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Preliminary Design Software For Solar On-Grid And Off-Grid Rooftop Systems

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Abstract— The demand and supply for Electric power can never be met due to various reasons like cost of generation, adequate space and transmission losses etc. To meet this need of power availability renewable energy has been introduced. One among this is solar energy which is gaining momentum in last few years which led to the development of solar rooftop systems. Despite significant efforts while designing a solar rooftop system, there are certain misinterpretations which are noticed after installation of the system. This work is all about a software based on Excel VBA which does the preliminary design using which we get a clear idea about the solar panels, inverters and batteries required quickly. This software allows PV system Integrators and consumers with minimal technical knowledge can also design Off grid and On grid system based on the requirement in their premises. This software avoids over sizing and under sizing of the system. Along with this, the software also provides estimated cost and return on investment of the system.

IndexTerms— Solar energy, PV rooftop system, on grid systems and off grid systems.

I. INTRODUCTION

Solar energy is the fastest growing energy technologies globally. The biggest challenge in generating solar energy is the constraint of space required. Solar energy being in the nascent stage, if developed would be the major source of power generation. India is blessed with an abundance of Sunlight and high solar insolation. India's potential of harnessing solar power is enormous with an average solar isolation of about 4-7 KWh / m^2 and 300 solar days in a year. A vigorous effort during last 5 years is seen as people from all walks of life are more aware of the benefits of renewable energy.

The Government of India has taken some of the primary steps such as reduce in solar energy cost and materialization of new and innovative business models for large scale development of solar energy. State governments in association with MNRE (Govt.of INDIA) have implemented solar rooftop system program. Government of India has a target of 100,000 MW generation of solar power by 2022 out of which 40,000 MW is to be accomplished through rooftop solar system. A rooftop solar system has a solar panel mounted on the roof of a residential or commercial building. The capacity of a residential mounted pv system is about 15 to 20 kilowatts while that of a commercial building is 100 kilowatts or more.

This software allows consumers to install off grid and on grid system based on the requirements in their premises and gives the details of the various components used in the pv system. Off-grid systems are used to charge the batteries. When required to operate the appliances the power is drawn from the batteries and is utilized. In on-grid systems the power generated from the solar panels is used by the power consuming units and excess power is feedback to the grid. If the power generated is not sufficient then the power is drawn from the grid. The power is feed to the grid at standard rates set by the public utility commission for per KWh power generated making a profit to the consumer and reflecting the benefits of use of solar electricity.

Problems related inefficiency with regards to the system design, improper placement and orientation of panels, and shading by objects such as trees around it, plague the installation process. In addition to this, surveying a site before the installation of panels, which when done manually, needs skilled manpower, and of course, utmost accuracy. These hurdles, if not overcome, can hamper the installed solar system from generating optimum amounts of electricity, and overall decrease the return on investment for the consumer. This in turn will lead to loss of confidence the consumers have in the installers. .

The software which is available in market HomerPro (USA),PVF chart (USA) ,PV Planner(Slovakia),PVSyst(Switzerland),RET screen(Canada),SAM(USA),Solar pro(Japan),[1] which are costly and to use this software one should have the descent technical knowledge.

So here an effort has been made to develop an user friendly and economical software which a person can use with a minimum computer knowledge. This software is developed with the help of Microsoft Excel and Visual basics (VB) so it can be compatible with all the systems.

II. PROBLEM STATEMENT & OBJECTIVES

The major problems faced during the installation are to decide whether to go for on-grid or off-grid operation, How to select the components in the available market, what should be the rating of the components, what will be the Return on

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Investment (ROI). Based on these problems the objectives are developed.

- To decide the size, number and type of connection of solar panel based on the load demand.
- To determine the size of the inverter.
- To determine the spacing between the array and the number of strings connected to the Inverter.
- To calculate the monthly power generated and net metering benefits of the designed system.
- Determine the battery bank size and type of connection of the batteries inside the battery bank

III. FLOWCHART

The flowchart of the work carried out is as shown in the figure.

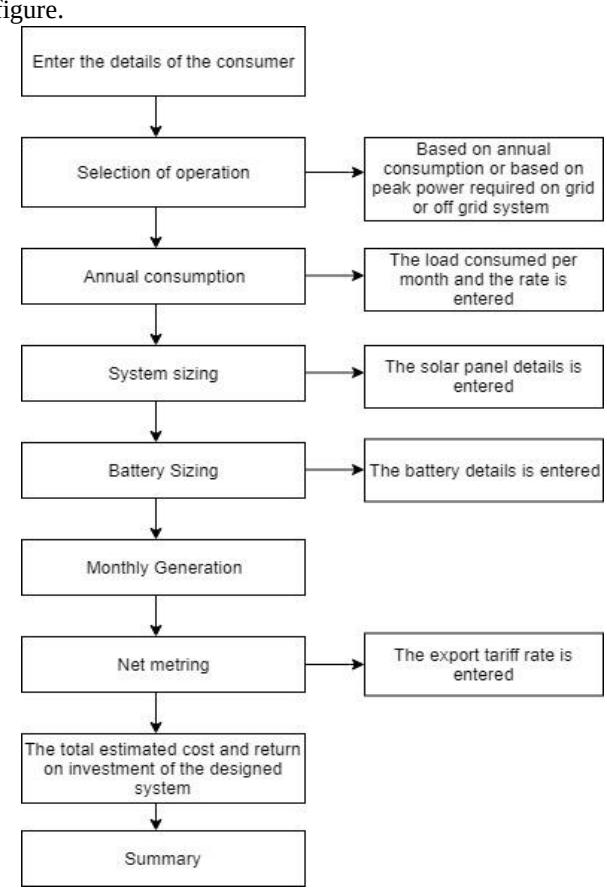

Figure 3.1 Flow chart of the overall work

The details of the consumer has to be entered in the first stage, then among the four operations any one of the method should be selected. If based on annual consumption method is used then the details of solar panel, inverter and battery should be entered which are nothing but the data sheet values are used including with the annual consumption details. If the peak load is selected then the peak load value should be entered

IV. METHODOLOGY

Based on the flowchart the below steps are followed
Step 1: Input the total load consumed or the peak power required.
Step 2: Determining the number of solar panels based on the total load consumption, DNI of the region and also considering the
Derating factor.
Step 3: Determining the inverter to be used.
Step 4: In case of off – grid systems the size of the Battery is decided by determining the Battery Capacity based on its efficiency and depth of discharge (DOD).
Step 5: Determining the number of strings and number of pv panels in each string.
Step 6: To calculate estimated cost of the system and return on investment.
Step 7: To provide summary sheet along with save and print option.

V. CASE STUDIES

A. Case 1 (Annual consumption and On-grid operation):

The case study was conducted for annual consumption in **House No. 118, Thalakaveri Layout, Bangalore(RR No. 14010863)** and the bill is generated by **BESCOM(Bengaluru Electricity company)**

TABLE 1 Annual Consumption bill of a consumer.

Sl No.	Month	Consumption (in KWh)	Tariff (in Rs.)	Sl No.	Month	Consumption (in KWh)	Tariff (in Rs.)
1.	January	333	2192	7.	July	611	4715
2.	February	362	2787	8.	August	428	3316
3.	March	537	3685	9.	September	421	3312
4.	April	884	6654	10.	October	394	3149
5.	May	532	3662	11.	November	379	2914
6.	June	337	2146	12.	December	201	1462

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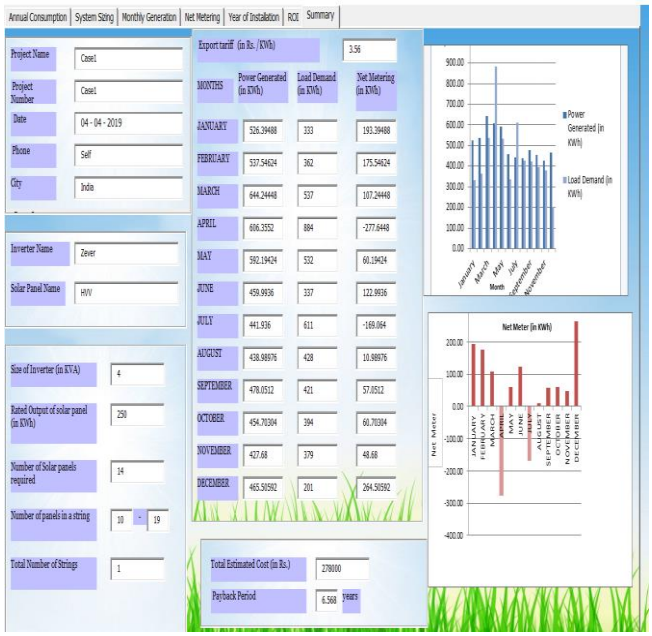

Figure 5.1 Simulation result of case1 study

The above simulation result gives the details of the designed On-grid system. The summary gives the details of the designed system such as size of inverter, solar panel details,power generated, net metering, estimated cost and the payback period of the system.

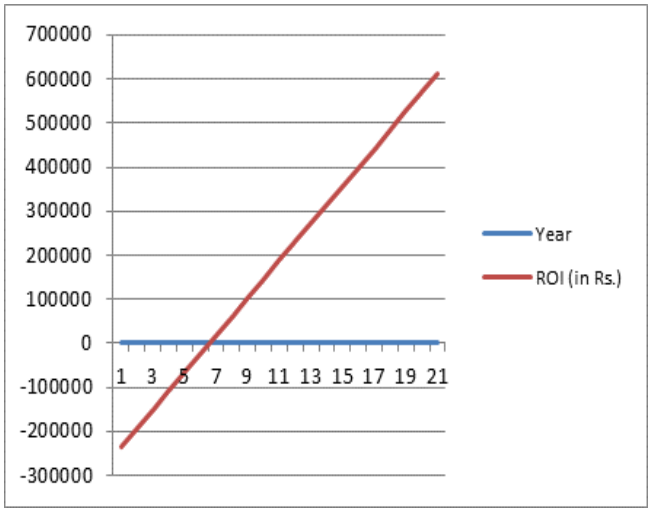

Figure 5.4 Graph of ROI

B. Case2(Peak power demand and OFF grid operation of 5KW system)

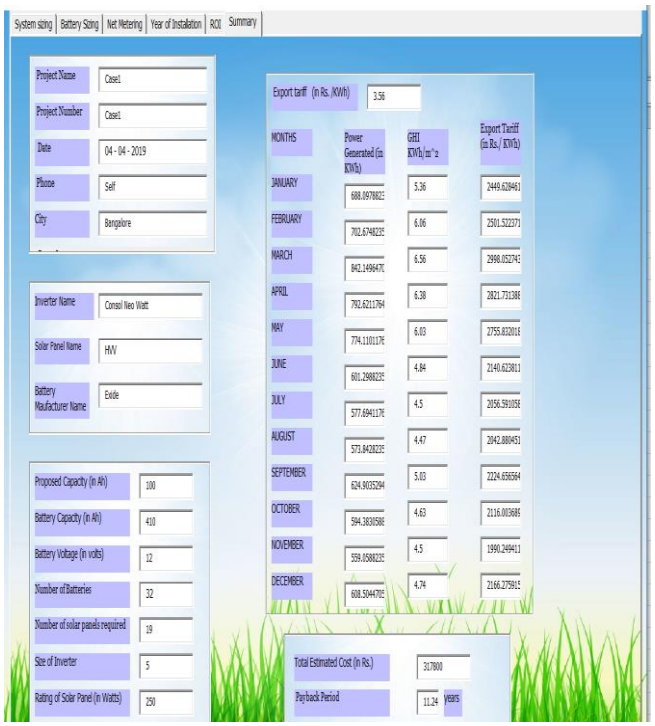

Figure 5.5 Simulation result of case2

The above simulation result gives the summary of an off-grid system based on peak power required. The summary sheet gives
the details of the inverter, battery details, power generated per month, export tariff, estimated cost and the total payback period

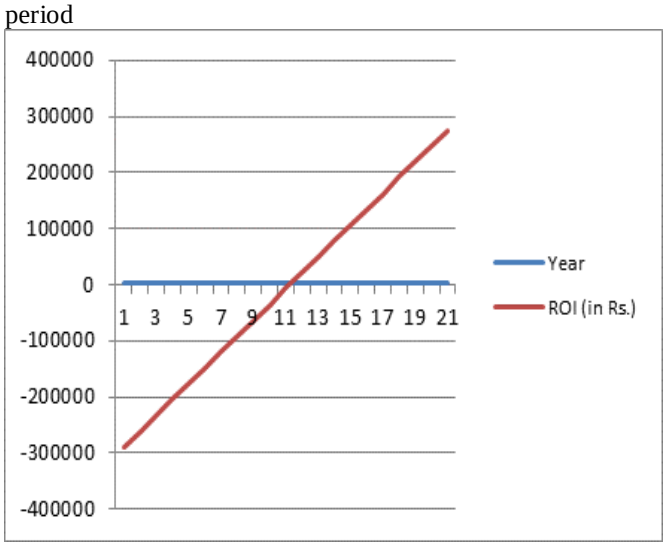

Figure 5.6 Graph of ROI

VI. RESULTS AND DISCUSSIONS

From the peak power demand or annual consumption, the total load consumed and size of Inverter required was determined. The number of strings to be connected to the inverter, minimum/maximum number of panels per string was calculated. Based on tilt angle the space between panel was obtained to avoid shadowing. Keeping DOD into consideration the number of batteries and their arrangement

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were obtained. The power generation per month, net metering i.e. import / export per month was predicted. Finally, the feasible report, estimated cost of plant and pay back period was calculated.

VII. FUTURE SCOPE AND CONCLUSION

Creating a user-friendly website.

- Developing mobile app with excellent UI.
- Develop the software and make it usable for paid users.
- Provide customized tool as when required.

This tool helps in getting a suitable power system design along with generating data of usage and inventory. The question on the economics has been answered by determining estimated cost and Return on investment. There is no restriction on the configurations to be used. A person with minimal technical knowledge will be able to generate a functional report which gives an overview on the technicalities and Economics involved.

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