

*Research Article*

## **Comparing the growth of renewable energy sources in Turkey, Iran and Iraq**

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### **ABSTRACT**

Fossil fuels are the primary energy source in most countries of the world, especially since the beginning of the industrial renaissance. Increased consumption of fossil fuels produces greenhouse gases, which significantly negatively impact the environment and human health. As a result of these disadvantages, the world needs to search for alternative low-carbon energy sources. The article focused on the amount of renewable energy generation in Turkey, Iran and Iraq from the collection of statistical data from 2010-2020. Turkey occupied the clear progress to benefit from renewable energy sources, followed by Iran and Iraq. The percentage of annual growth of power generation based on hydropower in Turkey, Iran and Iraq (71.4%, 28.5% and 0.1%) respectively. About other renewable energy sources, Turkey had the largest share in generating energy from wind and solar energy, with an annual growth rate of (88.03%, 98.22%), respectively. Finally, renewable energy can be considered a promising energy source for future generations when countries determine correct planning policies.

**Keywords** Renewable energy, Solar energy, Wind energy, Hydropower energy



## 1. Introduction

Fossil fuels have become dominant in energy production after the start of the Great Industrial Revolution in most countries of the world, which led to significant negative effects on human health and the global climate due to the emission of greenhouse gases resulting from burning fossil fuels. To reduce the emissions of pollutants resulting from burning fossil fuels, the world needs to switch to using renewable energy sources that are low in carbon and environmentally friendly. The International Renewable Energy Agency indicated in its report that 66% of the total energy should be from renewable energy by 2050 through the promotion, development and use of internationally concerted efforts [1]. The use of various renewable energy sources is widely considered beneficial, such as wind energy, solar energy, geothermal energy, hydropower in the face of crises from the use of fossil energy, and they are considered as clean energy sources [2, 3]. Clean energy has led to an increase in global awareness to reach a climate free from global warming and environmental pollution, which can cover the needs of local energy requirements, part of which is the traditional dependence on fossil fuels [4]. The great demand for energy has led to a global trend to exploit remote and mountainous areas to implement international commitments and agreements to use renewable energy sources as an alternative to traditional energy sources [5]. Future generations face many challenges in exploring and promoting the use of renewable energy sources through setting policies and increasing public opinion education towards a clean climate. Where it can be used to direct increasing global awareness by focusing on various global social networking sites and reaching useful insights into the advantages of using renewable energy technology as an alternative future energy plan [6]. China is the main player in renewable energy globally, accounting for half of the global production of solar and wind energy, with a growth of nearly 800 Gw, which is equivalent to an average annual increase of 18% between the period 2015-2020. A plan has also been drawn up to increase the percentage of wind and solar energy use in China at an annual rate of 14% and 18%, respectively, over the next ten years. The indicator is that China is on the right track in using renewable energy resources [7]. Turkey is one of the emerging countries in the production of fossil fuels, as nearly 80% of the total energy requirements are imported from other countries. Where the amount of energy consumption was  $230 \times 10^3$  K of oil, while the average energy production was  $35 \times 10^3$  K of oil for the year 2016. This leads to the fact that Turkey relied on renewable energy sources to meet the requirements and reduce the expenditures required to import fossil energy types from abroad [8, 9]. Oil was discovered in Iran in 1908, thus becoming one of the countries with oil production in the Middle East. Reliance on fossil fuels, especially oil, represents a major source of income for Iran. Then, crude oil consumption in energy sources decreased from 91% to 43% from 1980-2018 [10]. In contrast, the rate of natural gas extraction increased from 7% to 56% between 1980-2018, to be a major source of energy in Iran [10]. This country has not given great importance to the use of renewable energy sources to provide alternative sources, although it has a diverse resource environment to diversify its energy mix due to various economic and technical constraints. Therefore, various techniques and policies must be applied to exploit the natural sources of renewable energy in Iran [11]. Iraq is characterized as one of the countries with high oil productivity and is one of the members of the Organization of Petroleum Exporting Countries, so it depends on fossil fuels for domestic consumption for energy production [12]. Also, the geographical location gives it the privilege to benefit from solar radiation (one of the renewable energy sources), which reaches  $1899 \text{ Kw/m}^2$ , especially in central and southern Iraq. Despite that, there are no serious attempts to adopt renewable energy sources to be a parallel line to the production of fossil energy in the country. Where Iraq suffers from a severe shortage of energy as a result of the rapid growth in energy consumption, especially electric power plants as a result of the destruction of various wars from 1980 until now. Therefore, the Iraqi government must rely on tangible programs and policies to build renewable energy plants to fill the shortage. Research centers in Iraqi universities discussed presenting plans to exploit renewable energy of various kinds, such as solar distillation of non-potable water or the use of solar cells to generate electricity and increase its efficiency [13, 14]. In this statistical article, data on renewable energy technologies and the rate of consumption and production in Iraq, Iran and Turkey are considered. These countries have a variety of renewable energy resources that can be used in addition to fossil fuel energy, with the extent of the change in the share of renewable energy for the period from 2010-2020.

### 1.1. Main renewable energy sources

#### 1.1.1. Solar energy

Solar energy is one of the cheapest and cleanest renewable energy sources that can be directly accessed. The amount of solar radiation received varies according to several factors, including geographical location, the degree of clarity of the atmosphere, and others. Where the intensity of the incident solar radiation ranges from 50 to  $1500 \text{ W/m}^2$ . Several techniques have been developed to take advantage of this significant source to obtain energy that can be exploited in different fields (converting solar energy to thermal or photovoltaic) [15].

#### 1.1.2. Wind energy

One of the fastest growing types of renewable energy as an alternative to fossil fuels, it is abundant and renewable. It is classified as a type of electromechanical energy. The production capacity to benefit from wind energy has increased at a

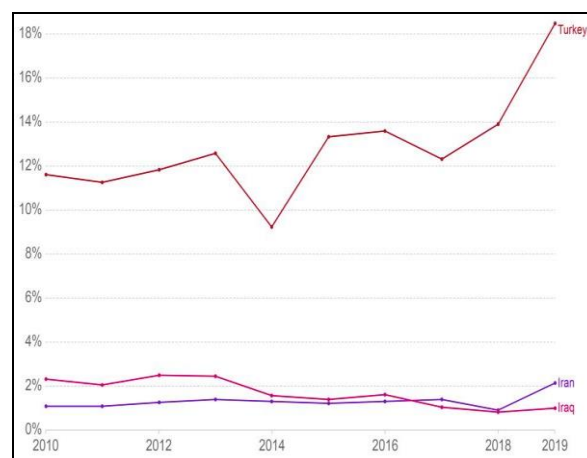
growth rate of 25% annually, from 8.25 GW in 2000 to 570 GW in 2020, according to the statistics of the International Renewable Energy Agency. Wind energy systems can be used in open areas, and it is not preferable to use them in the center of cities because of the obstacles that prevent the benefit from wind speed, which is the basis in the generation process [16].

### 1.1.3. Hydropower

Energy generated from the movement of flowing water at dams or reservoirs to move turbine blades to generate hydroelectric power. Many countries have taken advantage of this technology in building hydroelectric power stations, as Norway relies on this technology to generate 99% of the coverage of the need for electricity. China has also produced the largest hydroelectric power station with a generation rate of (80-100)TW.h/year. The benefits of hydropower lie as an environmentally friendly fuel source, as well as associated benefits such as flood control, irrigation methods, water supply, and drought reduction [17].

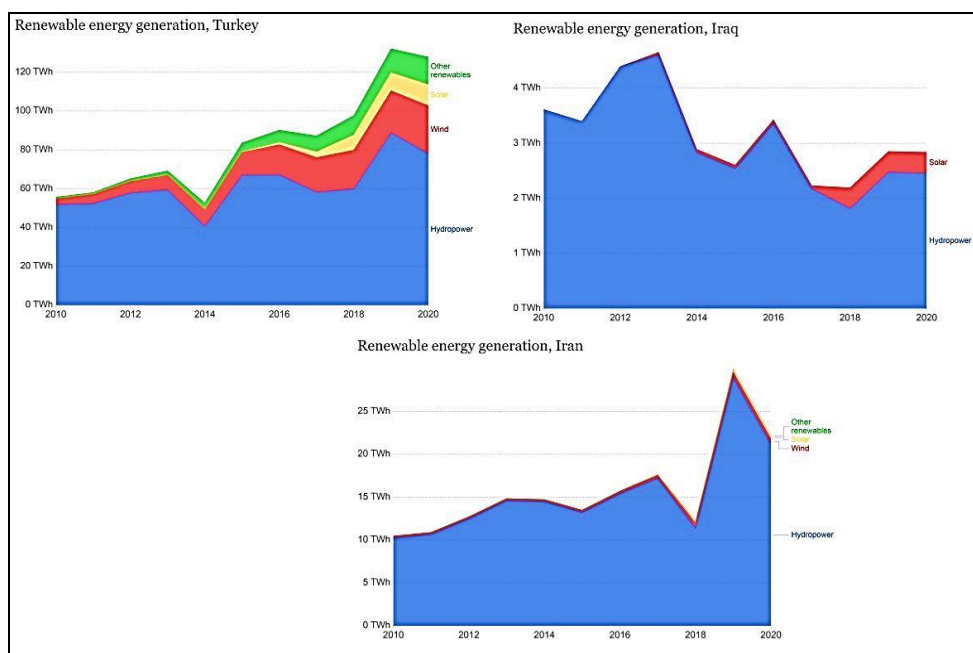
## 2. Results of data renewable energy

A study of the share of renewable energy consumption of all kinds (solar energy, wind energy, hydro energy and others) in Iraq, Iran and Turkey. Turkey took the lead in benefiting from renewable energy, with a rate of more than 12%, compared with Iraq and Iran, with small percentages that did not exceed 3%, as shown in Figure 1 [18].



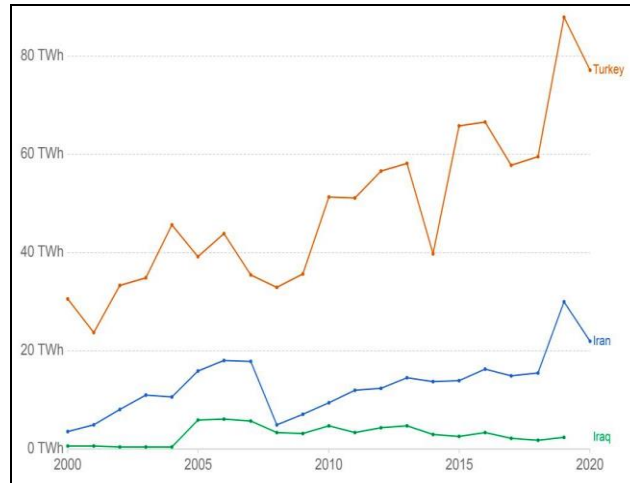
**Figure 1** The share of primary energy from renewable sources.

Figure 2 showed a stacked areal chart of the mix of renewable energy technologies according to their types and the relative annual contribution of each. We note that hydropower is the largest renewable source of energy generation in the study area, and Turkey's share of the most significant benefit from the renewable energy mix, followed by Iran and finally Iraq [18].



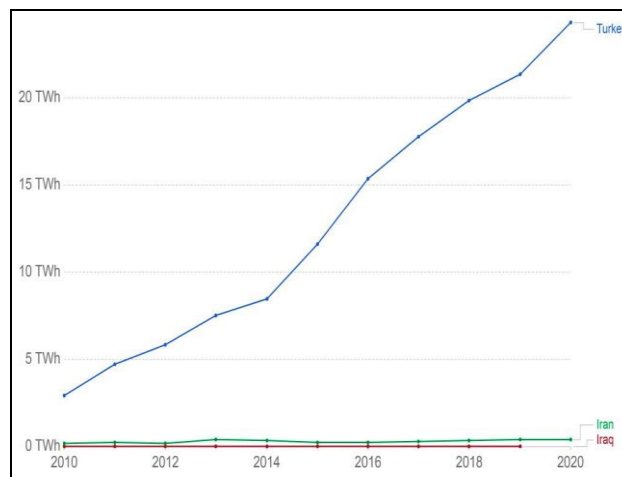
**Figure 2** Chart of the mix renewable energy generation of Turkey, Iraq and Iran.

Hydropower is the largest renewable energy source with low carbon and is used globally. Figure 3 shows that 60% of renewable energy is generated from hydropower. The amount of hydroelectric energy varies clearly according to the contribution and exploitation of each country in the study area. The annual birth rate of Turkey, Iran and Iraq were (53.9TWh, 12.79 TWh and 1.52 TWh) respectively [18].



**Figure 3** Annual hydropower generation is measured in terawatt-hours (TWh).

Wind power generation is one of the renewable energy technologies used in some countries to generate the energy needed to meet their needs. Figure 4 shows Turkey's uniqueness in exploiting wind energy generated from onshore and offshore wind farms, significantly different from Iraq and Iran. The growth rate during 10 years increased by 91.2 % in Turkey. On the other hand, wind energy was not exploited in Iraq and Iran despite the availability of the appropriate environment for it [18].



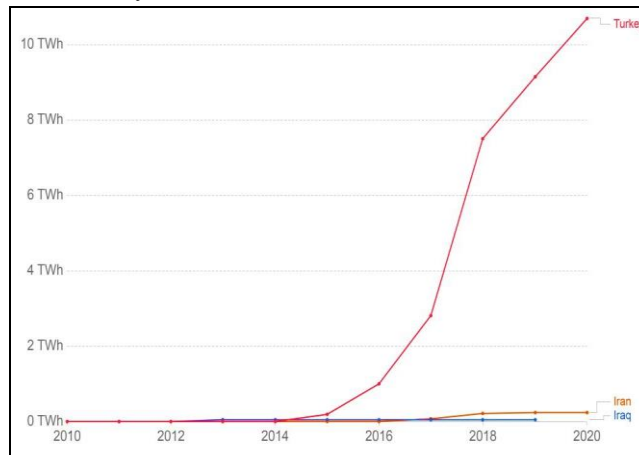
**Figure 4** Annual wind power generation.

The technologies for using solar energy are diverse, but it is worth noting that only a tiny part of the available solar energy has been used in our lives. Electrical energy is generated from solar energy by heat engines or photovoltaic converters. Among the applications made using solar energy are heating and cooling systems during architectural designs that depend on the exploitation of solar energy, potable water during distillation and disinfection, the exploitation of daylight, water heating, solar cooking, and high temperatures for industrial purposes. Figure 5 show the amount of energy generated from solar energy each year and the accelerating growth in each country.

### 3. Conclusion

Renewable energy is the amount of energy generated from natural resources that are continuously renewed, such as wind, sun and water, which do not produce greenhouse gases that are harmful to the climate. The world is heading towards benefiting from renewable energy to face environmental challenges and provide resources and economic returns that help meet external shocks about energy production and consumption. Some countries lacked actual policies to spread and develop the use of renewable energy of various kinds, so in this paper, the rates of renewable energy generation in Turkey, Iran and Iraq for the past decade were concluded. The share of primary energy consumption resulting from alternative energy sources shows Turkey's progress in the exploitation of alternative resources by 15.05% in 10 years,

compared to the lowest decrease in 2014 by 9.22%.



**Figure 5** Annual solar energy generation.

It seems that Iraq and Iran do not have a concrete economic policy in renewable energy generation, as their share did not exceed 2% for the same period due to their dependence on fossil fuels as a primary source of energy production. It was found that, despite the diversity of renewable energy sources with the availability of the appropriate environment for their exploitation, the share of hydroelectric energy accounted for the largest share of the average amount of energy produced, as it reached in Turkey, Iran and Iraq (64.32, 15.69 and 3.58) TWh respectively from 2010-2020. In contrast, the share of production from the rest of the renewable energy sources was tiny and untapped in Iraq and Iran, unlike Turkey, where the production rate was 16.24 TWh. About wind energy, noticed a linear and accelerated growth in Turkey, where its production in 2020 reached 24.32 TWh. The geographical location of the study area has an abundance of solar radiation for use in power generation. Still, the policies of hard work have started recently, with Turkey making a big jump in the production rate from 0.19 TWh in 2015 to 10.71 TWh in 2020, with Iraq and Iran remaining below the level acceptable. Finally, this article revealed the lack of seriousness of relying on renewable energy sources in the study area compared to the global growth in the development and use of clean energies with the availability of all climatic conditions and the abundance of natural resources. Instead, it relied on fossil fuels, despite the negatives that regional agreements on the environment and climate warned.

### Conflict of Interest

The authors of this article declare no conflict of interest through the processes of this work.

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