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Potential survey of photovoltaic power plants using Analytical Hierarchy Process (AHP) method in Iran

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ABSTRACT

Solar energy plays a crucial and high-priority role in protecting and maintaining our future environment. One of the most important and outstanding factor in building a power plant is how to choose the appropriate and suitable site for solar power plants. The purpose of this research is to investigate the most felicitous locations in order to establish the photovoltaic power stations in Iran.it is highly recommended to closely consider the economical and geographical conditions. The required data were mostly obtained from satellite images and ground measurements. The principle in this paper forms some effective factors made up of in site selection and developed some guidelines about how to divide them into four categories including the value of solar radiation on earth's surface, the economic features, the technical factors and geographical considerations. It is extremely necessary to recognize the need to closely examine an important issue that these factors were analyzed and weighted by Analytical Hierarchy Process (AHP) and then the potential map was extracted. An understanding and appreciation of results represent appropriate locations namely Fars and Sistan and Baluchistan provinces which have higher potential to build Photovoltaic power plants. Ultimately, through research, it has been developed a model and map with maximum efficiency for gaining a deeper understanding of the most suitable location for the fixed panel power plant which was obtained.

1. Introduction

Today, fossil resources are known as the main energy resources used throughout the world. The use of fossil fuels can bring about negative consequences such as air pollution. Fossil fuel resources are limited and depleting [1]. It is realistically necessary and critical for economic development to access new sources of energy in developing countries [2]. In Iran, due to the growing need for energy resources and the reduction of fossil fuel resources, we take renewable energies into consideration as a good and practical choice [3]. Suitable climatic conditions and solar radiation in most provinces make Iran a perfect place to utilize solar energy [4]. According to research, Iran has 300 sunny days in two-thirds of its surface within a year. Iran has a very good amount of radiation about 4.5–5.5 kWh per square meter per day [5].

Through investigating different conditions, researchers attempt to achieve conditions that could produce the highest amount of energy. These investigations point to the location as the most important parameter [6]. In the present time, many of the developed countries have been preparing potential solar map for their future.

The solar cells produce electricity from solar radiation that reaches the surface of the cell [7]. The more reached light produced (the more radiation and vertical angle), the more electricity achieved [8]. Determining the angle and the slope of solar panels is very important in order to get maximum energy [9]. Given the fact the sun is moving during the day, the earth slope and its direction toward sun as well as its latitude affect the panel's direction which need to be considered [10]. In Iran, in particular, despite some economic controversies, it is totally reasonable to optimize panels' angle manually and monthly by solar tracers in order to save energy and decrease relevant costs [11].

The main purpose of this paper is to present a comprehensive survey on site selection for photovoltaic (PV) power plants in IRAN based on an Analytical Hierarchy Process. This paper creates comprehensive strategic plan for utilization of solar energy technology development in Iran. This paper attempts to consider all effective factors for solar PV power plant.

In some case studies, the amount of solar radiation is used to prioritize regions. The amount of solar radiation is obtained from

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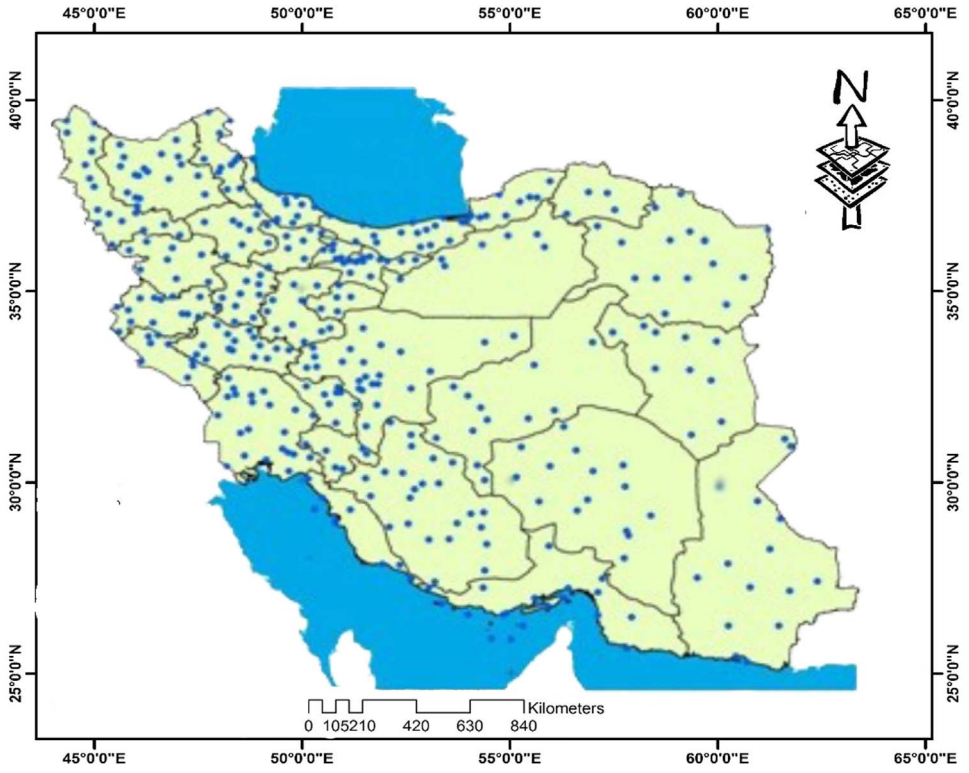

Fig. 1. The location map of synoptic stations in Iran [12].

Table 1
Scales for pairwise comparison [62].

Scale Value	Definition
1	Equal importance
3	Moderate importance of one above another
5	Essential or strong importance
7	Very strong importance
9	Extreme importance
2, 4, 6 and 8	Intermediate values between the two adjacent judgments

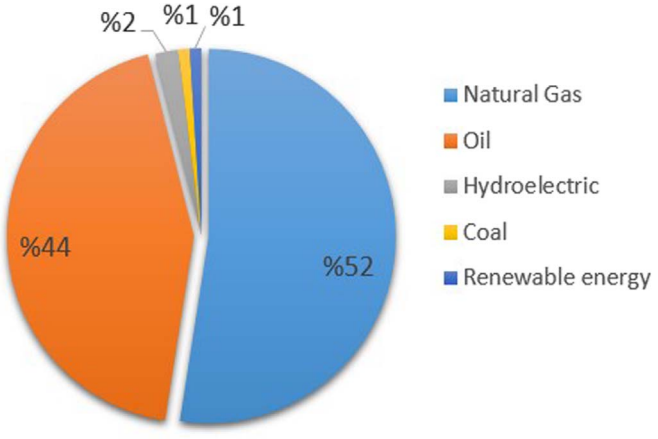

Fig. 2. The share of energy resources in Iran [67].

limited ground-based measurements or from discrete satellite data. Although ground-based measurements collect high accurate data, there are only a few stations with limited collecting data duration. On the other hand, interpolation methods are approximate methods which are not completely accurate. Fig. 1 shows the location of the synoptic stations in Iran. At these stations solar radiation is measured and tabulated.

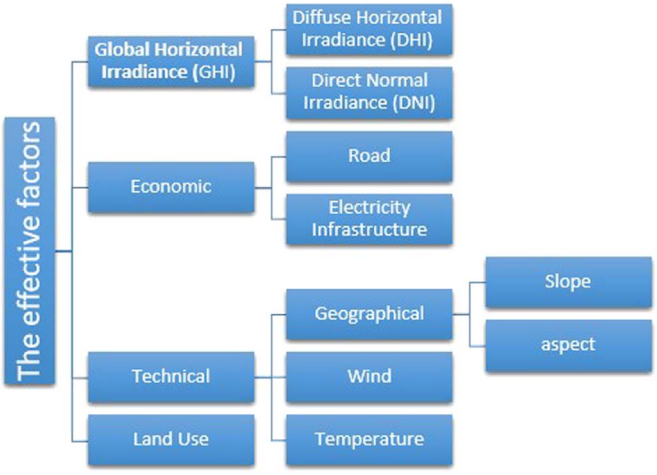

Fig. 3. The effective factors for PV plant site selection.

Geographic information system (GIS) is a powerful tool for modelling and site selecting renewable energy resources [13,14]. In recent years, more research has been conducted with the GIS tools. Geographic information systems require valid data for spatial analyses. One of the most effective data sources are satellite data. Satellite data provides good spatial, temporal, spectral and radiometric resolution [15].

The first case study for solar potential estimation in Iran was presented a model on the basis of Paltridge relation [16] considering the direct light of the sun by Daneshyar [17]. Using mathematical methods, instead of the spatial observations, made it a low-accurate model. Jafarpour and Yaghubi (1989) approximated the monthly and annual radiation of the sun for Shiraz [18]. They concluded that Shiraz annually receives 7250 MJ/m^2 energy from the sun that makes it one of the most potential cities in the country for solar power development.

Ashjaee (1993) acquired the proper precision to approximate daily