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Potential of Renewable Energy Resources, MicroSources and use of Microgrids in Areas of Jammu & Kashmir, India

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Abstract: ‘Microsources and Renewable Energy sources’ represents Distributed energy resources (DERs) and Microgrids means a distribution system for electrical energy, starting from electricity generation to its transmission and storing with the ability to react to dynamic changes on energy supply through co-generation and demand adjustment. Utilizing potential of available distributed energy sources, Microgrids can provide better electric service reliability and enhanced power quality to end users of electricity at conservative approach which might not be with the utility grids. A global research is going on Microgrids, its application and control to overcome the flaws of the centralized power grids. In India due to power crisis a heavy load shedding has been carried out since last five years as load demand increasing day by day. Presently the concept of Microgrids has been developing in rces (DERs). In this paper, potential of renewable resources of electricity in various areas of Jammu and Kashmir has been foretold and proposed how Microgrids can benefit the state. [1]

Keywords: Microsources, Microgrid, Distributed energy resources (DERs), Distributed Generation (DG), Electric Power System (EPS), Point of common coupling (PCC).

I. INTRODUCTION

In this time, with the fast rise in demand of electricity, to accomplish the sustained need of electric energy many scientist are forced to study the penetration of distributed generation in the power distribution system. To recognize the potential of distributed generation a system approach is to be taken which views generation and connected loads as a subsystem or a “microgrid”. It is proposed that microgrid concept will prove to be ideal solution for rural electrification besides its very well use in industrial parks, commercial and institutional campuses and many other situations requiring improved reliability and power quality. A microgrid enables small communities to take control of their energy use and reduce their carbon release through a new and innovative way of generating and managing electricity [2]. Today many countries are indulged in obtaining the innovative change in electrical distribution network. A microgrid is a group of interconnected distributed generators, loads and intermediate energy storage units that collectively treated by the grid as a controllable load or source. Microgrid is connected to single point, the point of common coupling (PCC) [3]. The objectives of its conception is to facilitate the high penetration of distributed generators without causing power quality problems to the distribution network. A significant goal is to deliver good value and consistent supply to sensitive loads. [4] Rural areas in India have been lagging in facility and distribution of electricity. According to a study, 31 million Indian households are still in dark and the supply suffers from repetitive outages and fluctuation in voltage and frequency. [5] The Indian electricity grid faces major challenges to reliability, cost effectiveness, and expansion. It is often too far and too expensive to practically connect rural towns to the grid. Solar, wind and other renewables may be the only way to provide these areas with electricity (US Dept of Energy 2010). Since, pillars of India’s economy are the farmers, at present the farmers can avail the electricity for 8-12 hours per day devoid of quality. Therefore, in this paper the stress is set on making availability of electricity through local generation by predicting the potential of distributed energy resources & suggesting use of microgrid. A microgrid is just a localized power grid that can operate independently or together with the area’s main electrical grid. In microgrids, energy storage systems deliver far more than just a compensative source of power. At utility level they aid various significant functions, such as leveling PV power flow, adjust frequency and voltage regulator. Near consumer end they can enhance the supply at peak periods and offer significant backup in case of crises. They are also used to decrease the cost of power by swapping electricity from the grid at peak hours of the day. Microgrids and storage system are currently very key gears to build climate change flexibility and to give energy way outs to distant areas. They are also eye-catching at a financial level in combination with proper storage systems these can provide individual and business energy at cheaper rates. Jammu & Kashmir’s (J&K) power demand is mostly met by the

Central Generating Stations (CGS) and the State's own sources. The State's own installed generation capacity is 1,419.37 MW comprising of 1,110 MW of Hydroelectric Power Stations, 198 MW thermal (Gas turbine) and 110.96 MW of SHPs. The village electrification programme in J&K has been pursued diligently. During 2015-16, 98% of the villages in the state were electrified. As per state budget 2016-17, the state government is planning to apply "Power for All" program in the state during the coming years, which is a joint initiative by the central and state governments for providing the states with 24X7 power supply and other sources. The state government planned to harness 9,000 MW of electricity in the state during 12th and 13th Five-year plan. During 2016-17, the peak demand for power in the state grew 4.16% to 2,650 MW from 2,544 in 2015-16. [6]

As per the power budget 2016-17, the power deficit of the state is recorded to be US\$ 600 million. Under saubhagya scheme 2018, J & K has no household left unelectrified. According to a survey, 3,57,405 unelectrified houses in J&K got electrified under DDUGJY and saubhagya scheme. Out of these 2,26,367 household were proposed under Deen Dayal Upadhyaya Gram Jyoti Yojana – (DDUGJY) and other allied schemes, while the remaining 1,31,038 uncovered households were proposed under the Saubhagya scheme. [7] Although, the state is fairly electrified, but providing continuous power at cheaper rate is difficult. According to a survey in 2018, consumers in Kashmir use extra 700 MWs of energy during winters. [8] Also power crisis is commonly seen in areas of Kishtwar and Doda. To address these problems and providing efficient, continuous, renewable electricity, microgrids are to be employed in the state.

II. POWER GENERATION SCENARIO IN INDIA

The electricity sector in India supplies the world's 5th largest energy consumer, accounting for 4.0% of global energy consumption by more than 17% of global population. The Energy policy of India is largely controlled by the Government of India's, Ministry of Power, Ministry of Coal and Ministry of New Renewable Energy and administered locally by Public Sector Undertakings (PSUs). About 65.34% of the electricity consumed in India is generated by thermal power plants, 21.53% by hydroelectric power plants, 2.70% by nuclear power plants and 10.42% by Renewable Energy Sources. More than 50% of India's commercial energy demand is met through the country's vast coal reserves. The country has also invested severely in recent years in renewable energy utilization, especially wind energy. In 2010, India's installed wind generated electric capacity was 14,550 MW. Additionally, India has dedicated massive amount of funds for the construction of various nuclear reactors which would generate at least 30,000 MW. In July 2009, India unveiled a \$19 billion plan to produce 20,000 MW of solar power by 2022. [1]

Conventional Energy Source	I C	% of total Generation in India	Renewable Energy Source	MW	Renewable Energy Source	MW
Coal Thermal Power	96743.38	54.66	Wind power	15000	From waste	2700
Gas Thermal Power	17706.35	10.00	Biomass		Geothermal power	10600
Oil Thermal Power	1199.75	0.67	Agro residues	16881	Tidal wave power	9000
Hydro Power	37367.4	21.53	Bagasse	5000	Solar power	10000
Nuclear Power	4780	2.7				

Table I: Conventional energy source power generation and Renewable energy source potential (in MW)

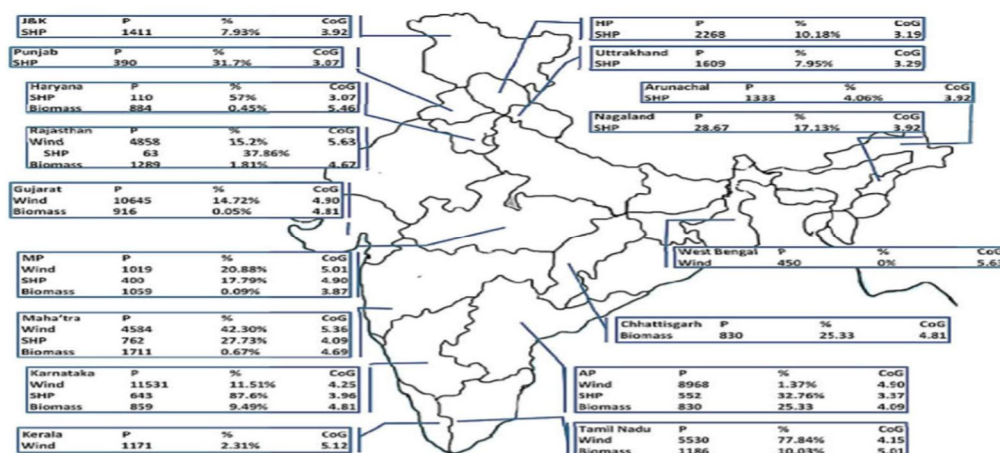


Fig.1: Potential capacity (P), installed capacity (I), and economic cost of generation in rupees/kW h (CoG) of renewable energy sources, by state as of fiscal year 2009-2010. Yearly average 100 rupees/US\$ exchange rate: 2.09 in 2010, 1.96 in 2009. [9] Source: MNRE, Gov., of India. [10]

III. POWER GENERATION SCENARIO IN J&K, INDIA

Table II: Installed power generation capacity of J&K=3297.28 MW [6]

Source	Power
Central utilities	1733.43 MW
State utilities	1513.03 MW
Private utilities	50.82 MW

Table III: Installed power generation capacity as of October 2017 [6]

Source	Power
Hydro power	2278.98 MW
Thermal power	791.47 MW
Renewable power	158.85 MW
Nuclear power	67.98 MW

IV. PROFILE OF ELECTRICITY CONSUMERS IN J&K

Table IV: Peak load consumption of electricity in various areas of Jammu. [11]

AREA	CATEGORY	LOAD
Gandhi Nagar	Domestic	152113 KW
	Commercial	20099 KW
Shastri Nagar	Domestic	45738.415 KW
	Commercial	16607.948 KW
Miran Sahib	Domestic	25665.816 KW
	commercial	2620.654 KW
Bishnah	Domestic	27306.14 KW
	Commercial	4002.08 KW

Table V: Consumer profile [12]

S.No.	Category of consumers	No of connections ending 12/2018
1	Domestic	117765
2	Commercial	16791
3	Agriculture	5569
4	Irrigation	226
5	Public lighting	12

V. DISTRIBUTED GENERATION (DG) IN J&K

The Institute of Electrical and Electronics Engineer, Inc. (IEEE) has defined the distributed energy resources (DER, s) as a source of electric power that are not directly connected to a bulk power transmission system. DR includes mutually generators and energy storage technologies. While the point of common coupling (PCC) as a subgroup of DR [13] (Fig. 2).

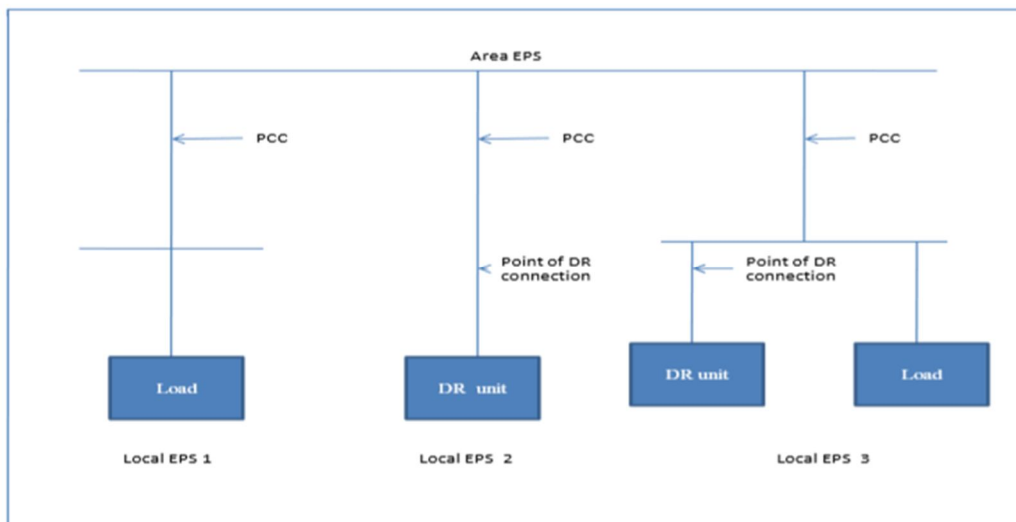


Fig.2: IEEE definition

Distributed Generation – Installation & process of electric power generation units connected to the local network or off-grid generation characterized by: Generation capacity stretching from KW to MW level, Generation at Distribution Voltages (11kV or below), Grid inter-connection at distribution line side, Inter-connected to a local grid, or totally off-grid, as well as captive. Right now a lot of research is going on Renewable Energy based Distributed Generation. Renewable energy resources presently available in India such as are Wind Energy, Biomass Energy, Bagasse Energy, Small Hydro Energy, Wind-Solar Hybrid Energy, Biomass Gasifier Energy, solar energy, geothermal energy, Solar energy and Tidal wave energy.

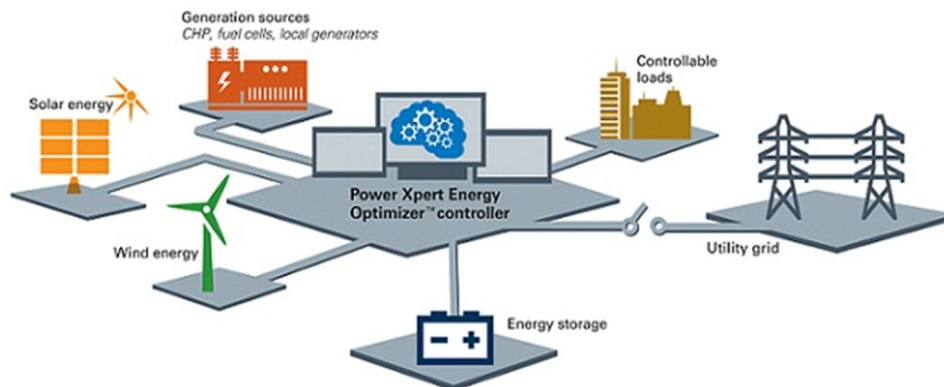


Fig.3: Parts of microgrid

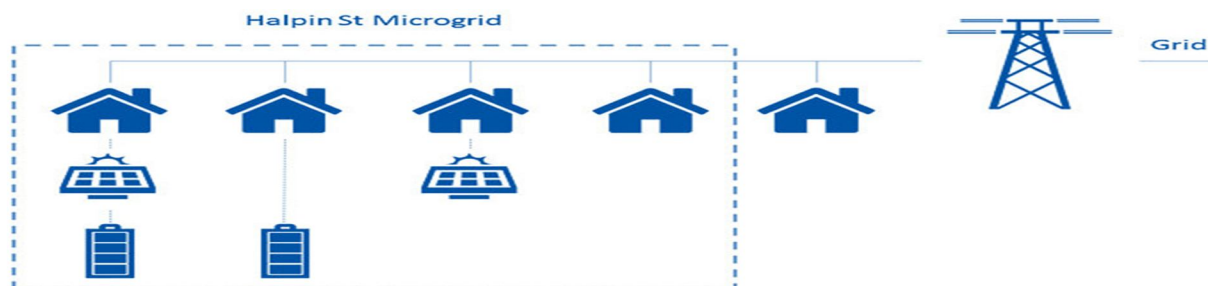


Fig.4: Microgrid in islanded mode

VI. PREDICTED POTENTIAL FOR RENEWABLE ENERGY SOURCE POWER GENERATION J&K

Solar power potential of Jammu and Kashmir: As per the study conducted by the National Institute of Solar Energy (NISE), Jammu and Kashmir has solar power potential of 111.05 GWp (Gigawatt-peak), which is the second highest in the country after Rajasthan where the potential is 142.32 GWp.5 [14]

The predictable annual globalization insolation for the Kashmir region is 4.9 kW h/m² /day a value close to countries like Spain and Australia which have put in much in solar energy [15]. Fig. 4 shows the quarterly average insolation for J&K as an estimate based on the scheduled insolation in a year.

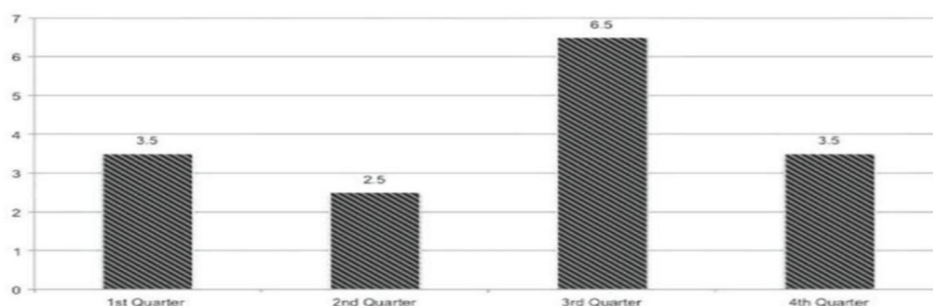


Fig. 5: Quarterly average insolation for J&K (kwk/m² /h) (1st Quarter-January to March, 2nd Quarter-Apr to June, 3rd Quarter-July to September and 4th QuarterOctober to December). [16]

Table VI: Wind power potential of jammu and Kashmir [17]

S. No.	District	Wind energy potential(kwh)
1	Leh	7000
2	Udhampur	5000
3	Anantnag	5000
4	Baramulla	5000
5	Kupwara	5000

Table VII: Hydropower potential of Jammu and Kashmir

S.No.	River	Potential
<u>1</u>	Chenab	11283MW
<u>2</u>	Jhelum	3084MW
<u>3</u>	Ravi	500MW
<u>4</u>	Indus	1608MW

Table VIII: Hydropower potential of dams in J&K.

<u>Baghlihar dam</u>	900 Mw
<u>Salal</u>	690 Mw
<u>Dulhasti</u>	390 Mw
<u>Uri</u>	240 MW
<u>Kishanganga</u>	330 Mw

Geothermal potential of Jammu and Kashmir: There is a need to study the potential of geothermal resources in India and to bind these resources for power generation. The Geological Survey of India approximates the potential to be of the order of 10,000 MW formed from the 400 thermal springs distributed in various geographic and temperature zones. All the 400 thermal springs that have been mapped are available for utilization and if harnessed these springs can provide significant energy in comparison to the current scanty utilization of 200 MW. Out of the 400 thermal springs, 150 are present within the Himalayan Geothermal Belt (HGB) with temperature fluctuating from 47 to 87 °C (Fig. 6).

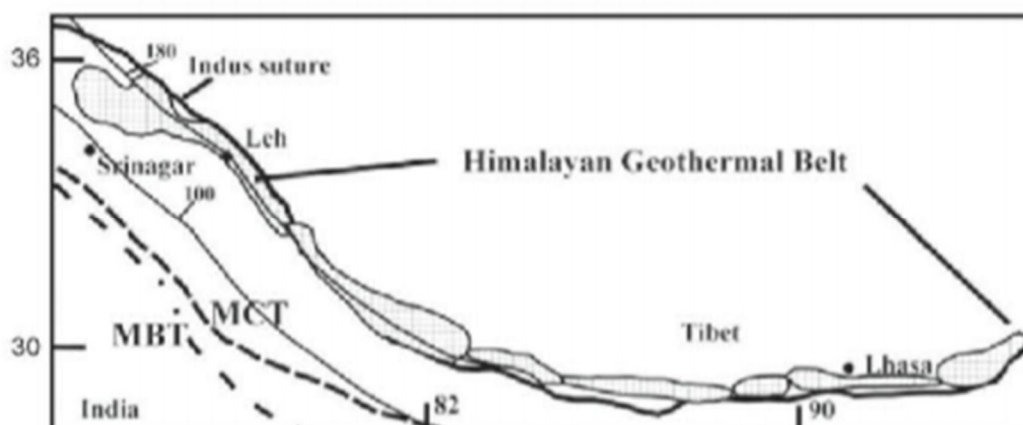


Fig. 6. Himalayan Geothermal Belt (HGB) showing regional structure and heat flow values and highlighting the potential in Leh.

Source: Varun Chandrasekhar and Chandrasekharam, 2007. [19]

The thermal outlying areas of Puga, Chumathang, Nubra located near to Leh and Manikaran, and other thermal locations in Kulu valley fall within HGB. Fig. 7 indicates the geothermal potential for India with considerable potential in the northeastern region of Ladakh., The Puga valley area is emphasized and has significant thermal springs that can be used for heating and for industrial purposes. Also demonstrations of various heat pumps are being carried out in the Puga valley and a 50 MW plant is being planned Fig. 7.

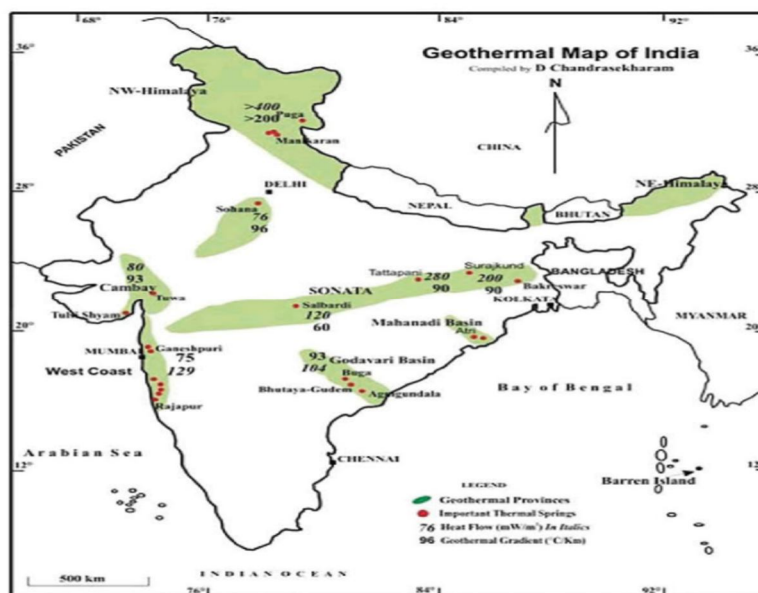


Fig. 7. Geothermal map of India indicating the geothermal potential in the Puga valley, J&K. [16]

Chandrasekhar and Chandrasekharam estimate EGS (Enhanced Geothermal Systems) reserve made on a granite exposed area of 1000 km² in the Ladakh region within the Himalayan geothermal belt is about 61,160 x 10¹² kWh. Leh is located within the Himalayan Geothermal Belt (HGB), Puga and Chumathang geothermal fields, which has potential of generating > 250 MWe from wet geothermal sources. In addition to this, the EGS potential of the high heat generating granites of HGB is about 1501 x 10¹⁵ kWh [20]. By implementing CDM over geothermal energy sources, in addition to providing projected electricity demand to Leh (54 MWe) in the next decade, the area can bar the presently receding Gangotri glacier receding at the rate of 18 m per year and help in protecting the Himalayan environmental ecosystem. In fact the HGB has the potential to produce enough electricity through geothermal resources and make J&K a zero electricity scarcity state.

VII. MICROSOURCES (DERs) BASED GENERATION

The excess energy generated during peak off hours can be accumulated by using EES technology, and can be then be discharged or used at peak hours. The application could yield a significant benefits including a reduced need for peak generation and reduced strain on transmission and distribution networks. Additional benefits are grid frequency regulation, voltage support which results in grid stability and reliability. The most common EES technologies are: Fuel cell, Electro- Chemical EES: - lead acid batteries, sodium – sulphur battery, Flow batteries etcNon-Electrochemical EES – pumped hydroelectric, compressed energy storage, flywheel, Ultra-capacitor, super conducting magnetic energy storage (SMES).

Table IX: predicted potential for micro sources power generation in India

S.No.	Micro sources	Potential (Mw)
1	Li-ion batteries	1000Mw
2	Ultra battery	46Mw
3	Fly wheels	42Mw
4	Compressed air energy storage (CAES)	440Mw
5	Super conducting magnetic energy storage (SMES)	1000Mw
6	Batteries	594Mw

VIII. THE MICROGRID CONCEPT

Microgrids are a network of tiny DERs and energy storage devices integrated into distribution, operation and planning. Microgrids with environment friendly DERs have an edge over such problems. Microgrids also reduce line losses and CO₂/NO_x emissions, increase overall efficiency through CHP operation, relieve T&D congestion and defer investments to upgrade existing generation. All the above benefits are possible if DERs of Microgrids have optimal size and location. Current deregulation regime encourages open competition amongst small /medium service providers in providing quality and reliable clean power to costumers at an economical rate. Economic power production is related to higher operational efficiency of the generating and distribution systems. In reforming process, taxes and penalties imposed on the tariff system, like environmental pollution tax, contracted failure penalties etc. pose problems for the fossil fuel plants.

IX. APPLICATION OF MICROGRID FOR RURAL ELECTRIFICATION

J&K state is facing a shortage of centralized power and gap between generation and demand increases rapidly. Consequently heavy load shedding (8-10 hours per day) has been implemented in rural areas using network islanding concept to maintain the power system stability. Also some of the areas are facing power outage . By the application of Microgrid concept, work is being done for efficient and continuous supply of electricity in J&K. A zero load shedding model is proposed using microgrid concept to utilize the potential of distributed energy sources and to make load free with green energy.

X. CONCLUSION

The above paper shows the potential of various renewable sources in the state. The above resources can be used as a boon to overpower the outages in the city by using their potential in a microgrid. The basic advantage of the microgrids is that potential from various renewable sources can be coupled at a single locus i.e. microgrid controller and can also be stored together to provide continuous supply to various areas of the state without interruption. Microgrids, if become a reality in the state can be used as a source to feed continuous, efficient and renewable electricity. It can be a great initiative make J&K a zero electricity deficit state.

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