Hybrid Renewable Energy Sources

*Makarand K. Patil, mkpatil07@gmail.com
Third Year D.M.E.
Zeal Education society's Dnyanganga Polytechnic Narhe, Pune 41

Abstract: One of the major worldwide concerns of the utilities is to reduce the emissions from traditional power plants by using renewable energy and to reduce the high cost of supplying electricity to remote areas. Hybrid power systems can provide a good solution for such problems because they integrate renewable energy along with the traditional power plants. a case study in order to investigate the ability to use a hybrid power system to provide the village with its needs of electricity. The simulation of this hybrid power system was done using HOMER software.

Keywords: hybrid, renewable energy, HOMER, photovoltaic, wind energy

1.Introduction: Renewable energy or "green energy" is defined as the energy generated from natural resources such as sunlight, wind, rain, and geothermal heat, which are renewable. Hybrid power systems usually integrate renewable energy sources with fossil fuel based generators to provide electrical power. They are generally independent of large electric grids and are used to feed loads in remote areas. Hybrid systems offer better performance, flexibility of planning and environmental benefits compared to the diesel generator based stand-alone system. Hybrid systems also give the opportunity for expanding the generating capacity in order to cope with the increasing demand in the future [1-4]. Remote areas provide a big challenge to electric power utilities. Hybrid power systems provide an excellent solution to this problem as one can use the natural sources available in the area e.g. the wind and/or solar energy. and thereby combine multiple sources of energy to generate electricity. A simulation is done using HOMER software.

2.Methodology

HYBRID POWER SYSTEMS

Hybrid power systems usually integrate renewable energy sources with fossil fuel, (diesel/petrol) based generators to provide electrical power and traditional diesel system acting as back-up in case of lack of the primary source .They are generally independent of large centralized electric grids and are used in remote areas. In these systems, it is possible for the individual power sources to provide different percentages of the total load. For instance, on a cloudy and windy day, when the solar panels are producing low levels of electricity, the wind generator can compensate by producing more electric power.
A hybrid power system, as the one shown in Figure, has the ability to provide 24-hour grid quality electricity to the load. Such a system offers better performance, flexibility of planning and environmental benefits compared to the diesel generator based stand-alone system. The operational and maintenance costs of the diesel generator can therefore be decreased thereby improving the performance of operation. Further, less fuel is used. The system also gives the opportunity for expanding its capacity in order to cope with the increasing demand in the future. This can be done by increasing either the rated power of the diesel generator, renewable generator or both of them. The advantages of using renewable energy sources for

generating power in remote areas are obvious. The cost of transported fuel is usually expensive for such locations. Further, using fossil fuel has many concerns on the issue of climate change and global warming. The main disadvantage of a standalone power system using renewable energy is that the availability of renewable energy has daily and seasonal fluctuations which results in difficulties in regulating the output power to cope with the varying the load demand

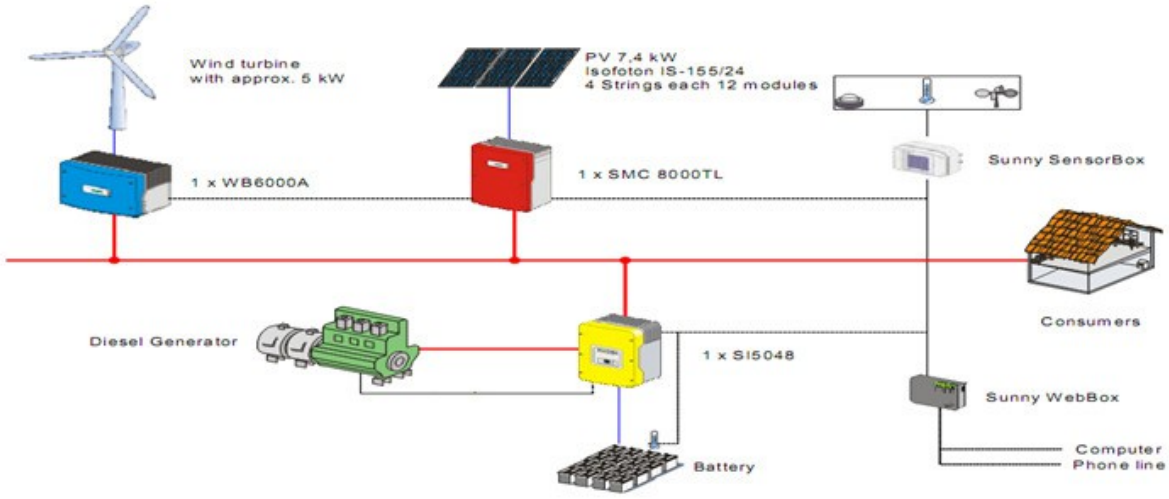


Fig.1. Hybrid power systems

SIMULATION OF HYBRID POWER SYSTEM USING HOMER SOFTWARE

In order to design a mini-grid hybrid power system, one has to be provided with information for the selected location. Typical information's required are; the load profile that should be met by the system, solar radiation for PV generation, wind speed for the wind power generation, initial cost for each component (diesel, renewable energy generators, battery, converter), cost of diesel fuel, annual interest rate, project lifetime, etc. Then using these data one can perform the simulation to obtain the best hybrid power system configuration. One of the available tools for this purpose is the HOMER software from NREL [3].

A. HOMER Simulation Procedure HOMER simulates the operation of a system by making energy balance calculations every hour for each of the 8,760 hours in a year. It finds the least cost combination of components that meet the specified electrical and thermal loads. HOMER simulates thousands of system configurations, optimizes for life cycle cost, and generates results of sensitivity analyses for most situations

B. Village Selection
The objective of this study was to select a village in a remote area in the Kingdom of Saudi Arabia to study the feasibility of using hybrid power system to supply the load of the village throughout the year. Al-Qtqt village was chosen for this purpose. It is located at 4°28'36.16"N 46°15'0.86"E and it is about 100 km from Riyadh City.

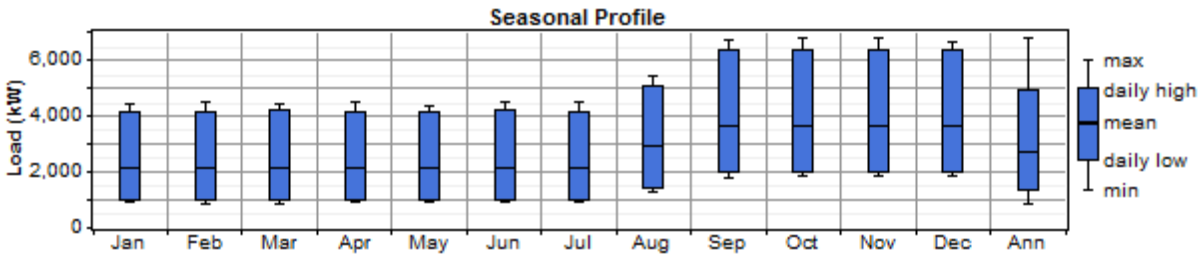


Fig. 2. Annual load profile for this village

Case 1: Solar Plus Grid without any constrains This case represent the current condition of the system where the village connected to the grid and the solar is added to the system to see the feasibility of the solar usage but without any constrains imposed.

Case 2: Solar and Wind Plus Grid without any constrains In this case the wind was also added to the system and the specification in HOMER software was still without any constrains. This was done to see the effect of adding a wind turbine to the system

Case 3: Solar and Wind Plus Grid but with constrains This case represents the same system as the previous case, but it was required that the system should use a Minimum Renewable Fraction. The Minimum Renewable Fraction was varied from 0 % to 50 %. If a wind turbine was removed from the system, then it translates to the case of solar plus grid but with constrains.

Case 4: Diesel, Solar and Wind without Grid and any constrains This case represents the ideal condition for the system where the village is off the grid and the system depends only on the hybrid power plant without any constrains of using a specific portion of renewable energy in the output power from the power plant.

Case 5: Diesel, Solar plus Wind without Grid but with constrains This case is similar to case four but constraints were imposed to use a pre specified percentage of renewable energy in the output power.

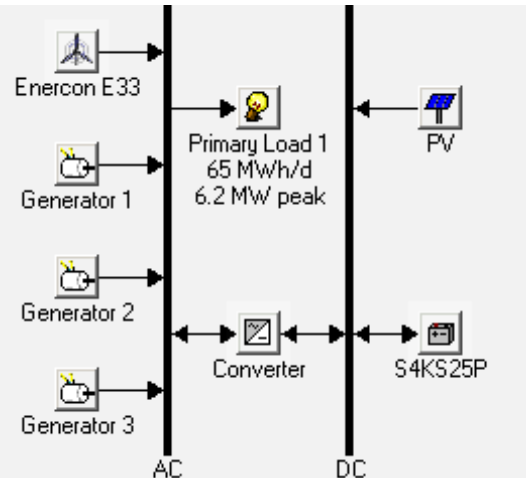
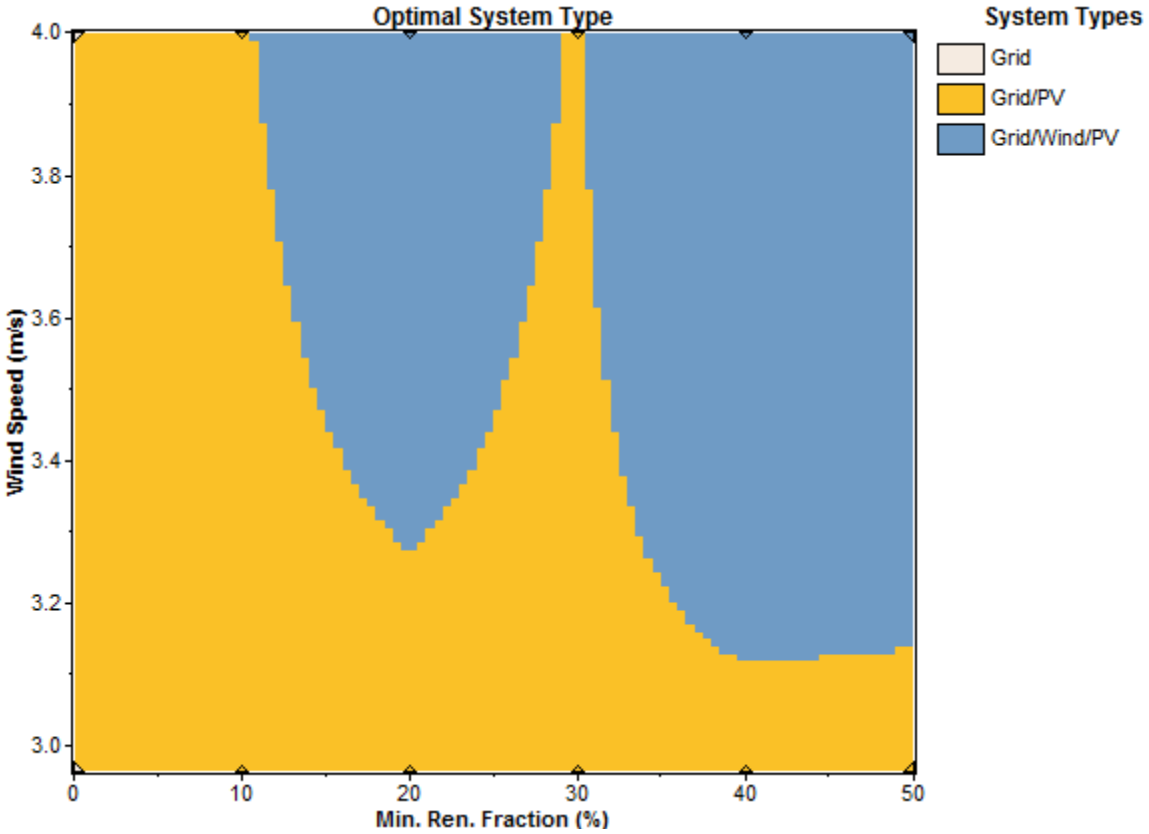
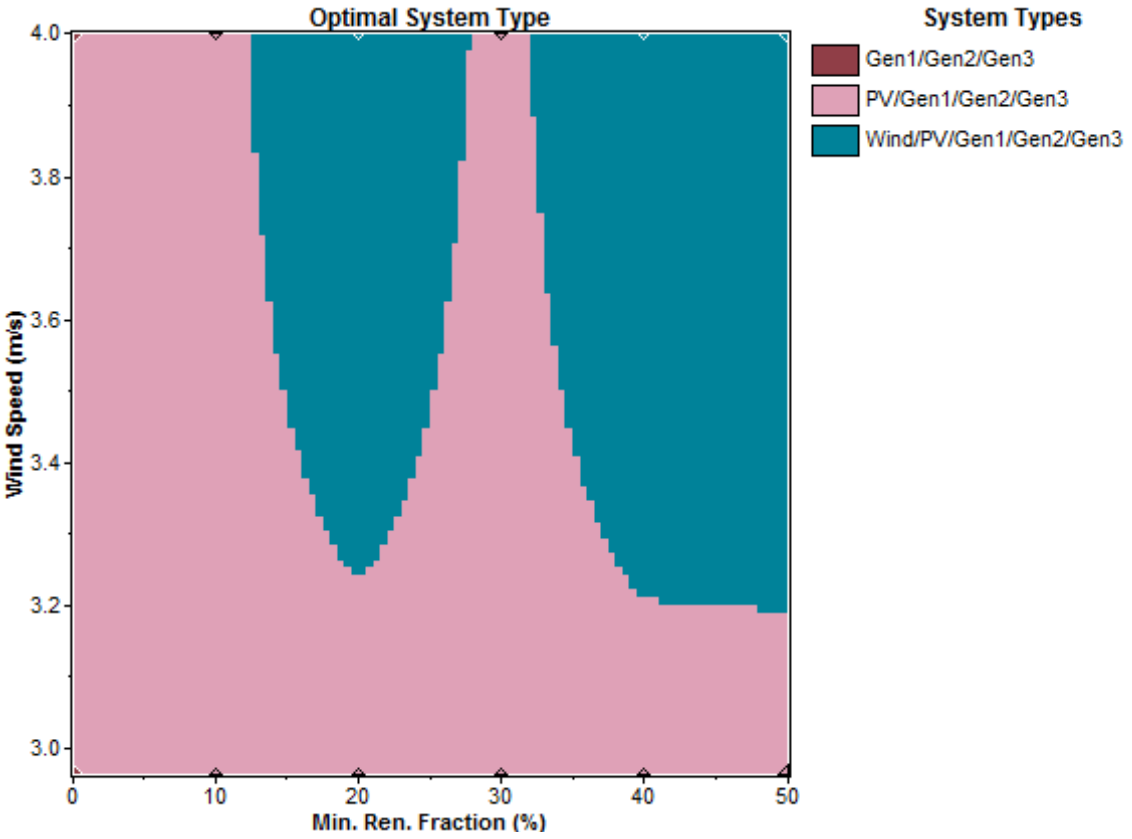


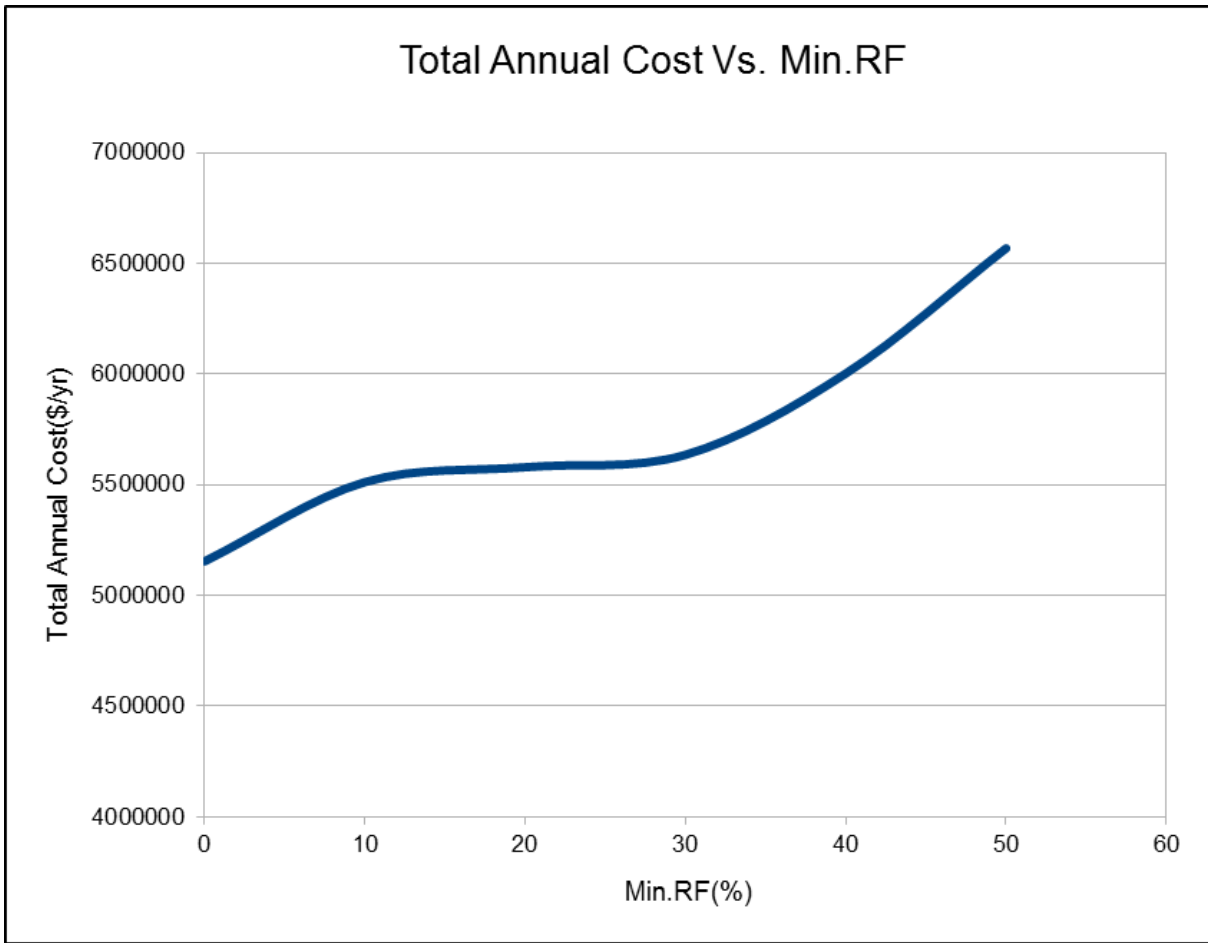
Fig:3- Hybrid power system configuration

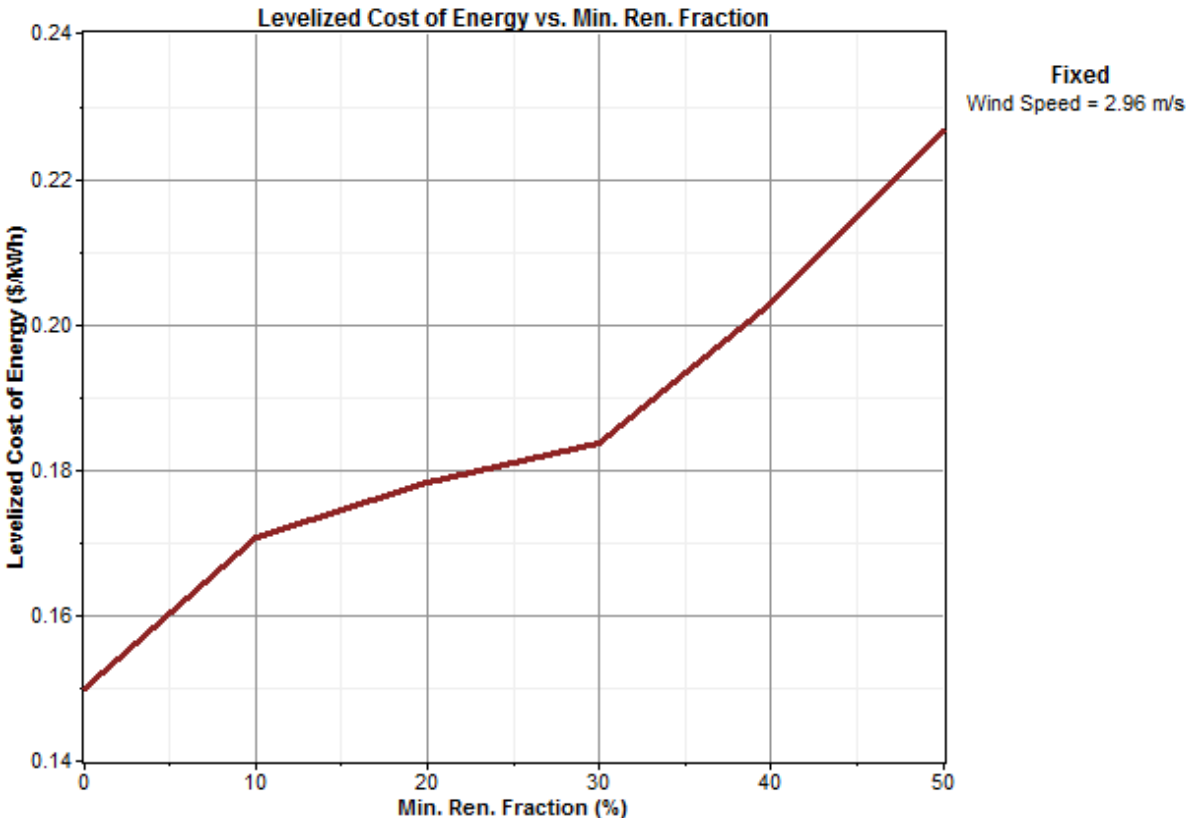
3.Conclusions and Future scope: To reduce the emissions from traditional power plants, by

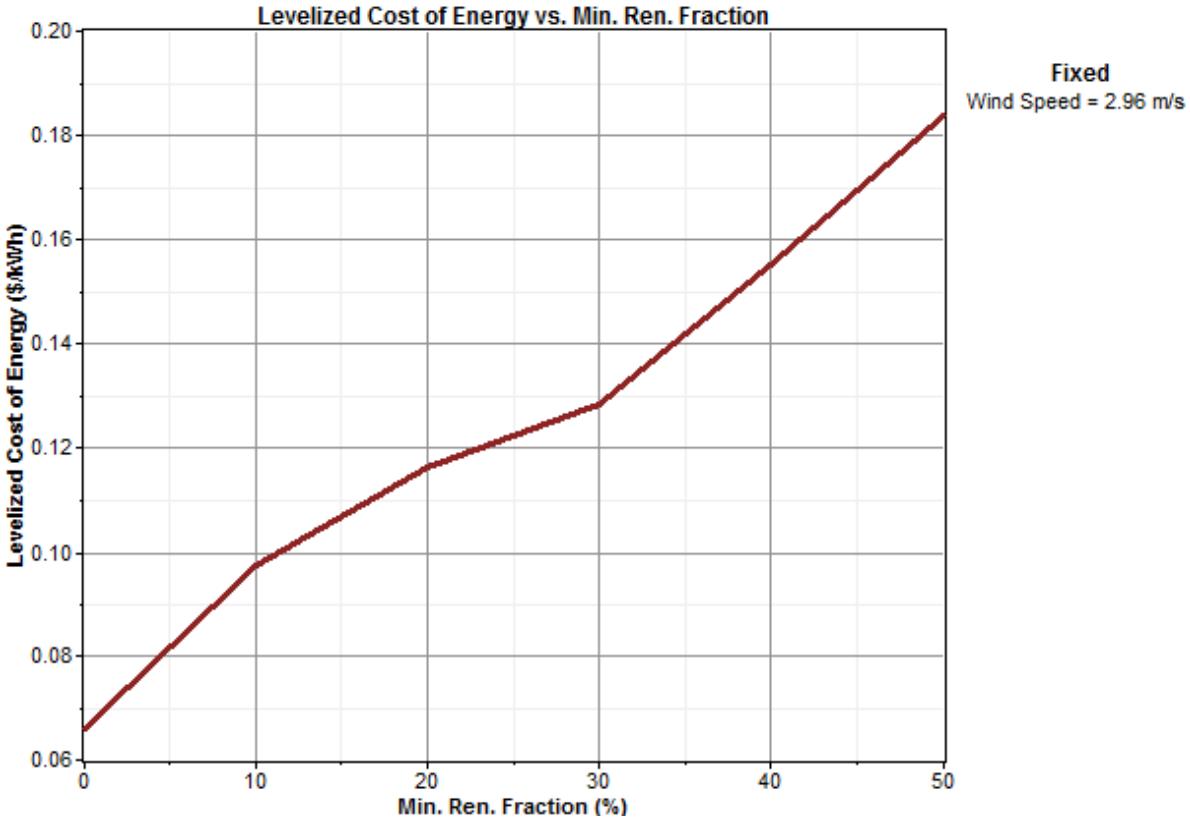
using renewable energy, and to decrease the high cost of supplying electricity to remote areas, hybrid systems are of considerable importance. Hybrid systems are one of the most promising applications of renewable energy technologies in remote areas, where the cost of grid extension is high. Since the price of fossil fuel increases with the distance of the location, hybrid energy systems could be an appropriate technology to reduce fuel consumption and environmental hazards. Applications of hybrid systems range from small power supplies for remote households providing electricity for lighting or water pumping and water supply to village electrification for remote communities. HOMER Software can be used to analyze and simulate the possible alternatives to decide for the best choice. Five case studies were designed and simulated. The output of the simulation helps to choose the optimal case for the system and the optimal percentage of Minimum Renewable Fraction. It is shown that the optimal case is the solar and grid combination and it represent a system connected to the grid with the addition of using renewable energy. The chosen percentage of Minimum Renewable Fraction, considering cost and emissions, was 30%.

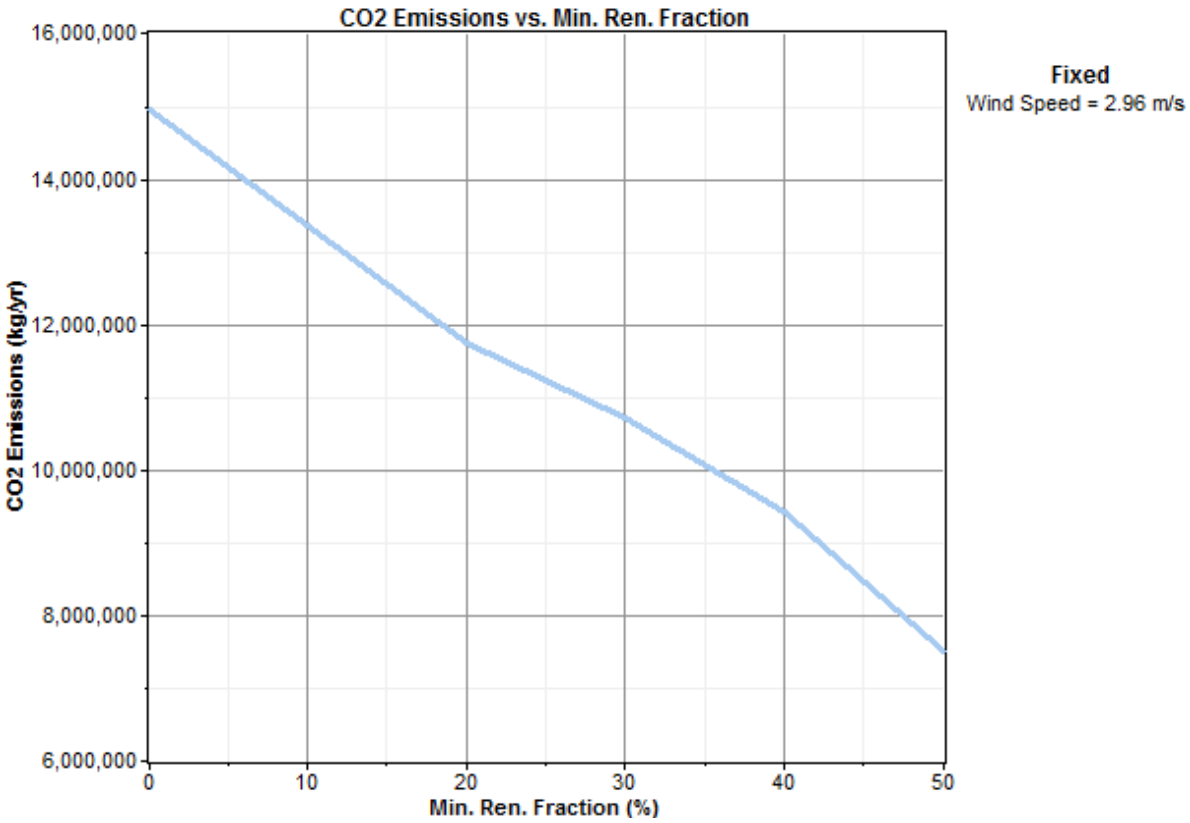



Optimal System Type
System Types
Gen1/Gen2/Gen3
PV/Gen1/Gen2/Gen3
Wind/PV/Gen1/Gen2/Gen3
Wind Speed (m/s)
4.0
3.8
3.6
3.4
3.2
3.0
0
10
20
30
40
50
Min. Ren. Fraction (%)


Total Annual Cost Vs. Min.RF
Total Annual Cost($/yr)
7000000
6500000
6000000
5500000
5000000
4500000
4000000
0
10
20
30
40
50
60
Min.RF(%)


Levelized Cost of Energy vs. Min. Ren. Fraction
Levelized Cost of Energy ($/kWh)
0.24
0.22
0.20
0.18
0.16
0.14
0
10
20
30
40
50
Min. Ren. Fraction (%)
Fixed
Wind Speed = 2.96 m/s


Levelized Cost of Energy vs. Min. Ren. Fraction
Levelized Cost of Energy ($/kWh)
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0
10
20
30
40
50
Min. Ren. Fraction (%)
Fixed
Wind Speed = 2.96 m/s



4.References:

[1] Y. Bhikabhai, "Hybrid Power Systems And Their Potential In The Pacific Islands", SOPAC Miscellaneous , Report No. 406 , 2005.

[2] G. Delvecchio, M. Guerra, C. Lofrumento, F. Neri, "A Study for Optimizing a Stand-Alone Hybrid Photovoltaic-Diesel System to Feed Summer Loads", International Conference on Renewable Energy and Power Quality, ICREPQ, Spain, pp. 167-168, 2005.

[3] A. A. Setiawan , C. V. Nayar, "Design of Hybrid Power System for a Remote Island in Maldives", The Proceedings of the HOMER Webcast - NREL USA, 2006.

[4] E. Mohamed, "Hybrid Renewable Energy Systems for the Supply of Services in Rural Settlements of Mediterranean Partner Countries HYRESS project", 4th European Conference PV-Hybrid and Mini-Grid 2008.

5] National Renewable Energy Laboratory (NREL), "HOMER the mircropower optimization model fact sheet", pp. 1-2, 2005.