Numerical Simulation and Performance Analysis of Grid Connected Solar PV System in Indian Scenario

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Abstract— Renewable energy sources, as the name implies, are sources that can be renewed over time and are therefore inexhaustible resources since they are available in an infinite quantity. Water, biomass, solar, geothermal, and wind are among the most widely used renewable energy sources. Renewable energy sources are in high demand due to the continuing depletion of fossil fuel and oil reserves. Furthermore, these nonrenewable resources threaten the environment by increasing carbon dioxide levels in the atmosphere. Solar energy has been described as the best green energy resource with the greatest potential of all known renewable energy sources, and hence it can serve as the best substitute for conventional resources. Solar energy has gained a lot of attention in the last decade all over the world. As the most well-known field, it is the subject of numerous studies in order to extract the maximum amount of energy. The demand for solar energy is rising at an exponential pace because of its various benefits, including the absence of fuel costs, pollution-free activity, and low maintenance.The purpose of this research is to perform the numerical model of the 1MWp and 100 kWp solar power plant for different manufacturing technology as well as locations. The research has been done using PV-Syst programming tool and it was utilized to create model of the plant and the research of losses and the demonstration of the proposed power station. Diverse assembling strategies and distinctive guidance plans have been used for the techno economic analysis of system..

***Keywords*-**Loss Analysis, PV-Syst, Grid Connected System, Yield.

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I. INTRODUCTION

In the current age of global warming and climatic change caused by the burning of fossil fuels, it has become important for us to find an alternative source of energy, and solar energy is one such energy source that has no negative environmental effects. All new power generation technologies contain a lot of carbon dioxide and other harmful greenhouse gases. Throughout their lives, both of these devices release a considerable amount of carbon dioxide. Some emit direct emissions, such as those from power plants, while others emit indirect emissions, such as those that occur during times when the plant is not operating. Fossil-fuel-based systems are the key culprits in this regard, since they emit the greatest amount of carbon footprints due to the fuels being consumed during the device's operating time cycle. As a consequence, their environmental consequences cannot be ignored or taken for granted. Some new energy fields, such as wind, solar, biomass, tidal, and nuclear, are listed as non-fossil fuel based technology because they emit very little carbon and therefore are considered carbon neutral. During their generation process, they do, however, emit some carbon dioxide. The heat and radiant light created by the sun are referred to as solar energy. The main benefits of using solar energy are that it is a sustainable source that is supposed to last for five billion years, it is abundant for everyone, it decreases our high electricity bills, it is a totally clean fuel that does not pollute the atmosphere, and most significantly, it will help us minimise our dependency on non-renewable sources like coal. Over the ages, all living beings have used this type of energy in some way or another to enhance their lives. As a result, we can assume that solar energy can be beneficial to a significant number of people. While several renewable energy sources exist, solar energy is projected to account for the majority of the total due to its various benefits, and it is one of the world's fastest growing renewable energy sources. When a French physicist named Edmund Becquerel tried illuminating a metal electrode in an electrolytic solution, he discovered the first photovoltaic effect. Richard Day discovered photovoltaic material thirty-seven years after his discovery, and he also made solid cells with an efficiency of about 1-2 percent. PV cell production is growing at an unprecedented pace in the modern era, thanks to rising efficiency and falling prices. Recently, there has been a large rise in public perception of global warming, and the prices of fossil fuels have been growing, drawing attention to the use of renewable energy sources. According to the statistics, the demand for energy is increasingly growing, and we must use this to maintain a balance between supply and peak load demands. For this reason, standalone power generation systems may be used in remote areas where traditional power generating systems are impractical.
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II. PV SYSTEM

Solar photovoltaic displays (PV system), which is the array for many of photovoltaic modules that are interconnected. By means of a single photovoltaic module that is produced, the modules are arranged in such a way that a number of capacities can be realized. The associated cluster module is like the cells of the module.The solar cell collectively forms a photovoltaic panel. They are

ISSN: 2454-4248
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manufactured from a semiconductor, for example silicon, and a thin semiconductor wafer of gallium arsenide has not been typically recompensed to form a negative electric field on the opposite side. If a circuit from both sides of the conductor is connected with the semiconductor which has been thumped clear of semiconductor material molecules, electrons will continue to stream up, as described in the figure 1.1.

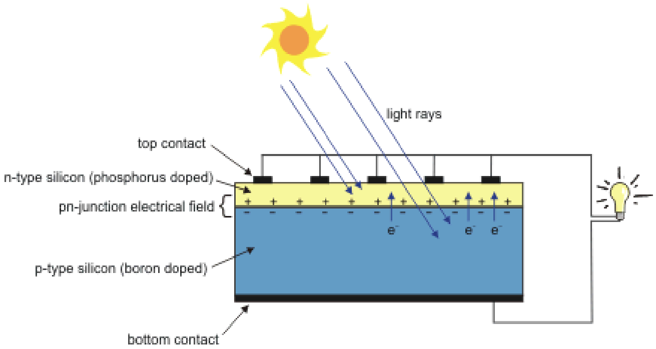

Figure. 1.1 Structure of a PV cell

After solar modules produce DC current, the networked photovoltaic system is connected straight to the community grid and then transform it into AC electricity, which meets the specifications of the grid, through the grid.It can be broken into two kinds of grid-connected photovoltaic systems based on whether there are batteries. Grid-connected battery photovoltaic systems may be deployed to suit in or out of the grid as necessary. If the grid is a problem, it can be used as a backup power source as well. Neither battery will, however, become backup power sources and cannot be scheduled for the grid-connected photovoltaic systems.

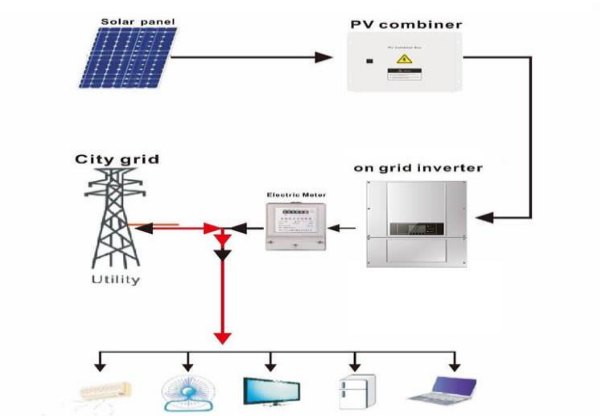

Figure 1.2 Grid Connected Photovoltaic system

There are two sides of each coin. There are both advantages and disadvantages for solar photovoltaic devices. All in all, though, solar photovoltaic devices are very useful for human growth. 1. Unlimited and unregulated renewable capacity. The solar radiation consumed by the surface of the globe will satisfy the need for ten thousand times worldwide. As long as four percent of the world market for solar photovoltaic systems is fulfilled, global demand will come from the generated electricity. Solar energy is clean, clean and not impacted by energy shortages or unpredictable oil markets;
2. Everywhere is solar electricity. it can supply electricity in the vicinity of the residential area where energy is produced and without the use of long distance transmission lines;
3. Petroleum and maintenance expenses include no renewable energy;
4. No movable pieces, simple to preserve, not casual to divide, particularly for unattended use;
5. The solar photovoltaic system creates no waste, no hazardous waste, no sound emissions, and no adverse atmospheric effect. It's a superlative energy without spot;
6. Small, appropriate and elegant, the architecture retro of the solar photovoltaic system. The load may increase or decrease and the solar energy ability of the square increases or decreases in order to reduce pollution.

Disadvantages

1. Given the erratic and unpredictable energy output and temperature, ground applications cannot or occasionally occur in rainy days at night;
2. The rate of change is minimal, the system has to work under normal conditions and the solar power obtained from the earth is 1000W / m2. It uses a lot of space;
3. The expense is much more expensive. They are three to fifteen times higher and early investment is high relative to conservative power generation.

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The inverter is used to convert the direct current (DC) generated by the solar panel into a load of alternating current (AC). Today, many investors on the market are based on battery connections and network systems. Investors need to determine the magnitude of the expected power level to be processed and are compatible with the conditions on the network side. Other components include JS mounting systems, wiring, switches, disconnectors and system monitors. These components have not been studied in detail. The use of DC cables should at least maintain high resistance losses and costs [39]. For the central inverter, there is also a junction box between the matrix and the inverter fuse to protect against voltage overload. In a network system, the grid itself is like an infinite energy store. Excess energy can be supplied to the grid.

II. SYSTEM MODEL

To use PVSYST and study the performance potential of photovoltaic and solar thermal systems, irradiation data and precise global temperatures are critical. In PVSYST, both wind speed and diffuse radiation are optional.

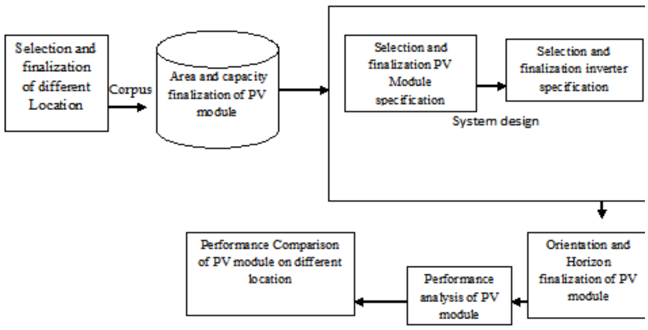

Figure 2. Architecture of the Proposed Grid Connected Solar PV System

PVSYST uses the irradiance data imported in PVSYST to create irregular markers using imported functional weather data. Unless otherwise stated, the information in this chapter is the PVSYST Contextual Help Manual. The layout and simulation of network-connected solar PV systems was extended using the following data sets.

Meteological Data- Meteonorm software provides monthly weather data for every point on the planet. They also use a stochastic model to provide time-based data based on synthetic generation. If there is a station in a given venue, Meteonorm will use interpolation between the three stations. Satellite data from five geostationary satellites was used as a supplement when soil data was poor. 8 km horizontal resolution. Soil measurement uncertainty ranges from 1% to 10% (Meteonorm results [46]) and satellite data ranges from 3% to 4% (low latitude). For terrestrial interpolation, the uncertainty is 1% over a distance of 2 km, 6% to 100 km, and 8% for distances greater than 2000 km. Horizontal diffuse illumination was calculated using the Perez model to separate the global radiation beam and the diffuse component. *Selection of Solar Panel*- In PV systems, the preset is based on area or power. Depending on the size, the panel is selected based on the rated power and operating voltage.

Selection of Inverter- In PV syst the selection of inverter is done in accordance with the selection of pv panel.The rating of invereter should match with the specifications of panel.

Orientation and Horizon- In the proposed work study, we have simulated a 1 MWp fixed tilt system that has been selected for fixed tilted linear shading. Photovoltaic systems have been established in Jaipur (26.9124°N, 75.7873°E and 431m), Kolkata (22.57260 N, 88.36390 E and 9 m) and Chennai (13.0827°N, 80.2707°E and 6.7 m) with latitude and altitude Height and altitude. Again, it is also developed for

Table 1 : Input Parameters of Geographical Locations

Input parameters of geographical location					
Project Site	Latitude (N)	Longitude (E)	Altitude (m)	fixed Tilted panel	
				Panel tilt	Azimuth tilt
Jaipur	26.9124^0 N	75.7873^0 E	431m	300	0
Kolkata	22.5726^0 N	88.3639^0 E	9m	220	0
Chennai	13.0827^0 N	80.2707^0 E	6.7m	100	0

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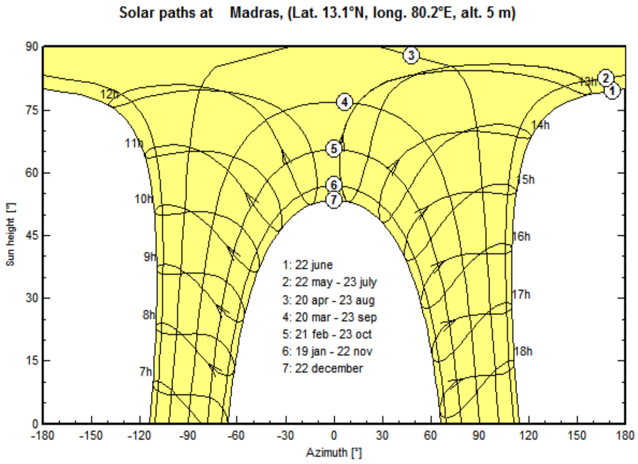

Figure 3. Solar Path at Kolkata

other places. The time zone is selected according to the Indian Standard Time (IST). In the next section, the stepwise integration of the mathematical equivalent model for a given grid-connected system in PV Syst is discussed.

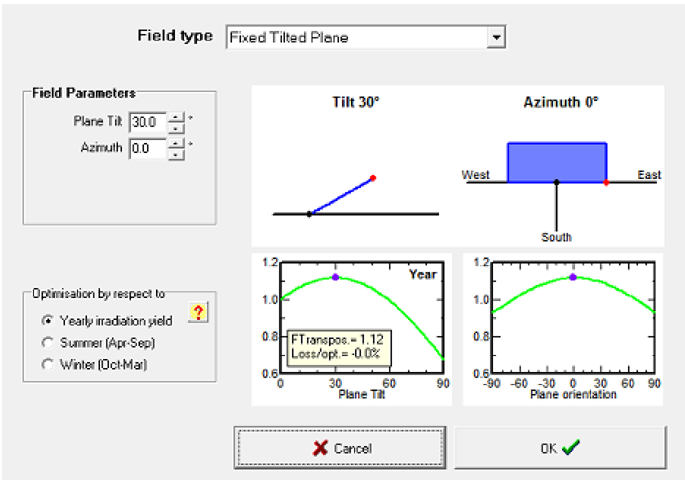

Figure 4. Orientation and Horizon finalization of PV module

III. SIMULATION & RESULT

The overall simulation has been performed on PVSyst 5.74. 1 MWp simulation results can be divided into three categories Production forecast/simulation, Loss simulation, and Economic simulationThese simulations were conducted for Jaipur, Calcutta, and Chennai for 1 MWp grid-connected solar PV systems so that we can analyze and compare performance.

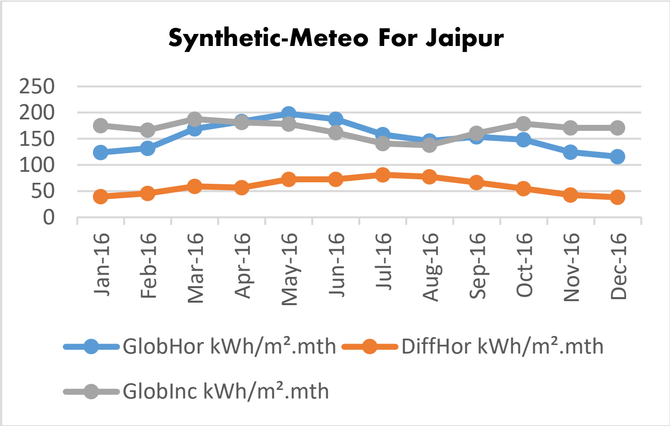

Figure 5. Design of Solar PV over Area

Losses Simulation-The yearly nominal yield and actual yield has been simulated using pv syst software for three different locations. The plot of yield has been characterized as normaized poroduction and main results.

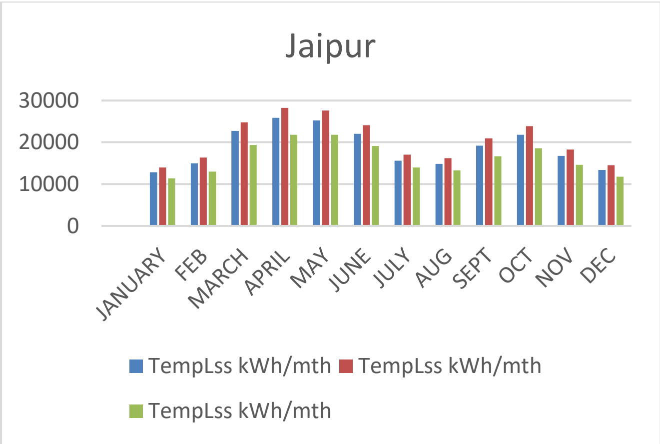

Figure 6. Loss diagram for Jaipur

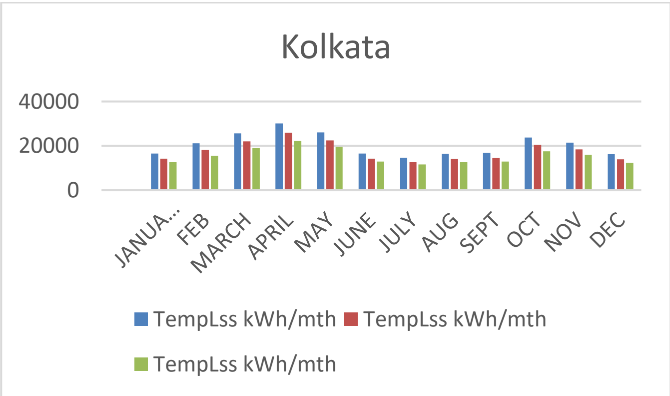

Figure 7. Loss diagram for Kolkata

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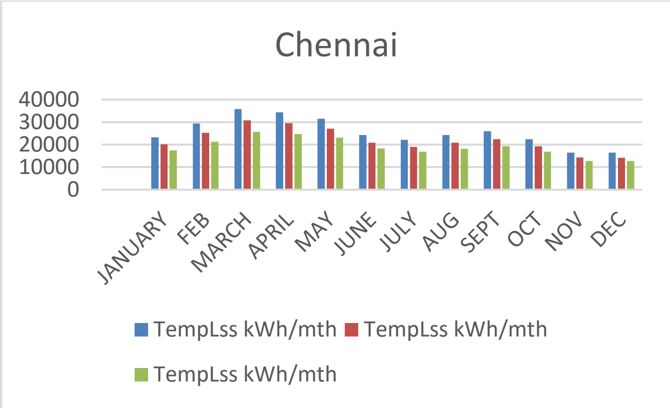

Figure 8. Loss diagram for Chennai

The table 3 compares parameters namely performance ratio, temperature dependent losses and energy output (Inverter) for different PV technology and compare it with values in three different cities namely- Jaipur, Kolkata and Chennai.

Table 3 Comparision of Simulation/Forecasting

Parameters	Yearly Value	Average	Forecasted	Yearly Value	Average	Forecasted	Yearly Value	Average	Forecasted
	MONO-SI			POLY-SI			THIN-FILM		
Location	J	K	C	J	K	C	J	K	C
PR	**0.78**	**0.79**	**0.78**	**0.79**	**0.77**	**0.76**	**0.83**	**0.82**	**0.81**
Temp-Losses	**245966**	**245204**	**306276**	**225144**	**211263**	**263603**	**195225**	**184900**	**227225**
Energy Output(Inverter)	**1598388**	**1475457**	**1602721**	**1577089**	**1447493**	**1569329**	**1670100**	**1538342**	**1676859**

**** J- Jaipur, K- Kolkata and C- Chennai.***

IV. CONCLUSION

It is important to upgrade the effective science model, architecture and procedure as well as direct methods for order and unwavering efficiency to enable an optimal use of solar energy. In our research work, we have tackled these problems and developed and of them successfully with the aid of appropriate programming. We've analyzed Phagi Jaipur's 1 MW PV-System solar power plant platform. In this research, PVsyst was used to perform a detailed analysis of the four locations that are Jaipur, Chennai, Kolkata and Mumbai on the basis of yearly data. We also defined the plane orientation, fixed tilt plane in this study by choosing the tilt angle. Then the system properties like system size, PV modules and inverter types were defined. After identifying all the input data, we performed simulations. The simulation process involved several variables and their results were shown in monthly tables and graphs form that are stored in the result file. For polysilicone modules, Jaipur has the best performance ratio. Compared to a single silicone component, Kolkata's performance is better than other sites. For single-unit silicone modules, the temperature-dependent loss at the Kolkata site is minimal. For the silicone module, the temperature-dependent loss of Kolkata is minimal for the film silica gel module, and the temperature dependence loss of the Kolkata site is minimal. For film modules, Chennai's final production is the highest compared to other parts. For silicone modules, Jaipur's final production is the highest compared to other locations. For mono silica modules, Chennai's final production is the highest compared to other parts. For thin film modules, Chennai's energy output works best on co. Compared with other parts. For polysilicone modules, Jaipur's energy output is optimal compared to other parts. For

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mono silica gel modules, Chennai's energy output is optimal compared to other parts. So we can see that the thin film module is the best, but the disadvantage of the thin film module is that it requires more area than other module technologies.

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