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Parametric Study of Grid Connected PV System with Battery for Single Family House

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Abstract:- *The environmental effects and load demand of electricity are the main factor driving towards renewable energy. The main aim is to demonstrate the model based methods for a grid connected solar PV system for Single family house that is for domestic application. As the Non-renewable energy sources is about to end, future of human energy needs is in Renewable energy. In this paper, Photovoltaic system connected to Grid is simulated using the Pvsyst software. In this study PVsyst software is used to design a grid connected PV system for geographical site chosen in India is located in Maharashtra, in the region of Karad, in the East of Kasegaon. Detailed system configuration, system losses and system output are determined here in this study.*

Key Words: PVSYST, Nonrenewable Energy

I. INTRODUCTION

Nonconventional energy is the future of human. Because of high consumption and the crices in availability of fossil fuel resource nonconventional energy (solar, wind ect.) is subject to great interest over the last decades. Solar energy is an emerging nonconventional energy source using all over the globe at micro as well as utility scale.

Solar energy is captured in a variety of ways, the most common of which is with photovoltaic solar panels that convert the sun's rays into usable electricity. Solar energy is a clean, inexpensive, renewable power source that is harnessable nearly everywhere in the world. Any point where solar radiations hits the surface of the any place on the earth is a potential location to convert solar energy in to electrical energy. And since solar power comes from the sun, it represents a limitless supply of power. Solar panels are mainly installed in three different forms: residential, commercial, and utility. Residential-scale solar is typically installed on rooftops of homes or in open land and is generally between 5 and 20 kilowatts (kW), depending on the required demand of consumer. Commercial solar energy projects are generally installed at a largerscale than residential solar energy projects.

So solar energy can provide solutions of all the present and future problems related to electricity. Solar power is the conversion of solar radiations into electricity, directly using photovoltaic (PV).Photovoltaic's convert light of sun into an electric current using the photovoltaic modules. A photovoltaic system consists of a PV array, battery, inverterand charge controller ect. The photovoltaic modules convertssolar radiations that is solar energy into dc power. If there is ac loads, the system requires inverter to convert direct current into alternating current.

There are mainly two types in photovoltaic system such as grid connected and standalone. Grid connected photovoltaic systems send electricity directly to the electrical network with operating parallel to the conventional energy source. In Grid-connected systems generation of electricity is done near the point of use, so that there is no need of the transmission and distribution lines. Its performance depends on the local wheather condition, orientation and inclination of the photovoltaic arrays, and inverter performance connected with it. Whereas, in stand-alone system there is no interaction with a utility grid, the generated power directly connected to the load. In some cases the photovoltaic systems does not directly supply a load, battery enery storage system is needed. The battery bank stores energy when the power supplied by the PV modules exceeds load demand and releases it backs when the PV supply is insufficient. This standalone PV power generation is utilized in house for the electrification purpose. A wide variety of tools exist for the analysis and dimensioning of both Grid connected and stand-alone photovoltaic systems. System designers and installers use simpler tools for sizing the PV system. Generally scientists and engineers uses more involved simulation tools for improvements. Software tools related to photovoltaic systems can be classified into pre-feasibility analysis, sizing, and simulation.

PVSYST is a one of the dedicated PC software package for PV systems. The software was developed by the University of Geneva, Switzerland. It integrates pre-feasibility, sizing and simulation support for PV systems. After defining projected location and calculated consumer energy demand, the user can selects the different components from a product database and the software automatically calculates the size of the whole photovoltaic system. In present study design, optimization and cost analysis of a solar power plant at residential rooftop as well as on utility scale in India is to be discussed.3

II. LITERATURE REVIEW

G. M. Tina (2009) presented Photovoltaic systems combined with either some form of storage, e.g. Battery Energy Storage System (BESS), or direct load control can play a role in achieving more economical operation of the electric utility system while enhancing reliability with additional energy sources. The proposed system may operate in multioperation modes, normal operation, power dispatching, and power averaging, according to coordinate control of both BESS and grid inverters

Angel A. Bayod-Rújula(2017) presents a review of the recent developments of photovoltaics integrated with battery storage systems (PV-BESs) and related to feed-in tariff policies. All the contributions provide an important resource for carrying out further research on a new era of incentive policies in order to promote storage technologies and integrated photovoltaic battery systems in smart grids and smart cities

RachitSrivastava (2017) introduced Grid connected photovoltaic system simulated using the Pvsyst software. In this study PVsyst software is used to design a grid connected PV system for Madan Mohan Malaviya University of Technology, Gorakhpur in India

Dr. J.S. Rajashekar(2018) introduces The actual system explores the opportunities to explore towards environmental friendly energy production. The environment effects and load demand of electricity are the main factor driving towards renewable energy. The main goal is to demonstrate the model based methods for a grid connected solar PV system for domestic & commercial application.

Krishan Kumar (2018) Presented simulation of solar photovoltaic system and the cost analysis of these solar PV systems. This work is done with real time radiation of sun and actual output of solar PV system. The experiment has done at different locations

C.P. Kandasamy (2013) presentedefficient PV system is designed for gridconnected environment using PVsyst software. For Gridconnected PV system, the viability of installing 1 MW plant invarious places of southern part of Tamilnadu are considered

Surabhi Sharma (2018) presents solar photovoltaic system design case study of an academic institution using PVsyst. The performance of the photovoltaic system depends on geographical location, solar irradiance, type of PV module and orientation of the module.

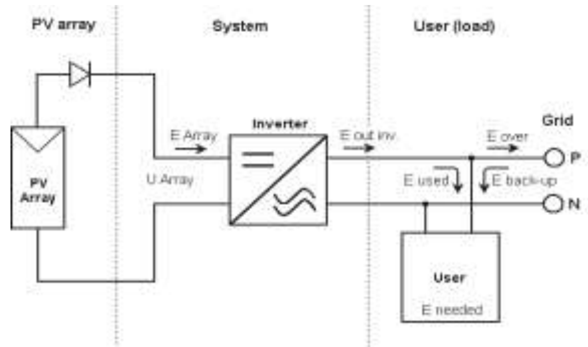
PriyaYadav (2015) discussed detailed methodology to design and simulate aphotovoltaic system using PVsyst software. Using the measured global solar radiationdata for Hamirpur, more accurate results are produced. Itis concluded that design of a PV system is entirely location dependent.

III. RESEARCH METHODOLOGY

Using Pvsyst software center, it's a computational research. PVsyst is software for simulating stand-alone and grid-connected PV systems. System location is in Karad near area. On the grounds of prior inquiry, validation will be carried out.GRID CONNECTED SOLAR PV SYSTEM –

A grid-connected solar PV power plant is being installed using PVsyst Software to power generation, economic feasibility of some of the locations in INDIA. Proposed model shown in figure of the grid-connected PV system. The validation location of Rethae Bk at the eastern of Kasegaon is used.

It is a computational study using Pvsyst software facility. PVsyst is simulation software able to simulate both stand alone and grid connected PV systems.. Validation will conduct on the basis of previous investigation.



IV. CASE STUDY AND VALIDATION

Fig 1 : Location of the system to Case study

The geographical site chosen in India is located in Maharashtra, in the region of Karad, in the East of Kasegaon It lies on 17.16°N latitude and 74.22° E longitude. It consists in a single family house, used as a family residence during the whole year.

Chart -1 : Geographical Location and Meteorology

Load Estimation

In a house following appliances are common and table 1 shows appliances with their rating and load estimations.

Table 1 : Load estimations

LOAD	WATTS	QUANTITY	HOUR/DAY	TOTAL WATTS	TOTAL WATTS-HOUR/DAY
TV	150	1	3	150	450
CFL	20	3	4	60	240
FAN	40	2	2	80	160
Total in Watts				290	850≅1000

So a house load is = 1 kW or 850 Wh/day

Chart -2 : Meteo data

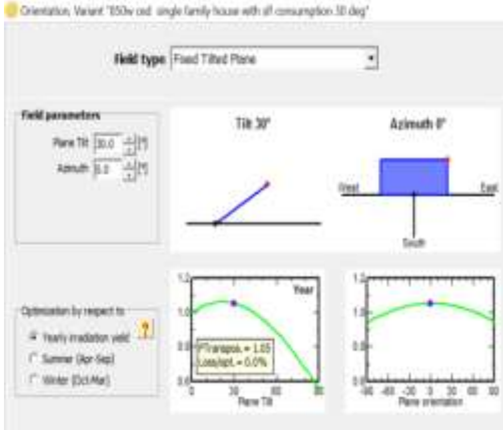


Fig -1: Plane tilt and Azimuth

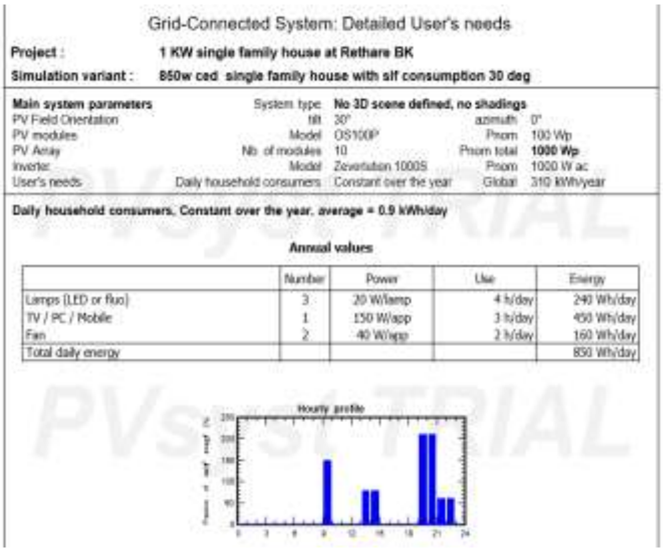


Table 2 : Result For a tilt of 30°

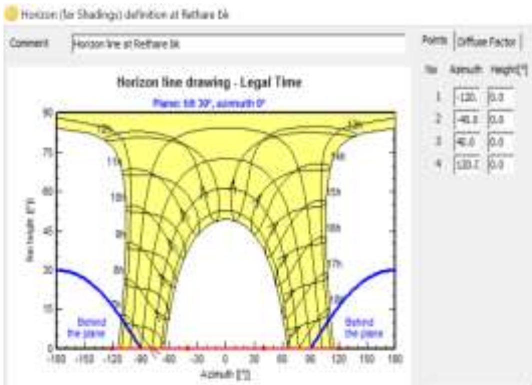


Fig -2: Horizon

Chart -3: Module and Inverter

Main system parameters	System type	**No 3D scene defined, no shadings**		
PV Field Orientation	tilt	30°	azimuth	0°
PV modules	Model	OS100P	Pnom	100 Wp
PV Array	Nb. of modules	10	Pnom total	**1000 Wp**
Inverter	Model	Zeverlution 1000S	Pnom	1000 W ac
User's needs	Daily household consumers	Constant over the year	Global	310 KWh/year
Main simulation results				
System Production	**Produced Energy**	**1559 kWh/year**	Specific prod.	1559 kWh/kWp/year
	Performance Ratio PR	76.15 %	Solar Fraction SF	83.19 %
Battery ageing (State of Wear)	Cycles SOW	90.9%	Static SOW	90.0%
	Battery lifetime	10.0 years		

V. RESULTS

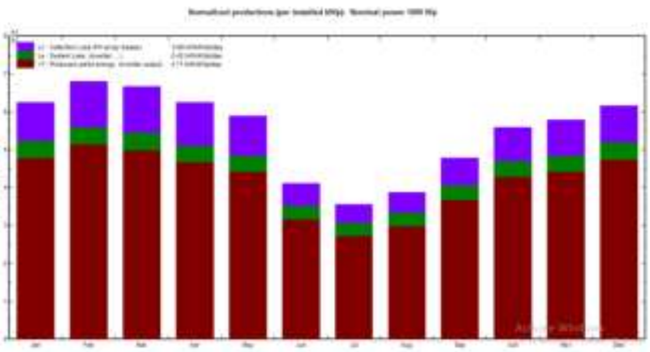


Table 3: Normalized production per installed KW

850w ced single family house with slf consumption 30 deg
Balances and main results

	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_User	E_Solar	E_Grid	EFrGrid
	kWh/m²	kWh/m²	°C	kWh/m²	kWh/m²	kWh	kWh	kWh	kWh	kWh
January	150.6	50.20	23.14	193.7	190.5	162.7	26.35	21.95	126.6	4.402
February	161.1	49.40	24.98	190.5	187.3	157.2	23.80	19.82	124.2	3.976
March	194.6	66.90	27.75	206.9	202.2	169.3	26.35	21.95	133.0	4.402
April	198.9	77.70	29.52	187.5	182.6	153.6	25.50	21.24	119.1	4.260
May	214.8	76.60	29.73	182.6	177.0	150.4	26.35	21.95	115.1	4.402
June	147.6	84.10	26.42	123.5	119.1	105.9	25.50	21.24	73.8	4.260
July	127.7	85.10	25.58	110.4	106.7	95.7	26.35	21.95	62.8	4.402
August	132.8	82.40	24.91	119.9	116.2	103.8	26.35	21.95	70.7	4.402
September	144.0	71.70	25.00	143.6	139.8	122.0	25.50	20.92	89.6	4.584
October	155.2	71.60	25.79	173.5	169.5	145.9	26.35	21.95	111.0	4.402
November	140.7	55.00	24.27	173.5	170.3	145.5	25.50	21.24	111.6	4.260
December	144.8	50.00	22.89	191.3	188.1	161.3	26.35	21.95	125.1	4.402
Year	1912.8	820.70	25.83	1996.9	1949.4	1673.3	310.25	258.10	1262.6	52.154

Table 3: Balances and main result

Grid-Connected System: Simulation parameters

Project :		**1 KW single family house at Rethare BK**		
Geographical Site	**Rethare bk**		Country	**India**
Situation	Latitude	17.17° N	Longitude	74.23° E
Time defined as	Legal Time	Time zone UT+5.5	Altitude	572 m
	Albedo	0.20		
Meteo data:	**Rethare bk**	Meteonorm 7.2 (1994-2013), Sat=100% (Modified by user) - Synthetic		
Simulation variant :		**850w ced single family house with slf consumption 30 deg**		
	Simulation date	29/08/19 09h20		
Simulation parameters	System type	**No 3D scene defined, no shadings**		
Collector Plane Orientation	Tilt	30°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	No Shadings			
Storage	Kind	Self-consumption		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	0.9 kWh/Day		
PV Array Characteristics				
PV module	Si-poly Model	**OS100P**		
Original PVsyst database	Manufacturer	Peimar		
Number of PV modules	In series	10 modules	In parallel	1 strings
Total number of PV modules	Nb. modules	10	Unit Nom. Power	100 Wp
Array global power	Nominal (STC)	**1000 Wp**	At operating cond.	901 Wp (50°C)
Array operating characteristics (50°C)	U mpp	154 V	I mpp	5.9 A
Total area	Module area	**6.9 m²**	Cell area	5.8 m²
Inverter	Model	**Zeverlution 1000 S**		
Original PVsyst database	Manufacturer	Zeversolar		
Characteristics	Operating Voltage	70-450 V	Unit Nom. Power	1.00 kWac
Inverter pack	Nb. of inverters	1 units	Total Power	1.0 kWac
			Pnom ratio	1.00
Battery	Model	**Sun power VL OPzS 12-70**		
	Manufacturer	Hoppecke		
Battery Pack Characteristics	Nb. of units	2 in series		
	Voltage	24 V	Nominal Capacity	50 Ah (C10)
	Discharging min. SOC	20.0 %	Stored energy	1.0 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	0.3 kWdc	Max. / Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	0.1 kWac	Max. / Euro efficiency	97.0/95.0 %
PV Array loss factors				
Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	443 mOhm	Loss Fraction	1.5 % at STC

Table 4: Report of PV system connected to Grid

VI. CONCLUSIONS

In this study PVSYST software is used to design a grid connected PV system for residensial load in particular geographical sitein India. Detailed system configuration, system output and system losses are determined in this study. From the simulation optimal size of the PV system is determined that is able to supply the electricity to the Domestic load throughout the year

Also, this study present a simple but efficient grid-Photovoltaic system for a domestic load that can meet the daily load demands. The result shows that the constant over the year, daily load requirement of a house is 0.9 KWh/day

VII. FUTURE SCOPE:

Future work to complete this project, Grid Connected PV system using Battery Storage with Utility Grid functionality, there is a great need of designing the control system that would control the designed inverter power of this paper. The control shall be able to integrate the inverter with Household load and also with Utility grid available. The second important work is the inverter prototype. After the simulation of the inverter power stage obtained the next step is the implementation of the actual system. However, it can be introduced and analyzed in the real-time setting with the assistance of LabVIEW. Component selection and rating is another job to do. Standard values are required in future job in order to adapt to certain operating settings.

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