

Spatial Assessment of the Potential for Solar Panel Installation using Multi-criteria Decision-making Methods (Case Study: A Section of Zone 2 in District 8 of Mashhad Metropolitan City)

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Extended Abstract

1. Introduction

Nowadays, energy is considered as one of the basic needs of humans. Given the limited resources of fossil fuels and increased level of energy consumption in today's world, the remaining sources of energy can no longer be relied upon. Exhaustibility, environmental pollutions, and fluctuations in fossil fuel prices are the major driving forces behind the effective efforts in using various sources of renewable energy. Accordingly, solar energy is a free and one of the most important and cleanest types of renewable energy. Given to the presence of air pollution, numerous vehicles, high population of tourists and pilgrims, and a different urban context with diverse buildings in Mashhad, urban managers are seeking more sustainable development for this metropolitan city; consequently, conducting studies to identify suitable locations for the solar panel installation throughout the city is necessitated. In this regard, the present study seeks to assess the potential of building rooftops for the solar panel installation at a section of zone 2 in district 8 of Mashhad. To this end, first, the effective factors in the production of solar energy were identified; then, the operation and installation conditions were specified according to the present standards. Finally, the locations with the highest potentials were identified.

2. Review of Literature

Photovoltaic systems (PV) are one of the most common applications of new energies. There are a variety of systems with different capacities installed and operated across the world. The significance of using photovoltaic technology is due to the direct conversion of sunlight into electricity with no need for the dynamic and chemical mechanisms. Rooftops are very ideal for PVs since the power supply for photovoltaic cells is the direct sunlight. Moreover, there are considerably fewer

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factors producing shadow on rooftops where a vast, unused surface is available. In this regard, selecting a proper location as well as incorporating effective criteria and indices for finding a location to install and operate this technology is of considerable importance.

3. Method

The present inquiry is a descriptive-analytical study with applied purposes. Data collection was carried out through library and field studies. Multi-criteria decision-making models including Analytical Hierarchy Process (AHP) and Ordered Weighted Averaging model (OWA) were employed using the ArcGIS 10.3 software for data analysis.

4. Results and Discussion

The potential for the solar panel installation on building rooftops at a section of zone 2 in district 8 of Mashhad was assessed in the present study. The investigated region had an area of 40 hectares with 923 blocks and a population of 1870 according to 2010 census. Multi-criteria decision-making models including AHP and OWA model were used to analyze the data of building use, building height, population, income over 20 years, tilts and their direction, potential power, shadow producing factors, rooftop area, and the extent of produced electricity in kilowatts. Given the initial cost for the installation of solar panels which should be economically viable, four factors including use, produced kilowatts, potential power, and income over 20 years were assessed. To prioritize and assign weights to criteria, 25 questionnaires were distributed among the experts. Ultimately, AHP was used to specify the final weights of criteria. The obtained weights for indices including use, produced kilowatts, potential power, and income over 20 years were 0.141, 0.483, 0.101, and 0.276, respectively. The Consistency Rate (CR) in this study is 0.8 which demonstrates the consistency of employed judgments for comparison. Then, OWA technique was used to assess each building's potential for the solar panel installation. To perform OWA, spatial information on use, produced kilowatts, potential power, and income over 20 years were entered in MCDM4ArcMAP tool in ArcGIS software followed by the application of OWA. The results obtained from the OWA model were classified into 5 groups in terms of priority using Jenks' method (1967) which is based on statistics in map production. Values 1 and 5 were assigned to the unsuitable and most suitable blocks for the solar panel installation, respectively.

5. Conclusion

The results of the study show that of the available area in 923 blocks assessed within the region of study, almost 19000 m³ of the rooftop spaces have the best conditions for the solar panel installation. Given the residential-commercial background and the high electricity consumption of the region, such a worthwhile potential could be considerably effective in the provision and sustainability of producing the required energy of the region. The presented method in this study can be employed by investors and urban planners to assess and evaluate the

potential of utilizing solar energy with the beneficial results for active organizations and offices as well as the public. Additionally, the method can also be implemented for all districts within the urban region.

Keywords: Geographical Information System (GIS), Solar energy, Ordered weighted model, AHP, District 8, Mashhad

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