Simulation of Hybrid Power System Using Homer Pro

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Abstract- *The demands of commercial electrical usage increases day by day. In this paper we propose an hybrid electrical production system to be used as a micro-grid to supply power in all times. The sizing and simulated output of such a system has been designed using the software called HOMER. HOMER here stands for Hybrid Optimization Model for Energy Renewable. The designing of micro grid includes PV panel and Wind turbine installation and a converter which increases the installation cost but reduces the amount payable to grid.*

Keywords- grid, Homer, simulation, wind, solar, load, optimization.

I. INTRODUCTION

Energy is critical to the economic growth and social development of any country. Indigenous energy resources need to be developed to the optimum level to minimize dependence on imported fuels, subject to resolving economic, environmental and social constraints. This led to an increase in research and development as well as investments in the renewable energy industry in search of ways to meet the energy demand and to reduce the dependency on fossil fuels. The focal point of this paper is to describe and evaluate a wind-solar hybrid power generation system for a selected location. Grid-tied power generation systems make use of solar PV or wind turbines to produce electricity and supply the load by connecting to the grid. To use solar and wind energy resources more efficiently and economically, the optimal sizing of hybrid PV/wind systems is important. One of the applications of a PV array and wind turbine is constructing a hybrid energy system PV/wind for use in commercial buildings. In the absence of one type of energy, another would be available to carry out the service. Other advantages are the stability and lower maintenance requirements; thus reducing downtime during repairs Of routine maintenance. In this study, the HOMER(Hybrid Optimization Model for Electric Renewable) computer modeling software was used to model the power system, its physical behavior and its life cycle cost.

Introduction to Homer Pro

HOMER (Hybrid Optimization Model for Multiple Energy Resources) is an optimization tool used for designing micro grid.

- HOMER simulates the operation of a system by making energy balance calculations in each time step (interval) of the year. For each time step, HOMER compares the electric and thermal demand in that time step to the energy that the system can supply in that time step, and calculates the flow of energy to and from each component of the system. For systems that include batteries or fuel-powered generators, HOMER also decides in each time step how to operate the generators and whether to charge or discharge the batteries.
- HOMER Pro has two optimization algorithms. The original grid search algorithm simulates all of the feasible system configurations defined by the Search Space. The new HOMER Optimizer® uses a proprietary derivative-free algorithm to search for the least-costly system. HOMER then displays a list of configurations, sorted by net present cost (sometimes called life-cycle cost), that you can use to compare system design options.
- When you define sensitivity variables as inputs, HOMER repeats the optimization process for each sensitivity variable that you specify. For example, if you define wind speed as a sensitivity variable, HOMER simulates system configurations for the range of wind speeds that you specify.

II. STRUCTURE OF THE PROPOSED MICRO GRID

A micro-grid is defined as a small energy system or network at the distribution level that can operate in stand-alone or grid-connected configuration. The main elements of a micro-grid are energy sources, storage systems and loads. The energy sources can be of any kind, i.e. renewable or no-renewable; however, a strong trend currently promotes the use of renewable energy sources because of the positive environmental impact that can be thus achieved.

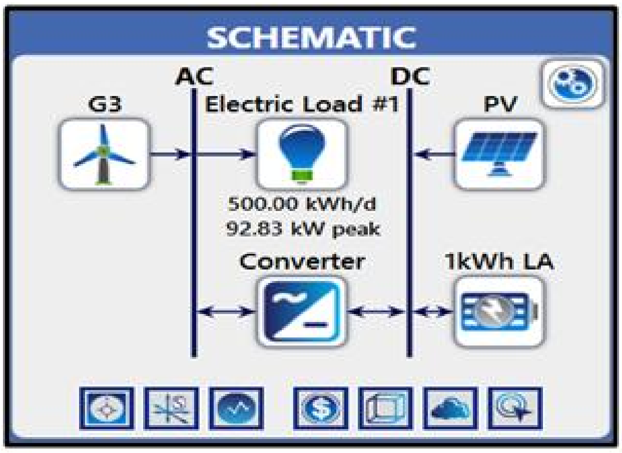

Fig.1 : Schematic Diagram

A. PV panels

PV panels are of mono-crystalline silicon flat plate type with the life time around 20 years and maximum efficiency of 17% .The Purchase price of 1kWh panel is about 48,000 without including the battery and a converter as the estimation of which will be provided in the upcoming sections. The replacement cost is about14,000;Themaintenance price is reduced at 4,800/year. The output of PV graph is shown-

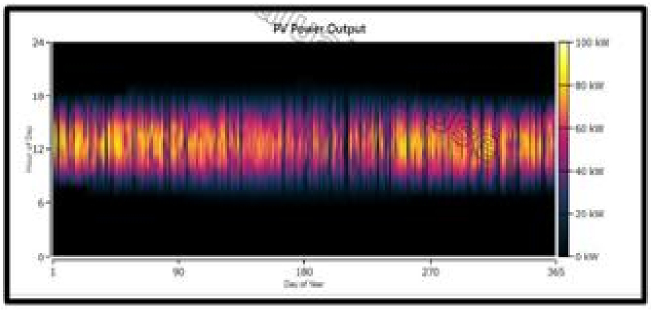

Fig.2:Generic flat plate PV output

Table -1: PV PannelOutput

Quantity	Value	Units
Minimum Output	0	kW
Maximum Output	90.6	kW
PV Penetration	90.8	%
Hours of Operation	4,385	hrs/yr
Levelized Cost	0.112	$/kWh

B. Vertical Axis WindTurbine

Usually the commercial building will have more than 4 floors such that the wind speed will be more in the ground level.Sowe prefer Vertical Axis Wind Turbine(VAWT) considering its efficiency and its operation. Then the notable thing is that it operates for any wind direction provided in area. Here we add a generic 10kWWind turbine of cost 4,00,000 and the operating and maintenance costs add up to 4,000/year.

There placement cost for a wind turbine will be around 1, 20,000.

Fig.3:Wind Energy Output

C. Battery

For this hybrid system we use lithium ion type battery and their characteristics are 1000Ah with a nominal voltage of 12v capacity. The purchase price is of 4500/battery ,the initial state of charge is considered to be 100%.The replacement cost will be around 1000/battery. The O&M cost includes 3000/year.The output of battery is given.

Table – 2:Battery Output

Quantity	Value	Units
Average Energy Cost	0	$/kWh
Energy In	63,839	kWh/yr
Energy Out	51,197	kWh/yr
Storage Depletion	141	kWh/yr
Losses	12,783	kWh/yr
Annual Throughput	57,240	kWh/yr

D. Converter

The basic converter is of 300kW as our peak demand is around 270kW.The Single converter of 300kW is used in this hybrid system having the purchase cost of 22,000 and their lifetime is around 20years.The converter output is shown in Tables.

E. LOAD

A load is connected in the system take an average of 500(kw/day) and of load factor of 0.22 and Their Lifetime of around10years.

Table -3: Converter Output

Metric	Baseline	Scaled
Average (kWh/day)	11.26	500
Average(kW)	.47	20.83
Peak (kW)	2.09	92.83
Load factor	.22	.22

Table - 4: Load Output

Quantity	Inverter	Rectifier	Units
Hours of Operation	4,255	3,458	hrs/yr
Energy Out	48,637	63,839	kWh/yr
Energy In	51,197	67,199	kWh/yr
Losses	2,560	3,360	kWh/yr

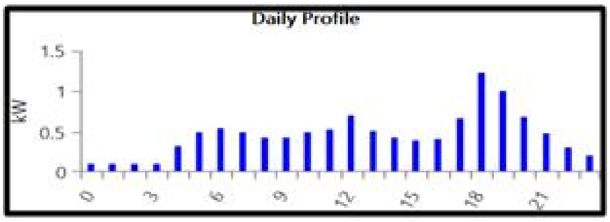

Fig.4: Daily Load Profile

III. SIMULATION RESULT AND DISCUSSION

From the simulation result of the wind turbine-solar PV hybrid system a variety of parameterslike cost summary for each component, cashflow, economic comparison, electrical share of each component, fuel summary etc. can be analyzed.

A. *Optimization Results*

The Optimization Results table lists all the feasible simulations (Non-feasible systems are not shown.) When you fist see the Optimization Results table, the results are categorized and filtered by system type. The radio buttons above the Optimization Results table allow you to filter the list of feasible systems according to system type.Optimization result display all the optimized values of selected system components in a proper table.

Table – 5:Optimization Table

Architecture				PV		G3	
PV (kW)	G3	1kWh LA	Converter (kW)	Capital Cost ($)	Production (kWh/yr)	Capital Cost ($)	Product (kWh/y
241	18	764	133	601,903	436,872	324,000	91,043
293		1,329	102	732,066	531,347		
	116	6,256	148			2,088,000	586,719

B. *Cost Summary Output*

The Cost Summary tab in the Simulation Results window displays cash flows as either a present value or annualized cost, categorized by component or cost type:

1. Net Present Cost displays the cost breakdown in terms of net present costs.
2. Annualized Cost displays the cost breakdown in terms of annualized costs.
3. By Component causes HOMER to categorize costs by component
4. By Cost Type causes HOMER to categorize costs according to type: capital, O&M, replacement, resource, and salvage value.

Fig.5: Cost summary

C. *Electrical Output*

The Electrical tab in the Simulation

Results window shows details about the annual production and consumption of electrical energy by the system.The Production table lists the total annual energy output of each electrical energy-producing component of the power system, plus the total electrical production.

The Consumption table lists the total amount of electrical energy that went to serve each of the system's electrical loads.

Fig.6: Electrical output

D. *Changes In Parameter Of Wind Turbine*

The parameter which we are changing in the wind turbine is height of wind turbine. A taller tower means far more – and cheaper – energy.Height of wind turbine decreased from 17 to 10-Height of wind turbine increased from 17 to 25-

Table - 6: Optimization Results

	PV		G3	
	Capital Cost ($)	Production (kWh/yr)	Capital Cost ($)	Producti (kWh/y
	732,066	531,347		
	693,066	503,039	72,000	16,591

Table - 7: Optimization result

	PV		G3	
	Capital Cost ($)	Production (kWh/yr)	Capital Cost ($)	Production (kWh/yr)
	408,477	296,480	360,000	114,717
	732,066	531,347		
			1,764,000	562,116

As we decrease the height from the base value of 17 to 10 ,the capital cost of the system remains same and the production of wind energy is also decreased as shown in the optimization table of wind turbine and for PV production and cost is decreased.

As we increase the height from the base value of 17 to 25 ,the capital cost of the system increased and the production of wind energy is also increased and for PV production and cost is decreased .

E. *Change In Parameter Of Solar Panel*

The parameter which we are changing in the solar pannel is derating factor (%). The derate factor for soiling accounts for dirt, snow, or other foreign matter on the front surface of the PV module that reduces the amount of solar radiation reaching the solar cells of the PV module.

we decrease the derating factor from the base value of 80 to 70-

Table - 8: Optimization result

	PV		G3	
	Capital Cost ($)	Production (kWh/yr)	Capital Cost ($)	Producti (kWh/y
	1,002,000	636,361		
	1,002,000	636,361	18,000	5,058
			2,088,000	586,719

Table - 9: Optimization result

	PV		G3	
	Capital Cost ($)	Production (kWh/yr)	Capital Cost ($)	Producti (kWh/y
	580,171	473,736	162,000	45,521
	695,219	567,678		
			2,088,000	586,719

As we increase the derating factor from the base value of 80 to 90 as shown in above diagram.

The capital cost of the system increases slightly and the production of energy is also increases . As we decrease the derating factor from the base value of 80 to 70, the capital cost of the system increases and the production of energy is also decreases as shown in the optimization table of solar pannel.

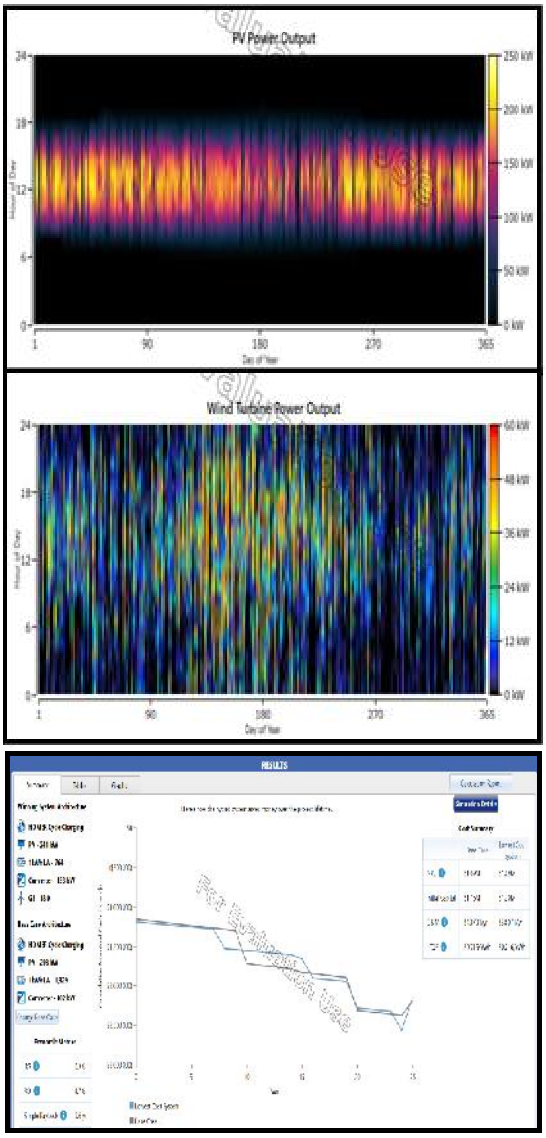

Fig.7:(a). PV output (b). Wind output (c). Simulation Result

IV. CONCLUSION

The application of HOMER pro software for designing a micro-grid system using renewable energy sources and non-renewable energy sources for meeting the power requirements of unreached communities. The software used to optimize the designed system and helped to maximize the efficiency of the system. From the simulation result of the designed Hybrid micro-grid system, it can be concluded that, the hybrid option of wind turbine and solar PV is highly cost effective and reliable system than the other possible hybrid combinations operating independently to meet the power demand of the rural communities.

Micro grid for the hybrid Power system is designed using Homer Pro.By initializing the Input load data, Sizing of system, Cost analysis and the respective output efficiency and the detailed output data is collected from the simulation tool. The following are the components of the designed micro grid: a flat plate PV wind turbine, Lithium Ion battery and Inverter to convert the DC power to AC load demand.

The following are the specification of the designed micro grid: a flat plate PV of size 241kW Generic, 18kW wind turbine, 1000Ah Lithium Ion battery-764 and a 133kW Inverter to convert the DC power to AC load demand

A clear comparison was done with Grid for a period of 15 years. Even though the COE is higher for hybrid system than the Grid, Due to the excess energy produced which give back to grid get payback from government which benefits by reducing the overall cost.

ACKNOWLEDGMENT

For the well preparation of this review paper, we are thankful to Dr. M.K. Bhaskar (Professor of Electrical Department) for the required and valuable guidance in completion of our review paper successfully.

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