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Assessment of offshore solar energy along the coast of India

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Abstract

Government of India is targeting 175 GW of solar power generation by 2022. As the land is scarce resource in India and per capita land availability is low, the selection of offshore solar power plant is commendable. The present study aims to provide preliminary estimation of offshore solar energy potential available in the exclusive economic zone (EEZ) of India. ERA-Interim solar radiation dataset from European Centre for Medium-Range Weather Forecasts (ECMWF) with a spatial resolution of 0.125º (approximately 12.5 km) over the period of two years(January 2015 to December2016)has been analyzed and validated with measured data. Geographic Information System (GIS) environment is used to develop maps with different classes of spatial distribution of annual mean Global horizontal irradiation (GHI) and corresponding solar energy output. Results show that average mean GHI and the estimated solar power generation in study area are 5.49 kWh/m^{2}per day and 9372TWh per day respectively. Further, Gujarat and Tamil Nadu regions are having higher radiation value than the other regions.

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*Keywords:*ERA-Interim reanalysis; GIS;Reclassification; Offshore solar energy; Indian EEZ

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1. Introduction

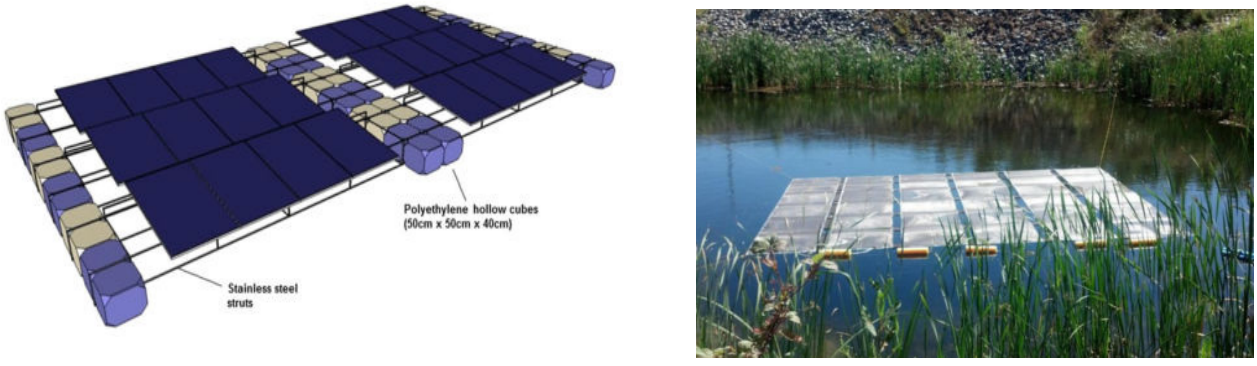
In 2050, the world energy consumption is projected to be 30 terawatts(TW) per year [1]. This energy cannot be produced from fossil fuels as there is fear of diminishment of these sources and there is a need to find other clean sources of energy for stabilizing thereleased amount of CO_2[1].Currently, the solar energy is the gilt-edged answer to the existing problems of energy need. With gradually increasing popularity of solar photovoltaic plant the energy need of the future can be fulfilled. Under National Solar Mission, India would empowered its solar resources by deploying 100000 MW of grid connected energy generating solar projects by 2022[2].

For solar plant, large areaof land is required. Due to high population, land is a scared resource in India. Therefore, offshore solarphotovoltaic (PV) plant could be a novel solution. There are other advantages of implementing offshore plants, which includes high solar panel efficiency due to cooler environment, cleaning of PV cells and reduction of evaporation losses. Offshore solar photovoltaic is new and developing field with very wide scope of improvement. The main problem faced in offshore solar application is the structure of the solar panel. There are number of the solutionshelpful in achievingeconomic viability. Many research works and projectson floating PV areunder progress. Currently, there are mainly two types of floating PV: Pontoon based floating PV systems[3], and flexible thin film floating PV systems[4].Fig 1 shows the floating type PV systems which are currently available.

For installation of solar photovoltaic, the global horizontal irradiation (GHI) at that location play very significant role. In the present study, the GHI for Indian Exclusive Economic Zone (EEZ) has been analyzedusing 2015-2016 dataand validated withthe measured data available for the year 2015. Based on year 2015-2016, map of mean yearly global horizontal irradiation is generated using geographical information system (GIS) and further, classification of area of the Indian EEZ is done based on the values of mean GHI.The mean GHI and solar energy outputis calculated for every class of Indian EEZ.

2. Data Source

Global horizontal irradiation has been estimated over Indian EEZ by using monthly means of daily meansurface solar radiation downward over the period of 2015-2016. This is taken from European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis interim (ERA-Interim) data set[5].ERA-Interim dataset is a global atmospheric reanalysis dataset since 1979, continuously updated in real time. Surface solar radiation downward can also be defined by value measured by a global pyrometer at the surface.The data has spatial resolution of 0.125° x 0.125° (nearly 12.5 × 12.5sq.km). The quality assessment of forecasted data is done by comparing the data of year 2015 with ground-measured data of GHI. The data of year 2015 at eight different geographically placed stations near to Indian coast were taken from the World Radiation Data Centre (WRDC) [6]. Table 1 shows the details of ground stations,which include WMO index, site name, latitude, longitude, and elevation from sea level.



(a) (b)

Fig. 1. Types of floating PV systems (a) Pontoon based floating PV systems [3]; (b) flexible Thin film floating PV systems [4]