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Cost Benefit Analysis of Hybrid (Wind/Solar) Power Generation System Using HOMER for Devabag, Karwar

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Abstract: This paper is based on cost analysis of Hybrid System by using HOMER software. The global warming and demand by global agencies to induce the development of Renewable Energy like Solar and Wind energy induced this paper. It presents cost analysis of solar and wind hybrid energy system and optimization result of all the components by HOMER Software which simulates the result and show cost analysis, cash flow, economies of system etc, by taking Load at small village Devabag, at Karwar. Environment friendly hybrid system can yield optimal benefit to localities' of Devabag Village of Karwar. Effort is made to design hybrid energy system with solar panels, wind turbine, generator, and battery. Here HOMER examines least cost analysis of configuration of hybrid energy.

Index terms HOMER, PV, Wind, Generator, Cost Analysis, Economies

1 INTRODUCTION

Energy system stimulates growth of social & economic development in region for households. Some Energy based on coal etc. is related to environmental pollution and degradation. Grid energy since not reached to villages or poor energy supply to villages etc. urgently requires switching from grid supply to standalone renewable energy. HOMER (Hybrid Optimization Model for Electric Renewable) simulation model developed to design a reliable and environment friendly standalone hybrid system. That assesses Techno-economic analysis with feasible component sizing. It assists to access the effect of uncertainties or changes in the input. HOMER is computer model developed by U. S. NREL (National Renewable Energy Laboratory) which assists comparison of energy generation technologies with wide range of application.

In this paper the simulation result of different combinations of hybrid energy components without grid is analyzed to reach out most cost effective system.

2 ENERGY RESOURCE FOR HYBRID POWER AND LOCATION OVERWIEW

The analysis is done at study location of Devabag Village, Karwar (Latitude 14.8185° N, Longitude 74.1416° E) and study show excellent result with abundant solar penetration and wind speed resources.

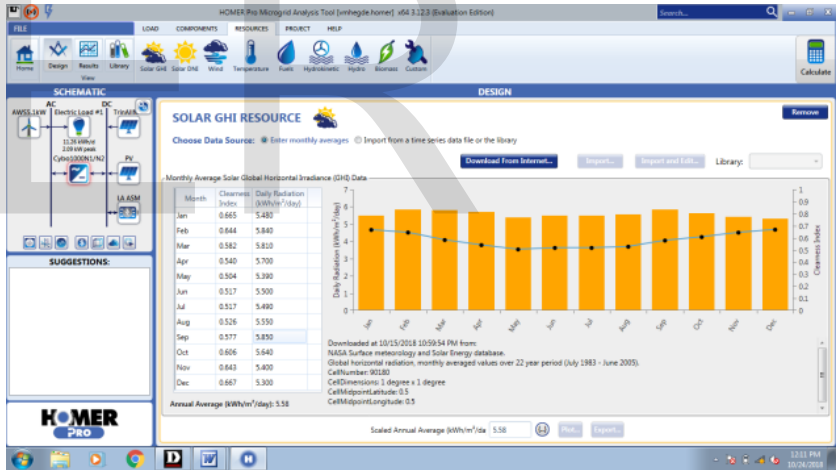

Fig 1 Solar GHI Resources

Fig.1 showing Solar GHI Resource on the basis of NASA Surface Data and solar energy database of project site.

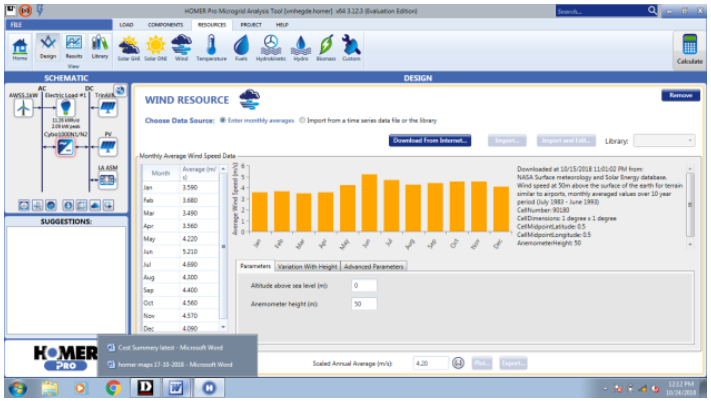

Fig 2 Wind GHI Resources

Fig.2 Showing Wind GHI Resource on the basis of NASA Surface Data and solar energy database of project site.

3 MODELLING IN HOMER

Based on feasibility of available Solar and Wind data, modeling is done using HOMER PRO Software.

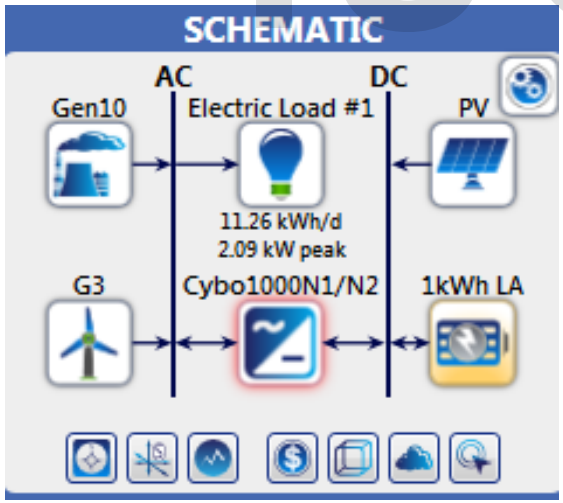

Fig 3 Schematic Design of Hybrid Energy System

Fig 3 shows modeling which comprises PV Panels, Wind Turbine, Generator, Converter and Battery. Load is also considered of study locality.

Fig 4 Electric Load

Fig. 4 show load of domestic equipments in site area of Devabag, Karwar. Typical house makes use of Tube light, Switch, fan and TV.

Table 1 Accumulated hourly data given below

Hour	Daily load (kW)	Hour	Daily load (kW)
0	0.109	12	0.691
1	0.095	13	0.519
2	0.095	14	0.418
3	0.095	15	0.397
4	0.327	16	0.409
5	0.5	17	0.658
6	0.55	18	1.231
7	0.5	19	1.003
8	0.42	20	0.676
9	0.43	21	0.48
10	0.495	22	0.3
11	0.533	23	0.204
Total Daily Load (kW)		11.135	

Scaled Annual Average of load (kW/h) is 11.26.The same is shown in the following graph

Fig 5 Scaled Data Monthly Average Load

Fig 5 show Average scaled data load month wise in households of Devabag, Karwar

4 INPUT VALUE OF PV

In the project site, Generic Flat PV Panel of 1 kw capacity used, Totally 5 panels used in series to get capacity of 5 kW. The Capital cost of PV Panels estimated Rs.240000 and replacement cost Rs.230000/- and Operation and maintenance cost is considered Rs.2000/yr. The life time of PV panel is estimated 25 years. Screen shot of Input PV details is shown in Fig. 6

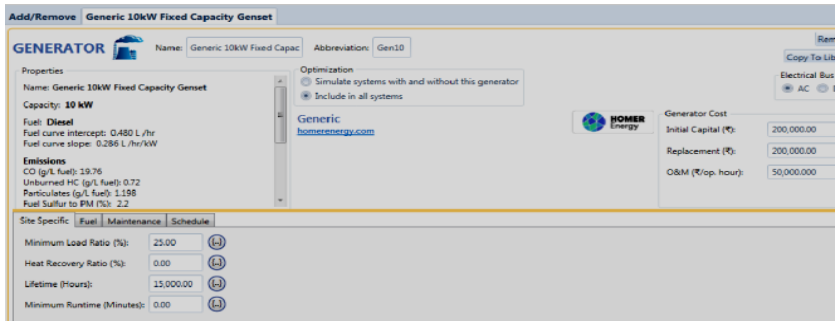

Fig 6 Input data of PV

5. INPUT VALUE OF WIND TURBINE

Generic 3 kW Wind Turbine installed with Capital Cost of Rs.330000/-, Replacement Cost of Rs.330000/- and Maintenance cost of Rs.2000/yr. Life time of wind turbine considered 20 years. Hub height is 17 m to yield better result in coastal belt of Devabag, Karwar

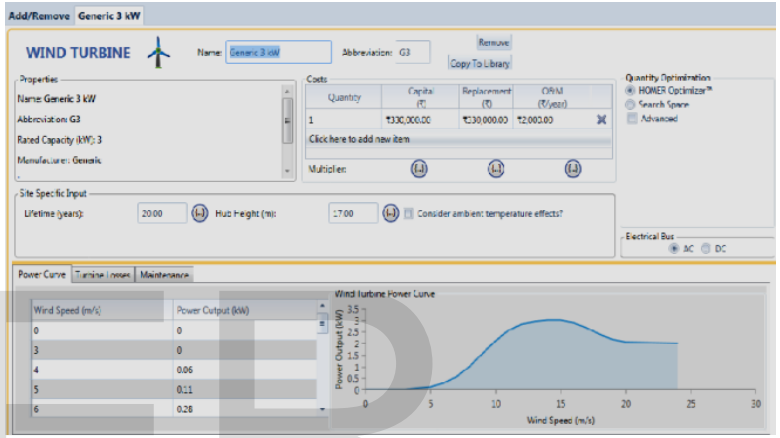

Fig 7 Input Data of Wind Turbine & power curve

Fig.7 Show Input value of wind turbine of 3 kW capacity. Wind turbine power curve is also shown based on following data month wise on average base.

Table 2 Monthly wind speed

Month	Average Speed (m/s)
Jan	3.59
Feb	3.68
Mar	3.49
Apr	3.56
May	4.22
Jun	5.21
Jul	4.69
Aug	4.3
Sep	4.4
Oct	4.56
Nov	4.57
Dec	4.09

6. INPUT VALUE OF GENERATOR

Generic 10 kW Generator is considered to reach emergency peak load. Capital Cost is Rs.220000 and replacement cost is Rs.220000 and O&M cost Rs.50000/yr towards fuel.

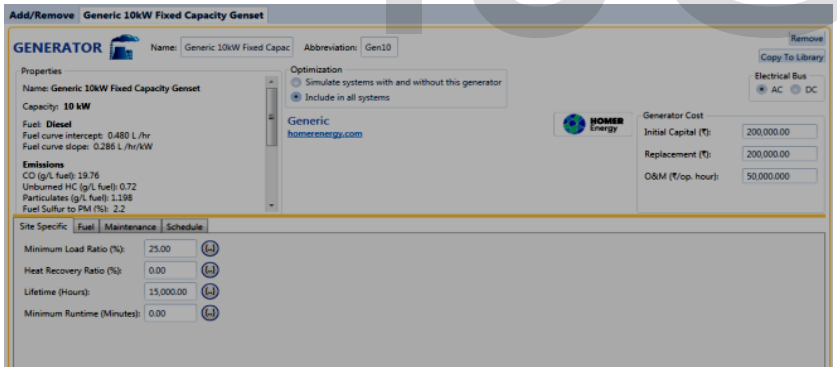

Fig 8 Input Value of Generic 10 kW Generator

As in Fig 8 included Generator in Simulation even though Optimization & simulation may be considered with or without Generator

7. INPUT VALUE OF CONVERTOR

Convertor with capacity of 4 kW is used and its capital cost is Rs.80000/-, Replacement Cost is Rs.75000/- and O & M Cost is Rs.2000/ yr. Convertor converts DC into AC for households of Devabag, Karwar and supports Standalone Renewable Energy supply in uninterrupted condition. Life time is 25 years and Convertor efficiency is 96 % and Rectifier efficiency is 100 % as shown in HOMER package.

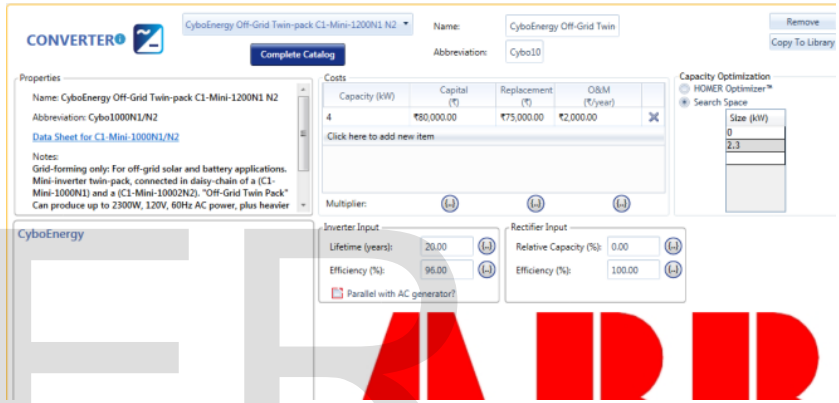

Fig 9 Input Values for Convertor

Fig 9 Shows Specifications of converter used to convert DC to AC

8. INPUT VALUE OF STORAGE

Generic 1 kW x 10 Acid Batteries used in series to store energy produced in this Hybrid Energy System of solar and wind energy. Capital cost is Rs.80000/-, Replacement Cost Rs.80000/- and maintenance cost is Rs.1000/- per year. Life time is 10 years and throughput is 800.00 kWh. Nominal Voltage 12 V, Maximum Capacity 83.4 Ah. Maximum Charge Current 16.7 A and Maximum Discharge Current 24.3 A are specifications of batteries.

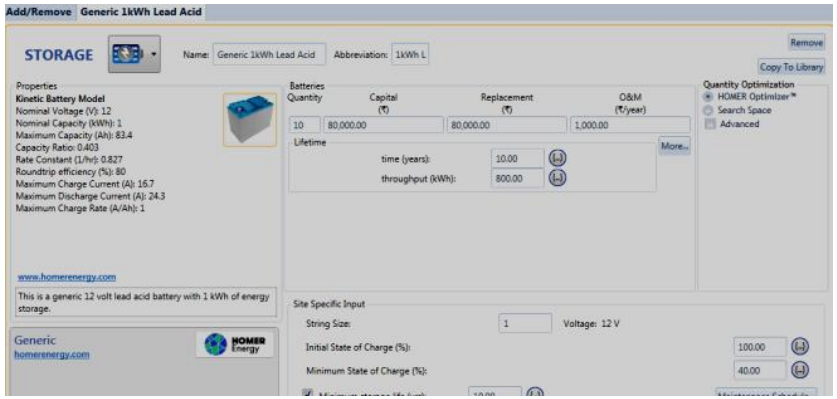

Fig 10 Input Value of Storage Battery

9. OPTIMIZATION RESULT

Sensitivity and optimization result obtained using HOMER PRO software designed by NASA NREL. It optimizes for lowest net present cost of project.

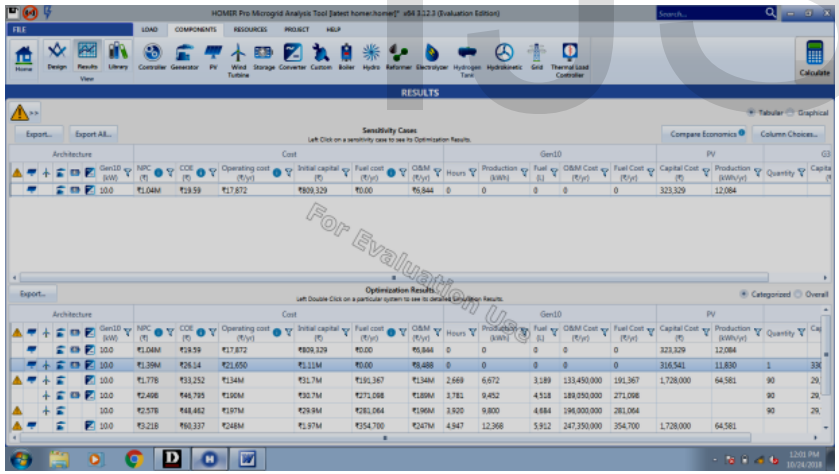

Fig 11 Optimization & Sensitivity Result

Fig. 11 shows Optimization and sensitivity result carried out in HOMER PRO for Hybrid Energy Project

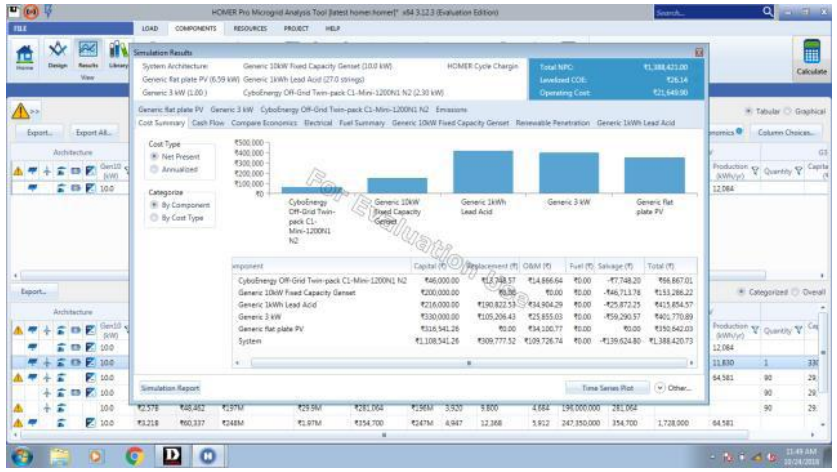

Fig 12 Cost Summery

Fig 12 shows Cost summery report analyzed by HOMER. The software analyzed 11382 solutions, out of which 11152 were feasible, 230 unfeasible due to limited battery life over period of 25 years.

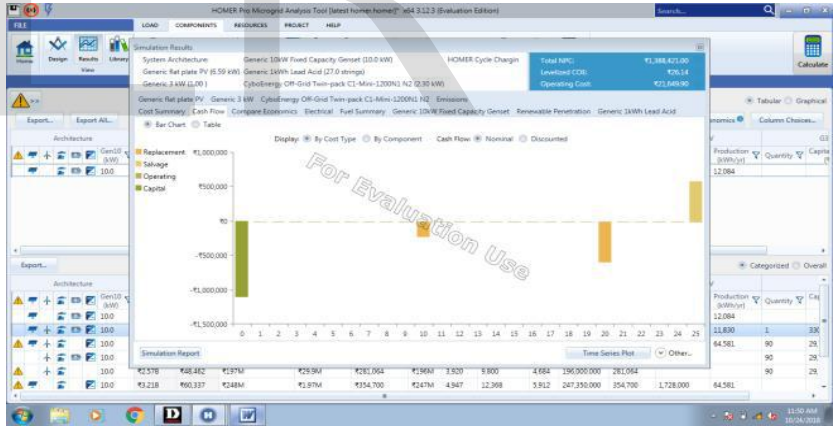

Fig 13 Cash Flow

Fig 13 shows cash flow graph of project of Hybrid Energy involving all the costs of components in initial stage and feasible gain over long period of 25 years.

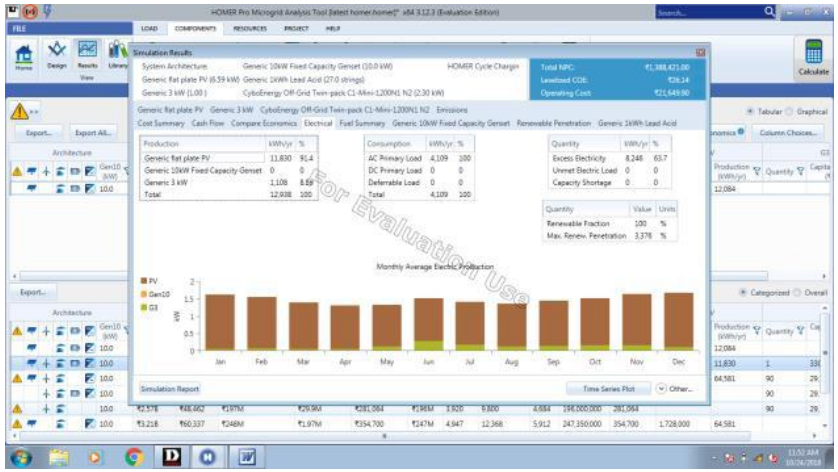

Fig 14 Monthly Average Electric Productions

Fig 14 show monthly average electric production of hybrid energy system at Devabag, Karwar

Table 3 capacity based matrices

Capacity based matrices	Value	Unit
Nominal renewable capacity divided by total nominal capacity	40.2	%
Usable renewable capacity divided by total capacity	35.0	%

Table 4. Energy based matrices

Energy based Matrices	Value	Unit
Total renewable production divided by load	294	%
Total renewable production divided by generation	100	%
One minus total nonrenewable production divided by load	100	%

Table 5 peak value of energy

Peak Value	Value	Unit
Renewable output divided by load (HOMER standard)	3,355	%
Renewable output divided by total generation	100	%
One minus nonrenewable output divided by total load	100	%

10. CONCLUSION & RESULT

The main target is to get better yield of hybrid energy which cost least per kWh.

In Optimization result HOMER not considered fuel cost of Generator as alone wind and solar energy produces access energy after utilization in load. The hybrid energy system consisting Solar PV, Wind Turbine, Convertor and storage battery show excellent performance and for 24 hours uninterrupted power supply is given to fishermen community households in Devabag Village, Karwar

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