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Design of a Solar Power System for Optimal Output

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ABSTRACT: The Grid-Connected solar PV (GCPV) system mounted on residential and commercial buildings are likely to become a small but important source of electricity generation in the next century. Because most of the power supply in the country is via centralized electric grid. This is new concept in utility power production, a change from large scale examination of many existing standards and practices to enable the technology to develop and emerge into the marketplace. This paper gives design idea of optimized grid connected solar PV plant proposed at Habibganj. Using actual data for both loads and irradiance is used for simulation of grid connected PV, done with the use of computer software package PVsyst 5.53.

I. INTRODUCTION

More than 27.7 GW of new photovoltaic (PV) systems have been installed all over the world, ranging from sizes of kilowatts up to several tens of megawatts. Around six countries have more than 1 GW of PV installed till now. During past few years, Italy led the market, which was followed by Germany, China, the U.S., France, and Japan. Europe is this time the main competitor on the PV souk and it has a split of 75% with all novel competence. Worldwide now there are 67.4 GW of PV systems which are already installed. The above data shows that PV is the third most popular renewable energy technology after hydro and wind [1]. Particular attention is specified for big PV plants of the range greater than 200 kW rating of power, because they facilitate the lessening of the PV plant cost per watt [2]–[4]. In this track, a variety of innovative dc/ac inverter configurations have been brought up lately, with objective of providing the proficient and money-spinning operating process of big PV power system [5]–[9]. Big PV systems are poised of numerous PV panels, each one in the variety of power in the range of 150–350 W. Throughout the design phase of a large PV plant, the designer has to select the values of many design parameters: number and type of PV modules and PV inverters, distribution of the apparatus in the setting up field, etc. In addition, the worth of the design factors are contradictory. For instance, the setting up of several PV modules augment the energy production of PV plant and also lead to high fixing cost and life time maintenance cost of the PV plant. Therefore, the design of a large PV plant is a large task. The process of installing a big PV plant is in general carried out by taking into consideration not only the cost of the installation, but also the annual energy production (AEP), the performance ratio (PR), and/or the levelized cost of generated electricity (LCOE). AEP is equal to the aggregate energy injected into the electric grid during a one-year period that the PV plant is servicing [10]. PR tells the whole effect of losses, and it is identical to the ratio of the final PV system acquiesce to the reference acquiesce [11]. LCOE is a metric that is used in the electricity souk to assess for the profit breakeven of other energy technology [12]. LCOE is about the electrical output of the system through its lifetime, and it is expressed in Rs /MWh.

A decision support tool to optimally plan large-scale PV generation investments is presented in [13]. The optimal values of the PV plant location, size, and time of investment, which comprise the optimization problem decision variables, are calculated such that the net present value of the investor's profit is maximized. The financial analysis of a large-scale PV plant is presented in [14].

In this paper comprehensive analysis to attain an optimal output from solar power system is done. This process is done using PVsyst software, to determine the tilt angle, number of PV module size, size of the inverter etc.

II. SOLAR PHOTOVOLTAIC ENERGY

Among all other renewable solar have its own benefits like potential of solar energy distributed in fairly equal manner and having potential to fulfil our all energy demand for subsequent thousands of year. Solar energy is the most readily available source of energy and it is free. Moreover, solar energy is the best among all the renewable energy sources since, it is non-polluting. Energy supplied by the sun in one hour is equal to the amount of energy required by the human in one year.

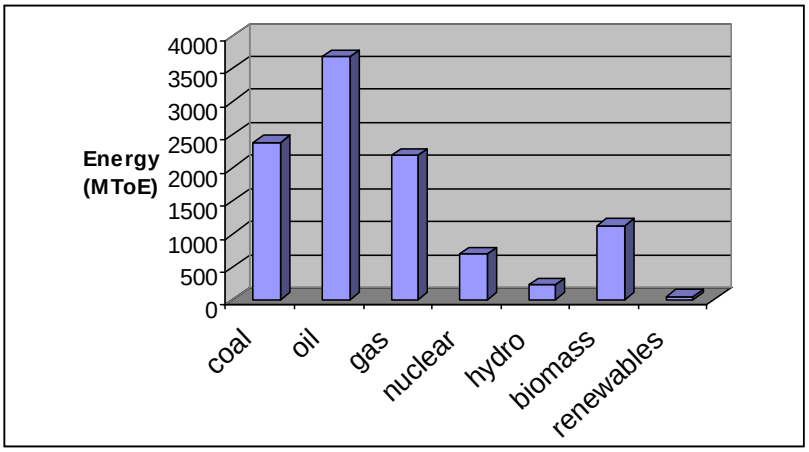

Fig. 1. World Primary Energy, 2013.

Photovoltaic (PV) energy is the most important energy resource since it is clean, pollution free, and inexhaustible. Therefore photovoltaic energy technology has been acknowledged as the important energy technology of the future. Photo voltaic arrays are used in many applications such as water pumping, street lighting in rural town, battery charging and grid connected PV systems [15, 16].

However, with solar photovoltaic technology, we are still behind in capturing this naturally free enormous amount of energy provided by nature.

Although it is very costly to design or buy, it is still very cheap to maintain, also since the output of Solar photovoltaic cell is DC in nature and almost all our domestic load is alternating hence a very much important stage is required after the conversion of solar energy into electrical energy i.e. DC to AC conversion stage or inverter stage. Also the output power of PV arrays is always changing with weather conditions, i.e., solar irradiation and atmospheric temperature. Still the direct conversion of the energy from sun (solar energy) to electricity by photovoltaic cell has a number of advantages.

αs = solar azimuth angle
α= azimuth angle of the PV generator
β= tilt angle of PV generator
γs= solar elevation from the horizon

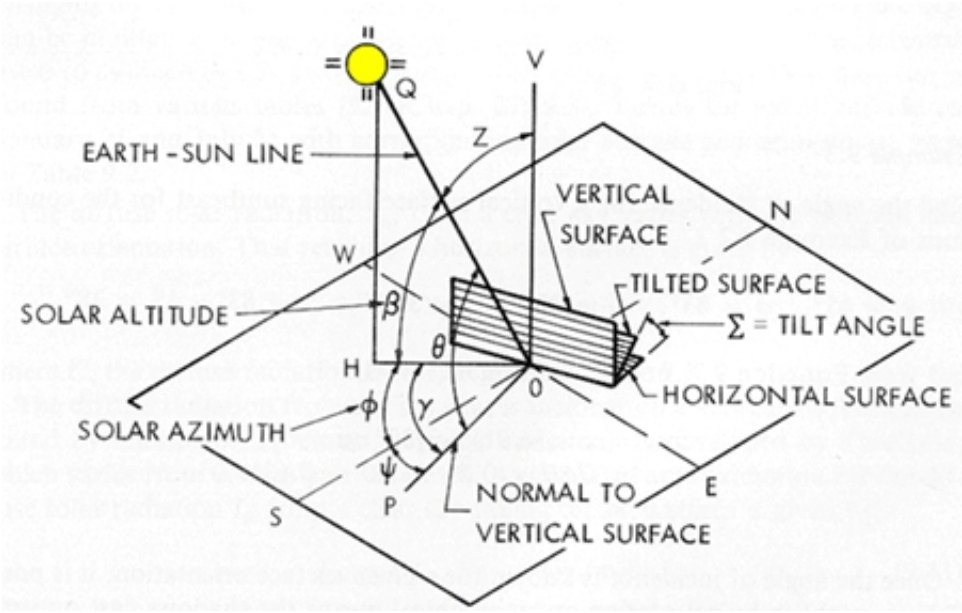

Fig. 2. The PV panel inclination angle on the Earth's surface under sunshine.

Due south is given by 0 degree, east is -90 degree and west is +90 degree. Solar altitude is very important parameter to estimate the real irradiation on a horizontal surface, because the intensity of the solar radiation on any surface is dependent on the solar elevation angle. While the Earth is rotating the elevation angle of the sun changes every month in the year and every day in the months and every hour in the day. The air mass factor determines the total distance where the sunlight has to travel to reach the Earth surface. gives the relation between air mass and elevation angle. As it is known the total power falling on a unit area from radiant source is called irradiance.

III. GRID CONNECTED SOLAR PV

The Grid-Connected Solar PV (GCPV) system mounted on residential and commercial buildings are likely to become a small but important source of electricity generation in the next century. Because most of the power supply in the country is via centralized electric grid. This is new concept in utility power production, a change from large scale examination of many existing standards and practices to enable the technology to develop and emerge into the marketplace [1]. As prices drop on-grid PV applications will become increasingly feasible, also development will benefit the nation from the point of sustainable development and environmental protection, such as the reduction of GHG emissions (CO_2, NO_2, SO_2), India's CO_2 emission from coal combustion are projected to 1.4 billion metric tonnes in 2030, which is 7% of world's total. Also advantageous in terms of the reduced use of land for power stations and the reduced dependence on conventional fossil fuels where the price will fluctuate and the supply could be interrupted. The ability of the Solar PV system to generate energy close to the point of consumption ensures that transmission and distribution losses are kept at minimum level, thereby promoting energy efficiency. So for the currently developing world the future is grid connected renewable.

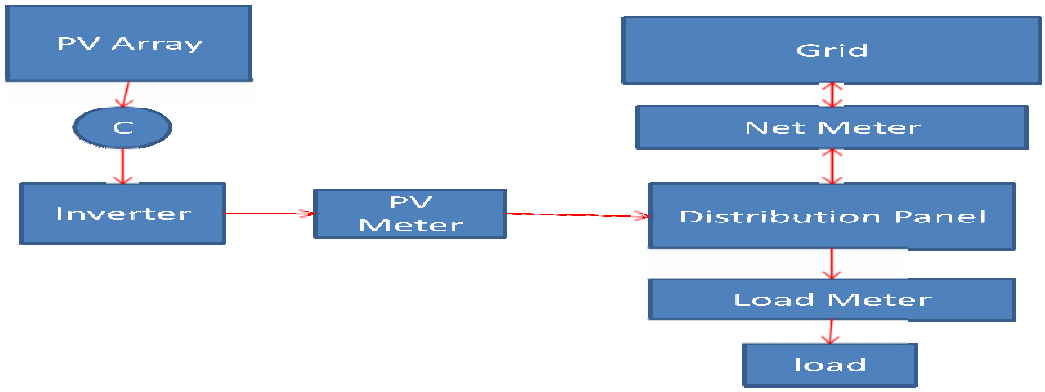

Fig. 3. Schematic representation of grid connected PV system.

IV. PROPOSED WORK AND OUTCOMES WITH PVSYST

This chapter presents the results for optimal and economic design of grid integrated solar PV system proposed for Habibganj (Central India). The research work used PVSYST software for optimal sizing of SPV system proposed for particular location. PVSYST addresses the problem of optimal design by its vast features.

Proposed work is technical and economic analysis and assessment of integration of main power supply of Habibganj location, Central India, with PV panels (a proposed case study). In order to reduce environmental impact and limit the use of ground, panels can be integrated in building premises (or shelters). Buildings planning to undergo roof renovation can plan to integrate solar cell modules into traditional roof material for the same purpose. As large scale public constructions, these have the common characteristics of other public constructions and there is huge potential of supplying power through alternative energy sources. The geographical location of the system (Habibganj, Bhopal in this case), the SPV fields (roof) and the type of the modules can be chosen from the commercially available menu. After that use of PVsyst is made to get optimized system design .The optimization procedure resulted in the determination of the optimum numbers and the types of devices, ensuring that the system total cost is minimized while guaranteeing the optimum availability of the energy.

For analysis, comparison and estimation of technical outputs of proposed PV project PVSYST, a computer software package is used, which is designed by energy institute of Geneva, which contains all the subprograms for design, optimization and simulation of PV systems, grid connected isolated and pumping applications. The program includes a separate database

for about 7200 models of PV modules and 2000 models of inverters.

Project design part, performing detailed simulation in hourly values, including an easy to use expert system, which helps user to define SPV-field and to select the correct components.

Tools perform the database meteo and component management. It also provides an extensive option of general solar tools (solar geometry, meteo on tilted planes etc.) Following diagrams depict the results obtained.

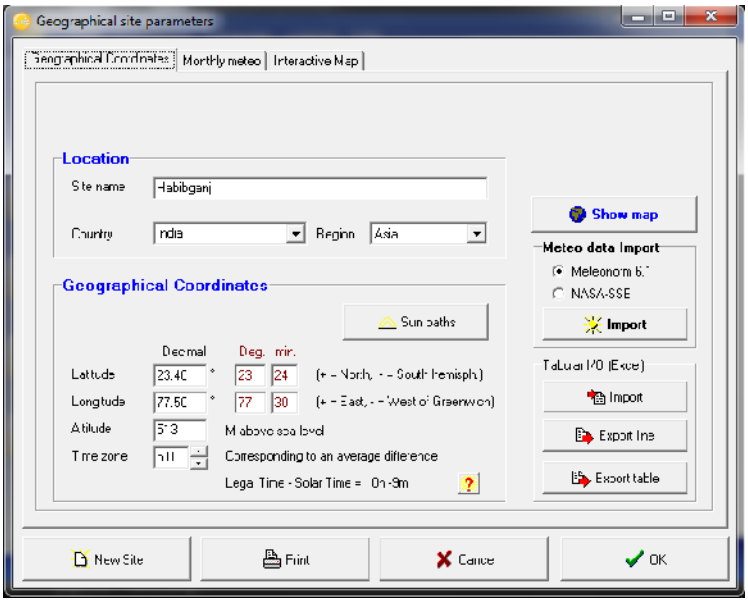

Fig. 4. geographical coordinates of Habibganj.

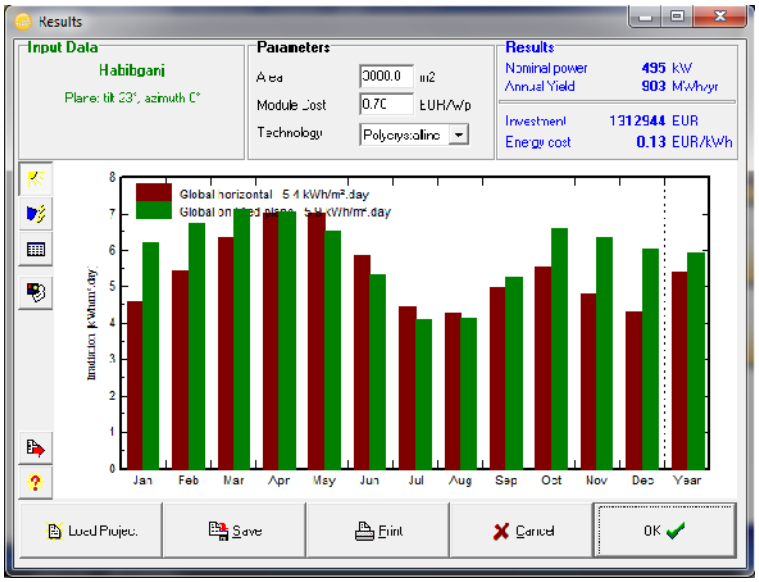

Fig. 5. Input data, solar radiation at Habibganj and primary results.

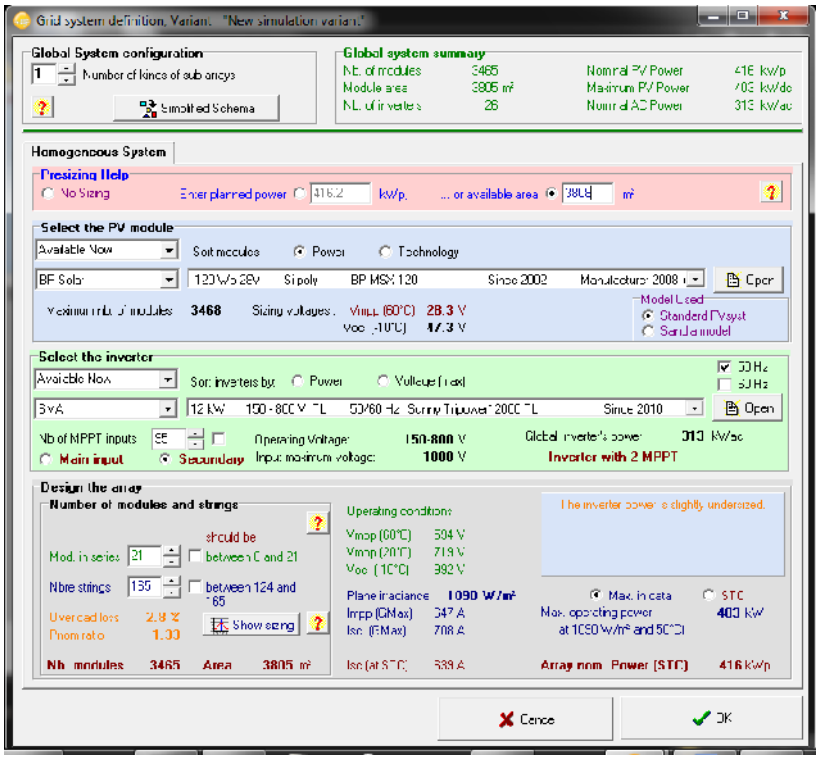

Fig. 6. Global system configuration.

V. CONCLUSION

In order to obtain electricity from a Renewable Energy Source (RES) reliably and at economic price, its design must be optimal in terms of operation and component selection. The optimum sizing of such systems require detailed analysis for a given location due to influence of various site dependent variables such as solar radiation, wind speed, temperature and their relation to system cost. The computation power of modern computers is increasing dramatically and hence computer based simulation and optimization have received more and more attention, and becoming an important tool for the design of power systems requiring a detailed analysis. pvsyst offers a good deal of accuracy for optimally designing a PV system.

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