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OPTIMUM SIZING OF PHOTOVOLTAIC AND GRID COMPONENT USING HOMER

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Abstract*:-In India as present as country is still dependent on thermal based power generation and in most of the areas of country as generation is not matching demand it is very much necessary to conserve energy and utilized renewable and nonrenewable energy sources in as effective manner. Micro grid component system sizing and design can be efficiently and effectively done using Micro grid system such as HOMER. Today's electricity grid is transitioning to a so-called smart grid. The associated challenges and funding initiatives have great efforts from the research community to propose innovative smart grid solutions. To assess the performance of possible solutions homer offers a cost effective and safe approach. This paper covers details of micro grid component sizing using homer software.

Keywords: Micro grid, Homer, Economic development, Optimization

I. INTRODUCTION

Renewable energy comes from natural resources such as wind, sunlight, geo thermal etc which are naturally replenished[1]. High cost and limited fossil fuels sources a cause of greenhouse gas emissions have given an extreme importance towards development of renewable energy sources[2].To meet increasing demands renewable energy will be key prospective in developing countries[3]. In view of large amount of unlimited energy source Solar energy can be considered as one of the very vital energy source to be focused on [4].In solar PV application solar energy is converted into electricity. Silicon solar cells are the most commonly. The components in PV system include array, modules, cells and their interconnection. It has a controller that works on maximum power point tracking or pulse width modulation technique used in such a system that automatically manages operation of such a system[5][6].

HOMER is the micro power optimization software developed by Mistaya Engineering, Canada for the National Renewable Energy Laboratory (NREL) USA, used in this analysis simplifies the task of evaluating designs of both off-grid and grid-connected power systems for a variety of applications.

A micro power system is a system that generates electricity and possibly heat, to serve a nearby load. Such a system may employ any combination of electrical generation and storage technologies and may be grid-connected or may be autonomous meaning separate from any transmission grid. Some examples of micro power systems are a solar–battery system serving a remote load, a wind–diesel system serving an isolated village, and a grid-connected to natural gas micro turbine providing electricity and heat to a factory. Power plants that supply electricity to high-voltage transmission system do not qualify as micro power systems because they are not dedicated to a particular load. It is the U.S. National Renewable Energy Laboratory (NREL) to assist in the design of Micro power systems and to facilitate the comparison of power generation technologies across a wide range of applications. HOMER models power system's physical behavior and its life-cycle cost, which is the total cost of installing and operating the system over its whole life span.HOMER allows the operator to compare many different design options based on their technical and economic merits. It also assists in understanding and quantifying the effects of uncertainty or changes in the inputs. In designing a power system, many decisions about the configuration of the system are to be made like components to include in the system design, size of each component to use, various cost of equipment etc. The large number of technology options and the variation in technology costs and availability of energy resources make these decisions difficult. HOMER's optimization and sensitivity analysis algorithms make it easier to evaluate the many possible system configurations.

HOMER simulates operation of a system by making energy balance calculations and displays list of configurations, sorted by net present cost that can be used to compare system design.HOMER models a particular system configuration by performing an hourly time series simulation of its operation over one year. HOMER steps through the year one hour at a time, calculating the available renewable power, comparing it to the electric load, and deciding what to do with surplus renewable power in times of excess, or how best to generate (or purchase from the grid) additional power in times of deficit. When it has completed one year's worth of calculations, HOMER determines whether the system satisfies the constraints imposed by the user on such quantities like the fraction of the total electrical demand served, the proportion of power generated by renewable sources, or the emissions of certain pollutants etc.HOMER also computes the quantities required to calculate the system's life-cycle cost, such as the annual fuel consumption, annual generator operating hours, expected battery life, or the quantity of power purchased annually from the grid.

There are mainly three task which HOMER performs three like : simulation, optimization, and sensitivity analysis. In the simulation process, HOMER models the performance of a particular micro power system configuration each hour of the year to determine its technical feasibility and cost of life cycle. In the optimization process, HOMER simulates many different system configurations in search of one that satisfies the technical constraints at the lowest life-cycle cost. In the sensitivity analysis process, HOMER performs multiple optimizations under a range of input assumptions to gauge the effects of uncertainty or changes in model inputs. Optimization determines the optimal value of the variables over which the system modeler has control such as the mix of components that make up the system and the size or quantity of each. Sensitivity analysis helps assess the effects of uncertainty or changes in the variables over which the designer has no control like the average wind speed or the future fuel price.

II. GENERATOR WITH PV MODULE AND LI ION BATTERY

In this simulation there is no connection between conventional plants and renewable sources. Some residential load is taken as an electric load. Biomass generator is connected to the AC bus where electric load is connected. There is PV array which generate power in DC. We connect electrical vehicle as a battery to DC grid. Electric vehicle is bidirectional which can operate in both V2G and G2V mode. In G2V mode it takes power from grid and in V2G mode it delivers power to the grid. Simulation diagram is shown in figure below.

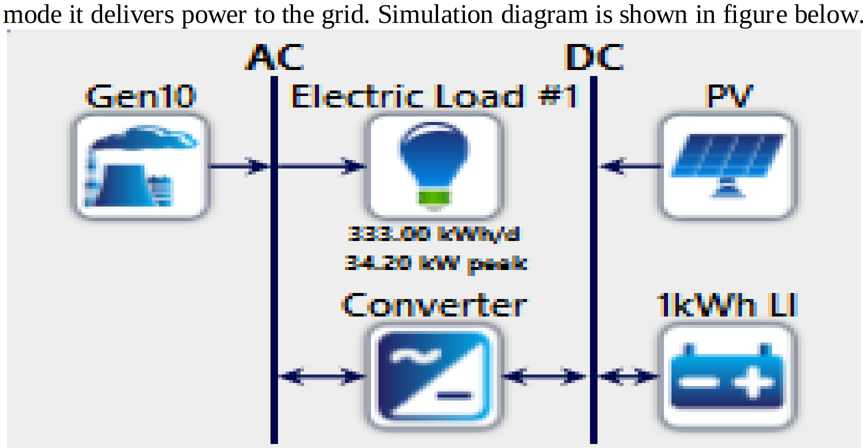

Figure 1 Proposed simulation diagram using HOMER.

Specification of Generator used for above simulation is shown in figure 2.

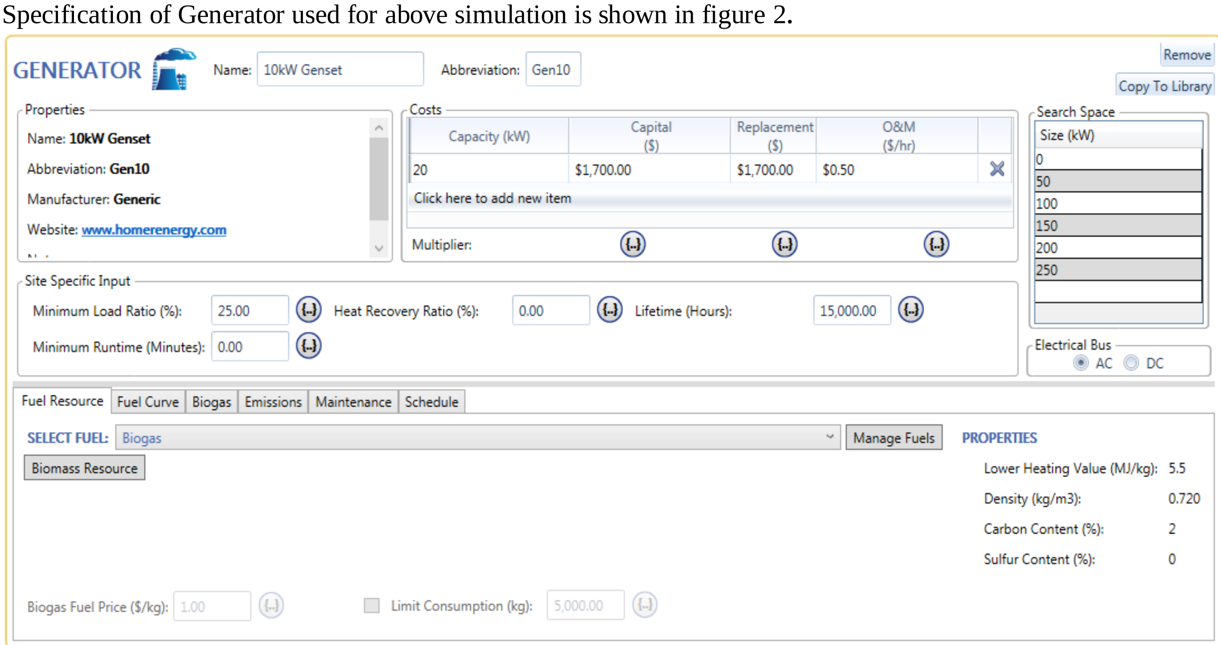

Figure 2 Specification of generator

In this simulation biomass generator selected. Capital, Running and maintenance cost of it are 1700$, 1700$ and 0.50$ respectively. Biomass is selected as fuels which have density of 5.5MJ/kg. It contains carbon of 2%. There are different sizes from 0 to 250 selected in search space to optimize the result of effective combination.Specification of PV system is shown in figure 3.

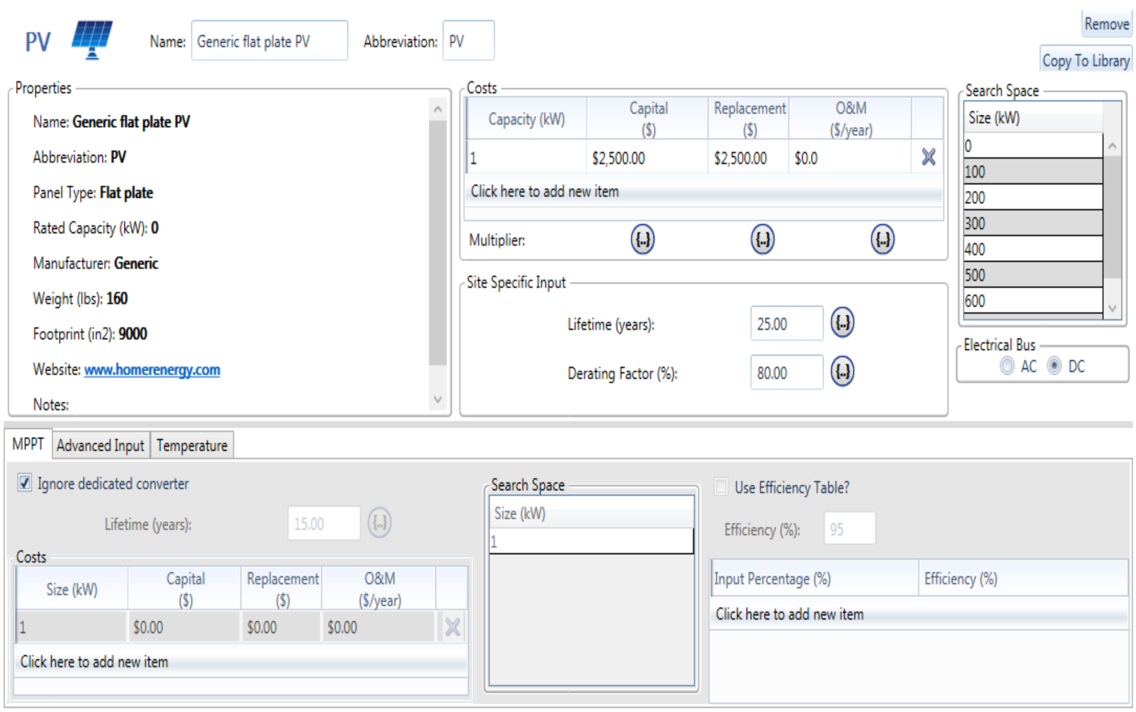

Figure 3 Specification of PV array

There are two types of PV available in HOMER from which we select flat plate PV which has capital cost, replacement cost and maintenance cost 2500$, 2500$ and 0$ respectively.

Battery specification for proposed simulation is shown in figure 4. There are different types of batteries available from which Li-Ion is selected in this simulation. 300$, 300$ and 20$ are capital, replacement and running cost respectively. Nominal voltage of battery is 6V and nominal capacity is 167Ah. There is 40 string of battery is selected. There is minimum state of charge is 20% below which battery cannot discharge.

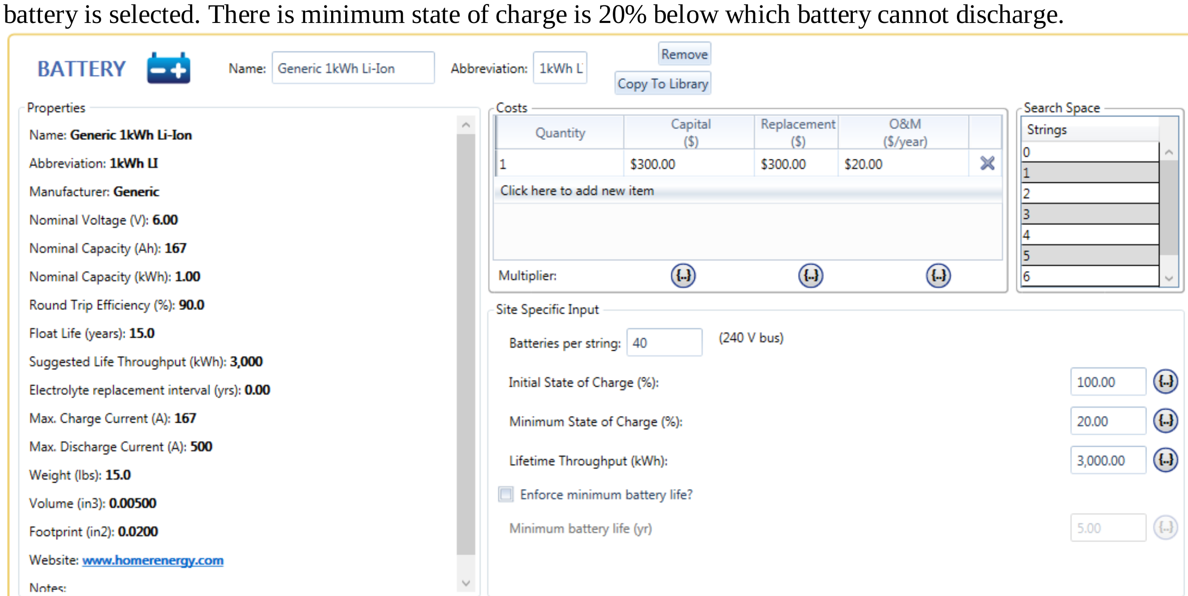

Figure 4 Battery specifications

Converter specification is shown in figure 5 below. There is convertor selected which has efficiency of 90% and lifetime is 15 years. This is bidirectional converter which means it can be use as an inverter as well as converter.

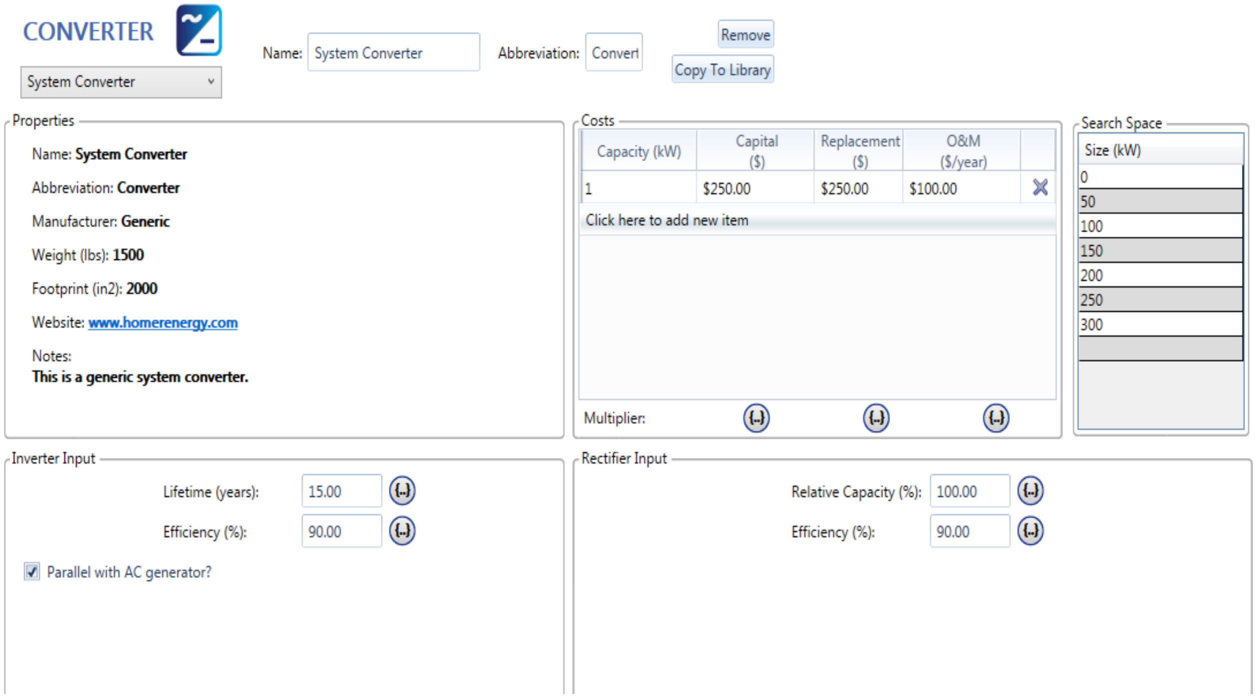

Figure 5 Converter specifications

Load specification for simulation is shown in figure 5

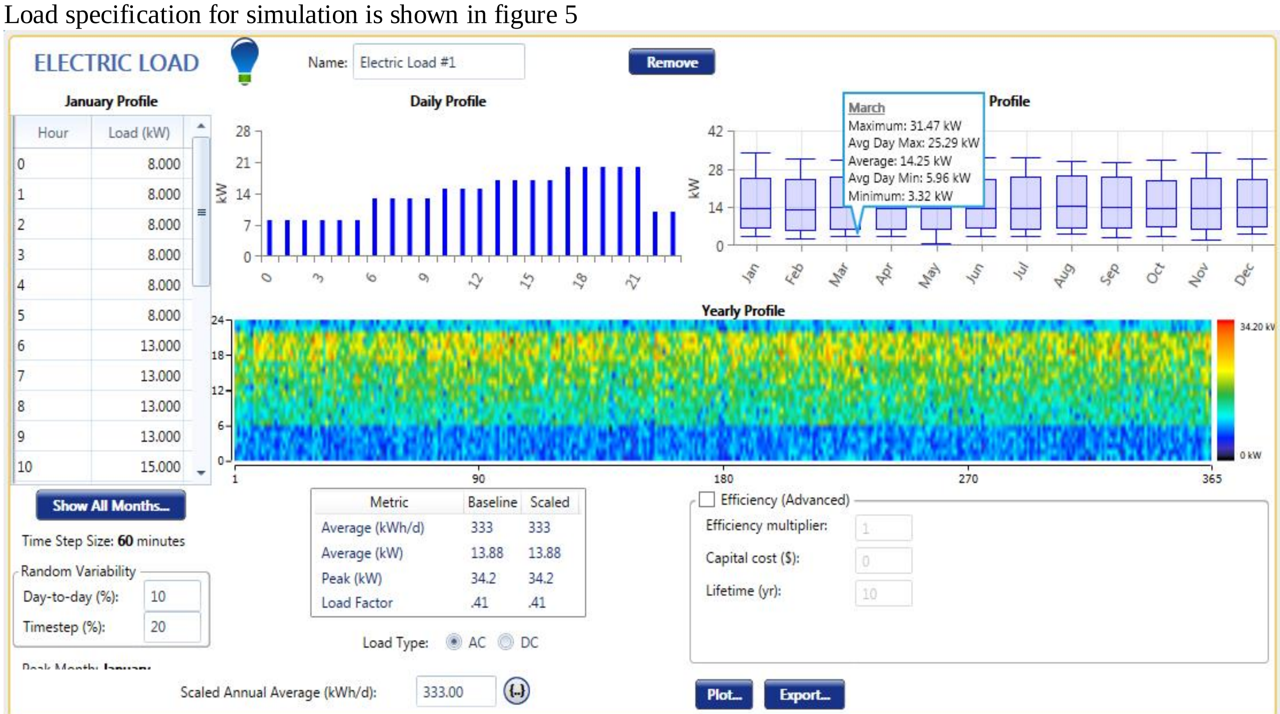

Figure 6 Load specification's

There is various loads like residential, industrial are available from which residential is selected in this simulation. Monthly loads are selected as per the study.

III. RESULTS:-

Result obtained after running simulation is shown in figure below.

Export... Column Choices... Sensitivity Cases: Left Click on sensitivity case to see optimization cases.

Architecture					Cost				System	Gen10			PV		1kWh LI	
PV (kW)	Gen10 (kW)	1kWh LI	Converter (kW)	Dispatch	COE ($)	NPC ($)	Operating cost ($)	Initial capital ($)	Ren Frac (%)	Hours	Production	Fuel (kg)	Capital Cost	Production	Autonomy	Annual Throug
	50.0			CC	$0.112	$176,231	$13,304	$4,250	100	8,760	135,459	85				

Export... Optimization Cases: Left Double Click on simulation to examine details. Categorized Overall

Architecture					Cost				System	Gen10			PV		1kWh LI	
PV (kW)	Gen10 (kW)	1kWh LI	Converter (kW)	Dispatch	COE ($)	NPC ($)	Operating cost ($)	Initial capital ($)	Ren Frac (%)	Hours	Production	Fuel (kg)	Capital Cost	Production	Autonomy	Annual Throug
	50.0			CC	$0.112	$176,231	$13,304	$4,250	100	8,760	135,459	85				
	50.0	40	50.0	CC	$0.123	$193,096	$12,520	$31,250	100	5,386	135,688	74			2	36,698
100	50.0	40	50.0	CC	$0.241	$377,963	$7,481	$281,250	100	2,588	72,728	39	250,000	152,690	2	29,581
100	50.0		50.0	CC	$0.252	$395,973	$9,803	$269,250	100	6,229	90,487	58	250,000	152,690		

Figure 6 Results of simulation

There are two results available in HOMER like sensitivity analysis and optimization analysis. In optimization analysis ,numbers of overall results are found. From various overall combinations ,some categorized combinations are found which are most effective ones shown in table.

IV. CONCLUSION

In developing country like India effectively utilizing energy resources is a key issue. Homer gives very good solution for effectively utilizing the resources. Sensitivity analysis and Optimization are the key elements of the software. Once the site is selected for placing the key components of power grid components. Homer gives best combination for running those plants effectively and efficiently with low emissions.

V. REFRENCES

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