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Solar Energy: An Ideal Solution for the Energy Crisis in the Union Territories of Jammu and Kashmir and Ladakh

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Abstract- *The union territories of Jammu and Kashmir and Ladakh are energy-undernourished union territories though they are hallowed with immense solar energy potential for thermal power generation and photovoltaic. Advancing and revitalizing resource gauging of all renewable energy sources is essential in the present layout where there has been a drastic scarcity of energy in the union territories. Among all Renewable Energy sources, solar energy can also play a key role in curtailing the energy crisis in the union territories of J&K and Ladakh and can be useful in providing energy in the future. It can dispense firm energy supply with additional income to the union territories of J&K and Ladakh and shall provoke employment in the union territories of J&K and Ladakh. This paper sheds light on how solar energy can lighten the energy demand to curtail energy crisis in the union territories of Jammu and Kashmir, and Ladakh based on Clean and green energy. The data obtained from National Renewable Energy Laboratory (NREL) proclaim that Jammu and Kashmir, and Ladakh are provided with about 5.3 kWh/m^2/day of mean direct normal irradiance (DNI) and 5.2 kWh/m^2/day of mean global horizontal irradiance (GHI). Both DNI and GHI can be turned into good accounts for solar thermal power generation and photovoltaic power generation.*

Keywords- Solar, Photovoltaic, Thermal, Direct normal irradiance (DNI), Global horizontal irradiance (GHI).

I. INTRODUCTION

The union territories of Jammu & Kashmir (J&K), and Ladakh have been confronting an appalling energy crisis that has escorted to rampant load-shedding, prolonged blackouts all over the union territories of J&K and Ladakh, and violent protests from the more pretentious citizens. The extensive debt actualized by subsidizing the power sector leaned the union territories' ability to inflate investment in critical public services like health and education. Also, constant and prolonged power outages disrupted business especially major manufacturing industries aggravating union territories' competitiveness and bringing down the employment opportunities of the union territories of J&K and Ladakh inhabitants [1]. The union territories of Jammu & Kashmir (J&K), and Ladakh are the northernmost union territories of India. The union territories are located in the northern Himalayas and comprise 6.7 % of the total geographical area of the country. It covers over 2.22 lakh square kilo-meter area out of which 30% is under cultivation. In Jammu, the average ambient temperature varies from 13^{0}C to 33^{0}C, in Kashmir varies from 0^{0}C to 25^{0}C, and in Leh region varies from -8 ^{0}C to 18 ^{0}C. The low ambient temperature results in massive energy requirements. This energy is mostly obtained by burning coal, firewood, and LPG. Sunshine days in Leh district are the highest in the entire India [2]. For solar cooking, solar drying, and solar thermal electricity generation through solar collectors or concentrated solar thermal (CST) technology, the Leh region is the best place. Solar energy is nature's most inexhaustible natural source and can play a key role in curtailing the energy crisis in the union territories of J&K and Ladakh.

II. DIRECT NORMAL IRRADIANCE (DNI) AND GLOBAL HORIZONTAL IRRADIANCE (GHI)

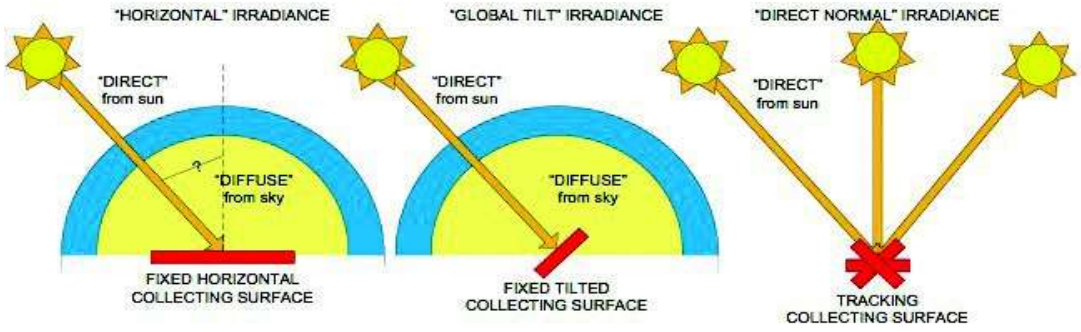

Figure: Types of radiation-collecting surfaces

Direct Normal Irradiance (DNI) is the amount of solar radiation coming directly from the sun per unit area gathered by the surfaces normal to the radiation. The amount of irradiance received annually can be maximized by keeping the surface perpendicular to

incoming solar radiation. The total amount of shortwave solar radiation received by a horizontal surface is called Global Horizontal Irradiance (GHI). These radiations can be passed down in photovoltaic installations. GHI contains Direct Normal Irradiance (DNI) and Diffuse Horizontal Irradiance (DHI). DHI is the amount of radiation incident per unit area on those surfaces that cannot catch radiation directly from the sun. Molecules and particles present in the atmosphere scatter them. These radiations turn up equally from all directions [3].

III. SOLAR: POTENTIAL AND ASSESSMENT

Harnessing solar energy is the tiniest preference for all the concerned organizations in the union territories in spite of the fact that the union territories of J&K and Ladakh have the second-highest solar potential in India next to Rajasthan. According to the National Institute of Solar Energy (NISE), the union territories of J&K and Ladakh have solar power potential of about 110 GWP (Giga watt-peak). This value of solar power potential is the second highest in India next to Rajasthan where the solar power potential is about 142 GWP [4]. Considering the importance of provoking green and clean power by utilizing solar energy, the Union Government a few years back launched Jawaharlal Nehru National Solar Mission (JNNSM). The objective of the Mission is to progress and deployment of solar energy technologies in the country and to create the policy conditions for solar power dissemination across the country so that India becomes the global leader in solar energy. Due to this, the ministry of union territories of J&K and Ladakh stimulates the promotion of clean and green power in the union territories of J&K and Ladakh and tracks down appropriate investment procedures that could leverage the Clean Development Mechanisms (CDM) [5]. It is worthwhile to mention here that the average solar energy at Leh is estimated to be 5.5 kWh/m^2/day. Also, the estimated average for Kargil is 5.4 kWh/m^2/day and for Nubra is 5.3 kWh/m^2/day because these areas of the Ladakh region have the best solar radiation in the country. The annual global irradiance for the Kashmir region is estimated to be 4.9 kW h/m^2/day [6].

Solar power produces no hazardous solid, liquid, or gas wastes and also does not create pollution. It can be produced by Photovoltaic cells which are made of semiconductors and through Energy Collectors. These collectors of energy are classified into the parabolic trough, parabolic tower, parabolic dish system, etc.

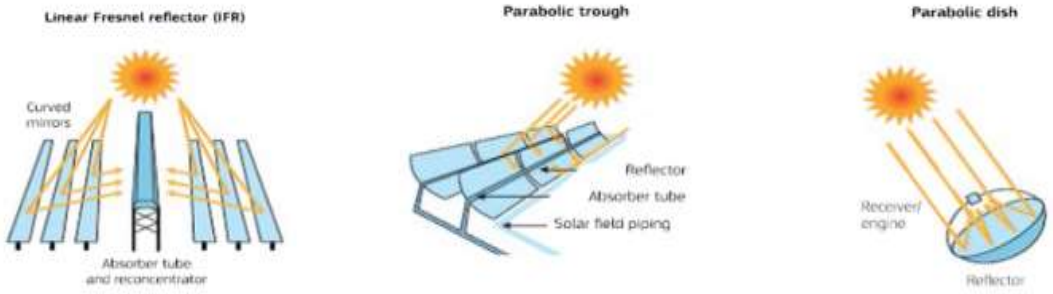

Figure: Types of solar systems

Figure: Solar photovoltaic system

Solar energy collectors (flat-natured) need GHI data whereas concentrated solar energy collectors need DNI data. Determining the efficiency of photovoltaic GHI is the most important factor. For solar thermal applications, DNI is important. Concentrated photovoltaic (CPV) systems focus a large amount of radiation onto a small solar cell. These are either refractive making use of lenses or reflective making use of mirrors. Direct normal irradiance (DNI) from the sun is used by Thermal power systems to generate heat. Mirrors are used by these systems to concentrate solar radiation. The heat generated by the systems can be used for producing steam. This steam, in turn, can be used to run the turbine of electricity generators. Thermal power systems, contrary to photovoltaic, can take benefit of all solar radiation coming from the sun thereby giving rise to high efficiencies. Estimation of solar energy resources is performed by a high-

quality solar radiation monitoring station. The estimated values of GHI and DNI set up a great scope of solar thermal technology via concentrated solar technology (CST) and photovoltaic systems [7-9].

IV. RESULTS AND DISCUSSION

Table: DNI and GHI data for union territories of J&K and Ladakh based on NREL [6].

S. No.	Month	Direct Normal Irradiance(kWh/m^2/day)			Global Horizontal Irradiance(kWh/m^2/day)		
		Jammu	*Srinagar*	*Leh*	*Jammu*	*Srinagar*	*Leh*
1	January	3.44	2.78	4.78	2.97	2.60	2.95
2	February	4.38	2.52	3.77	3.88	3.06	3.39
3	March	5.31	3.85	6.33	5.31	4.59	5.31
4	April	5.65	4.63	6.76	6.46	5.67	6.01
5	May	6.37	5.83	6.97	7.32	6.81	7.35
6	June	5.21	6.15	6.68	7.00	7.20	7.52
7	July	3.88	5.69	6.49	6.00	6.70	7.34
8	August	4.31	5.62	6.45	5.70	6.17	6.72
9	September	5.40	6.07	7.43	5.60	5.71	6.22
10	October	5.65	6.48	7.95	4.97	4.92	5.26
11	November	4.49	4.89	7.58	3.74	3.56	4.09
12	December	3.95	2.99	6.05	2.99	2.60	3.15
13	Annual	4.84	4.80	6.43	5.17	4.97	5.50

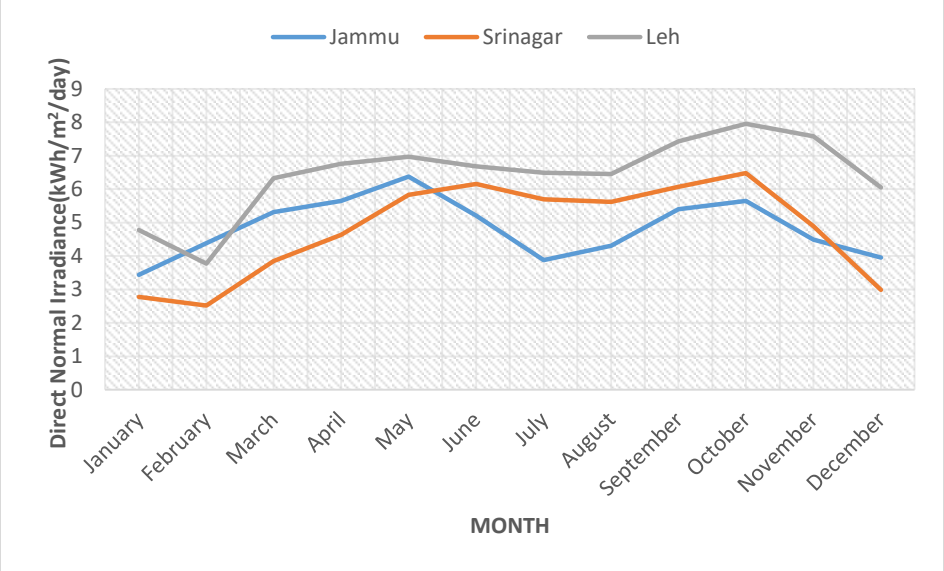

Fig. 2a: DNI data (monthly)

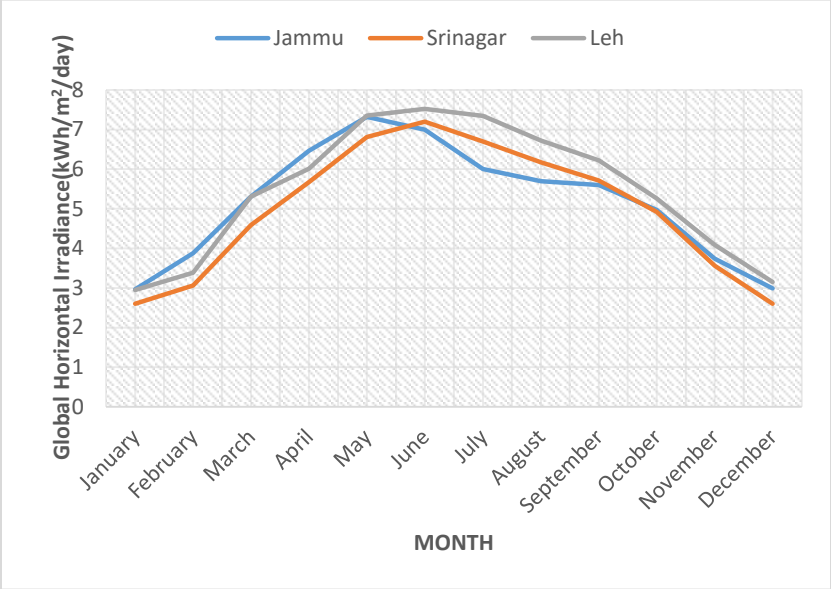

Fig. 2b: GHI data (monthly)

Based on NREL, figure 2 shows Direct Normal Irradiance and Global Horizontal Irradiance for Jammu, Kashmir, and Leh regions. From the data, we conclude that the annual solar radiation received (3.5 kWh/m^2/day to 7.9 kWh/m^2/day) in all the parts of the union territories of J&K and Ladakh is relatively high. The month of January is very bad for producing solar energy while June is excellent. The higher efficiency of solar panels and solar photovoltaic electricity can be ensured with Low ambient temperature and high GHI. In the union territories of J&K and Ladakh concentrated solar technologies have high efficiency and dish collectors have high-grade heat application due to high DNI. The demand for electricity is comparatively high in the summer months. This energy demand can be met through concentrated solar technologies using solar radiation which is always good in the summer months. During winter months, the demand for electricity can be made available to areas like Leh, Kashmir, and parts of Jammu which have inadequate energy solutions at present by blending solar photovoltaic and solar thermal technology. The processed heat can be employed by using Flat plate collectors as well as evacuated tube collectors which are mainly used for low-grade heat application (under 40 ^{0}C – 90 ^{0}C). Solar-concentrated technologies are useful in high-grade heat applications (above 100 ^{0}C).

V. RECOMMENDATIONS AND CONCLUSIONS

We can make use of solar energy in daily life as solar parks, solar photovoltaic (SPV) home lighting systems, Street lighting systems, Traffic signals, Blinkers, Illuminated hoardings or Display boards, Power packs, and Power plants to meet electricity and lighting needs of individuals in rural areas, communities, villages, urban areas, commercial complexes, institutions, industry, etc. Solar energy is free although the cost of establishing solar energy collectors and apparatus needed to turn solar energy into electricity or into hot water is high. In remote areas, where there is very difficult to extend the electricity power grid solar energy is one of the solutions. Rechargeable batteries can be used to store solar energy. Moreover, Small and Medium-Sized Enterprises will be the key players in the deployment of sustainable solar energy harnessing technologies and in providing services that support industry and consumers. The photovoltaic systems can be installed in grid mode and the energy (electricity) produced can be sent to consumer use via developing Smart Grids. The achievement and success of the solar energy technology development will also depend to a large extent on the government policies and their application in relation to competing for energy demands in the union territories of J&K and Ladakh. The major resistance experienced in the expansion of solar energy technology is the lack of awareness about the technology. Awareness programs should be initiated by the Central and union territories of J&K and Ladakh governments about the utilization of solar energy technology. Subsidy and support through tax exemption, feed-in tariffs (FITs), green certificate (GC), production tax credit (PTC), investment tax credit (ITC), soft loans, etc. to the local Entrepreneurs should be extended by the government, especially to those who are working in a rural area and are initiated to install solar energy set up there. In institutions, hospitals, petrol pumps, markets, homes, and offices a large number of energy (electricity) Units are consumed daily by fans, compact fluorescent lamps (CFL), home entertainment devices, hot tubs, pools, pumps, etc. This energy can be made available by using solar energy technology. Thus, solar energy is an ideal and effective alternative source of energy and is the most elegant choice to make for meeting our energy demand and curtailing the energy crisis to some extent in the union territories of J&K and Ladakh. By switching to appropriate solar energy technologies, the union territories of J&K and Ladakh can lighten their growing energy demands based on Clean and green energy.

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