A Novel Approach for Solar Potential Assessmentusing Geoinformatics for Rural India

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Nearly 30 crores of people in rural India lack access to electricity, promoting the use of non-renewable sources of energy such as kerosene, chulhas (wood fired), petrol, diesel, etc, which not only results in massive environmental damages but also significant health and serious hazards. Solar energy offers an opportunity to channel this huge infrastructure gap and advance the social, economic, environment and health indicators of 30 percent of India's population.Non-renewable sources of energy are depleting fast. It is recommended to use renewable energy since non-renewable energy sources are limited in nature. Climate change, increase in the cost of the non-renewable energy sources are the factors that are warning us to use renewable energy sources. Solar energy is the cleanest form of energy available on Earth's surface. A lot of research is going on to use renewable sources of energy. The government is also focusing on maximum utilization of solar energy and methanol with diesel/petrol. There are subsidy schemes for the people/institutions in different states to install solar panels on their rooftops. In the upcoming five years, India aims to mount 10,000 small-scale solar power grids across the country to provide basic electricity to households. But providing access to a nominal supply of clean power –for two LED lights for few hours and charge a cell phone is perhaps not enough to meaningfully improve people's lives, new research suggests. In a recent study in Uttar Pradesh, thousand plus houses have received clean electricity for the first time. This has resulted in the decrease in their spending on costly kerosene for lighting purpose.

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* Mr. Mudit Kapoor, Ph.D. Scholar from Indian Institute of Technology, Roorkee, is pursuing his research on "Solar Potential Assessment, Cloud Computing, Big Data, GIS, Remote Sensing." His popular science story entitled "A Novel approach for Solar Potential Assessment using Geoinformatics for Rural India" has been selected for AWSAR Award.

Fig.1 Solar Photovoltaic (SPV) panels installed at the rooftops

Solar Photovoltaic (SPV) uses solar energy to generate electricity. SPV absorbs solar irradiances to produce electricity. The SPV is made of a semiconductor which has fourelectrons in the outer shell. So when the sunlight falls on the SPV the electrons get charged by this energy. To accommodate this extra energy, electrons travel from one place to another place inside the semiconductor. This extra energy has been used to generate electricity using SPV. The solar cell has been developed using dyes naturally found fruits/juices (viz., Indian jamun, plum, black currant, and berries) by researchers at IIT Roorkee. IIT Roorkee has adopted five villages for rural development under the scheme of Unnat Bharat Abhiyan (UBA). The five villages under this UBA scheme are Meerpur, Chandpur, Chharba, Beladi Salhapur, and Puranpur located in Uttarakhand. This research focuses on these villages in providing electricity by utilizing the solar energy. Different types of installation places such as land, canal-top, rooftops have been analyzed for SPV installation in this research. This research also focuses on the optimum tilt angle required to install the SPV panels. Studies on Salhapur and Meerpur have been performed to estimate the energy requirement and solar potential assessment.The energy requirements and solar potential assessment have been carried out for these two villages.

A geodatabase of these two villages has been created to assess the solar potential and energy requirements. Satellite images have been downloaded to create the land use land cover (LULC) map of the villages. The important parameters such as area, perimeter, population, agricultural land, and well pumps have been taken into consideration for the assessment.

The energy requirements of Salhapur and Meerpur villages are 8.5 MWh And 10.5 MWh. The annual solar potential assessed over rooftops of the Salhapur and Meerpur are 84.95 MWh/day and 47.5 MWh/day. The survey has been performed to assess the length of the Ganga canal need to install the solar panels to feed the electricity requirements of the nearby village and towns. The population and socio-economic data have been obtained from the online website of India Census 2011. It has been found from the studies that solar energy is capable of fulfilling the requirements of these villages.

The energy requirements of the villages are of great importance. Energy demands are increasing to cater to the needs created by new techniques/technologies available in the market. Some of the techniques such as drip irrigation, well pump, etc. are forcing the farmers to use electricity. This UBA scheme is a very innovative scheme started by the Government of India for rural development of the villages and towns located nationwide. A software tool has been developed by Geomatics Engineering, IIT Roorkee, and published in the Springer Spatial Information Research journal (http://www.solarcloudgis.appspot.com/). This tool has two modules. In the first module, it has the capability of estimating the energy requirements of the household, institute, village or town. The parameters used by this software for estimating the energy requirements include type and number of electric equipment, wattage, and hours of usage. Based on these inputs it calculates the energy requirements on the daily, monthly, and yearly basis. The second module is capable of predicting the solar potential available at the specific location.

The inputs for this module are tilted monthly/annual GHI, latitude, longitude, number of rainy and cloudy days. This software tool is designed to work efficiently in the Indian context. It has been tested and modeled with the live solar plant data to work accurately. The decentralized and modular nature of solar panels makes it easily approachable and installable at different locations. The intensity of solar radiations available on the hills is more in comparison to the ground. This is because of the aerosols, dust particles and pollution on the ground. Therefore, installation of solar panels at the hills produces more electricity than on the ground. It has also been validated with the Pyranometer survey conducted by us. We have got the solar irradiance of 865 W/m^2 at Roorkee and 921 W/m^2 at Pauri Garhwal. This clearly states that solar irradiance at hills is more intense than on the ground. Our approach has also stated the best optimum tilt angle required to install the SPV panels based on specific latitude of the location and other important parameters. In Uttarakhand, Uttarakhand Renewable Energy Development Agency (UREDA) is also providing subsidies to the people living on hill terrain to install solar panels and sell the excess power to the state government in exchange for units. This research is helping local people and government in providing subsidies and policy-making for people's benefit.