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Orignal Article

Simulation and Modeling of installing solar panel without battery and solar panel with battery

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ABSTRACT

This paper state a comparison between installing solar panel without battery and solar panel with battery, in addition a comparison between two types of batteries. So the paper has indicated how unfeasible having solar panel with batteries due to the high cost and it's represented in the net positive value. While having solar panel without batteries has very attractive net positive value which means it's feasible. So always go with solar panel without battery in case on grid option is available. The feasibility of having solar panel connected on grid will be mostly good, of course it will be based on the electricity regulations, but nowadays, the cost of each kwh produced by solar panel is much cheaper than any electricity party can afford. In some cases where batteries are essential to run the load, it's important to make sure that all extra production (Spillage) can be stored in the battery.

1. Introduction

Renewable Energy has been always a dream for all people, so they can brag about it [1-2]. Though there is a big debate of the feasibility of having renewable energy at present. Well, this is tricky matter [3-4]. Renewable energy has tens of sources, but speaking on what people can afford, PV is the suitable source. So shall we just install solar panel on our houses roof without feasibility study and wait to gain electricity to run the house or gain money by selling it back to the grid? The answer is definitely no. There are several factors would shape the methodology of having solar panel such as regulators for selling and buying electricity, efficient systems in the house, behavior …etc.) [5]. SAM program provide a comprehensive package of analyzing data related to renewable energy such as solar panels, winds, geothermal, Biomass etc [6]. The analysis include variety of critical parameters that shall be identified through inputs based on specific requirements such as location, capacity etc [7]. when parameters are being identified, a simulation is available to showcase the project in very attractive charts.

2. Research Methodology

As the demand in renewable energy increases with time, a clear investigation shall be done on the feasibility of having solar panels on the roof top and compare between the available packages. So this research will show case the electricity performance of residential building and compare having only with only solar panel without storage device (batteries) and with storage. The comparison will spot the light on electricity produced during one hour, one day and one month and how battery can shave the peak and save energy, but in the other hand, the storage

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feasibility and financial aspects will be considered as major player in making decision. The research will expand the analysis and present two types of batteries, Lithium Manganese oxide (LMO) and Lithium iron phosphate (LFP) in order to provide enough options and investigate on their performance when it's integrated with solar power system.

3. Result and discussion

Having Solar panels without storage is very affordable choice if we compare it with the one with batteries, however, the decision shall be made based on the availability of grid connection. So If the location was connected with electricity grid and has bi-directional meter, there will be no need to have batteries and lot money could be saved, because the grids can be used as battery system where extra produced electricity a day can be sold to the electricity provider as per its regulation then can be bought later on during shortage of production. So in order to have a fair comparison between solar panels packages, A multiple parameters shall be sat and fixed such as Location, capacity, electric load, Tilt and azimuth angle which are shown in below Table.1. & Fig.1.

Table.1. Describe the Location, capacity, electric load, Tilt and azimuth angle

Location	Phoenix, Arizona
Capacity	50 Kw
Tilt	20 Degree
Azimuth	180 Degree

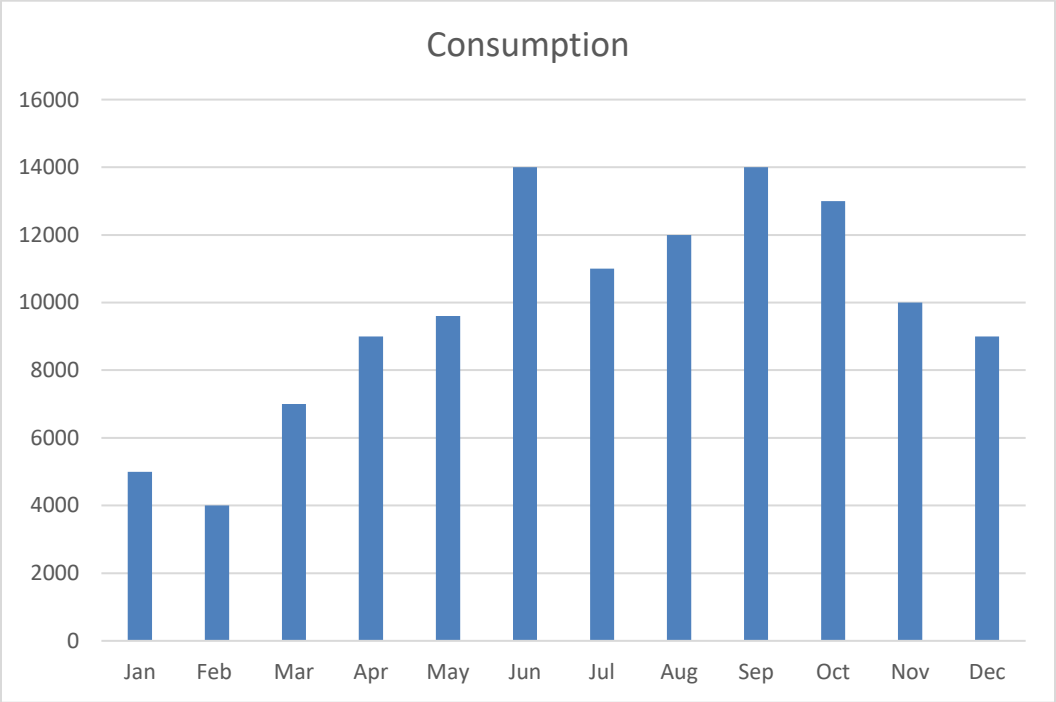

Figure.1. Shown the consumption graph of capacity and electric load by each month

First Packages which is solar panels without storage has SunPower T5-SPR-315 type with efficiency reach to 19.3% and maximum power is 315 Kw. Second Package is solar panel with storage has SunPower SPT 310 Mono type with efficiency reach to 19.3% and maximum power is 312 Kw.

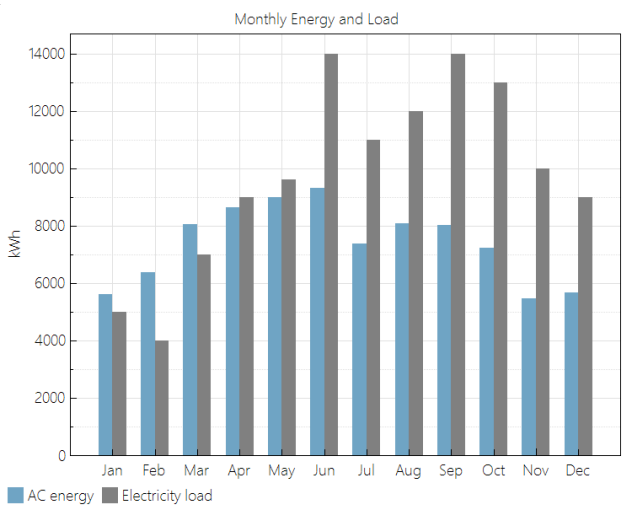

Figure 3 solar with battery

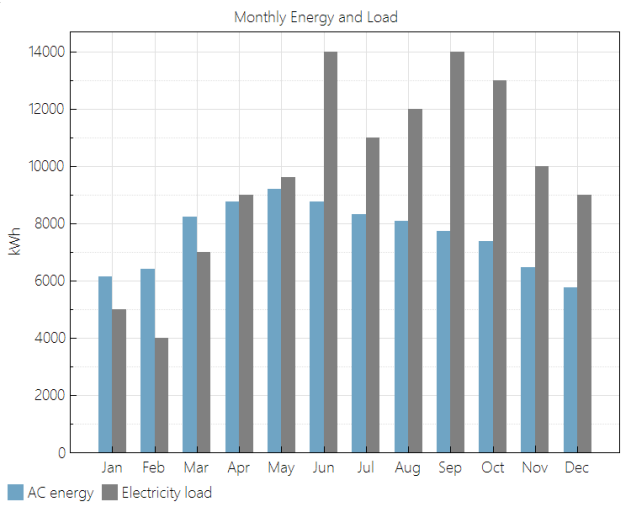

Figure 4 solar without battery

Fig.2-3 shows breakdown of electricity production and load for both packages. It also shows some losses in energy production mainly in winter months (Jan, Feb and Mar), and that due to lake of storage system integrated with solar panel. In other hand. All extra produced energy in figure 3 will be stored in the battery. From financial aspect, below figure 4-5 and table.2 present detailed analysis for both packages.

Table.2. Describe the metric for PV with and without

Metric	PV with battery	PV without battery
Annual energy (year 1)	88,845 kWh	91,252 kWh
Capacity factor (year 1)	20.3%	20.7%
Energy yield (year 1)	1,775 kWh/kW	1,810 kWh/kW
Performance ratio (year 1)	0.74	0.76
Battery roundtrip efficiency	91.94%	
Battery charge energy from system	100.0%	
Levelized COE (nominal)	23.45 ¢/kWh	9.02 ¢/kWh
Levelized COE (real)	18.72 ¢/kWh	7.20 ¢/kWh
Electricity bill without system (year 1)	$18,205	$15,257
Electricity bill with system (year 1)	$3,463	$5,353
Net savings with system (year 1)	$14,742	$9,904
Net present value	$-29,219	$36,410
Simple payback period	23.0 years	11.8 years
Discounted payback period	NaN	NaN
Net capital cost	$505,513	$137,195
Equity	$0	$0
Debt	$505,513	$137,195

Theses analysis indicate the significant variance in the costs for both packages, as Solar panels without battery cost only 137K $ while solar panel with battery system cost around half million dollar which is three times of first package cost. So The battery will be necessary only if the location was in remote area where no grid is available. Levelized cost of energy for solar panel without battery is quite attractive, it's only 9 cent per Kwh, while the one with battery will reach to 23.45 cent per Kwh. So in order to decide which option is feasible, we need to compare net present value, if the value is positive it means that it's feasible, if it's negative it means that it's not feasible and

you're losing money. Solar panel without battery shows NPV around 36,417 $, while solar panel with storage system has NPV around -29,219 $ which indicate how unfeasible this option.

Comparison between Lithium Manganese oxide (LMO) and Lithium iron phosphate (LFP).

Second Packages which is solar panels with LMO storage has SunPower SPT 310 Mono type with efficiency reach to 19.3% and maximum power is 312 Kw. Second Package is solar panel with LFP storage has SunPower TF SPR 315 E type with efficiency reach to 19.3% and maximum power is 315 Kw. Fig.4-5 and Table.3 shows breakdown of electricity production and load for both packages.

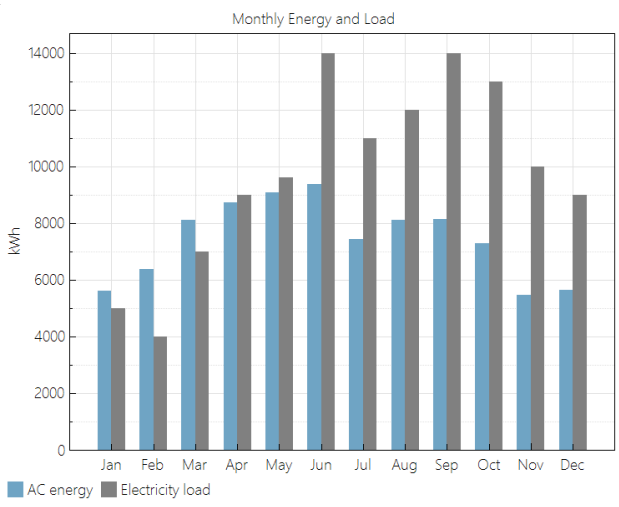

Figure.4. Monthly energy/load for LEP

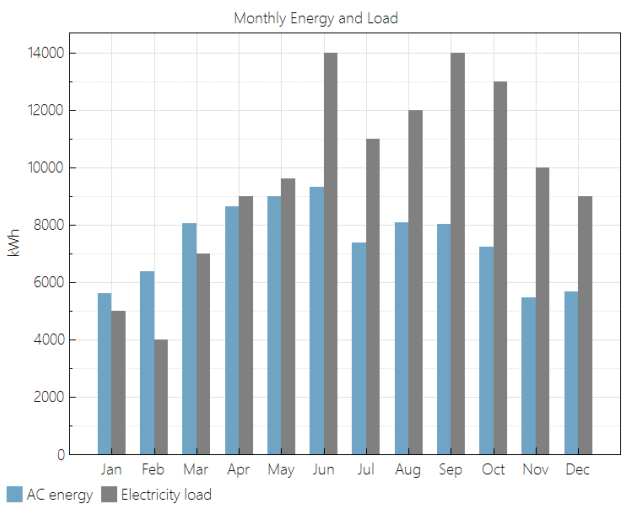

Figure.5. Monthly energy/load for LMO

Table.3. Shown detail financial comparison

Metric	LMO	LEP
Annual energy (year 1)	88,845 kWh	89,388 kWh
Capacity factor (year 1)	20.3%	20.2%
Energy yield (year 1)	1,775 kWh/kW	1,773 kWh/kW
Performance ratio (year 1)	0.74	0.74
Battery roundtrip efficiency	91.94%	91.79%
Battery charge energy from system	100.0%	100.0%
Levelized COE (nominal)	23.45 ¢/kWh	23.37 ¢/kWh
Levelized COE (real)	18.72 ¢/kWh	18.66 ¢/kWh
Electricity bill without system (year 1)	$18,205	$18,032
Electricity bill with system (year 1)	$3,463	$3,151
Net savings with system (year 1)	$14,742	$14,881
Net present value	$-29,219	$-27,123
Simple payback period	23.0 years	22.7 years
Discounted payback period	NaN	NaN
Net capital cost	$505,513	$506,451
Equity	$0	$0
Debt	$505,513	$506,451

Since production and location was fixed, there is no much difference between Lithium Manganese oxide (LMO) and Lithium iron phosphate (LFP) from financial aspect. The above table emphasizes that.

4. Conclusion

Solar panel technology was significantly improved recently which reduce its cost to new records, unlike battery technology still considered to be expensive. So always go with solar panel without battery in case on grid option is available. The feasibility of having solar panel connected on grid will be mostly good, of course it will be based on the electricity regulations, but nowadays, the cost of each kwh produced by solar panel is much cheaper than any electricity party can afford. In some cases where batteries are essential to run the load, it's important to make sure that all extra production (Spillage) can be stored in the battery.

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