Innovative Energy & Research

Tanashu, Innov Ener Res 2021, 10:2

Research Article Open Access

Solar and Wind Resource Assessment for Technoeconomic Feasibly Study in Bahir Dar, Ethiopia

Minyahil Tanashu*

Bahir Dar Institute of Technology, Faculty of Electrical and Computer Engineering, Bahir Dar, Ethiopia

Abstract

Now a day, solar and wind energy are getting more attention because of concerns related to the depletion of resources global warming and minimizing CO2 emission. Solar and wind energy are the main recourses. The paper discusses the assessment of solar and wind energy potential assessment for the feasibility study of Bahir Dar, Ethiopia. The Hybrid Optimization of Multiple Energy Resources (HOMER) software is used to analysis of the feasibility study, the inputs to the HOMER model are climate data, electrical load, technical and other parameters for generation economic, and storage are considered during the design, modeling, and techno-economic analysis of the system

Keywords: Pilomyxoid astrocytoma; Haemorrhage; Hypothalamus optic chiasma; CSF dissemination

Introduction

Due to the continual oil price increment, growing concerns of global warming, the contradiction between depletion of oil/gas reserves and the fast growth of global energy demand; renewable energy like solar, wind and hydropower are becoming a new source of power to sustainable development.in order to overcome energy poverty problem implementing renewable energy-based system are very important to enhance the living standard of rural community for development [1]. Several developing countries like Ethiopia are more depends on biomass to satisfy their energy demand. Study of tenonectomies of solar and wind system are very important

Literature Review

The following different authors were conducted for a micro grid power systems study at different times, sites and different countries. Due to space limitation, only some selected materials are reviewed.

In a paper, design and modeling of standalone hybrid power system with MATLAB is presented where the simulation result shows the system with battery connected preform batter in efficiency but system cost is large compering to other system [2].

In a paper, design, analysis and performance study of a hybrid PV diesel and wind system for selected site is considered [3]. The system simulation result is analyzed using HOMER. Result obtained through HOMER simulation is considered as promising.

A hybrid system containing PV/wind/micro-hydro/ and diesel generator simulation model was presented for Sundgarh district of Orissa state, India [4]. Two simulation have been carried out in this case study, one with combination of wind/solar and diesel generator and the second was a combination of wind/PV/small hydro and diesel generator

In paper, a hybrid wind/PV/ diesel system analysis for urban resident, the paper compares deferent micro grid topology using the performance index of net present cost, cost of energy and renewable energy fraction [5].

Resource Assessment

Assessment of the loads, solar radiation and wind speed in the selected site is an important step

Solar radiation and wind speed data

Solar radiation: The sun supplies energy in the form of radiation which is one of the important inputs for the solar array for the generation of an electric energy.

Information from site surveys is used in combination with the demand as the basis for preparing final design and planning of the overall installation.

Sit assessment involves determining of:

- A suitable location for the array and wind turbine
- Shading of solar panel
- The mounting methods

The power output during winter, which has lower solar radiation, is much less than the yearly average and in the summer months the power output will be above the average .

The solar radiation and wind speed of Bahirdar town is obtained from Ethiopian Metrology Agency. Five years solar radiation, collected from Ethiopian Metrology Agency, is given in Table 1 and Figure 1.

When solar irradiation data are available for a particular location then the equivalent number of sun hours, use to estimate the daily module output, can be determined. One equivalent sun means a solar irradiance of 1000 w/m^2.

$$Average\ Sun-hour = \frac{Average\ Solar\ irradiance\ per\ day}{1kw.m^2} = \frac{5.27kwh.m^2}{1kw.m^2} = 5.27h$$

Average wind speed data for Bahir Dar town at 2m height is

***Corresponding author:** Minyahil Tanashu, Bahir Dar Institute of Technology, Faculty of Electrical and Computer Engineering, Bahir Dar, Ethiopia, Tel: 251909530952; E-mail: tanashuminyahil@gmail.com

Received December 05, 2020; **Accepted** February 10, 2021; **Published** February 17, 2021

Citation: Tanashu M (2021) Solar and Wind Resource Assessment for Technoeconomic Feasibly Study in Bahir Dar, Ethiopia. Innov Ener Res 10: 240.

Month	Solar Irradiation (Kwh/m2/day)
January	5.43
February	5.64
March	5.89
April	6.18
May	5.51
Jun	4.79
July	4.37
August	4.16
September	4.94
October	5.68
November	5.58
December	5.04
Average	5.27

Table 1: Solar irradiation (Kwh/m2/day)

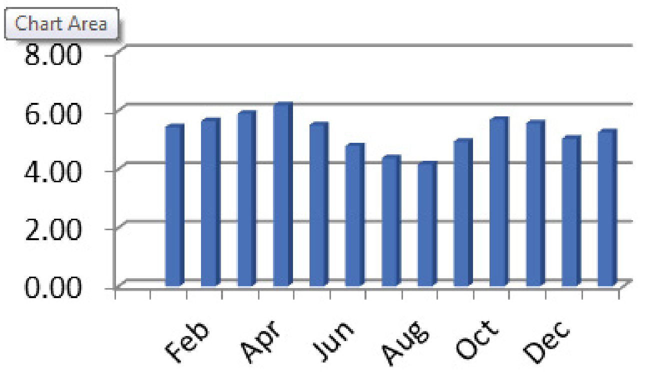

Figure 1: Solar irradiation of Bahir Dar.

Table 2: Wind speed data at 2m height

Month	***Wind Speed (m/s) @ 2m***
January	0.8
February	1.0
March	1.2
April	1.3
May	1.1
Jun	1.1
July	0.9
August	0.8
September	0.8
October	0.9
November	0.9
December	0.8
Average	0.96

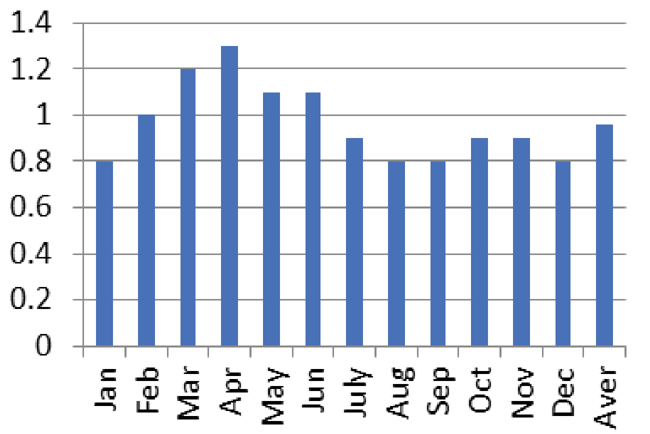

Figure 2: Wind speed of Bahir Dar Town.

collected from Ethiopian Metrological Agency as indicated in Table 2 and Figure 2.

The wind speed at the turbine height can be determined by Halmon's equation

$$V_2 = V_1\left(\frac{h_2}{h_1}\right)^{\alpha}$$

$$= 2x\left(\frac{24.15}{2}\right)^{0.4}$$

$$= 5.42m/s$$

Knowing the minimum and maximum equipment operating temperature is very important to determine the system parameters and for safe operation of the equipment as shown in below figure 3.

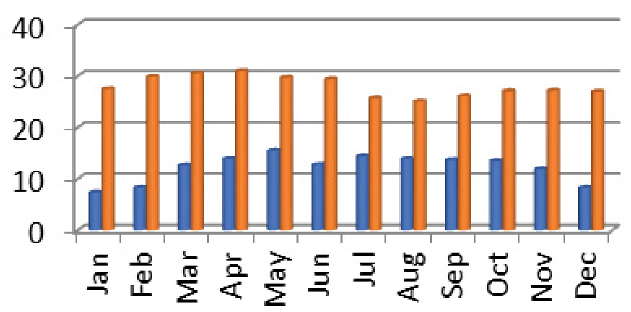

Figure 3: Minimum and Maximum Average Temperature

Load Estimation

In of this paper the load demand the community is categorized as follows:

- **Household load:** which includes of (lighting, TV, Radio, and baking appliances)
- **Commercial load:** flour milling machine
- **Community load:** which consists of lighting, desktop computer, printer, vaccine refrigerator, communication radio, television, microscope.
- **Deferrable load:** Water supply

Domestic Load

Household Electricity consumption as shown in below table 3

Commercial Load

Consumption Characteristics of Flour milling Machine shown in below table 3

School Load

School Electricity Consumption as shown in below table 4

Health Clinic Load

Health Clinic Electricity Consumption as shown in below table 5

Community church

Community church Electricity Consumption as shown in below table 6

Estimation of Deferrable Load

Pump Power Consumption Characteristics for Water Supply as shown in below table 7

The deferrable load that considered in this paper is water pumping load. The water requirement considered per household per day is 0.1 $m^{3.}$ The water supply for both the health clinic and primary school is 2.4 m^2 per day with two units of pumps that draw electrical power of 150 W with a discharge capacity of 10 liter/min installed to provide water for the community service center. The household's usage would be pumped by 6 units of pumps with rating capacity of 550 W that

Single House Hold Electricity								
No	**Appliances**	**No.in use**	**Power(W)**	**Total Power(w)**	**Hrs/day**	**Watt-hrs/day**	**TT power(w)**	**Hours/day**
1	Lamps	3	11	33	6	198	14850	18:00-24:00
2	Cell phones	1	5	5	2	10	2250	08:00-10:00
3	Radio	1	5	5	4	20	2250	08:00-12:00
4	Tv	1	65	65	4	260	29250	08:00-12:00
5	DVD Player	1	30	30	4	120	13500	08:00-12:00
	Total					488		
	No of units					450		
	Total for Single house hold Electricity units					488		

Table 3: Household Electricity consumption

Electric Load Consumption Characteristics of Flour milling Machine units								
No	**Appliances**	**No.in use**	**Power(W)**	**Total Power(w)**	**Hrs/day**	**Watt-hrs/day**	**TT power(w)**	**Hours/day**
1	Flour Milling	1	1250	1250	5	75000	**12500**	**09:00-14:00**
	Total					75000		
	No. of Units					1		
	Total					75000		

Table 4: Consumption Characteristics of Flour milling Machine

School Electricity Load									
No	**Appliances**	**No in use**	**Power(W)**	**Total Power(w)**	**Hrs/day**	**Watt-hrs/day**	**TT Power(w)**	**Hours/day**	
1	Lamps	14	11	153	12	1848	154	18:00-06:00	
2	Cell Phones	5	5	25	2	50	25	05:00-07:00	
3	Radio	3	10	30	3	90	30	08:00-11:00	13:00-17:00
4	TV	1	65	65	3	195	65	08:00-11:00	
5	DVD	1	30	30	3	90	30	08:00-11:00	
6	Computer	1	60	60	8	480	60	8:00-12:00	
7	Printer	1	50	50	1	50	50	15:00-16:00	
	Total					2803			
	No.of units					1			
	Total for school electricity Load Units					2803			

Table 5: School Electricity Consumption

Health Clinic Electricity							
No	**Appliances**	**No in use**	**Power(W)**	**Total Power(w)**	**Hrs/day**	**Watt-hrs/day**	**Hours/day**
1	Lamps	13	11	153	12	1848	18:00-06:00
2	Cell Phones	5	5	25	2	50	05:00-07:00
3	Radio	3	5	5	8	90	08:00-11:00
	TV	1	65	65	12	195	08:00-11:00
5	DVD	1	30	30	4	90	08:00-11:00
6	Computer	1	60	60	8	480	8:00-12:00
7	Printer	1	50	50	1	50	15:00-16:00
8	Laboratory Micros	1	20	20	6		
9	Vaccine freezer	1	60	60	24		
	Total					2803	
	No.of units					1	
	Total for school electricity Load Units					2803	

Table 6: Health Clinic Electricity Consumption

delivers 45 litter/min of water. Water storage capacity for 3 days is also recommended [6-8].

During the summer the water distribution center with the aid of pumps is expected to decrease and to be shared by rain water. The amount of water to be supplied by the rain water is expected to be 30% of the deferrable load. In June only 10% reduction is suggested. Table 8 shows pump power consumption of water supply.

Deferrable storage capacity of water for the community service centers

Energy Storage capacity = $2*150*Hr/\ d*3d = 3.6kWh$

Deferrable storage capacity of water for the household service

Energy Storage capacity = $6*150*7Hr/d*3d = 69.3kWh$

Total = $3.6*69.3=72.9kWh$

Peak load = $2*150 + 6*150 = 3.6kW$

HOMER model of the hybrid system

Wind turbine was rated at 10 kW and PV array was rated at 100 kW is shown in Figure 4.

Primary load input

The primary load profile which is generated by HOMER from the input data's is given in Figure 5.

Deferrable load input

The monthly deferable load is shown in the Figure 6 blow.

Resource inputs

Monthly average wind speed developed which fed into HOMER is shown in Figure 7.

Weibull distribution

The wind distribution is shown in Figure 8 for K=1.93 and 4.40 m/s.

Figure 9 below presents the monthly average solar source potential of the village under case study. As shown in the Figure April was the sunniest month. The Figure indicates that solar resource is abundant through the year and electricity generated by PV panel could be promising. The maximum solar radiation is for the April month with a radiation of 6.99 kW/m^2/day and the minimum is occurred in July with 3.87 kWh/m^2/day.

Community Church							
No	**Appliances**	**No in use**	**Power(W)**	**Total Power(w)**	**Hrs/day**	**Watt-hrs/day**	**Hours/day**
1	Lamps	12	11	132	12	1584	18:00-06:00
2	Cell -Phones	2	5	10	2	20	05:00-07:00
3	Microphone	1	5	50	6	300	08:00-24:00
	Total					1604	
	No.of units					1	
	Total for school electricity Load Units					1604	

Table 7: Community church Electricity Consumption

Pump Power Consumption Characteristics for Water Supply							
No	**Appliances**	**No in use**	**Power(W)**	**Total Power(w)**	**Hrs/day**	**Watt-hrs/day**	**Hours/day**
1	Health Center	1	150	150	4	600	05:00-09:00
2	Primary School	1	150	150	4	600	18:00-22:00
3	Community	6	550	3300	7	23100	18:00-24:00
	Total					24300	
	No.of units					1	
	Total for school electricity Load Units					24300	

Table 8: Pump Power Consumption Characteristics for Water Supply

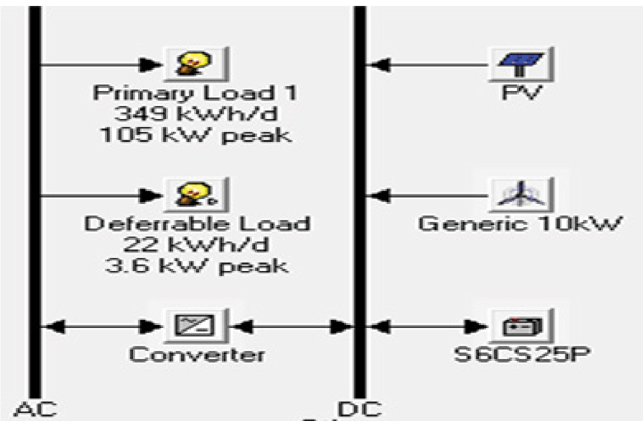

Figure 4: HOMER model of the microgrid power system

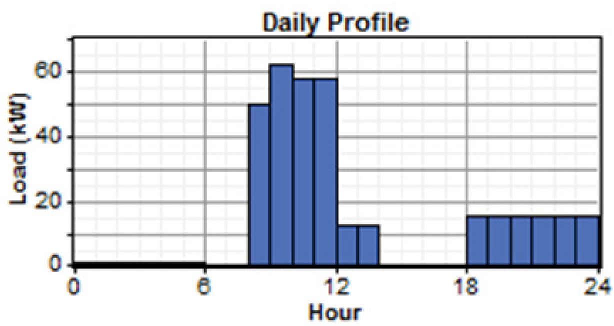

Figure 5: Daily primary load profiles

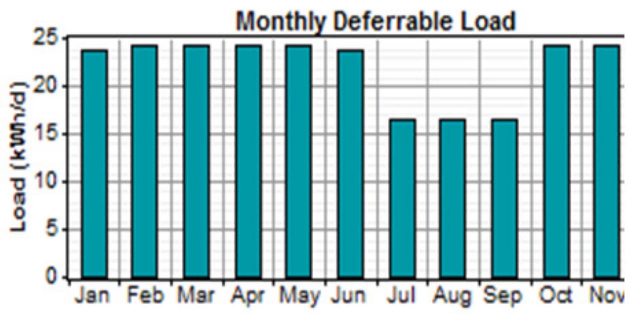

Figure 6: Monthly deferrable load profiles

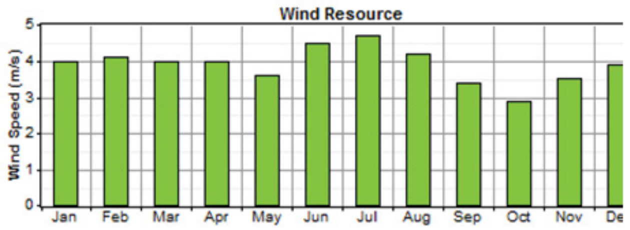

Figure 7: Monthly average wind speeds at 10m

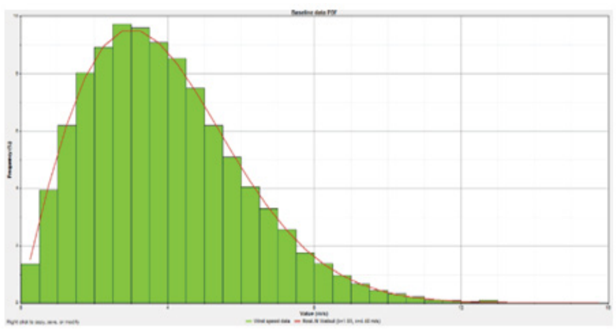

Figure 8: Wind speed probability density function at 10m

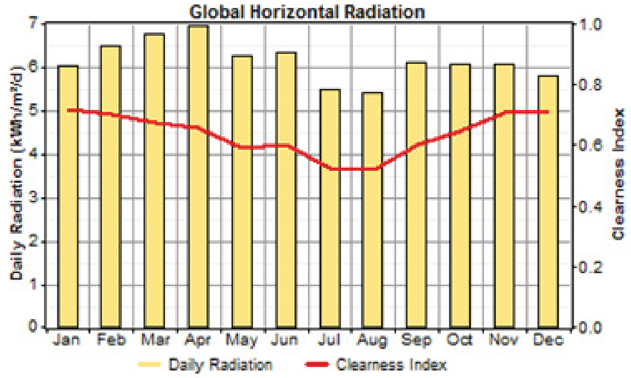

Figure 9: Monthly average radiations

Conclusion

Rural electrification is a challenge for developing countries like Ethiopia because of the economic and geographical location constraints. To meet the energy requirement micro grid power renewable energy technologies can be sustainable solutions. To upgrade the living standard of rural villages environmentally friendly renewable energy resource will be the future energy possible solution.

In this paper, data collection and community load estimation, techno-economic feasibility study using HOMER of a micro grid power system containing PV and wind power is studied. The study was carried out for 100 households in the town of Bahir Dar, Ethiopia.

Even though the sites have an excellent solar resource the optimal system configuration obtained through simulation in HOMER have higher wind penetration than PV due to higher capital costs for PV. Due to the continued reduction in PV module prices, PV could also be a major component in the hybrid systems in the area. Though the levelized cost of electricity from the hybrid systems demonstrated in this study is highly comparable to the subsidized electricity price in the country; it is significantly lower than a diesel only electricity supply.

References

1. Kebede MH(2014)Dynamic Modeling and Techno-Economic Analysis of PV-Wind-Fuel Cell Hybrid Power System: The Case Study of Nifasso", Addis Abeba University,Addis Ababa, Ethiopia 1-123.
2. Pachori A, Suhane P Design and Modelling of Standalone Hybrid Power System with Matlab/Simulink ,International Journal of Scientific Research and Management Studies 1:2349-2353.
3. Hoque MM, Bhuiyan IKA,Ahmed R, Farooque AA, Aditya SK(2012) Design, analysis and performance study of a hybrid PV Diesel-wind system for avillage GopalNager in Comilla. Global Journal of Science Frontier Research, Physics and Space Sciences 12:1-10
4. Deepak Kumar Lal, Bibhuti Bhusan Dash, A.K. Akella (2011)Optimization of PV/wind/Micro-Hydro/Diesel Hybrid Power System .International Journal on Electrical Engineering and Informatics 3:307–325.
5. Yenen M, Ercan F, Fahrioglu M (2012)Photovoltaic Solar Energy Generation. Solar Thermal System 2:1-4.
6. Drake JW, Driscoll EM, Golay MJ, Peters MW (2005) Practical Handbook of Photovoltaic Fundamentals and Applications, Elsevier advanced technology, UKTester. Academic Press 2nd Edition 1-1268.
7. https://shop.theiet.org/wind-power-integr-2nd-ed
8. http://www.vensys.de/energyen/produkte-und-service/vensys-1-5-mw.php