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Challenges and barriers in Iraq for solar PV generation: a review

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Abstract

This study presents a review in the challenges and obstacles for implementation of solar photovoltaic power generation in Iraq. These problems that confront Iraq are represented by a technical, financial, political barriers and other. Based on solar GIS map for Iraq, the average daily solar radiation is about (5-5.5) kW/m²/day, and this received, considerable amount of energy should properly and technically be utilized. Not only, The Iraqi government must take serious steps, plans and policies to overcome these challenges, but also, put developed strategies, make scenarios with programs from specialized and expert persons.

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1. Introduction

The energy sources in the nature can be divided into two main types: nonrenewable (traditional or fossil fuel) energy resources and the renewable (sustainable) energy resources. Since human being on earth, the essential problems are the food and energy. The first use of fire in the heating, transportation, lighting etc. After that, the steam engine based on coaled-fired extracted from mines has been discovered to solve the transportation issue to be the first industrial evolution, and these steam engines have become the power of source for trains, factories, agricultural equipment's and other usages. Then, a new source of fuel is crude oil has been found out to be followed by refining of source and take advantage of it in the conversion to gasoline which helps to run the engines of internal combustion such as cars and aircraft, which started the second industrial evolution. With the spread of electricity, the energy usage has been changed significantly. The electric power plants were becoming larger and larger until many electricity generation dams were built and power connections between the cities were provided as well as electricity was delivered to rural areas. The use of energy has grown very rapidly which provides the necessary energy for transportations, houses and factories. It has been further developed with the advent of nuclear energy, which has benefited humans in the operation of giant reactors to produce electricity, but this energy still limited in use because of its risks and high cost. Now, the world is observing the current revolution, the revolution of renewable energy. Renewable or sustainable energy is the type of energy that is collected from renewable resources (natural sources) such as, sunlight, wind, rain, tides, waves,

and geothermal heat. There are two main advantages of renewables, the first one is naturally replenished on a relatively short period of time, and the second is an environment friendly energy resources that does not cause pollution by emitting toxic gases.

The world uses renewable energy sources for several reason, the first is the depletion of fossil fuel energy. According to researches, these resources will be diminished in their production at the end of this century due to the alarms coming from fossil fuel production in the world [1]. The second substantial reason is the environmental effect of the nonrenewable energy resources which are harmful sources and destroyers for environment completely. The Earth is a natural and balanced ecosystem, what happens in one part affects the other parts, i.e. there is no environmentally independent part. Since the creation of the earth, the idea is based on the regularity of its parts. The human, in excessive use, released huge quantities of passions gases of nitrogen oxides, carbon and sulfur which their nature is totally destructive to the ecological balance. Factories and millions of transport vehicles, such as airplanes and cars, daily release tons of dangerous dioxide gasses into the atmosphere, causing serious environmental damages. Some of the important environmental phenomena that occur due to the emission of these gases are greenhouse effect and the phenomenon of acidic precipitation.

These risky phenomena effect the earth surface in increasing the temperatures. From the research centers studies and metrological stations reports, it is noted the temperature of the earth is increased by 1 °C and of the last century and the projections for several scenarios which indicates increasing the surface temperature from (3-5) °C until the year 2100 [2]. This one degree of Celsius may seem very small value but has a noticeable impact on the surface of the earth. The global mean sea level has been increased in the last fifteen years ago and this is due to melting ice blocks in the Arctic. Therefore, some cities and villages are exposed to collapse and drowning in some countries of the world such as the Boston city in USA [3]. Three months ago, National Aeronautics and Space Administration (NASA) declares in the news that there is a huge cavity in Antarctic Glacier signals rapid decay, may causing increasing sea level for that area [4].

Through the previous illustrations, the image has become clear why the world uses renewable energy sources. Based on renewables global status reported from renewable energy policy network (REN21) in 2018, 26.5% of the global electricity generation is from renewable energy resources those are: 16.5% hydropower, 5.6% wind power, 2.2% bio-power, 1.9% solar PV and 0.4% ocean, CSP, geothermal power. While, 73.5% of world electric power generation from non-renewable electricity (fossil fuel generation). Nevertheless, the renewable power technologies go on to attract further more investment dollars than did fossil fuel power generation plants. It is estimated that \$310 billion was committed to constructing new renewable power plants comparing to approximately \$145 billion committed to fossil fuel-fired generating capacity and including nuclear power capacity [5].

Solar photovoltaic is an influential renewable energy resource which is widely existing in many countries around the world as a secondary source for electricity generation to other renewable and non-renewable energy resources. Different applications of solar cells can be mentioned in our life such as small scale PV systems to generate electricity for houses, large scale solar systems which connected to the grid synchronously, lighting systems, heating systems, solar pumping, electrical cars that works on solar cells, airplanes, trains, satellite in the space, ships and parking cars and others. Iraq occupies a good geographic location that enables it to obtain a daily global solar radiation rate on a horizontal surface estimated from (5-5.6) kWh/m²/day as shown in Figure 1 [6]. The southern region received solar irradiance more than of the northern area because of the rains, clouds and humid weather in north. Several years ago, ministry of electricity (MoE) announced a plan to install solar powered lamps to light the streets of Baghdad and some of other Iraqi cities. But, this project has been failed for many technical reasons, including the battery banks of PV cells were exposed to high temperatures throughout the daytime resulting to damage batteries, and because of the absence of maintenance, the project completely failed.

Therefore, several studies in Iraq are suggested from researchers about the potential of solar energy technologies. Afaneen A. Abbood et al. [7] suggested an implementation of management techniques using solar PV systems for residential sector in Baghdad city. MATLAB software based for estimating the solar radiation data and PV system design. System of 2kWp PV rooftop solar panels with 10m² area and 20% efficiency has been proposed in order to control electricity peak loads. Hasan N. Muslim et al. [8] presented an optimized storage energy PV system designed to utilize the not beneficiary solar energy as well as to reduce the electricity peak loads at night. Six applicable techniques for storing energy were proposed and built using MATLAB software in order to reduce the losses and optimize the electricity usage. Hasan N. Muslim et al. [9] proposed financial and economic analysis to assess the feasibility for

using a 2kWp designed photovoltaic system with a battery system have a capacity of 500Ah for each residential consumer of Baghdad city in Iraq in comparison with a 2.5kVA gasoline generator and thus determining the total expected revenue from the use of solar system against using traditional electricity generation sources (gasoline generator). Afaneen A. Abbood et al. [10] investigated PV system designed of 1MW grid connected under Iraq climate condition in Karbala city. The designed PV system contains a studying in solar insolation estimations, system technical design, losses of PV system, environmental impact, performance and economic calculations for this system. Hasan N. Muslim [11] proposed an algorithm to optimize the solar tilt angle based on MATLAB software so as to maximize the solar generation, and calculating the monthly and annually optimum tilt angles for different case studies which are: Najaf, California and New Delhi.

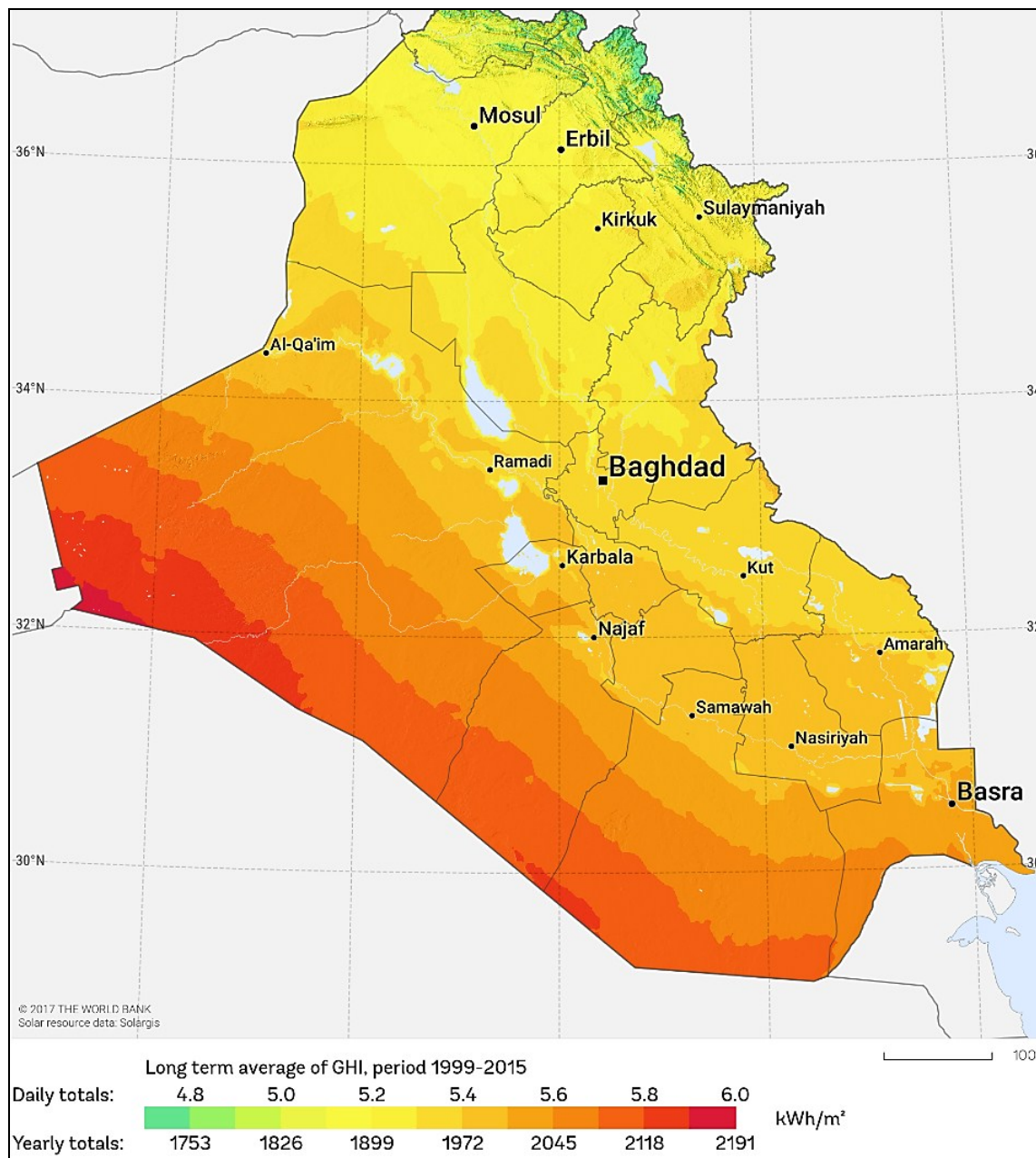


Figure 1. Horizontal solar radiation in Iraq (kW/m²) by solar GIS map [6].

From the literature survey, some of researchers have been study the PV system design with technical concerns including the environment effects, and others work on the optimization of tilt angles to maximize the solar radiation, while many of them presented analysis about the feasibility of implementation solar power systems including the economic evaluations and determining the revenue. It

is clear that there is excellent idea about the implementation of solar energy system in Iraq with extensive and adequate researches, but there are still obstacles and challenges that prevent the serious work on renewable energy projects in general and solar energy in particular.

2. Potential challenges in Iraq for solar PV implementation

In this study, a review will be presented for solar power generation in Iraq and discussing the barriers with challenges that makes of failure of renewable energy resources employment and these problems should be solved actually. These obstacles that faces Iraq to progress solar systems maybe technical, political, industrial and others as follows.

2.1 Encroachment on the national electric grid (slums)

The "Ministry of Electricity" (MoE) is the governmental institution responsible for electricity and performs many tasks, such as supplying electric power to the consumer through the generation, transmission and distribution of energy, construction of electric power plants, maintenance and continuous follow-up of power plants, transmission lines and distribution system, responsible for the stability of the electric power system, induction and work on renewable energy projects to reduce the emission of toxic gases which effects the environment, and others. Encroachment on grid means taking electrical power out of the electrical grid illegally, i.e., it is electric power consumed unpaid in cost. Iraq's electricity grid suffers weakness in the distribution sector, resulting in losses of (30-40) % for 2014 [12] shared between the transmission and distribution losses, which is low, and the irregularities and encroachment on the national grid. So far, this major problem has not been resolved and the ministry has not taken firm and serious steps on this issue. All of this has led to an increase in electricity loads very significantly as the ministry has become unable to meet the actual need for electricity consumed.

2.2 Technical obstacles

The technical issues are numerous; including the technical problems in the power generation electricity side, and on the demand side (consumer). The most important matter is the connection of smart meters in the grid which perform essential and major tasks whereas the consumer can control the electrical loads, prevent it from overrunning the electrical grid and monitoring the consumer by connecting these meters to the control units.

2.3 Energy efficiency

This point means that the energy should be highly efficient both at the electricity generation level and at the energy consumption level. On the level side of consumption, energy efficiency is a type of energy management, which efficiently devices that consumes electricity. The Central Organization for Standardization and Quality Control (COSQC) in Iraq is a governmental organization that takes on the task of raising production efficiency through quality control with monitoring local and imported goods and products, in addition it is working to standardize criterions and support the technical progress for the production and service sectors. In Iraq, this institution does not take its real role in achieving its objectives because the most imported electrical appliances do not meet the technical specifications and standards in their use as consumption which are poor quality, consume high current and unsafe devices. In general, trade in Iraq is not subject to controls in the import of goods from the countries of the world.

2.4 Energy management strategies

Energy management is planning, implementing and monitoring all the activates and programs which are designed to influence consumer in way of his electricity usage to achieve essential goals those are: electrical peak load clipping or reduction, load shifting, energy conservation and valley filling. Based on research study in China and several countries around the world, the energy management techniques can reduce the consumption of electricity from (20-40) % [7]. As the applications of these strategies: increasing the electricity tariff in the peak load periods, reduce tariff structure in the off-peak periods and increasing all the time of the day. Iraq lacks the application of these global technologies in energy management which would reduce the consumption of electricity by a very noticeable percentage.

2.5 Environment and design parameters

The calculations and formulas concerning with the design of solar energy systems do not take into consideration the weather and climate changes under which the solar panels operate, and those are:

- Dust and storms in some months of the year, where some of the cities in Iraq are characterized by unclear sky during the year because of the desert areas surrounding these cities and lack of afforestation. Dust can reduce by about (20-30) % of the solar system production.
- Rain that will effect on the work of the solar system.
- Rising temperatures leading to lower solar generation. Iraqi weather is characterized by the short period of the transition seasons (spring and autumn) and long of summer months. According to the characteristics of the solar panel, the productivity falls by a certain amount within the mathematical equations, which is called (temperature coefficient) whereas this factor is calculated at standard test condition (STC at 25 °C). Temperatures in the summer season in the middle and southern regions in Iraq range from (40-50) °C. The solar cells are exposed to the heat from the sun throughout the day leading to accumulation of temperature on its surface which called the cumulative temperatures, and may reach 70 °C which can reduce PV generation by a value of temperature coefficient.
- The absence of the sun for several days and the appearance of clouds in many cases, which leads to a change in the intensity of solar radiation.

All of these factors are important technical factors that must be taken into account in the design of solar systems, especially in Iraq, but are not considered factors that prevent the implementation of solar energy projects, which can be solved with accurate software calculations (programs) and the use of new technologies within solar projects.

2.6 Supporting investment gap

The countries of the Middle East in particular and the countries of the world in general support solar PV projects because they are profitable developments. Iraq become impoverished for several important points in this regard,

- Developing and supporting local companies in the field of solar energy.
- The existence of legislative policies and resolute decisions in the field of supporting the investment of this sector.
- Interest in this subject where there is no culture of renewable energy among the people (social factor). The usefulness of solar PV systems has not been deliberately clarified for the people to make them convinced to use renewables.
- Attention to some sectors and regions, such as agriculture and remote rural areas, which does not require high technical procedures to meet the need of solar PV.

2.7 Political barriers

Iraq suffers from many political problems that negatively influence on the work of the country and the ministries in general, including financial problems, especially that Iraq has went through many wars and the last of them is the control of the terrorist organization "ISIS" on the city of Mosul and other cities of Iraq. They were completely eliminated, resulting in heavy losses in lives, funds and infrastructures. the government orientation has become towards the occupied cities. Currently, Iraq is governed by political parties that manage the joints of the country. Each party works for its own interests independently from the other. The political obstacle is a major and important reason that has led to a large gap that prevents the government services in general, and the electricity sector in particular.

3. Conclusion

From the previous discussion, there are many political, technical, financial, environmental and governmental types of barriers that prevent PV power generation in Iraq. Some of these problems can be solved technically and by financial supporting. While the others, are difficult. It is concluded that the solar PV projects can be implemented, but it is still limited, unless the above challenges be resolved.

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