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PERFORMANCE INVESTIGATION OF OFF-GRID PV SYSTEMS FOR REMOTE LOCATION: INDIA

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Abstract: Off-grid photovoltaic (PV) system' execution incredibly relies on upon the working conditions. The ecological conditions particularly temperature have solid effect on the power generation of PV modules, particularly temperature. Limited establishments in various regions have one of a kind conduct coordinated with the natural conditions, yet lines up for the most part with the principle qualities of PV system. In this original copy, a test pilot plant setup is outlined and introduced in Mp India. Investigation of PV system with these natural qualities is once in a while tended to. In this work, control creation of PV modules and reliance on climate conditions is inspected and demonstrated. Climate information has been gathered and outlined with regards to this fill in too. Created models can be utilized to appropriately evaluate the power generation capability of the introduced off grid PV system and to sufficiently measure the power plants to coordinate sought load profiles. The proposed off grid PV system cost of energy is 0.66$ and renewable factor 48.The total net present cost (345294$) is much less as compare to conventional diesel generator system. This system produce less emission which is reduce environmental issues and beneficial for human health.

I. INTRODUCTION

The Renewable energy which can be converted to electrical energy directly without any intermediate process is solar energy. Solar photovoltaic system are considered as one of the most reliable and matured technologies amongst various renewable energy sources [1]. With the rapid expansion of wind and solar power and a steady increase in hydropower, the position of renewables has been cemented as an indispensable part of the global energy mix; by 2035, renewables will account for almost one-third of the total electricity output [2]. Out of all kinds of renewable technology, solar power is growing more rapidly. Solar energy is clean, eco-friendly and is abundantly available. In recent years, the need for clean energy in an effort to reduce emissions and minimize reliance on fossil fuels has led to world-wide installation of large-scale renewable energy systems. In 2009, European Union Renewable Energy Directive has set a target of generating over 32% of total power from renewable energy by 2030, with a target of 100% by 2050. Research study has revealed that at each instant, the earth surface receives approximately 1.8 × 1011 MW of power from solar radiation which is much more than the total global consumption of power [3],[5]. There are two distinct methods for solar power generation namely solar photovoltaic and concentrated solar thermal. Between the two, solar photovoltaic is the matured and financially viable options for power generation. Solar Photovoltaic (PV) plants (henceforth referred to as PV plants) directly converts sunlight into electricity without any rotating machine. The attractive features of PV systems are modularity, low maintenance and operation cost, low weight, environmental cleanliness and soon. Mostly, individual capacity of PV module ranges from 100W to 320W [3]. A several thousands of such PV modules need to be connected in order to get the MW range of power from PV system, thereby, requiring significant land area for the deployment of a large-scale PV. Beside the significant land area requirement, higher setting up cost compared to other renewable technologies, and intermittent output with a low capacity factor are the other limitations of this generation technology. In this paper design an off-grid PV system with battery and diesel generator to fulfil required load of the design location. A block diagram of off-grid PV system is shown in fig 1.[4]

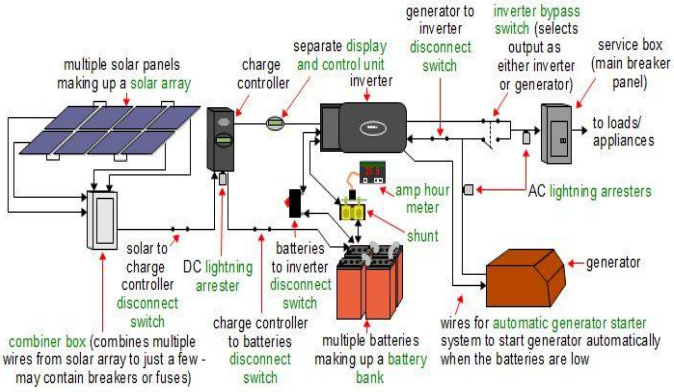

Fig.1 off-grid PV system

II. COMPONENTS OF OFF-GRID PV SYSTEM

The proposed off-grid PV system is a combination of Photovoltaic cell, battery unit for storage purpose and diesel generator for buck-up protection, which increase the efficiency of PV system. The design location of off-grid PV system is barwani MP, India which has annual average solar radiation 5.31KWh/m2 /d and clearance index is 0.589. the detail of data is shown in table 1.

Table 1 solar radiation data

S.No	Months	Insolation (KWh/m² /d)	Clearance index
1	January	4.810	0.684
2	February	5.650	0.697
3	March	6.350	0.675
4	April	6.990	0.668
5	May	7.210	0.656
6	June	6.080	0.546
7	July	4.770	0.432
8	August	4.170	0.393
9	September	5.190	0.533
10	October	5.790	0.684
11	November	4.900	0.675
12	December	4.510	0.675
13	Average	5.531	0.598

A. Photovoltaic economic information

Sun powered PV is concurrent in series. At the point when the sunrays hit the Solar PV exhibit, it produces power [6]. The magnitude of photovoltaic panel plan that utilized as a part of this system is 0.280w. The chief and option taken a toll for every limit is $450 and $420individually. The lifetime for this photovoltaic exhibit framework is 20 year with a derating component of 80% and ground reflection is 20%. The cluster slant edge is set to 22.98 and zero azimuth (AZ) compares to south (S), and positive esteems counsel with west-bound introductions. The following framework for PV plant is disregarded yet the effect of temperature is considered.

Generator

Diesel generator (DG) is used for proposed off grid PV system has assessed breaking point of 5kw and appraised speed is 1800 rpm generator conveys AC. The capital cost and substitution cost of the generator are $500 and $450 independently. The operation and upkeep cost of the generator is $0.2/hr. The Diesel worth is utilized for affectability investigation. At display, diesel cost is roughly 0.84$/L and for a significantly remote range this could increase up to 0.95$/L. At the point when half breed sustainable power source framework create adequate measure of energy, diesel generators act as support for the site.

Battery

A battery accumulation demonstrate is rehearsed as an emotionally supportive network and it too keeps steady. The batteries associated in parallel-arrangement development. The kind of battery that used for the structure is vision 6FM 200D model with the rating of 12V, 200Ah, 2.4kWh. The cost for one battery is $212 with the substitution cost of $ 212.

Power Converter

In this proposed off grid PV system, converter is utilized which may work each as a partner degree electrical converter and rectifier taking a gander at the way of stream of energy. Re-enactment purposes the measure of the converter is taken as 5kWFor a 5 kW structure the foundation and substitution costs are taken as $22500 and $1950, independently. Cost investigation appeared in Fig. The productivity and life expectancy of a unit is taken to be 85% also, 15 years individually.

III. HOMER SOFTWARE

A concise note about the Hybrid Optimization Model for Electric Renewables (HOMER) programming, what it can do and where it can be connected will be plot in this segment. As indicated by its site, the product is copyrighted by the Midwest Research Institute (MRI) and given by the National Renewable Energy Laboratory (NREL) worked by MRI for the U.S. Department of Energy (DOE). The product, in its total frame, is accommodated free. This incorporates data about sites giving information sources, for example, for sunlight based radiation and wind speed, and furthermore data about sources of energy segments, for example, wind turbines, generators, batteries, and so forth. So, HOMER finds the slightest cost blend of parts that meet a required load, in light of a hourly examination of the info factors, for example, wind and sun based information. For frameworks that meet the yearly load, the life-cycle cost is additionally assessed by the product. HOMER can be connected to various system plans: utility associated or off-grid, distributed generation and non conventional or conventional advancements [7].

IV. RESULT AND DISCUSSION

The design of PV-Battery-DG hybrid system model is shown in fig.2. The homer software show the best optimal combination as 15kW PV 10kW generator 12 batteries and 5kW convertor which is shown in fig 3

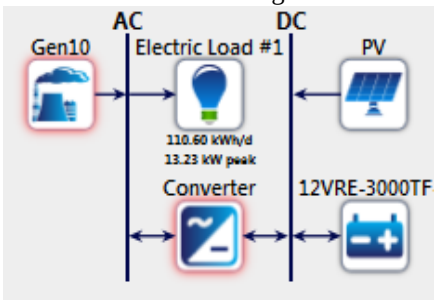

Fig 4.PV-Battery-DG

Architecture						Cost				System	Gen10	
	PV (kW)	Gen10 (kW)	12VRE-3000TF-L	Converter (kW)	Dispatch	COE (₹)	NPC (₹)	Operating Cost (₹)	Initial Capital (₹)	Ren Frac (%)	Fuel (L)	Hours
	15.0	10	25	5	LF	₹ 0.66	₹ 3,44,294	₹ 19,138	₹ 96,889	48	11,044	6,305
		15	10	5	LF	₹ 0.74	₹ 3,86,295	₹ 29,148	₹ 9,490	0	21,773	8,169
	1.0	15		5	LF	₹ 0.78	₹ 4,08,302	₹ 30,604	₹ 12,669	0	23,355	8,760

Fig 3. Simulation result of PV-Battery-DG

The PV-Battery-DG hybrid system total net present cost is 344294$, cost of energy(COE) is 0.66$ and operating cost is 19138$. The renewable fraction is 48%which mean it reduces the emission. PV-Battery-DG hybrid system cash flow and energy flow is shown in fig 4.

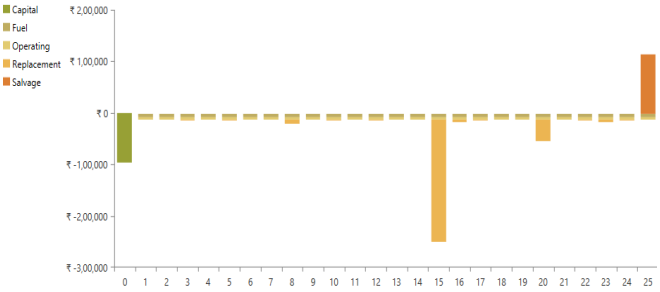

Fig.4.PV-Battery-DG hybrids system cash flow

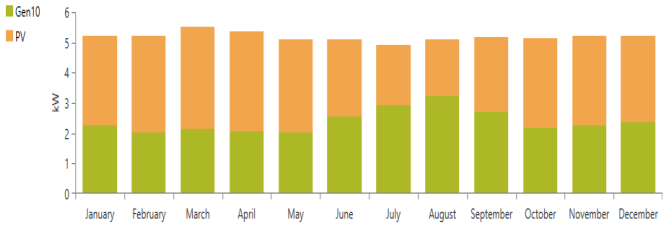

Fig 5. Average monthly production of PV-Battery-DG hybrid system

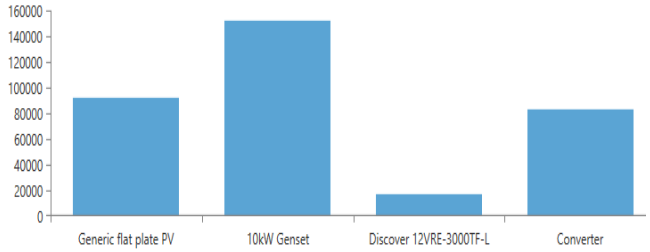

Fig 6. Cash summary of PV-Battery-DG hybrid system

V. CONCLUSION

There has been substantial investment in the physical electricity infrastructure of the country since independence. There have been numerous programs in just the last decade for accelerating rural electrification. These programs have focused on rural electricity development; on ambitious coverage targets but not on financing or creating incentives for sustainable maintenance of infrastructure stock; on triage of emergency measures and not on providing reliable services. A systemic plan for modelling stand-alone hybrid energy system capable of utilizing various resources, for supplying the basic energy needs of remote rural areas has been presented and discussed. The approach is based on minimizing an cost of energy and emission based on optimum utilization of energy resources in cost effective manner. The formulation is quite general and is applicable for any demand-supply combinations. The proposed stand-alone PV system has minimum cost of energy and reduces the carbon emission. The comparative analysis of three different combinations of hybrid system, and found PV/Generator/Battery system is optimal solution. This system has lowest cost of energy 0.66$/kWh, totlat net present cost is 344294$ and renewable fraction 48% which reduces the dependability on conventional energy sources. PV /Generator/Battery system has less emission production, which reduces the adverse effect on climate conditions and human health. It is recommended that, total net present cost and cost of energy may be reduce if one or more renewable energy sources add with existing PV system.

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