature tested under the range of 20 °C–70 °C.

3. Methodology:
In computer science and operations research, the ant colony optimization algorithm (ACO) is a probabilistic technique for solving computational problems which can be reduced to finding good paths through graphs. Artificial ants stand for multi-agent methods inspired by the behavior of real ants. The pheromone-based communication of biological ants is often the predominant paradigm used.[2] Combinations of artificial ants and local search algorithms have become a method of choice for numerous optimization tasks involving some sort of graph, e.g., vehicle routing and internet routing.
As an example, ant colony optimization[3] is a class of optimization algorithms modeled on the actions of an ant colony.[4] Artificial 'ants' (e.g. simulation agents) locate optimal solutions by moving through a parameter space representing all possible solutions. Real ants lay down pheromones directing each other to resources while exploring their environment. The simulated 'ants' similarly record their positions and the quality of their solutions, so that in later simulation iterations more ants locate better solutions.[5] One variation on this approach is the bees algorithm, which is more analogous to the foraging patterns of the honey bee, another social insect.
This algorithm is a member of the ant colony algorithms family, in swarm intelligence methods, and it constitutes some metaheuristic optimizations. Initially proposed by Marco Dorigo in 1992 in his PhD thesis,[6][7] the first algorithm was aiming to search for an optimal path in a graph, based on the behavior of ants seeking a path between their colony and a source of food. The original idea has since diversified to solve a wider class of numerical problems, and as a result, several problems have emerged, drawing on various aspects of the behavior of ants. From a broader perspective, ACO performs a model-based search[8] and shares some similarities with estimation of distribution algorithms.

Algorithm:

1. Development of the algorithm for the entity described CGPV system mode.
2. The algorithm will use the values of calculated PV instantaneous output power, cell temperature and inverter efficiency.
3. The process will be followed for perform calculations to find array generated power.
4. The losses of the system will be calculated. The losses include wire losses and temperature inverter losses.
5. The results will be generated for the optimum converter model, tilt angle, yield factor, capacity factor and PV energy production.

4. Result and Discussion:
These are the regions which are near the equator of the earth. Tropical regions also called Tropical zone. In simple words we can say that climate in tropical region is warm to hot and moist year around. The areas falls under Tropical Regions in India are Assam and part of Sahyadri Mountain Ranges (Tropical Rainforest)Parts of Maharashtra (Tropical Savannah),Parts of Punjab and Gujarat (Tropical Steppe),Most parts of Rajasthan (Tropical Desert).

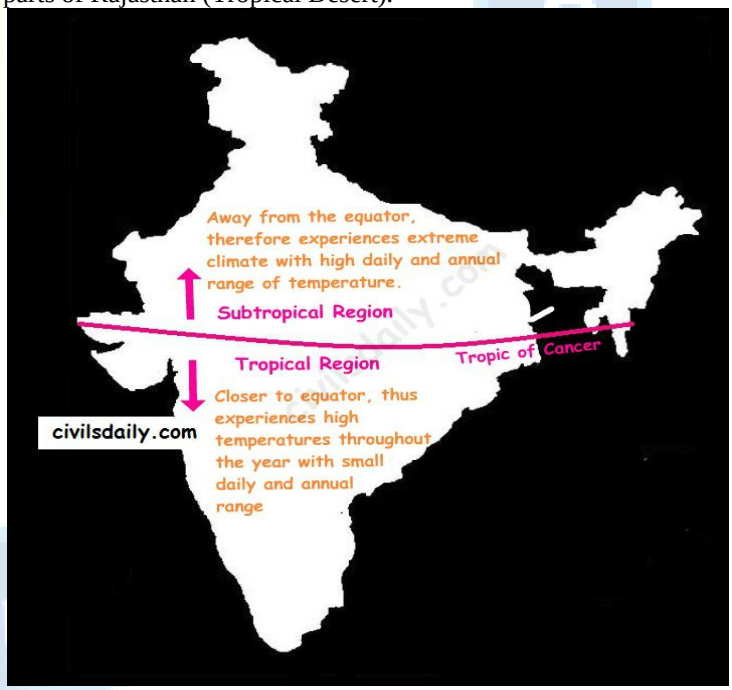

Fig. 1: Tropical and sub tropical regions of India.

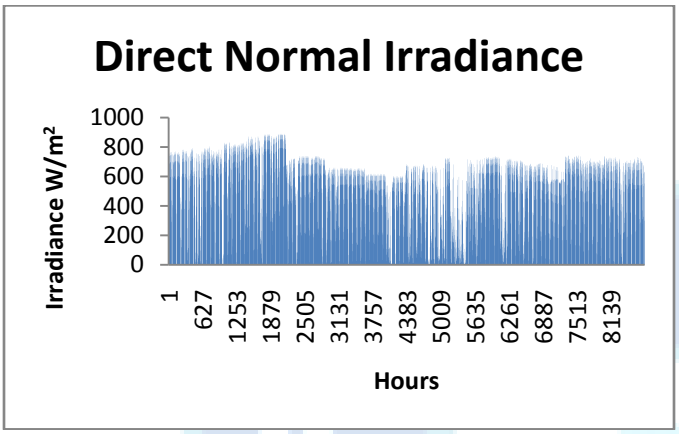

Fig. 2: Direct normal solar irradiance (W/m^2) with respect to time in Hours.

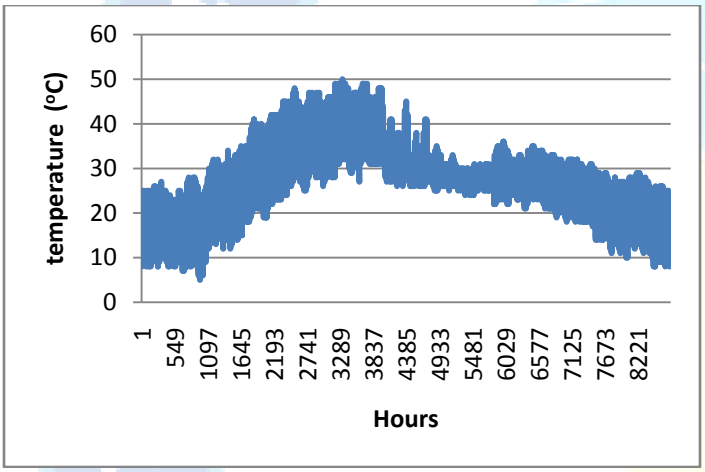

Fig. 3: Variation in atmospheric temperature (^{O}C) with respect to time in Hours.

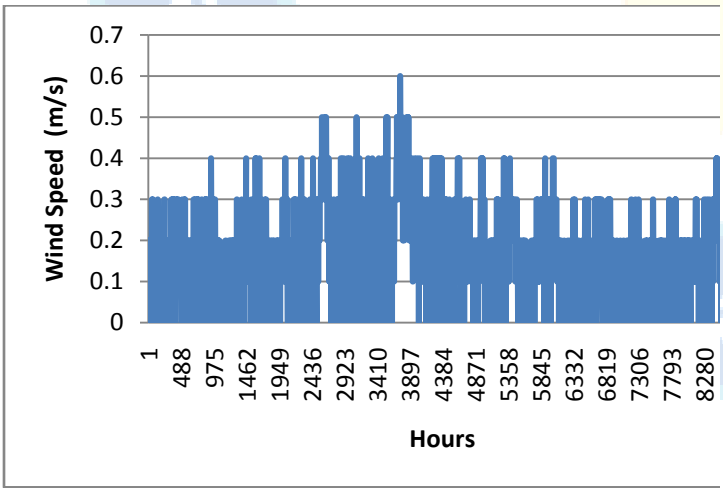

Fig. 4: Wind speed with respect to time in hours.

5. Conclusion:

The solar energy is one of the best alternative that may prove as an alternative for electrical power resources.The study is performing an evaluation a techno-economic & design of a Grid-connected Photo Voltaic model system in Jaipur city, India as a subtropical Region of sizing for 1 Mega Watt. The simulation based ob numerical mode is made by MATLAB based coding. The optimum size array finally obtained is 250 Watt with 4000 number of modules. The results are derived using the proposed optimization techniques. The results showing better yield factor, capacity factor and efficiency.

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