

Implementation analysis of technical-economic solar and wind energy potential for small homes: a case study.

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Abstract

One of the best way to reduce of greenhouse gas using of renewable energy actually renewable energies are as the best solution to reducing of global warming and it needs to reducing of fossil fuels. Country of Iran has a high potential in renewable energy such as solar, wind energy that can with a regular program use of them. The aim of this study is the analysis and assessment of solar and wind energy potentials in Zanjan city of Iran. At first, the required data from the national meteorological organization have been obtained and analyzed. A analysis has been carried out by HOMER software leads to the conclusion that, though installing large scale wind turbines is not feasible for the studied site; its solar potential would offset the wind's shortfall. The result for solar energy radiation shows the potential of solar energy is sufficient for Zanjan likewise due to good wind speed in Zanjan area, can be say this city has a privilege in renewable energies.

Keywords: Grenewable energy, solar energy, wind energy, homer software, economic justification.

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Introduction

Progress in renewable energy deployment is caused that utilization of fossil fuels reduced also from the environmental point of view in contrast to fossil fuels, renewable energy are in general pollution free which indeed it is essential factor for human life also there is an attempt to limit emission of carbon dioxide by using of renewable energy, actually the problems caused by fuel fossils is very harmful for mankind [1-3]. Renewable energy especially solar and wind energy technologies have seen much progress in different parts, Solar and wind energy can play a remarkable role as non-conventional resource in the world. About solar and wind energy applications many studies have been conducted related in different countries [4-6]. For example studied an assessment solar and wind energy in Bucaramanga, Colombia [7]. A review about renewable energy research progress in Mexico done [8]. A case study about empirical models for estimating global solar radiation have been done [9]. Technical and Economic Assessment of solar PV/diesel for Ethiopia country have been analyzed [10]. Determined the characteristics and potential of wind power for Kudat and Labuan located in Malaysia [11]. Presentation of Solar radiation model [12]. Wind energy potential of two sites in North-East, Nigeria considered [13]. Presented a study about solar radiation prediction by using of adaptive neuro-fuzzy approach in Nigeria [14]. Their results indicated which growing of the solar and wind energy is outstanding and has positive effects on our life also help us to having a better future, Meanwhile it was demonstrated that the growth of investment on the solar and wind energy will make a health space for our infants and other kind of members society [15]. Iran is one of the largest oil producers in the world and it was caused that approach usage of renewable energy be less than fuel fossils but [16]. Iran like developing countries has focus on renewable energy development [17].

Description Studied Area

Zanjan city is capital of zanjan province. It is located in north of Iran. This city is located at Coordinates 36°41'N and 48°29'E and at an altitude of 1,663 m meters above sea level. At the 2011 census its population was 386.851. Zanjan is a tourist city and also has a lot of historic places and historical attractions such as ancient market. The climate is cold in winter and autumn and moderate in spring and summer.

Technical-Economic Analysis of Solar Energy

In this study the Homer software that is conventional was used to a technical-economic analysis on the solar energy generation potential of the studied area. Figure 1 shows the diagram of horizontal radiation pertaining to Zanjan city solar energy potential is shown in Figure 1. As this figure shows, the highest level of solar radiation is 7.860 kWh/m²/d per square meter, which has been received in June and the lowest level is 2.126 kWh/m²/d per square meter, which has been received in December also in this figure, clearness index and daily radiation

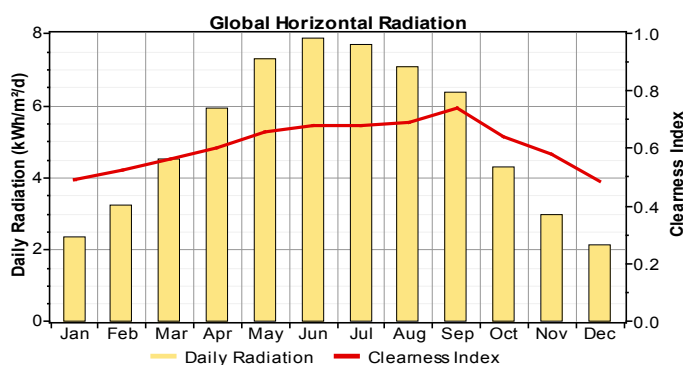


Figure 1. Global horizontal radiation for Zanjan.

are plotted for different month of the year and the red line was drawn by the software and it is a clearance index.

Table 1 shows Specifications of System architecture that is including PV Array 7 kW, generator 1, 7 kW, battery 24 Vision 6FM55D also inverter and Rectifier 7 kW.

The monthly average electricity production by the photovoltaic collectors and generator 1 are each shown in Figure 2. In this figure the electrical power generation by the generator makes a significant contribution.

Table 2 Shows the Specifications of PV System by each household, the Rated capacity is 7 kW and Total production is 12,205 kWh/yr.

Table 3 shows Specifications of Generator System that is including Hours of operation, Number of starts, Electrical production, Mean electrical output, Fuel energy input, Mean electrical efficiency.

Figure 3 shows monthly average of Generator 1 Output that in this figure colors from black to red and unit age kW and respectively have been breakdown.

Table 1. Specifications of system architecture.

PV Array	Generator 1	Battery	Inverter	Rectifier	Dispatch strategy
12 kW	12 kW	14Vision 6FM55D	7 kW	7 kW	Cycle charging

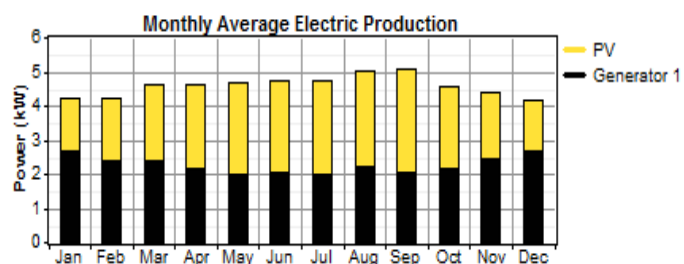


Figure 2. Monthly average electric production of pv-generator hybrid.

Table 2. Specifications of PV system.

Rated capacity kW	Mean output kW	Capacity factor %	Total production kWh/yr	PV penetration %	Hours of operation Hr/yr
12.00	2.31	19.3	20,255	65.3	4,387

Table 3. Specifications of generator 1 system.

Hours of operation hr/yr	Number of starts starts/yr	Operational life yr	Capacity factor %	Electrical production kWh/yr	Mean electrical efficiency %
6,404	404	2,34	32.6	19,983	23.7

Table 4. Specifications of battery system.

String size	Strings in parallel	Bus voltage (V)	Nominal capacity kWh	Losses kWh/yr	Annual throughput kWh/yr
1	14	12	9.24	84.4	378

Table 4 shows Specifications of Battery System that each parameter in separation part has divided.

Figure 4 shows the battery bank state of charge for Zanjan city that battery has not been fully charged for the entire 24 hours of the day and sometimes has a fluctuation; Red color which is the graphical representation of battery performance in Figure 4 confirms this observation.

Table 5 shows Specifications of converter considered for each PV system consisting capacity, Mean output, Capacity factor, Hours of operation and Losses.

Figure 5 summarizes the annualized cash flow for this system, broken down by component for PV-diesel battery-converter. The maximum cost after the generator cost is belong to the PV cost.

Table 6 shows detailed breakdown of the NPC for PV-diesel battery-converter hybrid system that in this table the highest and lowest total lifetime cost of the system is belonging to the generator and converter, which have values of US\$ 61,807 and US\$ 1,188 respectively in addition this system exhibits a maximum in terms of cost of the system, which is US\$ 79,624.

Technical-Economic Analysis of Wind Energy

For analysis of wind energy in this system Homer software was used and all analysis presented in different tables and figures. Table 7 shows the specifications of wind System architecture that for this system 2 Generic 3 kW, a generator 7 kW and 24 Vision 6FM55D were selected.

Table 8 shows Specifications of Generator System for wind energy that in this table total rated capacity 6 kW and Total production 2,769 kWh/yr obtained.

Table 9 as PV analysis shows Specifications of Generator 1 System that is consisting Hours of operation, Number of starts, Operational life, Capacity factor, Electrical production, Mean electrical output.

Figure 6 shows Generator 1 Output that has a range from 0.0 to 12 kW h/d.

Table 10 shows that is breakdown of Specifications of Electrical System which is consisting Wind turbines, Generator 1, Excess electricity, DC primary load, Capacity shortage and Renewable fraction.

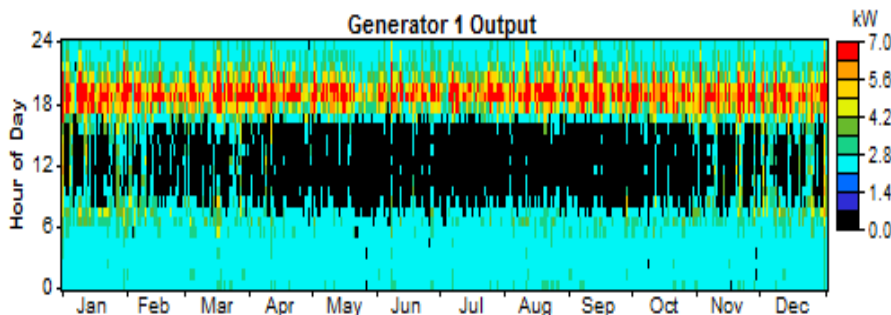


Figure 3. Monthly average of generator 1 output.

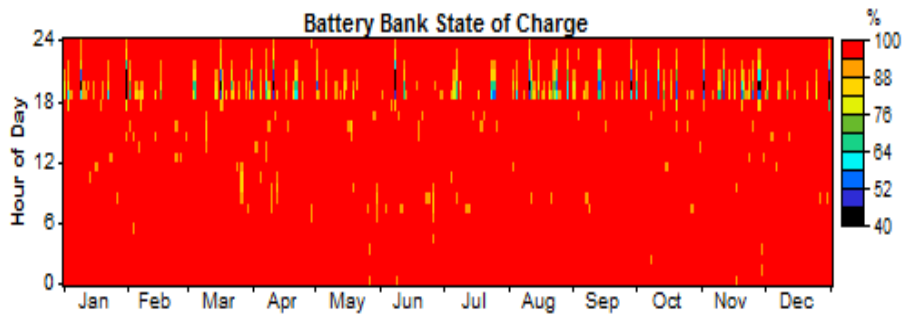


Figure 4. Battery bank state of charge.

Table 5. Specifications of converter considered for each PV system.

Capacity (kW)		Mean output (kW)		Capacity factor (%)		Hours of operation Hrs/yr		Losses kWh/yr	
Inverter	Rectifier	Inverter	Rectifier	Inverter	Rectifier	Inverter	Rectifier	Inverter	Rectifier
7.00	7.00	1.39	0.04	19.8	0.5	4,449	4,225	1,348	58

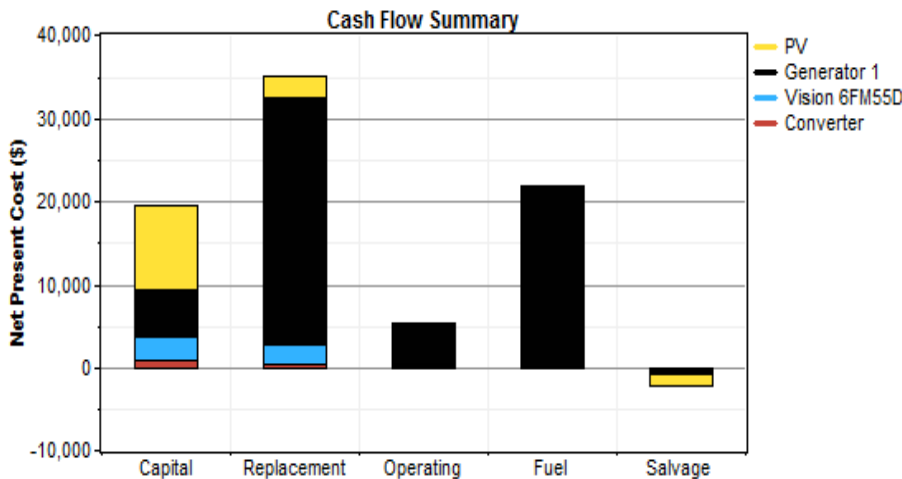


Figure 5. Annualized cash flow summary by component for PV-diesel battery-converter-Zanjan city.

Table 6. Detailed breakdown of the NPC for PV-diesel battery-converter hybrid system.

Component	Capital (\$)	Replacement (\$)	O&M (\$)	Fuel (\$)	Salvage (\$)	Total (\$)
PV	10,000	2,494	256	0	-1,398	11,352
Generator 1	5,833	29,701	4,775	21,941	-444	61,807
Vision 6FM55D	2,800	2,537	179	0	-239	5,277
Converter	817	273	149	0	-51	1,188
System	19,450	35,005	5,359	21,941	-2,132	79,624

Table 7. Specifications of wind system architecture.

Wind turbine kW	Generator 1 kW	Battery	Inverter kW	Rectifier kW	Dispatch strategy
1 Generic 3	7	24 Vision 6FM55D	7	7	Cycle Charging

In this system Fraction for Wind turbines 4%, Generator 1, 96 % and DC primary load 100% obtained also Figure 5 shows Monthly Average Electric Production breakdown wind-diesel. The monthly average electricity production by the wind turbine and generator 1 are each shown in Figure 7. The electrical power generation by the generator is obviously in this figure.

Table 11 indicates Specifications of Generator System for wind energy of this considered system that String size, Strings in parallel, Bus voltage, Nominal capacity, Losses and Annual throughput have been shown.

Table 8. Specifications of generator 3kw system.

Total rated capacity kW	Mean output kW	Total production kWh/yr	Wind penetration %	Hours of operation hr/yr	Levelized cost \$/kWh
3.00	0.136	1,190	3.84	5,181	0.171

Table 9. Specifications of generator 1 system.

Hours of operation hr/yr	Number of starts/yr	Operational life yr	Capacity factor %	Electrical production kWh/yr	Mean electrical output kW
8,725	28	1.72	50.5	30,983	3.55

Table 10. Specifications of electrical system.

Wind turbine kWh/yr	Generator 1 kWh/yr	Excess electricity kWh/yr	AC primary load kWh/yr	Capacity shortage kWh/yr	Renewable fraction %
1,190	30,983	894	31,021	7.32	0.037

Figure 8 shows the battery bank state of charge for Zanjan city and it is obvious that battery has been fully charged for the entire 24 hours of the day.

Specifications of converter considered for wind system has been shown in table 12 and is including Capacity, Mean output, Capacity Factor, Maximum and Minimum output.

Figure 9 shows summarizes the annualized cash flow for this system, broken down by component for Wind-diesel -battery-

converter that as PV-diesel battery-converter system the maximum cost is belong to the generator cost and then vision 6FM55D has maximum cost. Also in this study total net present cost 98,275\$, leveled cost energy 0.248 \$/kWh and operating cost 6,636 \$/yr obtained.

Table 13 shows detailed breakdown of the NPC for Wind-diesel battery-converter hybrid system the highest and lowest total lifetime cost of the system is belonging to the generator and converter, which have values of US\$ 85,756 and US\$ 1,188, respectively also this system present a maximum in terms of cost of the system, which is US\$ 98,275.

Conclusion

At present, energy is the main factor of growth activities and different production sin side by side of world, likewise in recent years, there has been an increasing amount of literature on renewable energy systems that about it can say that. It was proved that given the limited sources of fossil fuels energy storage than past decreased and demands increased also many causes such as citted development and different industrials

have led to an increasing demand for energy, then Moreover enough energy lack in future is main cause of changing people attitude for rising renewable energy using in the world. In this study potential of wind and solar energy for Zanzan area in Iran analyzed and considered. The Results showed Zanzan city in solar and wind energy has a pretty potential and can providing require of people energy for their home likewise due to having high potential investment of it has economic justification.

Suggestions for Future

1. Creating a regular program long term to reduce of global warming by more use of renewable energy instead of fuel fossils.
2. More public training and encourage people to get absorbing to clean energy program for future.
3. Presentation renewable energy lessens in schedule children.
4. Support of everybody that use of renewable energy as power energy to its house.

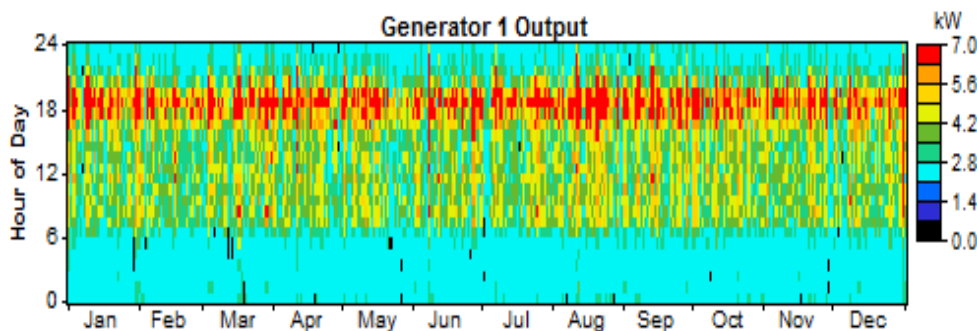


Figure 6. Generator 1 output.

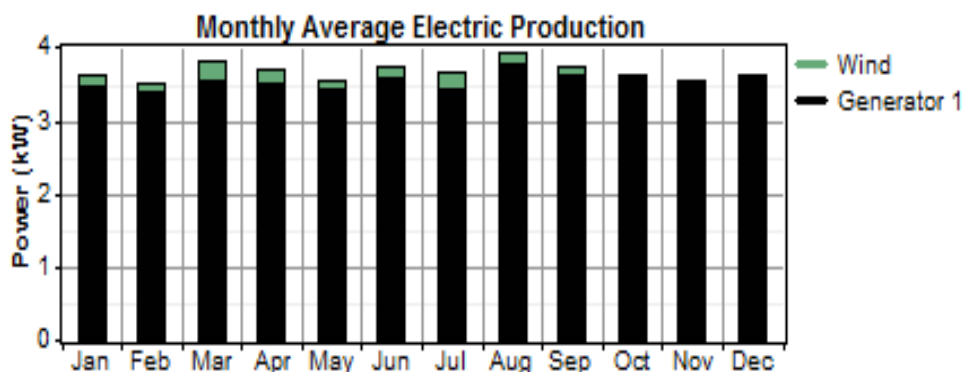


Figure 7. Monthly average electric production.

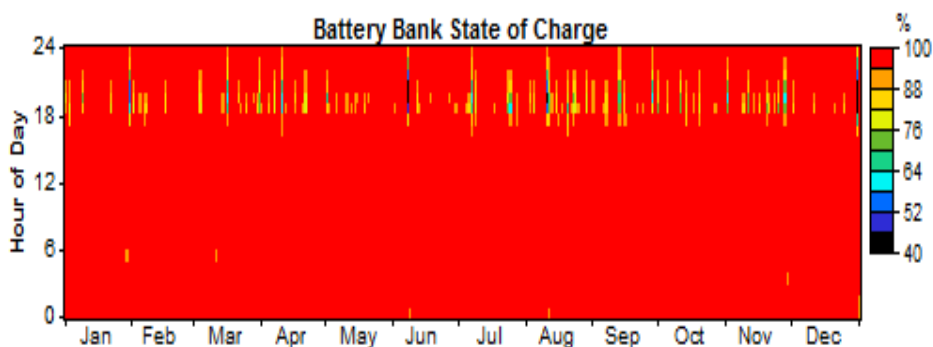


Figure 8. Battery bank state of charge.

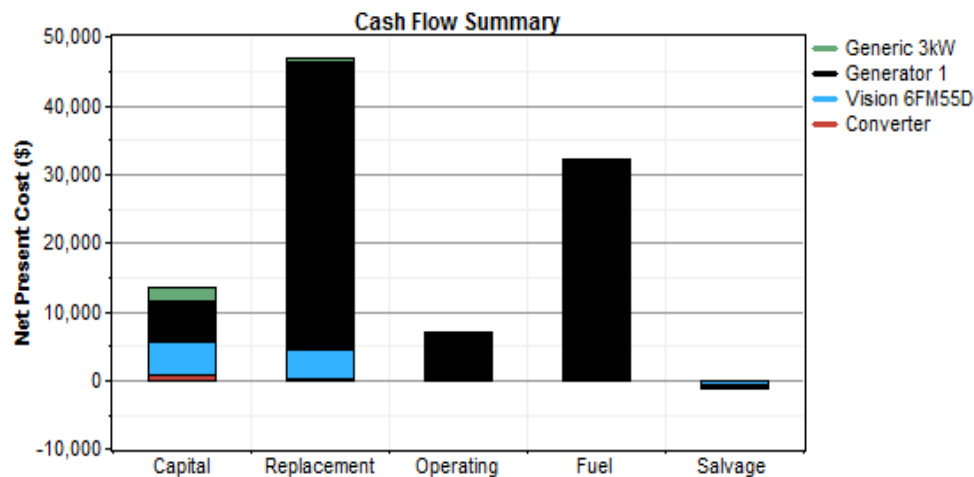


Figure 9. Annualized cash flow summary by component for wind-diesel battery-converter-hybrid system considered for Zanjan.

Table 11. Specifications of battery.

String size	Strings in parallel	Bus voltage (V)	Nominal capacity kWh	Lifetime throughput kWh	Losses kWh/yr
1	24	12	15.8	6,144	75.6

Table 12. Specifications of converter considered for each PV system.

Capacity (kW)		Mean output (kW)		Capacity Factor (%)		Hours of operation hrs/yr		Losses kWh/yr	
Inverter	Rectifier	Inverter	Rectifier	Inverter	Rectifier	Inverter	Rectifier	Inverter	Rectifier
7	7	0.13	0.04	1.9	0.5	4,165	3,873	128	55

Table 13. Detailed breakdown of the NPC for wind-diesel-battery-converter hybrid system.

Component	Capital	Replacement	O&M	Fuel	Salvage	Total
	(\$)	(\$)	(\$)	(\$)	(\$)	(\$)
Generic 3kW	2,000	668	64	0	-124	2,607
Generator 1	5,833	41,744	6,506	32,295	-623	85,756
Vision 6FM55D	4,800	4,177	307	0	-559	8,725
Converter	817	273	149	0	-51	1,188
System	13,450	46,861	7,026	32,295	-1,357	98,275

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