OPTIMAL SITE SELECTION FOR A SOLAR PV PLANTS IN SAUDI ARABIA

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Overview

Solar photovoltaic (PV) is growing at an extraordinary rate which brought the global total to approximately 942 GW by the end of 2021. Though, one of the barriers in solar power development is the inconsistency and variability of solar irradiation which can be geographically dissimilar from one site to another. To select a site for such an installation, certain aspects must be investigated, such as how good the PV power plant location is, and how to minimize the total cost of the project concerning proximity to existing infrastructures while maximizing power output from the solar panels. Site selection for the utility-scale photovoltaic (PV) solar farm is a critical issue due to its direct impact on the power performance, economic, environmental, social aspects, and existing as well as future infrastructures. Saudi Arabia has a high solar irradiation and is targeting to diversify the energy mix used in electricity generation by deploying more solar PV across the country and increase the share of renewable energy and natural gas to around 50% by 2030. The primary goal of this research is to evaluate and select the best location for utility-scale solar PV projects using geographical information systems (GIS) and a multi-criteria decision-making (MCDM) technique in Saudi Arabia.

Methods

Given the fact that several criteria can influence the solar PV site selection, applying multiple criteria decision-making (MCDM) methods can help facilitate site selection for utility-scale grid-connected PV solar energy. MCDM methods have been successfully applied in many energy-planning projects. In recent years, the Geographical Information System (GIS) has become increasingly popular for various site selection studies, particularly for energy planning. Screening possible sites for PV projects is a prime strategic process as suggested by several studies and strategic organizations such as the National Renewable Energy Laboratory (NREL). The model considers different aspects, such as economic and technical factors, with the goal of assuring maximum power achievement while minimizing project cost. An analytical hierarchy process (AHP) is applied to weigh the criteria and compute a land suitability index (LSI) to evaluate potential sites.

Results

Real climatology and legislation data, such as roads, mountains, and protected areas, are utilized in the model. The solar analyst tool in ArcGIS software is employed to calculate the solar insolation across the entire study area using actual atmospheric parameters. The air temperature map was created from real dispersed monitoring sensors across Saudi Arabia using interpolation. The overlaid result map showed that 16% (300,000 km^2) of the study area is promising and suitable for deploying utility-size PV power plants while the most suitable areas to be in the north and northwest of the Saudi Arabia. It has been found that suitable lands are following the pattern of the approximate range of the proximity to main roads, transmission lines, and urban cities. More than 80% of the suitable areas had a moderate to high LSI.

Conclusions

This research offers a high-level overview of the potential of site suitability of utility-scale PV technology in the study area based on integration of the geographical information system and multi-criteria decision-making tool. The AHP technique is used to evaluate the importance of each decision criterion in selecting the best site for utility scale solar PV power plants. Our study for Saudi Arabia case indicates that most suitable areas are found north and northwest of the study area as well as west of Taif city near the west coast. High suitability areas comprise 50% of the suitability areas and are mainly spread around the central region. This location will be important to consider for grid connected utility-scale PV power plants since it is one of the most populated areas in Saudi Arabia. The eastern region of the study area shows moderate to high LSIs since it has a decent infrastructure together with the high density of high solar irradiation.