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POWER GENERATION DEVELOPMENT BASED ON SOLAR POTENTIAL AT URBAN AND RURAL REGIONS SELECTED LOCATIONS IN PAKISTAN

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ABSTRACT

In Pakistan has chosen seven areas to investigate the feasibility of developing a photovoltage plant system sources has become a major purpose in this research. The technical feasibility research of photovoltaic systems based on crystalline technology proposed with varying monitoring systems in terms of fixed, 1 axis, inclined axis, and two axes was analyzed utilizing PVGIS and the PV Watts software. The simulations comes about appeared that the performance of the 2-axis is superior in contrast to another tracking system. On the basis of standard parameters, the environmental and economic viewpoints of the proposed plant are analyzed. The technical performances acquired by means of PVGIS have been high performances compared to the results of PV Watts. During this research, different performance parameters were calculated, such as the annual production of photovoltaic energy, the annual radiation in plane, the photovoltaic capacity, the performance factor, the capacity factor. In additions, the Levelized cost of energy (LCOE) for the fixed inclination, 1-axis, inclined axis and 2-axes for the plants. PV plants for all areas were gotten within the extend of \$0.178-\$ 0.239 / kWh, \$0.14 - \$ 0.202 / kWh, \$0.145 - \$0.203 / kWh and, \$0.133 - \$ 0.191 / kWh, separately.

KEYWORDS: ***Grid-Connected, Performance Parameters, PV Power Plant, Simulation Software's & Tracking System***

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Original Article

INTRODUCTION

The natural source of energy technology takes into consideration the significant substance a period of one hundred years the 21st that be able to scale down global warming and through the usage of fossil power. Worldwide, the trend in the level of energy consumption has been growing due to industrialization and has changed rapidly throughout people's lives over the past not many decennaries. (Bano and Rao 2016; Padmavathi and Daniel 2013; Sharma and Chandel 2013; Shiva Kumar and Sudhakar 2015; Khanna*et al.,* 2017). An optional origin in the manner that energy of solar and biomass energy is desired to reduce greenhouse gas emissions.(Kumar *et al.,* 2017).The natural sources of energy do a model prospect since global power conservation be required to take place over the centenary (REN21 *et al.,* 2012; De *et al.,*2011; De *et al.,* 2014; Amber, K. P.; Ashraf, N., 2014; Muhammad *et al.,* 2017). One of the foremost imperative renewable vitality resources is solar-powered vitality. Solar based vitality is ecologically friendly and economically idealize feasible electric energy generation. Solar-powered vitality is changed over to electricity utilizing solar-based PV advances. Currently, solar energy is one of the main reliable sources of power because its employments essentially sun brightness planned for creating electrical vitality.The mechanism of the sun is comparative nearly close to a nuclear reactor. It discharges energy in the shape of scaled-down parcels called photons. The method nearly close converts these scaled-down parcels to electricity is recognized as sun powered vitality (Kamrul Islam Chowdhury*et al.,* 2017; Khan and Pervaiz 2013). The vitality and financial framework work to keep all the others destined for the enlargement along with economical development of a state.Today it proceeds to progress in energy persist on the world. A 5.6 percent increase in global energy consumption in 2010, which has been the largest since 1973 (Statistical Review of World Energy, 2017). Pakistan found in a locale of ones the most noteworthy sun oriented insolation within the world.The indicate sun-powered radiation is almost 5.5 kW m^{-2}, as well as the amount of sunlight in Pakistan, which is roughly the day of three hundred. In expansion, the generation of solar energy is foreseeable for over 100000 megawatt. Meanwhile, Pakistan is an oil-importing state besides the economic framework be afflicted with good figures due to the imposition of oil prices. Most share portion of the state of Pakistan, its energy generation by implies of thermal framework oil (oil of furnace), natural gas, high-speed diesel in the role of fuel, and coal is roughly at the display. Due to the rapid growth of the economic system and population, the demand for vitality is rapidly rising. The electricity production capacity in Pakistan is over 20000 megawatt.Typically not adequate to urge together electricity necessities in place of the province of Pakistan. Agreeing to the calculation of the government of Pakistan as well as the generation of capability needs to create by fifty percent according to 2010 in order to meet foreseeable needs (IqbalZaidi*et al.,* 2012; Sheikh *et al.,* 2010). In this proposed research, online computer programs are utilized such as PV Watts additionally PVGIS that is Photo Voltaic Watts (PV Watts) from the National Renewable Vitality Research facilities, and PVGIS which is from the European Commission. The major objective of the studies is to explore the seven selected areas in Pakistan having a reasonably analyzed solar energy, financial, and environmental assessment of a 1 megawatt (1MW) solar photovoltaic system. The point of this ponder is to gauge the sun based power potential at seven chosen districts in Pakistan to be specific Gujranwala-GRW, Islamabad Capital Region-ICT, Jhimpir-JHI, Kati Bandar-KAT, Khanewal-KHA, Multan-MUX, and Sialkot-SKT.In this academic work, 5 carrying out parameters: first annually photovoltaic power generation, second annually in-plane irradiations,third photovoltaic capability, fourth performance aspect, and the last one capability figure are calculated.Basically, this consider examines 1- framework portrayal of the proposed plant of 1 MW Sun-powered PV plant, 2- the simulation of the project plant of 1 MW Sun oriented PV plant by utilizing PVGIS (Photovoltaic Geographical Data Frameworks) program and PV Watts computer program, 3- The method for calculating the yield, 4- Potential level of solar resources and power era variety examined & result as well as 5- comparison of accomplishment proportion. This consideration has been carried out within different seven chosen climatic cities of Pakistan during the year 2019 and was used for a period of 17 years (2001-2017).

MATERIALS AND METHODS

Location and Geographical Data

In this academic work, the techno economics of photovoltaic systems connected to the one MW grid at seven chosen districts in Pakistan is estimated. For this different region proposal of 7 chosen, to be specific Gujranwala-GRW, Islamabad Capital Region-ICT, Jhimpir-JHI, Kati Bandar-KAT, Khanewal-KHA, Multan-MUX, and Sialkot-SKT. The points of interest and geographic data of the chosen locale have appeared in Figure 1 and displayed in Table 1.

Table 1: Design of Exploringthe different Regions in this Project (Location data)

Selected Zones	Coordinates		Elevations(m) Above ocean Level	Zones Characteristic
	Latitude(°N)	Longitude(°E)		
Gijranwala	32°09′42″	74°11′17″	226	Urban area
Islamabad	33° 43' 17.33"	73° 02' 35.84"	604	Capital city
Jhimpir	25° 00' 60.00"	68° 00' 60.00"	40-50	Rural area(Flat terrain)
Kati Bandar	24° 8' 34.602"	67° 27' 3.2616"	1	Castle area
Khanewal	30°18′00″	71°55′59″	139	Urban area
Multan	30°11′44″	71°28′31″	129	Urban area

Sialkot	32°29'33.6"	74°31'52.8"	256	Urban area

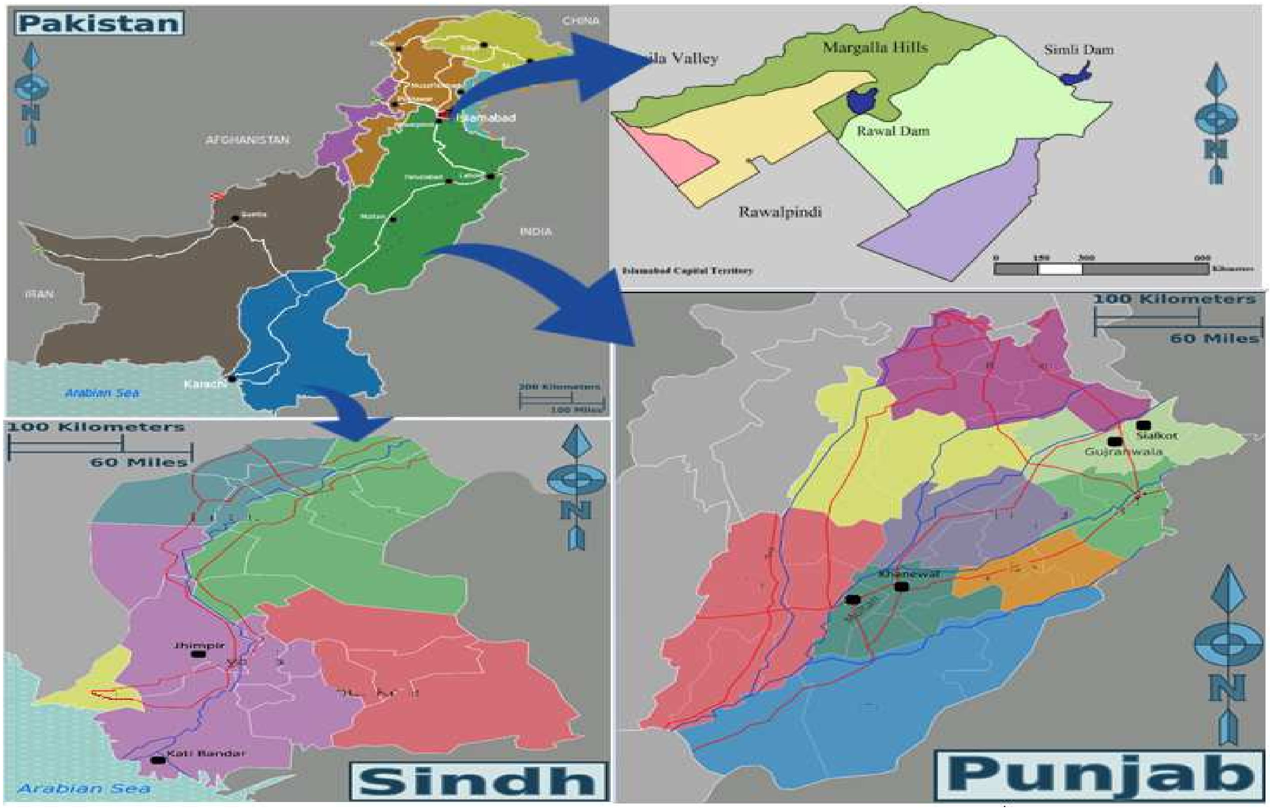

Figure 1:The State of Pakistan outline 7 chosen Areas of Geographic Data (Khan, M. A. 2018)

Subtle Elements of Research 1MW Grid Associated Sun Oriented PV Energy Plant System

The establishment of photovoltaic systems in examined areas is very helpful, decreases the assigned figure to operations and the upkeep to be an accomplishment. There's no unsettling influence whereas working the power-plants. The conversion of energy is environmentally friendly and does not produce any carbon-C emanation. Whereas fabricating the solar power-plant component a few carbon emanations are conceivable. Considering in intellect all the conceivable outcomes, the 1MW photovoltaic power-plant be proposed for these chosen areas to decrease fossil fuel utilization. The photovoltaic solar system connected to the grid-connection of the subsequent module (Shukla*et al.,* 2016):

Solar-components*:*Today's solar oriented module fabricating industry creates an assortment of sun based panel based solar-powered boards. Be that as it may, in large scale PVC plant establishments, crystalline sun oriented module is broadly utilized.

Inverter: the inverters are chosen based on the nominal power of the solar system, for a photovoltaic system size of 1 MW, it is possible to use an inverter with a nominal power of 1 MW. Sometimes four inverters with 250 kW capacity are utilized.

Assemblies: include structures where photovoltaic panels, inverters and other elements are located. The assembling of photovoltaic panels is one of the main ones to consider here, make beyond any doubt that they are mounted in ideal angles as per the area conditions.

Network Association: Substation and its components such as transformer, immaculate measuring frameworks, and assurance frameworks are the foremost imperative components for the grid association.

AC/DC-cables: cables are essential for interfacing panel, inverters, and grid.

Figure 2 appears all the components of the photovoltaic solar system with their individual determination. Within the proposed 1 MW solar-based photovoltaic plant, in the event that any overabundance power is produced, it can be provided to the framework/grid. In the event that there's any deficiency the power given to the lattice/grid can be utilized. The phenomenon is mostly alluded to as "net-metering".

Figure 2:Graph Appearing the Components of the Solar-Based Photovoltaic-PV Plant

Design of Photovoltaic Systems

Five acres of land is needed, ordinarily to introduce 1 MW sun oriented/solar photovoltaic-PV system, whether there is a peaked roof/an open surface, the sun-powered panel is evaluated by the Yingli solar-based manufacturer, 4 THEIA arrangement inverter has 250 KW, there's 235 capacity for 4284 photovoltaic-PV panels for each as well as two energy transformer.

Angle of Inclination

The angle of inclination proposed for the photovoltaic solar system is almost very close to the latitude of the place, as it is the best for maximum absorption of solar radiation. In any case, Pakistan is nearly exceptionally near to tropical locales and involvement tremendous possibilities of sun-powered radiation. The angle of inclination for this proposed system is considered the optimized value of the simulation research conducted in the PVGIS online program tool.

Installation of Solar Panels

Project solar panel utilized in this research support of photovoltaic systems it is crystal clear. During this research Yingli Solar-based YL235P_29b (235W) had been chosen. The nominal rating of the solar panel is 235 W each, to obtain the voltage and current based on the requirements of the inverter; the panels are orchestrated within the wire. For more details, the performance characteristics are given in Table-2 (maker information sheet).

Table 2:Computer-simulation for Direct Research

Sl. No.	Presumptions	Information Regard
01	The capacity of the photovoltaic solar system	1MW
02	Range required	Five acres of land
03	Utilized of photovoltaic panels	Yingli-Solar YL235P-29b (235W) Solar based PanelsVoç: 37V, Isç: 8.540A

04	Utilized-Inverter	THEIA 250-TL Inverter-Input Voltage: 451–821 V-DC Output-Voltage: 300V A-C Recurrence: 50 Hz Efficiency: >98%
05	Misfortune rate	0.50 percent per yearly
07	Obligation division	11.50 percent
08	Loan-term for this research	Five Year

Inverter-control

The nominated offer produced products through tHeiA™ inverter with the capability of 250 kW utilized. The proposed inverter with the chosen THEIA series which inward rate is 250 kW.The inside working characteristics are tabulated in Table 2 in the serial number of 4, Presumption an inverter, and information data in the same row as serial no.04.

Proposed Simulation on the Computer Programs

Computer-based online programs are utilized during this research to comparing outcomes gain for the suggested project 1MW solar-based PV energy system, which names are PVGIS and PV Watts.

Online computer-based software "PVGIS"

The PVGIS-online computer-based software utilizes as a photovoltaic geographic data framework. This software broadly utilized for assessing the performance of the sun based PV energy plant (and is one of the foremost widely called gadgets to assess the solar PV power plant tactics) in often regions such as European, Asian, and African countries. The European-commission has created an online-web application within geological area interface with regard to analyzing "Geographical evaluation of solar resources and the performance of photovoltaic technology". It is online-tool encircles packages that incorporate the sun based radiation-databases, performance assessment strategies, and gauges of financial parameters, counting power cost (Shiva Kumar and Sudhakar 2015; Shukla*et al.,* 2016).

Online computer-based software "PV Watts"

Second online computer-based software PV Watts used. It could be a performance demonstrate with straightforward economics connected to power costs. It may be a widely known tool outlined through the National Renewable Vitality Lab (N R E L), which permits consumers to achieve simulation with geological information. The client has the choice to enter the information necessary for measuring the photovoltaic solar system also, achieve computer simulation(Shukla*et al.,* 2016; Kouro*et al.,* 2015). Whereas utilizing PV Watts the user may choose any area for carrying out the evaluation.

Methodology of Simulation

In this research, 1-MW photovoltaic solar plant has been built; the structure of the simulation study utilizing the PVGIS and PV Watts computer program has appeared in Figure 3. After-that choosing computer program tools and the simulation strategy is portrayed stepwise. The simulation strategy for both program PV-module is the nearly comparative slight contrast in section into expanding parameters such as tilt angles and azimuth angles. PVGIS computer program is permitted to optimize of tilt and azimuth-angle, but it isn't conceivable within the PV-Watts. The simulation strategy has alluded to as the taking after steps (Kumar *et al.,* 2017).

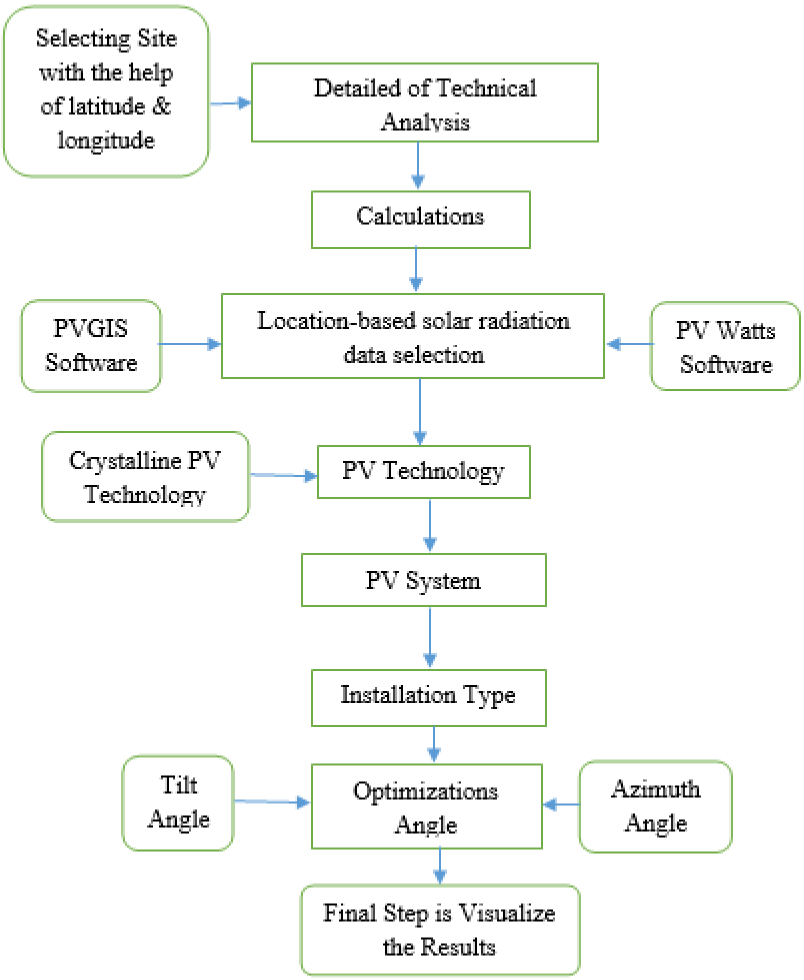

Figure 3:System of the Simulation Method.

Integrating and Computer Simulation from the Input Information

A few assumptions and inputs were utilized to mimic utilizing the PVGIS and PV-Watt tools. The characteristics of the area's geographic coordinate system like Latitude and Longitude for the chosen destinations have appeared in Table-1.Databases of solar radiation (PVGIS-SARAH) choose PV applied science (crystalline-silicon), PV framework measure (1000kW), and two-axis, figure out through PVC gadget, and damage to the system (approximate 14 percent). However, a few pieces of information are raised in Table-1 and Figure 3. In expansion, a few modern parameters are given amid the simulation preparation.

Economical Investigation and Natural Impacts

The economic investigation form on yearly investment funds and payback-periods of the suggested photovoltaic-PV system is examined utilizing equation 1and 2.

Yearly investment funds = Yearly Energy-Generation X FiT Rate(1)

Denoted, yearly investment funds have been shown to in \$/annual, yearly vitality production is appeared to in MWh/annual, furthermore, FiT rate show to the feed-in tax rate for sun-powered energy obtain in Pakistan.

$$\text{Payback\_Period} = \frac{\text{Inital investment}}{\text{yearly investment funds}} \quad (2)$$

Denoted the payback period is appeared to in annual, starting share is the capital essential for the installation of the suggested power system in $, and yearly investment funds are the sum of income that can be created from the solar energy system in $/annual.

Carbon extenuation examination of the suggested assignment is assessed utilizing the taking after approach: Greatest conceivable CO_2 outflows that may well be decreased with the solar energy systems in view of Equation 3.

$$\mathrm{CO_2 outflows} = \text{Yearly energy generation X Emission factor} \; (3)$$

Denoted, CO_2 moderation has been shown to in tCO_2/MWh, yearly vitality production is the sum vitality created by the suggested assignment into MWh/kWh, and outflow figure is the sum of the emanations that are discharged per kWh/MWh. Nevertheless, the solar energy system can't be totally considered as zero-emanation power production frameworks.Therefore, it is necessary to estimate the CO_2 discharged per kWh of electricity production utilizing the solar plant or the wind cultivate. From which the issued release of the suggested projects is assessed utilizing equation 4.

$$\mathrm{CO_2 moderation} = \text{Yearly power generation X } \mathrm{CO_2} \text{ per kWh} \; (4)$$

Denoted the CO2 moderation has appeared in tCO_2 / MWh and the CO2 per kWh seems to be in tCO_2 / MWh.

The net reduction of CO2 emissions with the suggested project computed utilizing the equation 5.

$$\text{Net } \mathrm{CO_2} \text{ reduction} = \mathrm{CO_2 moderation} - \mathrm{CO_2 emission} \; (5)$$

LevelizedCost of Energy (LCOE)

LCOE is the proportion of reduced esteem of the overall taken a toll of the to extend amid its lifetime counting both capital costs and operating and maintenance costs fetched to the power generated over the lifetime of the venture. It is a solid measurement of comparability diverse power generation technology and is characterized in a phase of $/kWh or else $/MWh. LCOE can be referred to as equation 6 (Mohammad *et al.,* 2018; Vides-Prado, A.; Camargo, E. O.; Vides-Prado, C.; Orozco, I. H.; Chenlo, F.; Candelo, J. E.; Sarmiento, A. B., 2018).

$$LCOE = \frac{theentiretyoffetchedoverlifetime}{thetotalofpowergeneratedacrossalifetime} (6)$$

RESULTS AND DISCUSSIONS

Solar based Asset Potential Changes

Presented in Fig 4 and tabulated in Table 3, the authors observed that major variation amid the research differentiation of solar possibilities utilized PVGIS and PV Watts's program in the chosen areas. Taking into account the PVGIS online computer simulation, the month to month generation of photovoltaic energy is 222000 kWh, the utmost solar radiation potential in Jhimpir is reached within the month of May, i.e. 301kWhm^{-2} taken after by April, i.e. 2591kWhm^{-2}. The least potential is watched within the month of Aug, i.e. 219kWhm^{-2}. Additionally, as well as Kati Bandar, month to month photovoltaic vitality generation is 222000 kWh, utmost radiation is watched within the month of May, i.e. 301kWhm^{-2}taken after by April, i.e. 291kWhm^{-2}. The least potential catalog according to PV-Watts simulations is 219 kWhm^{-2}within the month of February.

Taking into account the PVGIS online computer simulation, the month to month generation of photovoltaic energy is 193000kWh, the utmost solar radiation potential in Khanewal is reached within the month of May, i.e. 276

kWhm^{-2}taken after by April, i.e. 261kWhm^{-2}. The least potential is watched within the month of January, i.e. 182kWhm^{-2}. Additionally, as well as Multan, month to month photovoltaic vitality generation is 193000kWh,utmost radiation is watched within the month of May, i.e. 276 kWhm^{-2}taken after April, i.e. 261 kWhm^{-2}. The least potential catalog according to PV-Watts simulations is 185 kWhm^{-2}within the month of January.

Utilizing PV-Watt in the territory of the capital of Islamabad and in the rural area Jhimpir has the utmost and least potential in these places.Taking into accountthe PV-Watts online computer simulation tool, the utmost solar radiation potential in the territory of the capital of Islamabad, the month to month generation of photovoltaic energy is 194886.375kWh,the utmost radiation is watched within the month of May, i.e. 288.4kWhm^{-2}taken after by Jun, i.e. 253.09kWhm^{-2}, severally. The least potentials catalog according to PV-Watts simulations is 156.28kWhm^{-2}within the month of January has appeared in Fig. 4.

Taking into account the PV-Watts online computer simulation tool, the month to month generation of photovoltaic energy is 125257.375kWhm^{-2}, utmost solar radiation potential in the rural area Jhimpiris watched within the month of April, i.e. 166.99kWhm^{-2} taken after by July, i.e.166.55kWhm^{-2}, severally. The least potentials catalog according to PV-Watts simulations towithin the month of November, i.e. 138.51 kWhm^{-2}has presented in Fig. 4.

Table 3: Comparison of specialized performance of twoprograms that utilized i.e. 1- PVGIS, 2-PV Watts

#	PVGIS							
	Technical-Parameters	**Fixed**						
		GRW	**ICT**	**JHI**	**KHT**	**KHA**	**MUX**	**SKT**
	A	32	33	27	27	31	30	33
	B	2	1	-1	2	1	0	3
1	C	1550000	1570000	1760000	1720000	1610000	1610000	1550000
2	D	2080	2090	2360	2370	2180	2190	2090
	Technical-Parameters	One-axis						
		GRW	ICT	JHI	KHT	KHA	MUX	SKT
	A	50	51	48	48	49	49	50
3	C	1910000	1970000	2230000	2230000	1970000	1980000	1920000
4	D	2550	2620	2960	2960	2660	2670	2580
	Technical-Parameters	Inclined-axis						
		GRW	ICT	JHI	KHT	KHA	MUX	SKT
	A	33	34	27	27	31	31	33
5	C	1910000	1970000	2240000	2240000	1970000	1990000	1930000
6	D	2550	2620	2970	2970	2660	2680	2580
	Technical-Parameters	Two-axis						
		GRW	ICT	JHI	KHT	KHA	MUX	SKT
7	C	1970000	2030000	2310000	2310000	2030000	2040000	1980000
8	D	2640	2710	3080	3080	2750	2760	2660
		PV Watts						
	Technical-Parameters	Fixed						
		GRW	ICT	JHI	KHT	KHA	MUX	SKT
9	C	133227.3	133384.9	179611.1	201271.9	142917.5	146698.3	13088 23101
10	D	6.307201	6.181874	7.828153	8.678186	6.810738	7.010336	6.133713

	Technical-Parameters	One-axis						
		GRW	ICT	JHI	KHT	KHA	MUX	SKT
11	C	176032.2	181652.2	195021.1	243218.8	184640.5	189911.1	174111.1
12	D	8.216418	8.318053	8.480145	10.38204	8.66795	8.940768	8.057419
	Technical-Parameters	Inclined-axis						
		GRW	ICT	JHI	KHT	KHA	MUX	SKT
13	C	177982.2	183932.7	200425.1	246749.6	186461.9	191496.4	176163.9
14	D	8.349801	8.460301	8.731966	10.56143	8.803146	9.069018	8.189443
	Technical-Parameters	Two-axis						
		GRW	ICT	JHI	KHT	KHA	MUX	SKT
15	C	270560.4	283897.3	217963.6	299657.3	274444	276896	271061.3
16	D	12.73776	13.13562	9.530506	12.88093	13.0295	13.19696	12.66655

*A = Slope Angle, B = Azimuth Angle, C = Yearly PV energy production [KWh], D = Yearly in plane irradiation [KWhm^{-2}]

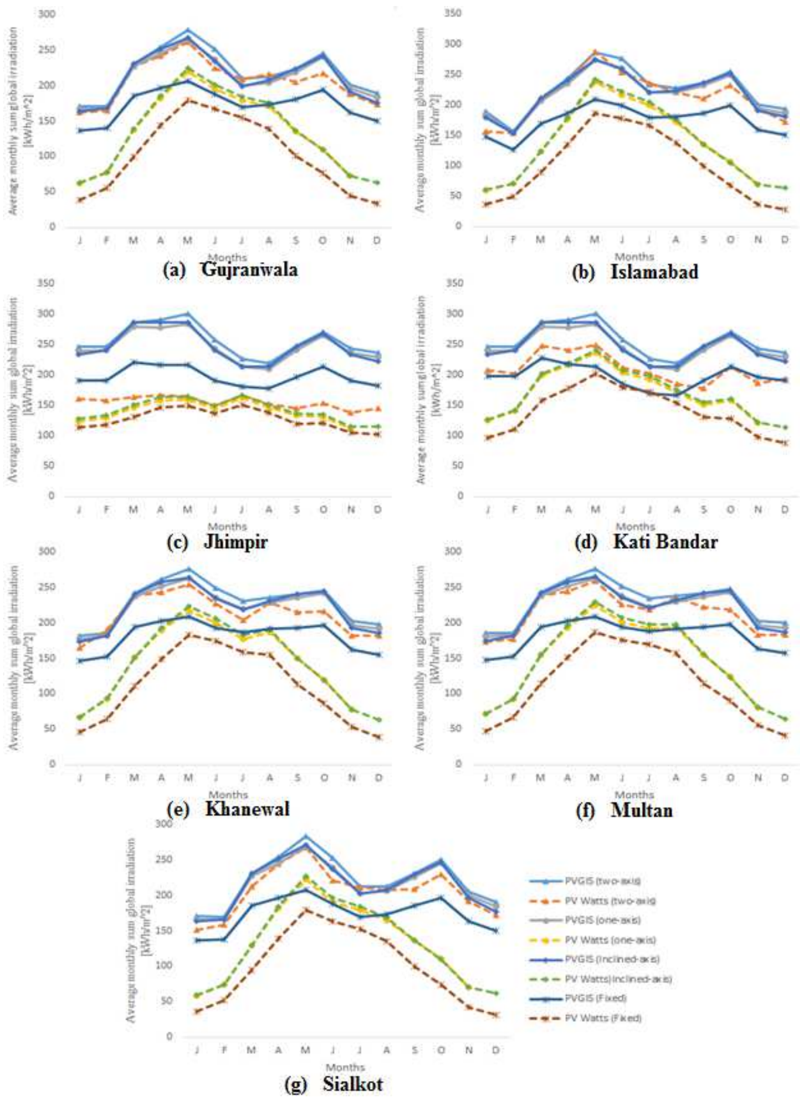

Figure 4: Month to month irradiation by plane in (a), (b), (c), (d), (e), (f), (g), and utilized both online computer program (PVGIS and Photovoltaic Watt) Incident solar radiation data in the photovoltaic framework.

Development Variant in Power Production

Development in yearly-energy eras are comprehensibly watched by the simulated research carried in two diverse computer program PVGlS and PV Watts.The PVGIS computer-based software tool are believed to have shown rather high performance compared to the tool of PV Watts.In addition to software, energy changes are perceived in Pakistan by the chosen seven-region name mentioned in Table-1and Figure 1.The photovoltaic system proposed according to the simulated research was carried out using PVGIS in Jhimpir-JHI and it is evaluated that it has an annual production of photovoltaic energy, for the annual irradiation in the plan, the results information are mentioned in Table 3 in the row of 7, and 8. The maximum, minimum energy generated is in May, August, and the capacity factor result. Detailed monthly energy generations based on PVGIS are presented in Fig. 5. Likewise, the photovoltaic system proposed at KatiBandar-KHT is estimated that it has an annual production of photovoltaic energy, for the annual irradiation in the plan, the results information are mentioned in Table 3 using Two-axis system in the row of 7, and 8. The maximum, minimum energy generated is in May, April, and the capacity factor result. Detailed monthly energy generations based on PVGIShave appeared in Figure 5.

Based on the comes about Gujranwala-GRA and Sialkot-SKT very near using PVGIS has the minimum performance of yearly PV energy production, yearly in-plane irradiation, and minimum capacity factor and taken after by Sialkot has been displayed in Fig 5 and according to simulated research mentioned in Table 3 in the column of GRW and SKT using PVGIS with two-axis and in the row of 7, and 8. The detailed of maximum and minimum energy generations on the month-to-month premise based on PVGIS have appeared in Figure 5.

1MW Solar-PV plant simulated using PV Watts at Kati Bandar and Jhimpir and it is evaluated that it has an annual production of photovoltaic energy, for the annual irradiation in the plan, the results information are mentioned in Table 3 in the row of 15, and 16. The highest, lowest energy generated is in March, August, November, respectively, and the capacity factor result. In addition, all detailed monthly energy generations based on PVGIS have appeared in Figure 5.

Besides, the variation in energy generation with respect to the optimal angle of inclination and the horizontal installation position is analyzed.In the event that the proposed 1MWp PV framework is introduced at the horizontal position, the sum of the vitality era is marginally lesser in a few months than to the vitality era at optimal inclination angles. The vitality generated at an optimal inclination angle has appeared in Table 3, 5 months are very higher than vitality produced at a horizontal position. Essentially, the subjected photovoltaic framework at optimal inclination angles has appeared in Table-4 than the even position.

Accomplishment Differentiation of Performance BetweenPV Watts and PVGIS Software

Utilizing the two-software computer program to be specific PV Watt and PVGIS to evaluate the performance of comparison for the proposed MW Solar PV system at some selected regions in Pakistan are tabulated in Tables 3 and 5. The fundamental presumption and formulae for investigation are somewhat distinctive for both the software. Hence, PVGIS predicts better esteem for chosen locales than PV Watts. A deviation of 11 to 12 percent with respect to the energy era and the capacity figure is noticed. There is a slight change within the comes about produced by both the computer program. In expansion, the comes about of this document are compared with the few existing publications task of the comparative capacity worldwide. Table-4 are presenting the comparison of previous research. Examination around power production and add up to energy for four diverse tracking frameworks using different computer programs such as PVGIS and as well PV Watts which are fixed, 1-axis, 2-axis, and inclined axes following framework. Differentiate the all-tracking framework energy production and add up to vitality for distinctive months all by the year for each month. In this study, compared 4 distinctive frameworks completely different sorts of criteria, considered a two-axis tracking system is extra productive in terms of output power and creating add up to the energy. To sum up, the highest annual production of energy production values mentioned in table 3 in the row of 7 and 8 in Jhimpir-JHI and Kati Bandar-KHT, uses the PVGIS online computer-based software with the two-axis monitoring system and, in contrast, the lowest annual energy generation at Sialkot-SKT and as taken after Gujranwala-GRW, production values mentioned in table 3 in the row of 9 and 10, utilized the PV Watts online computer-based software with a fixed location system.In compute add up to vitality for one year, discovered that the full yield vitality for fixed tracking framework utilized PV Watts which are production numbers have appeared in Table 3 in the row of 9where the two-axis following system's one is energy generation shown in Table 3 in the row of 7. In brief, in spite of the fact that the two-axis tracking framework utilized the PVGIS software is most productive.

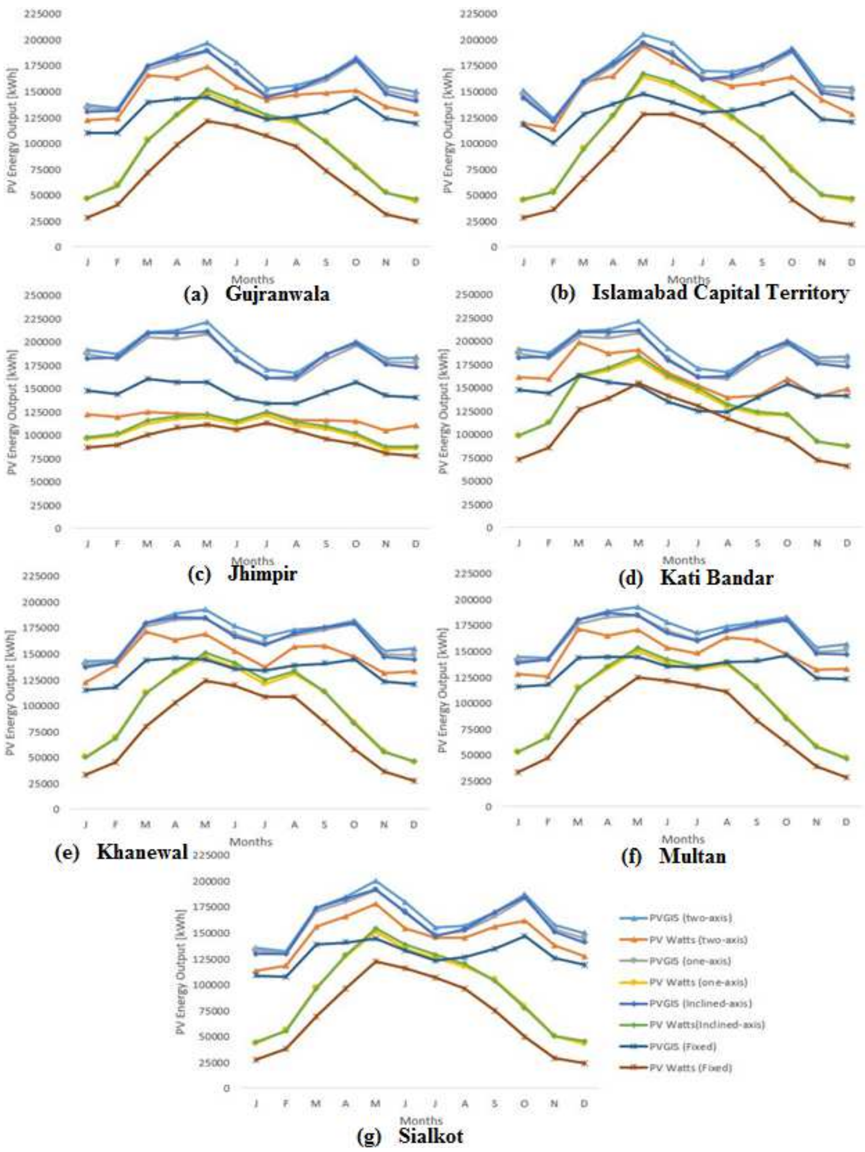

Figure 5: Month to month energy-output 1 MW of a solar photovoltaic system such as utilized computer program i.e. PVGIS and photovoltaic Watts at (a), (b), (c), (d), (e), (f), (g).

Table 4: Differentiation of performances outcomes about with the existing writing publications

Areas	PV-Technology	Plant-Capacity (MWp)	Annual-Energy (kWh)	Yield-Factor (kWh/year/kW)	Capacity Factor (%)	References
Cyprus	Mono Crystalline Silicon	1	1,820,850	1820.85	20.79	Poullikkas. (2009)
Ghana	Poly Crystalline Silicon	1	1,159,000	1163.00	13.2	ATPS. (2013)
Andhra Pradesh, India	Mono Crystalline Silcion	1	1,656,000	1656.00	18.90	Goura. (2015)
Jaipur, India	Poly Crystalline Silicon	1	1,551,000	1551.00	17.7	Bano and Rao. (2016)
Oman	–	1	1,771,480	1771.48	21.7	Kazem et al. (2017)
Turkey	Poly Crystalline Silicon	1	1,544,000	1544.00	17.62	Yaniktepe, Kara, and Ozalp(2017)
UMP Pekan, Malaysia	Crystalline Silicon	1	1,390,000	1390.00	15.86	Kumar et al. (2017)
UMP Gambang, Malaysia	Crystalline Silicon	1	1,380,000	1380.00	15.75	Kumar et al. (2017)

Reduction of Greenhouse Gas-GHG Emissions

The suggested project 1 MW solar photovoltaic system connected to the network (Grid) is generally considered carbon-free during its operating life and as such are a really useful source to assist decrease the impacts of climate alter.Greenhouse gas analysis works to help the user estimate the greenhouse gas mitigation potential from the suggested project research. As expressed by the internal energy use information for the chosen districts, Jhimpir-JHI and Kati Bandar-KHT. In this research, Greenhouse gas (GHG) emissions were recorded for the chosen regions.Suggested projected 1MW solar photovoltaic system connected to the grid desire save almost 1157.38 tons of tCO2 outflows yearly and generated yearly vitality 2310 MWh/year. All the recorded and estimated data are presented in Table 5.An economic investigation is conducted during research to evaluate expected costs as well as benefits. In the aspect of financial profitability, this study analyzes the net value of the assistance, the annual saving, the production of electricity, the period of simple recovery of the emission factor during the life cycle system, as demonstrated in Table 5.

Table 5: Payback period and tariff calculation

Name	GRW	ICT	JHI	KAT	KHA	MUX	SKT
	Fixed						
Capacity factor	0.177	0.179	0.201	0.196	0.184	0.184	0.177
Produced Energy [MWh/year]	1550	1570	1760	1720	1610	1610	1550
Feed in Tariff rate	0.055	0.055	0.055	0.055	0.055	0.055	0.055
Annual Saving [RS/MWh]	84.475	85.565	95.92	93.74	87.745	87.745	84.475
Payback period	7.035	6.945	6.195	6.339	6.773	6.773	7.035
Levelized cost of energy [RS/KWh]	23.75766	31.89933	26.42706	25.22583	25.89318	26.02665	23.75766
CO2per kWh	0.105	0.105	0.105	0.105	0.105	0.105	0.105
Emission Factor	0.606	0.606	0.606	0.606	0.606	0.606	0.606
CO2 Mitigation by PV plant [tCO2/MWh]	939.3	951.42	1066.56	1042.32	975.66	975.66	939.3
CO2 Emission from PV plant [tCO2/MWh]	162.75	164.85	184.8	180.6	169.05	169.05	162.75
Net CO2	776.55	786.57	881.76	861.72	806.61	806.61	776.55

reduction[tCO2/MWh]							
	1-axis						
Capacity factor	0.218	0.225	0.255	0.255	0.225	0.226	0.219
Produced Energy	1910	1970	2230	2230	1970	1980	1920
Feed in Tariff rate	0.055	0.055	0.055	0.055	0.055	0.055	0.055
Annual Saving [RS/MWh]	104.095	107.365	121.535	121.535	107.365	107.91	104.64
Payback period	5.709	5.535	4.89	4.89	5.535	5.507	5.679
Levelized cost of energy [RS/KWh]	18.6858	26.96094	21.75561	20.68785	20.82132	20.95479	18.6858
CO2per kWh	0.105	0.105	0.105	0.105	0.105	0.105	0.105
Emission Factor	0.606	0.606	0.606	0.606	0.606	0.606	0.606
CO2 Mitigation by PV plant [tCO2/MWh]	1157.46	1193.82	1351.38	1351.38	1193.82	1199.88	1163.52
CO2 Emission from PV plant [tCO2/MWh]	200.55	206.85	234.15	234.15	206.85	207.9	201.6
Net CO2 reduction[tCO2/MWh]	956.91	986.97	1117.23	1117.23	986.97	991.98	961.92
	Inclined axis						
Capacity factor	0.218	0.225	0	0.256	0.225	0.227	0.22
Produced Energy	1910	1970	2230	2230	1970	1980	1920
Feed in Tariff rate	0.055	0.055	0.055	0.055	0.055	0.055	0.055
Annual Saving [RS/MWh]	104.095	107.365	121.535	121.535	107.365	107.91	104.64
Payback period	5.709	5.535	4.89	4.89	5.535	5.507	5.679
Levelized cost of energy[RS/KWh]	0.203	19.35315	27.09441	22.28949	21.3552	21.48867	21.48867
CO2per kWh	0.105	0.105	0.105	0.105	0.105	0.105	0.105
Emission Factor	0.606	0.606	0.606	0.606	0.606	0.606	0.606
CO2 Mitigation by PV plant [tCO2/MWh]	1157.46	1193.82	1351.38	1351.38	1193.82	1199.88	1163.52
CO2 Emission from PV plant [tCO2/MWh]	200.55	206.85	234.15	234.15	206.85	207.9	201.6
Net CO2 reduction[tCO2/MWh]	956.91	986.97	1117.23	1117.23	986.97	991.98	961.92
	2-axis						
Capacity factor	0.225	0.232	0.264	0.264	0.232	0.233	0.226
Produced Energy	1970	2030	2310	2310	2030	2040	1980
Feed in Tariff rate	0.055	0.055	0.055	0.055	0.055	0.055	0.055
Annual Saving [RS/MWh]	107.365	110.635	125.895	125.895	110.635	111.18	107.91
Payback period	5.535	5.371	4.72	4.72	5.371	5.345	5.507
Levelized cost of energy [RS/KWh]	17.88498	25.49277	20.42091	19.48662	19.75356	19.75356	17.75151
CO2per kWh	0.105	0.105	0.105	0.105	0.105	0.105	0.105
Emission Factor	0.606	0.606	0.606	0.606	0.606	0.606	0.606
CO2 Mitigation by PV plant [tCO2/MWh]	1193.82	1230.18	1399.86	1399.86	1230.18	1236.24	1199.88
CO2 Emission from PV plant [tCO2/MWh]	206.85	213.15	242.55	242.55	213.15	214.2	207.9
Net CO2 reduction[tCO2/MWh]	986.97	1017.03	1157.31	1157.31	1017.03	1022.04	991.98

CONCLUSIONS

The research aims to study the feasibility of developing a solar energy analysis of the photovoltaic system connected to the 1MW grid for seven chosen areas in Pakistan, based on the simulation outcome displayed in this document. To achieve these aims, utilized computer-based software such as PV Watts and PVGIS to assess the specialized, monetary, and natural aspects of the proposed photovoltaic system. Major conclusions the taking after simulation investigation research:

The highest yearly vitality generation of 1MW photovoltaic system was assessed at 2310000kWh at Jhimpir-JHI & Kati Bandar-KAT with a 2-axis tracking framework.

Overall summary, fulfillment highest annual energy production in Jhimpir-JHI & Kati Bandar-KAT utilize PVGIS computer program with a two-axis tracking framework as compared to the minimum annual energy production in Sialkot-SKT & taken after by Gujranwala-GRW, utilize PV Watts program with fixed tracking framework.

Taking into account the PVGIS simulation, the monthly production of photovoltaic energy is 222000kWh, extreme sun based radiation potential at both areas Jhimpir-JHI & Kati Bandar-KAT is accomplished. While on the other hand, the least potential recorded according to the PV Watt simulation is 219kWh/m^2 in August and February.

According to the online program simulation results in the two-axis tracking system is the foremost efficient and cost-effective as compared to another system.

Based on the current guaranteed feed-in tariff (FIT) of the photovoltaic solar system seven chosen areas in Pakistan, the Levelized cost of energy (LCOE) for the fixed inclination, 1-axis, inclined axis and 2-axes for the plants. PV plants for all areas were gotten within the extend of $0.178-$ 0.239 / kWh, $0.14 - $ 0.202 / kWh, $0.145 - $0.203 / kWh and, $0.133 - $ 0.191 / kWh, separately.

Agreeing to the result analysis can be overall summarized, which suggested project systems of the photovoltaic power plant would give operational advantages to electricity generation in Pakistan in seven chosen areas.

ABBREVIATIONS	
AC	Alternative current
CO2	Carbon dioxide
DC	Direct current
FIT	Feed-in tariff
GHG	Greenhouse gas
GRW	Gujranwala
HZ	Hertz
ICT	Islamabad Capital Territory
JHI	Jhimpir
KAT	Kati Bandar
KHA	Khanewal
LCOE	Levelized cost of energy
MUX	Multan
MW	Mega Watts
NREL	National Renewable Energy Laboratory
PV	Photovoltaic
PV Watts	Photo Voltaic Watts
PVGIS	Photovoltaic Geo-graphical Information Systems
Rs.	The currency of Pakistan used a symbol for the rupee
SKT	Sialkot
tCO2	Total carbon dioxide

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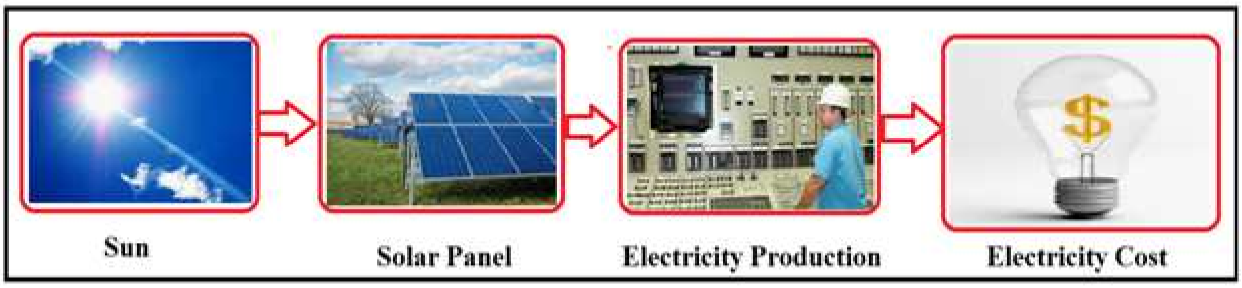
GRAPHICAL ABSTRACT



HIGHLIGHTS

- PV Solar power plant potential of the selected locations is suitable

- The selected locations in Pakistan have a very big solar energy potential and for the investors to develop grid-connected Photovoltaics solar power plant projects in the opportunities of actual market.
- The grid-connected PV solar power plant systems projects are economically feasible for selected locations in Pakistan.