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EMERGING SCENARIO OF UTILIZING POTENTIAL OF SOLAR POWER IN UTTARAKHAND AS A FINANCIAL VIABLE OPTION

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***Abstract* - Uttarakhand has a unique scenario of power spectrum as there is meagre possibility of thermal power due to non-availability of fossil fuel, various environmental & ecological issues hampering the pace of harnessing Hydro potential and ruling out Nuclear energy due to vulnerable Seismic threat. Lack of adequate levelled and plain land and fuel resources in the hilly state opens up new vistas to explore more potential for renewable clean energy in Uttarakhand. Rapidly rising population, growing economy and changing lifestyles account for the continuous increase in surging demand for power. With 300 sunny days and solar radiation of 2-6 (kWh/m2/day) in Uttarakhand, Solar energy can be utilized to provide reliable and sustainable alternative. This technical paper analyzes the solar potential, its utilization and implementation by efficiently harnessing it for electrification, success stories of various modules under operation**
elsewhere and workout the techno-economic viability to fulfill the power demand especially in isolated and remote habitations of Uttarakhand.

***Keywords*: UREDA, Solar Energy Potential, Uttarakhand.**

INTRODUCTION.

Energy plays a vital role in the development of regions and communities. It is a basic necessity in all human activities as consumer good in households as well as an input into the productive sectors of the economy, agriculture and industry enhancing development of the entire region. Although, it is never explicitly recognized as a basic human need or the cause of poverty, however continuous and efficient supply of energy not only facilitates the forces of development, but also builds human capacity and enables a better quality of life.

With energy issues, rises its effect on environment. The fragile ecosystem of planet earth is under the attack in many fronts as a result of rapidly using conventional sources of energy for surging the demand for energy. The increasing effects of Global warming are forewarning with the actuation of many global environmental issues. In order to avert climatic catastrophe, adaptation and development of alternative energy sources is absolutely necessary. Renewable energy is the answer to reducing the effects of climate change and help save environment. The renewable energy sources include energy sources such as solar energy, wind energy, geothermal energy, hydropower, and biogas/biomass. Solar energy is the most abundant and environmentally friendly renewable source of energy. The Sun is an unlimited source of energy that could be harnessed to surge rising energy demand without resulting in harmful CO2 emissions.

The present paper therefore reports the possibilities of using solar energy as a viable financial option in state of Uttarakhand, India. A techno- economic analysis has been done by studying the solar potential in different districts of Uttarakhand, government policies and cost & revenue models. It is found out that this study can be used in the state to improvise the efficient solar energy generation hence influencing economic growth positively.

I. ENERGY SCENARIO IN UTTARAKHAND

Uttarakhand is endowed with enormous natural resources. After bifurcation from Uttar Pradesh, it has shown positive sign of development. But the growth has not been uniform since growth process in Uttarakhand has been limited to plain districts pretermitting Hilly area. 11.62 % of state population still lives below poverty line. [1]

According to the census 2001, percentage of households using electricity as their primary source of lighting in Uttarakhand was 60.3% which rose to 87% in census 2011 with only 0.4% of country's household using solar energy. Out of 15745 villages of Uttarakhand, 15638(99.3%) has been electrified under RGGVY (Rajeev Gandhi Grameen Vidhyutikaran Yojna) till 31 May 2015 [2].

Power consumption in the state is about 824 kWh per person per year, which is far above the all India average of 592 kWh [3]. Power consumption in the state of Uttarakhand has grown more than 5 times in the eight years from 2002 to 2010 [4]. As per the Central Electricity Authority (CEA), the expected demand of the energy for Uttarakhand for the year 2011-12 is 10480 MU and the available energy is 8363 MU; while the peak demand of the state is 1600 MW and the availability is of 1430 MW [5].

II.SOLAR POTENTIAL IN UTTARAKHAND

In a study by Kawajiri et al. [6] on effect of temperature on PV potential in the world, it was found out that Himalaya region of South Asia and Andes of South America are the two best places in the world to produce solar energy. These areas have a lot of sunshine and therefore a high amount of solar irradiation at low temperatures helps improve solar panel performance. Just four per cent of the area with the highest potential in the Himalayas, or around 120,000 square kilometres, could power the entirety of China, based on 2007 electricity consumption data.

Uttarakhand is a Himalayan state of India with some of the highest peaks of world. It has high solar potential with solar

insolation at an annual average of 4.30 (kWh/m^2/day). Juhi Joshi [7] mapped monthly and annually global horizontal irradiance (GHI) district wise in Uttarakhand. In solar terms, irradiance is the amount of solar energy per unit area received over a given time. The intensity of the sun's radiation (irradiance) at the top of the earth's atmosphere at the mean distance of the earth from the sun is roughly constant (solar constant) with an observed value of 1366 Watts/m2 {0.3%}. However, only about half of this energy reaches the earth's surface on an average [7].

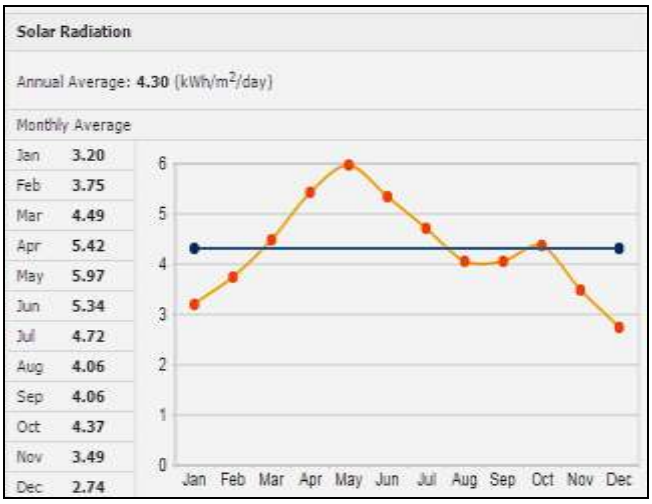

Figure 1: Solar Irradiation in Uttarakhand.

According to the database on MNRE (Ministry of New and Renewable Energy) website, a graph of monthly and annual average of solar irradiation received by Uttarakhand is shown in figure 1. Juhi [7] made solar map indicating month-wise variations in GHI across the location of study area over Uttarakhand of month-wise solar potential of different districts of Uttarakhand to identify the most and least suitable potential areas of energy terms of radiation availability. The dark red color in the map delineated that the most solar energy potential in that location and light yellow delineated the least solar energy potential in that location.

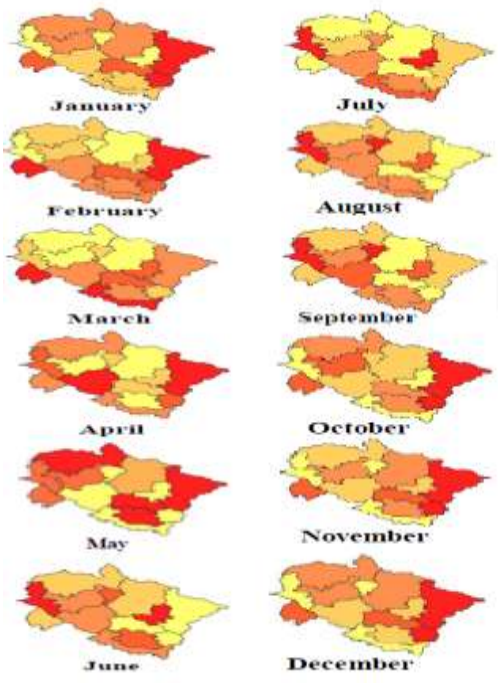

Figure 2: Month-wise solar irradiation map of Uttarakhand. [7]

III.GOVERNMENT POLICIES AND REGULATIONS FOR HARNESSING SOLAR ENERGY IN UTTARAKHAND

There are three institutions involved in governance and regulation of the energy generated through renewable energy projects in Uttarakhand. First is Uttarakhand Renewable Energy development Agency (URDEA), which is the state nodal agency for Renewable Energy programmes. Energy Conservation and Development projects under RGGVY, implementation of various renewable energy programmes by involving local panchayat, District administration etc. are its key areas of work. Second is Uttarakhand Electricity Regulatory Commission (UERC), which promotes generation of electricity from RE by providing connectivity to the grid and setting measures for sale of electricity and fixing the percentage of Renewable energy generated electricity in the total electricity supply by a distributor and lastly, Uttarakhand Power Corporation Limited (UPCL), which is the state power distribution utility. UPCL executes the Power purchase Agreement (PPA) with the power generating company, be it through RE, cogeneration or conventional sources. UPCL will have the first right of purchase the electricity generated by Solar energy projects, which may be made in whole or a part as per the requirement. The price of electricity to be purchased by the UPCL will be determined by the UERC; the price so determined is announced in advance to all producers. The Government of Uttarakhand (GoU) will provide guarantee for the payments to be made by the UPCL for such purchases. UPCL will undertake to transmit through its grid the power generated and make it available to the producer for captive use or third party sale within/outside the State for which wheeling charges uniformly applicable to all producers are announced in advance. UPCL extends the facility of Banking to the developers at mutually agreed terms. For evacuating energy from the generation site, requisite network of transmission or distribution lines are provided by UPCL. The GoU provides requisite clearances in a time bound manner through a single window mechanism. For this purpose a high level empowered committee is constituted to accord necessary approvals and clearance [9]. Under the Uttarakhand Solar Policy- 2013, there are four types of solar projects supported by GoU.

Type I Projects: projects for direct sale of electricity to DISCOM of Uttarakhand (UPCL).

Type II Projects: projects on private land.

Type III Projects: projects on GoU land.

Type IV Projects: projects established under Jawaharlal Nehru National Solar Mission Programme of MNRE, Government of India.

IV.COST ANALYSIS.

Rupesh et. al. performed a Techno-Economic Assessment of Renewable Energy Technologies using Integrated Analysis and estimated a cost of 800 Lacs per MW for establishing a solar power project with a payback period of 6.95 years [10].
In a report on rural electrification by Vasudha Foundation, for solar PV as energy fuel, the generation cost of 1kWh is INR 9.00 and other maintenance and distribution cost per kWh is

INR 0.20 giving an overall cost of INR 9.20/kWh with estimated life of 25 years for a unit [11].

Raghavendra et. al. [12] performed a techno economic study of energy supply systems using dynamic methods for checking economic feasibility. Table 1 shows the outcome of project through a set of economic indicators.

Economic Indicators	PV Solar Plant
Net Present Value	300945.88
Internal Rate of Return	12%
Annuity	33152.467
Cost Annuity	P71175
Dynamic Payback Period	7.75
kWh Cost	2.3

Table 1: Economic indicators for single unit. [12]

The data shows that since November 2014, regional module prices dropped anywhere between 11%-15% (maximum drop) indicating a continued downward slide in solar photovoltaic (PV) power project tariffs. The Central Electricity Regulatory Commission (CERC) has proposed nearly 20% cut in the benchmark capital cost of such projects for Financial Year (FY) 17 compared to the current financial year. CERC has proposed that the benchmark cost for solar projects be 5.01 crore/megawatt (MW) for FY 17, down from 6.05 crore set for the current fiscal [13].

INR (Lacs)/ MW	**FY16**	**FY17**
PV modules	332.35	310.19
Land cost	25	25
Civil and general work	50	35
Mounting structures	50	35
Power conditioning unit	50	30
Evacuation cost up to inter-connection point(cables and transformers)	45	30
Preliminary and pre-operative expenses including IDC and contingency	48.50	26.13
Total Capital Cost	**605.85**	**501.32**

Table 2: Capital Cost Norms for solar PV projects [13]

CONCLUSION.

Uttarakhand receives good amount of solar radiation, about 3–6 kWh/m2/day and possesses the best temperature conditions for efficient energy generation. The solar potential data can be used for decision making to capture the solar energy for sustainable development. Power producers of Uttarakhand could adopt remote un-electrified villages to provide Green Electricity. It's time to exploit Uttarakhand green potential and opt for eco-friendly methods of energy generation. With decrement in the cost of PV modules, the establishment cost has decreased making solar power project more economical in future. With short payback period as compared to other sources of energy generation, solar power generation is a profitable project. This paper shares the information which should be communicated to the public so that they can consider private installations of green energy sources.

REFERENCES.

1. "Table 162, Number and Percentage of Population Below Poverty Line". Reserve Bank of India, Government of India. 2013. Retrieved April 20, 2014.
2. Progress Report of Village Electrification as on May 2015, Central Electricity Authority.
3. Uttarakhand development report, planning commission, government of India, New Delhi.
4. Surabhi Mittal, Gaurav Tripathi, Deepti Sethi, Development Strategy for the Hill Districts of Uttarakhand ,Indian council for research on international economic relation, July 2008).
5. UTTARAKHAND April 2010 by India brand equity foundation.
6. Kotaro Kawajiri, Takashi Oozeki, Yutaka Genchi, Effect of Temperature on PV Potential in the World, *Environ. Sci. Technol.*, **2011**, *45* (20), pp 9030–9035
7. Juhi Joshi, a research study on developing solar potential map using GIS. International Journal of Emerging Trends & Technology in Computer Science 2013 Volume (section) 2(3): 220-224.
8. T. V. Ramachandra, Gautham Krishnadas, Solar energy potential assessment using GIS, Energy Education Science and Technology 2007 Volume (issue) 18(2): 101-114.
9. Uttarakhand State Govt. Policy for Harnessing Renewable Energy Sources. (Annexure ofG.O.No.263 /I (2) / 2008 -04 (8)-96/2001, dated 20-1-2008).
10. Rupesh Thakre, Dutt Subroto, Techno-Economic Assessment of Renewable Energy Technologies using Integrated Analysis, International Journal of Engineering and Innovative Technology (IJEIT) May 2014 Volume (issue) 3(11): 346-348.
11. Current Status of Rural Electrification and Electricity Service Delivery in Rural Areas of India, report by Vasudha Foundation.
12. M.Vijaya Raghavendra, U.Ranjith Kumar, Comparative Techno Economic Study of Energy Supply Systems in a Remote Village, International Journal of Education and Applied Research 2014 Volume (Issue) 4(1) : 68-71.
13. Terms and Conditions for Tariff determination from Renewable Energy Sources, Central Electricity Regulatory Commission. Petition No. 17/SM/2015