Performance Evaluation and Cost Assessment of Multi Solar Cell Technologies for Jamshoro Climatic Condition Using Pvsys Software

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Abstract: Mono crystalline material at low temperature or standard temperature work very good, and performance ratio is very good but when temperature increase the performance of mono crystalline material is decrease especial in month of Jun and July. The performance ratio of mono is 71% throughout year at Jamshoro condition,**+96.5%** module efficiency from an irradiance of 1000w/m to 200w/m(AM 1.5, 25). The performance ratio of mono crystalline is 71.3%, but the performance ratio is decrease in month of May, Jun, July due temperature changes module conversion efficiency of thin film is 12.5% and the performance ratio is 78.% in Jamshoro climatic condition cost of poly crystalline material in Jamshoro condition is 75 per watt with hybrid system and 65 with on grid system, life cycle of poly crystalline material 40 years, in Pakistan.

Keywords: *Photovoltaic technology, simulation, pvsyst, performance, incident irradiance, conversation efficiency*

1. Introduction

In the world energy plays a vital role and energy is directly affected the world. The energy power is separated two major types namely conventional and other is non-conventional. Environmental phenomena also effected such as fuel combustion, conventional energy creates many problem to all living things on the earth [1].Demand of conventional energy is reduce in economic market due to renewable energy , renewable energy provide solution for safety in the earth , solar energy or photovoltaic energy are more interesting ,renewable ,inexhaustible and non-polluting. Photovoltaic systems works on the solar cells which is made of semiconductor material such as silicon (Si) solar radiation coverts into electrical energy, solar energy store in solar semiconductor cell and its interconnected in the solar modules or panels. [4].Solar technology is very good response among various renewable energy, pollution less natural resource solar radiation coming from sun is much more than the consumption on earth. It's very important and suitable for environment, this system is also noiseless. The active social networker follows both companies and other people. And suitable to replace, conventional energy into non-energy. In Pakistan demand for electricity is increasing day by day, when power for use given by grid station then actually resources are consumed that can be used in case of any emergency but effect of load shedding, due to large amount of gap between demand and supply in country, so there is deficiency of desired power consumption. In Jamshoro people are not much aware about the climatic condition according solar cell technology, which Solar cell technology is suitable, what are measurements are required, when we installed solar system, how reduce cost and the main thing losses how reduce the loss and improve the efficiency of the system. The information and knowledge stored in their mind are based on raw and figures.

2. Related Work

In comparative analysis of four different solar cell technologies in which making 10kw grid connected solar system, tilt angle is 31% and other parameters like meteorological data and technical specification. Copper indium gallium selenide (CIS) performance is best lowest cost, capacity factor (15.04) and performance ratio (PR) is (0.7717).[1].The main thing is in this research paper not work on losses, cost and sizing of the system.

According to [2], if efficiency increase temperature is decrease 5% of solar radiation is converted to electricity, the temperature is converted into heat due to low conversion efficiency of cell. The conversion efficiency of solar energy to electrical of poly crystalline is 12% to 20%, in this research paper not giving method to increase the efficiency of the system.

In 4 PV technologies and 2 different simulation tool namely RETscreen and pvsyst are used 3 phase inverter are used the efficiency of inverter is 98%,meterologyical data taken from various public domain sites ,2nd factor after temperature is 40% dust contributes degradation in peak power of photovoltaic which also effected of cell. In this research paper not mention how to reduce the losses from solar panels like dust[3].

Research is ongoing on this field throughout world to provide the detail information multi photovoltaic solar cell technology in different climatic condition of the world using simulation software like RETsreen ,TRANSYS, HOMER, PV- F CHART etc. Researcher used different methods for designing models of system in various

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parameters. Find performance of solar cell using simulation but the not address the efficiency improvement and cost. [4,6].

3. Methodology

PVsyst, a modeling and simulation software is used for the analysis of complete PV technologies. The input parameters required by pvsyst are tilt angle (22˚), meteorological data and technical speciation of the system component (PV, modules, inverter, etc.).The result are obtained in the form of energy output by different type of technologies like ploy, mono, thin film ,performance ratio and capacity factor. Consideration of various losses and their optimal limit. design side selecting of cables, inverter transformers, module placement).Case study of 50kW Solar PV system project at MUET library Jamshoro.

4.1 Software used

PV system software develop by the energy group of Geneva Switzerland, PVsys simulation software used for design and modeling a gird connected system, off grid system and standalone system. PVsys software used for finding input parameters like tilt angle, meteorological data, and specification of system components like (inverter, pv panel) , also giving result of the different multi solar cell in form of energy , it also given the efficiency results ,capacity ratio.[9]

This software gives ,the graph of component behaviors ,mismatching or double orientation ,electrical PV array behavior under partial shading, quick metro calculation. The PVsyst software offers resource assessment solutions for grid connected, off-grid, and DC grid based systems based on an extensive set of database consisting of solar modules, inverters and other. Its calculation of energy generation is based on Meteorological data. PVsyst provides the option to use hay's model and Perez model. In this study we have used Perez model for the transportation of solar irradiation data.

4. Results and Discussion

4.1. Metrological Data

To the check feasibility of the system to analysis a PV system at a location, metrological data of site plays vital role. For this data is obtained from acquisition system installed at MUET Library Jamshoro Sindh Pakistan. In MUET Jamshoro received about 321 days of sunshine over whole year, the irradiance in a whole year in Jamshoro is (1934 KW/m²) ,lowest solar radiations is received in the month of January and the highest solar radiation (206.1KW)/m². Table no 1 shows variation of global radiation falling on horizontal surface of the MUET JamshoroTable.1. Statistical data.

Jamshoro Mehran University_42 .9KWp
Balances and main results

	GlobHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	EffArrR %	EffSysR %
January	134.6	16.87	182.1	169.8	61820	60004	13.82	13.41
February	139.1	20.29	171.6	159.6	57206	55535	13.57	13.18
March	177.5	25.30	197.3	182.6	63919	59480	13.19	12.27
April	192.0	30.19	195.4	180.2	61748	59260	12.87	12.35
May	206.1	33.34	195.9	179.7	61247	52321	12.73	10.88
June	197.7	33.92	183.1	167.7	57330	55668	12.75	12.38
July	171.9	32.30	161.1	146.9	50968	46692	12.88	11.80
August	163.8	31.19	160.4	146.6	50982	49518	12.94	12.57
September	178.4	30.68	191.2	176.8	60802	58974	12.94	12.56
October	166.6	28.53	199.5	185.8	63827	61903	13.02	12.63
November	140.4	23.30	186.3	174.2	61109	59281	13.35	12.95
December	126.1	18.17	174.5	162.6	58895	57172	13.74	13.34
Year	1994.1	27.03	2198.6	2032.5	709853	675809	13.15	12.52

Legends: GlobHor Horizontal global irradiation; EArray Effective energy at the output of the array; T Amb Ambient Temperature; E_Grid Energy injected into grid; GlobInc Global incident in coll. plane; EffArrR Effic. Eout array / rough area; GlobEff Effective Global, corr. for IAM and shadings; EffSysR Effic. Eout system / rough area

Figure.1. Simulation results of the designed system

4.2 Solar Radiation

The output of the PV arrays depend strongly on the solar radiation, which is depend on the orientation and the tilt angle of the PV model of the system, the solar radiation is measured on horizontal surfaces. Solar irradiation in Jamshoro shown in Fig 1

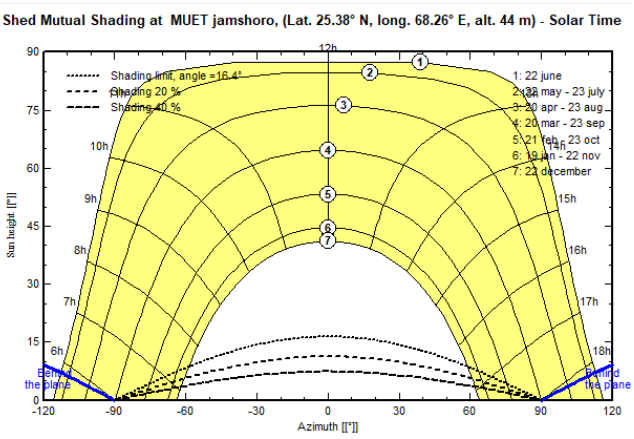

Figure.2. Simulation results of the Jamshoro climatic

4.3 System description

A grid connected system which you can say that on grid system which sink with grid, its work on frequency if any case gird (WAPDA) is not available the system is off, in the condition the gen set is on, this system is beneficial for educational institutions and industrials, its fixable for large scale in like 50 KW solar system, but hybrid mean with batteries, in hybrid first priority is solar, 2nd grid and last is batteries. In large scale the hybrid system is not fixable, in this system you not calculate return of investment (ROI).without battery backup is reduce significantly which leads to reduce the cost of system, in hybrid system the cost of per watt is 160 rupees solar system with batteries but in on gird system which without batteries which cost is around 95 rupees per watt in 2017 in Pakistan market. The power from the PV module is fed into inverter and then from inverter to utility grid [8].

4.4 System Design

First conduct the site survey where system is install, the calculate the area of the roof, boundaries of the roof, where is south face, how much degree out from south (Azimuth angel) then calculate the wire distance of inverter, inverter to batteries, panel to inverter etc., the most important thing is that tilt angle of the location.

In Jamshoro the tilt angle of the panel is 18˚ and its shading Losses 1.0%.Fig 1 shown the graph of the tilt angle of the system which is installed at MUET library Jamshoro Sindh Pakistan. The shading loss is very minimum like 1.8% in 18˚tilt angel at Jamshoro.

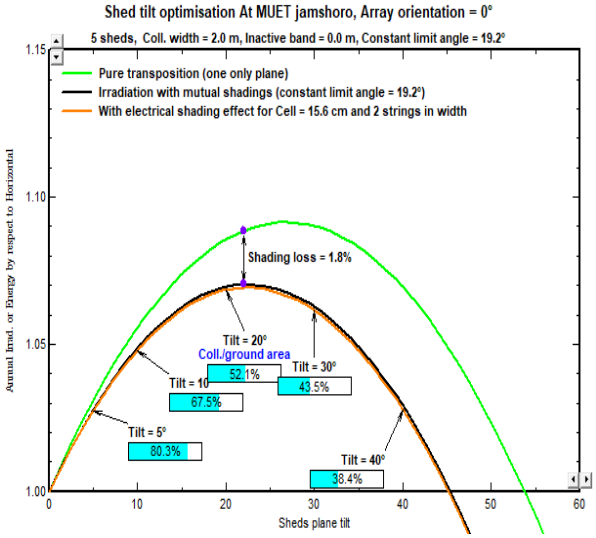

Figure.2. Simulation results of the tilt angle of Jamshoro

4.5. System Components

4.5.1. PV Modules

In the comparative research study, we taken different solar cell technology like (mono crystalline, poly crystalline and thin film solar cell like amorphous silicon), comparing their performance ratio in Jamshoro climatic condition.

Table.1. Characteristics of PV module

Manufacture	JA solar	Canadian solar	Jinko china
STC power(wp)	330	330	330
Number of cells	72	72	72
Open circuit voltage (v)	37.5	38.7	37.3
short circuit current (A)	8.28	8.58	8.23
Module area (m^2)	1	2.3	1.58
Temperature cofficient (mV/˚C)	-0.058	-0.043	-0.046
Diode quality factor	1.3	1.35	2.43
Efficiency of Module	12.30%	16.12%	15.40%

4.5.2. Inverter

The inverter used for simulation of this system is 25 KW SMA Inverter German brand, this inverter is toper inverter in efficiency and performance ratio based, and in this study we install 2 inverter of 25 KW for design a system at library MUET Jamshoro. Inverter are used to convert DC voltage into AC voltage, so that the power can be supplied to the grid utility. Grid inverter is installed which SMA, in SMA the MPPT (maximum power point tracking) system circuit are built-in, which help of MPPT the operating point of PV module can be restricted close to maximum power point of the modules. MPPT is used for better performance of solar PV system as compare to PWM inverter [8].

4.5.3 Energy Production

Energy production by solar cell modules over a whole year 2017 in Jamshoro in climatic condition

Table 11.Energy production of different PV modules during one year

Energy suppied to gird in KWh			
Month	Mono	poly	CIS
January	134.6	126.3	132.5
February	139.1	129.2	131.9
March	177.5	165.3	145.6
April	192	185.2	163.7
May	206.1	200.1	195.1
Jun	197.7	192.3	173.4
july	171.9	178.5	181.3
August	163.8	172.6	185.6
September	178.4	169.3	172.5
October	166.6	166.3	176.4
November	140.4	193.6	200.3
Dcember	126.1	139.3	140.2

4.5.4. Performance Ratio

Performance ratio is measure for the performance of a PV system. The performance ratio are taking into account environment factors (temperature, irradiance etc.) the performance ratio is the ratio of energy output of the system and irradiance incident on the given site or location where system installed. In this comparative study for Jamshoro climatic condition the high performance ratio of poly is 78.3% lowest performance ratio of mono is 71.0%

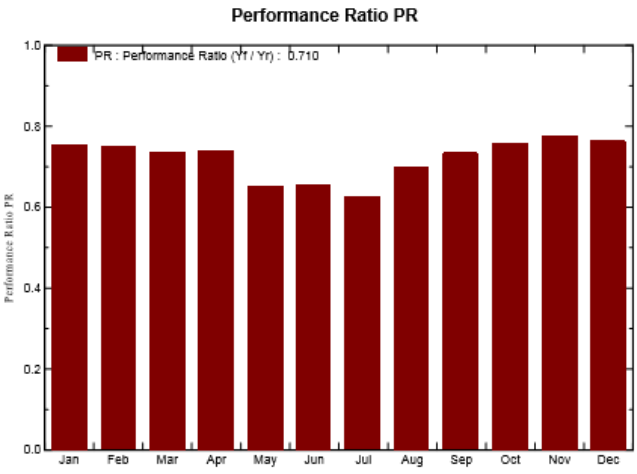

Figure.3.The performance ratio of mono crystalline

The performance ratio of poly crystalline material at Jamshoro climate for hole year in this fig. the performance ratio of poly material is constant specially in the mouth of May June and July, because in Jamshoro the temperature is exceed 45˚ so the performance of poly 76.3% in Jamshoro climate condition

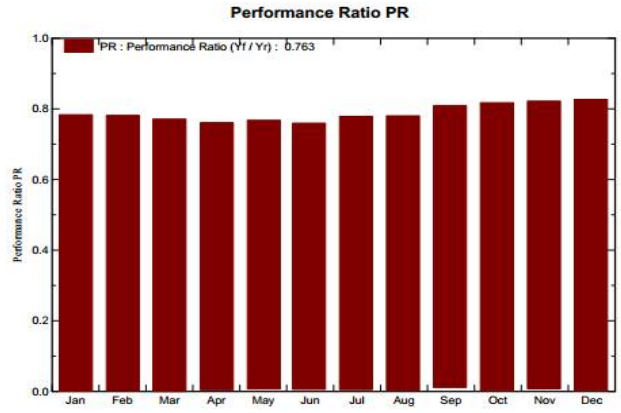

Figure.4.The performance ratio of mono crystalline

The performance ratio of thin film crystalline material at Jamshoro climate for hole year in this fig. the performance ratio of thin film material not is exceed 45˚ so the performance of thin film crystalline material 72.2% in Jamshoro climate condition.

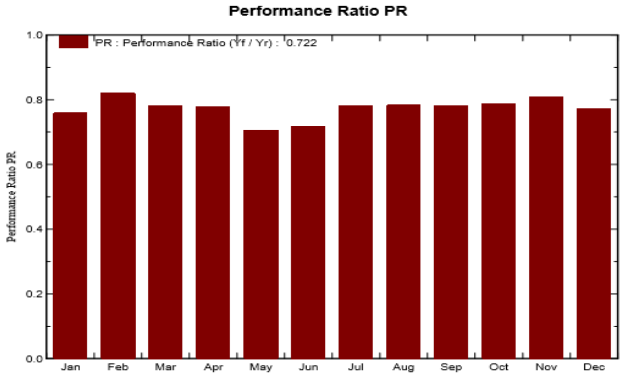

Figure.4.The performance ratio of thin film

4.5.5. Land Requirement

Total area required for set up a 50 kW solar plant at Mehran university central library Jamshoro Sindh Pakistan, in MUET Jamshoro by the different solar cell technologies is presented in Table IV. If better efficiency solar cell technology module are used then the area of the system can be used significantly.

Technology	Efficiency%	Area required (m^2)
Mono crystalline	12.5	88
Poly crystalline	16.2	64
Amorphous silicon(a-si)	7.2	143
CIS	11.3	90

8. Capacity Factor

Net capacity factor of a power plant is the ratio of total amount of energy produced by a plant during a certain period of time and the amount of the plant energy, would have produced at full capacity. In this study we are considered three solar cell technologies, POLY is highest capacity factor (14.6%) and the lowest is a-Si capacity factor is (11.04%), and the mono capacity factor is (13.5%).

5. Conclusion

In this paper has presented different ambient temperature effect and different incident irradiance effect to the performance of PV model. The pvsyst simulation results shown that efficiency of solar cell technologies was effected by irradiance and ambient temperature in Jamshoro climatic condition poly crystalline material is suitable for solar system and the tilt angle is 18˚ degree is very good for Jamshoro. The performance ratio for each technology is assessed and found to be 71.58% for mono crystalline technology at 25C temperature, mono is suitable for cold areas, and cost of mono is higher than poly which is 75 rupees per watt. In Jamshoro, the performance ratio 72.2% for thin film technology at 50℃ temperature. Performance ratio 78.3% for poly crystalline technology on monthly basis and 45C temperature, the cost of poly is cheaper than other two technologies and performance is better in higher temperature, so poly is suitable for Jamshoro climatic condition and cost effective. Must use simulation software like pvsyst, Helios cope, pvsole, RET screen etc. and calculate whole parameters of photovoltaic system, which also suggest you to which solar cell technology is suitable for this location.

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