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Research Article

The Renewable, Sustainable, and Clean Energy in Iraq Between Reality and Ambition According to the Paris Agreement on Climate Change

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ABSTRACT

For quite some time now, Iraq has witnessed a great shortage, not only in the production of electric power, but even in the distribution system. In addition to this shortage, which exacerbates the problem is the large increase in the population of Iraq, in addition to the great problems that the country has experienced, especially the fierce confrontation with ISIS terrorist gangs, which drained a lot of Iraq's human and material energies and negatively affected the energy reality in our country, not to mention the All or most of our electric power plants run on heavy fossil fuels and have old technology tracks. Iraq has power shortages, and there are various obstacles that must be solved in order to keep up with projected demand. Based on the results of this study, it appears that solar, wind, and biomass energy are underutilized at now but have the potential to significantly contribute to Iraq's renewable energy future. Wind power offshore in the Gulf (near Basrah in southern Iraq) also has untapped potential that has to be explored. There has been talk about the Iraqi government's efforts to harness green energy. The purpose of this article is to examine and debate the present and future of renewable energy in Iraq. Renewable energy applications such as solar, wind, and biomass have been discussed. Finally, suggestions for making use of various energy sources are provided.

1. INTRODUCTION

Global demand for energy, particularly electrical energy, is increasing. Not only are oil prices rising, but pollution from the use of fossil fuels is also rising, and the possibility of oil supply depletion remains. All of these issues encourage researchers to look into using solar, wind, and other renewable energies to generate electricity [1]–[5]. Iraq is a member of OPEC and covers over 430,000 km2, though the exact figure depends on whether land and water areas are included. Iraq's Gulf coast is 58 km [6]. The following is a brief summary of the four main geographical zones that have been identified:

1. The desert plateau accounts for roughly 40% of Iraqi territory. West and southwest of the Euphrates River, a broad, stony plain with scattered sand stretches. From the border to the Euphrates River, a network of seasonal watercourses (or Wadis) runs.

2. About 20 percent of Iraq's landmass is comprised of the highlands in the northeast. This region, which reaches as far south as the border between Mosul and Kirkuk and continues on toward the Iraqi borders with Turkey and Iran, is home to mountain ranges that can reach an altitude of up to 3,600 meters.

3. Upland region comprises about 10 percent of Iraq's total land area. A region that is a transition zone between the highlands and the desert plateau. It is situated between the Tigris River, which is located north of Samarra, and the Euphrates River, which is located north of Hit and is a part of a larger natural area that extends into Syria and Turkey.

4. The alluvial plain covers approximately 30% of Iraq's land area. The combined deltas of the Tigris and Euphrates rivers formed this delta. This region begins north of Baghdad and extends all the way to the Gulf.

These regions have been categorized, according to the findings of the researchers [7–9].

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We must develop renewable energy sources to power the economy as it transitions from depending on fossil fuels to relying on renewable materials due to climate change and the global energy crisis. Therefore, biofuels give governments, researchers, and entrepreneurs with a huge potential. Massive production and utilisation of advanced biofuels can help relieve the global energy crisis and battle climate change. Fundamental to the concept of biomass as a renewable energy resource is the capture of solar energy and carbon from ambient CO2 by growing biomass. Biofuel generation from biomass has enormous positive impacts on sustainable development and climate change mitigation.

2. SOLAR ENERGY IN IRAQ

Energy, like food and drink, is a requirement. Everything in our environment takes energy. The earth's population has grown over time, which is directly proportional to the amount of energy consumed. All imaginable gadgets and equipment require some form of energy to work. With the depletion of fossil fuel supplies, it is vital to identify feasible renewable energy resources that can reduce reliance on fossil fuels [10]. The country of Iraq is well-known for having an abundance of sunny days each year. Studies have shown that the capital city of Baghdad alone in Iraq receives more than 3000 hours of solar radiation each and every year. The hourly solar intensity ranged from 416 W/m2 in January to 833 W/m2 in June. January had the lowest solar intensity. Even Europe's long summer days aren't enough to compete with the amount of sunshine that's been recorded in Iraq [11]. After the energy crisis that occurred in 1973, research into solar energy was initiated in Iraq. A great number of studies have been carried out in order to establish equations for the representation of the solar intensity in Baghdad. During that time period in Iraq, a large number of studies, both theoretical and practical, were initiated to investigate water heaters and coolers for residential use that were powered by solar energy [11]. Photovoltaic (PV) cells failed in previous Iraqi attempts. Solar cells were used on street lights in Iraq but were unsuccessful because the cells had low-efficiency factors and Iraqi weather is marked by dusty conditions. Despite this, PV cells found limited use in individual rooftop systems, community water pumping stations, and areas where the terrain makes it difficult to connect to a utility grid [12]. A safeguard against pollution from increased crude oil production and poorly constructed refineries over the next few years. As a means of reducing CO2 emissions, all of these activities produce CO2 emissions, renewable solar energy, and environmentally friendly hydropower to meet the country's electrical power needs [13], [14]. Researchers are working to overcome photovoltaic panels' primary drawback—a decrease in efficiency at high temperatures—by cooling the solar panels and storing the surplus heat for later use. The use of phase change materials for the storage of heat generated by photovoltaic panels is one method [15].

The following are Iraq's primary solar radiation characteristics:

- The yearly changes in the northern territories varied by over 300%, from 7 MJ/m2 in December and January to 23 MJ/m2 in June. The annual changes in the southern territories ranged by around 200%, from 13 MJ/m2 in December and January to 27 MJ/m2 in June and July. The annual changes in the middle territory varied by about 250% and can be compared to the average annual changes in the northern and southern regions.

- Strongly descending from north to south, solar radiation rises in the winter and falls in the summer. In the summer, the distribution of sun energy over the Iraqi regions is significantly more consistent (from June to August).

- The drop of solar energy from east to west is deemed negligible and susceptible to estimation mistake.

- The assessment of solar radiation is based on relationships developed from big data collected by meteorology stations in cities and major towns. Because of pollution, these areas receive less radiation than the surrounding areas; hence the actual levels of radiation are higher than the measured numbers [4].

2.1 Photovoltaic (PV) systems

A photovoltaic (PV) system, also known as a solar power (or photovoltaic) system, is an electrical power system that generates usable solar energy using PV cells [16]. Solar panels, which collect sunlight and transform it into energy, a solar inverter, which transforms direct current into alternating current, and various mounting, cabling, and electrical accessories round out the system's many parts. A solar tracking system and built-in battery could further boost the system's efficiency. PV systems directly turn light into electricity [17]. They should not be confused with other solar technologies, like concentrated solar power or solar thermal, which are used to heat and cool. A solar array is just the group of solar panels, which is the part of the PV system that can be seen as shown in the Figure below.

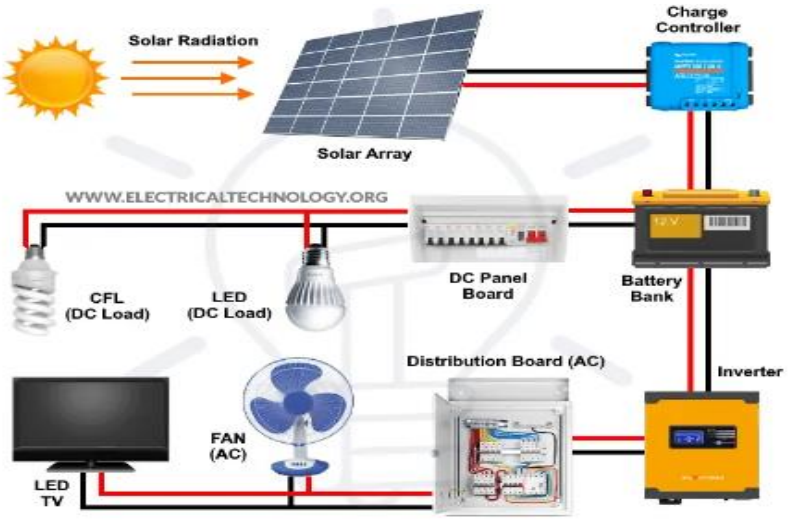

Fig. 1. Show us how to design and install a solar PV system [10].

It does not include the rest of the hardware, which is often called the "balance of system" (BOS). PV systems can be small and mounted on a roof or built into a building. They can produce anywhere from a few to a few tens of kilowatts of power. Large utility-scale power stations can produce hundreds of megawatts of power. Most PV systems today are connected to the grid. Only a small part of the market is made up of off-grid or stand-alone systems.

- Solar PV technology is suitable for generating electricity in Iraq because of the uniform distribution of solar radiation across the country.
- The solar photovoltaic (PV) technology can also be utilised for the generation of electricity in power plants located in remote desert areas that are not connected to the grid.
- High air temperatures and the presence of dust both have a negative impact on the efficiency of photovoltaic cells. As a result of the dusty climate in Iraq, it is essential to investigate the different types of dust, the density of dust, the rate at which dust accumulates, and the effect that dust has on the performance of PV system.
- The use of phase change materials allows for the storage of excess heat generated by photovoltaic panels, which is one of the methods that can be used.

2.2 Solar thermal systems.

The core principles of the circular economy, which include waste-free fuels and a focus on reducing, reusing, and recycling, will drive a shift in the way we think about economic growth. To that end, one of the most important long-term strategies is the shift to renewable energy. Consequently, this study examines, discusses, and reports on the possibilities of employing renewable energy resources, notably solar energy, in Iraq. We take a look at the current state of solar energy and its prospective applications in the industrial and electrical sectors. Future possibilities for solar energy adoption in Iraq are supported by a compilation, grouping, and presentation of sun radiation big data and weather parameter values from many publications. The study's other goal is to encourage the government of Iraq to invest more resources into renewable energy sources by raising public knowledge of the topic [4]. There has been a rise in the number of households using solar water heating systems.

PV and/or CSP system implementations have shown that the efficiency and reliability of these systems are dependent on a wide variety of factors. These factors include orientation (longitude and latitude), environment (solar intensity, temperature, humidity, wind, dust, rain, pollution, etc.), and the PV technology that is utilized. Therefore, it is imperative to conduct an exhaustive analysis of the aforementioned issues before making a commitment to a PV or CSP project of a considerable scale (in megawatts).

3. WIND ENERGY IN IRAQ:

Investigations into the use of wind power in Iraq have taken the form of a great number of research studies. More than twenty stations were selected for further investigation. The daily model of wind velocity predicts that the highest values will occur in the middle of the day and in the wee hours of the morning. These maximum values ranged anywhere from 5 to 10 meters per second. The wind speed in the summer is higher than it is in the winter, which is fortunate because the demands placed on electrical energy during the summer months are higher than they are during the winter months as a result of increased cooling and ventilation loads [18]-19].

There are three distinct regions that can be distinguished within Iraq. The first territory accounts for 48 percent of Iraq and has wind speeds that range between 2 and 3 meters per second. The second territory accounts for 35 percent of Iraq and features wind speeds that range from 3.1 to 4.9 meters per second. The third territory accounts for 8% of Iraq and has wind speeds of more than 5 meters per second, making it a region with relatively high winds. According to the findings of these studies, the following is an approximate breakdown of the energy density found in windy regions: 378 W/m2 in Al-Naseria, 353 W/m2 in Ana, 337 W/m2 in AlKout, , 194 W/m2 in Al-Nekhaib and 174 W/m2 in Al-Emarra. These findings allow for the calculation of an average energy value of approximately 287.2 W/m2 to be made [3], [4], [20]. The governorates of Iraq as well as their borders with their neighboring countries are depicted in the following figure.

Fig. 2. Shows the governorates of Iraq and Iraq's borders with neighboring countries [5].

4. BIOMASS ENERGY IN IRAQ AND IN THE WORLD

Biomass is a renewable resource derived from plant matter that can be burned to produce energy. Materials like wood , waste cooking oils, energy crops, agricultural leftovers, and household trash are all examples [21]. It is common practice to use the terms biomass and biofuel interchangeably due to the similarity between the two concepts. Some people classify things under others. Biofuel, according to official bodies in the US and EU, is any fuel that can be converted into a liquid or gaseous form and used for vehicular propulsion. "Raw or processed organic matter of biological origin utilized for energy," as defined by the European Union's Joint Research Centre, describes solid biofuels like firewood, wood chips, and wood pellets [22]. Biodiesel, sometimes known as "biodiesel," is a diesel fuel made from plant or animal fats. Transesterification is the chemical process by which methyl, ethyl, or propyl esters are created from lipids such as animal fat (tallow), soybean oil, or other vegetable oil. Biodiesel is a drop-in biofuel, meaning it can be used in place of regular diesel in both engines and distribution networks, unlike vegetable and waste oils. However, most engines cannot run on pure Biodiesel without modifications, thus it is commonly blended with petro diesel (usually to less than 20%). Some biodiesel mixes are approved for use in furnaces.

The most effective biomass-to-energy conversion to date has been the production of biodiesel from rapeseed oil , Soybean oil and Palm oil in (2020) as shown in Figure (2) [21].

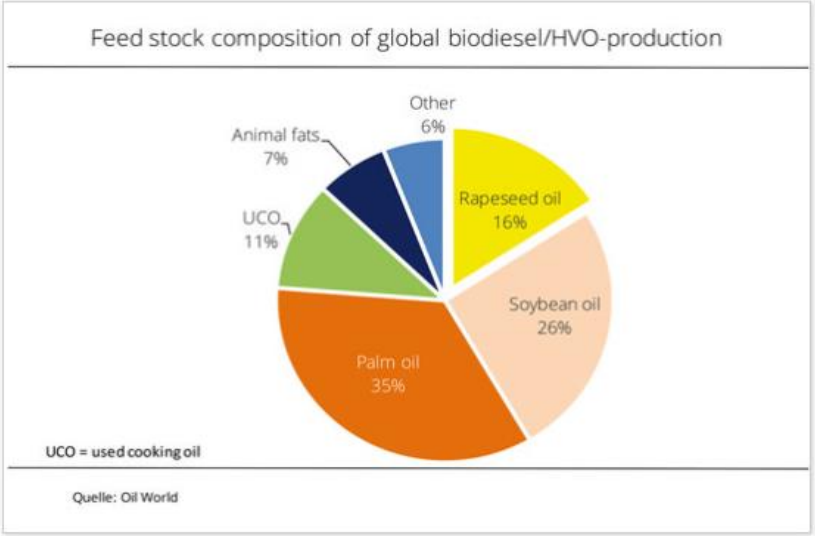

Fig. 3. The most effective biomass-to-energy conversion to date has been the production of biodiesel.

According to the Chart of the week (48 2022) In the crop year 2022/23, global output of vegetable oils is expected to reach new highs. Rapeseed and soybean oil production, as well as palm and sunflower oil, will increase. According to the most recent US Department of Agriculture (USDA) forecast, global production of vegetable oils would total 219.8 million tonnes in 2022/23. This is an 8.3 million ton increase over 2021/22. In other words, production will presumably meet the current crop year's demand of 213.6 million tonnes. According to Agrarmarkt Informations-Gesellschaft (mbH) research, palm oil will continue to be the world's most important vegetable oil in terms of production and consumption, with worldwide output predicted at 79.2 million tonnes. This equates to a 3.2 million ton rise over the next two years. In other words, palm oil accounts for slightly more than 36% of global vegetable oil production. Indonesia continues to be the greatest palm oil producer, with 46.5 million tons produced, followed by Malaysia (19.8 million tonnes) and Thailand (just under 3.3 million tonnes). Emissions are a natural byproduct of the combustion of diesel fuels, which are subject to oversight by the Environmental Protection Agency in the United States (E.P.A.). Because these emissions are a byproduct of the combustion process, an engine's fuel system needs to be able to control both the combustion of fuels and the reduction of emissions in order to be in compliance with the Environmental Protection Agency's regulations. To reduce the amount of pollution caused by diesel vehicles, a number of innovative technologies are currently being put into use. Both the exhaust gas recirculation system (also known as EGR) and the diesel particulate filter (also known as DPF) are intended to reduce the amount of harmful emissions produced by the vehicle [23].

Bioethanol Sugarcane, sugar beets, and corn are the three most common sources for commercial bioethanol production. Sweet stem sorghum, cassava, and cellulosic materials including grasses, trees, and diverse waste products from farming, woodworking, and municipal trash are some more options.Various types of cane grown in Al-Ahwar, including dates and sugar cane, can be converted into bioethanol. They can all be grown commercially in large quantities in Iraq. Inadequate agricultural credit, a lack of security, antiquated technology, and a generally deteriorating irrigation and agricultural infrastructure are all problems plaguing the Iraqi agricultural sector right now. Many countries worldwide are increasing their use and production of biofuels like biodiesel as an alternative energy source to fossil fuels and oil. Governments have implemented legislation and laws as incentives to reduce oil dependency and increase the use of renewable energies in order to promote the biofuel industry. Many countries have their own policies regarding biodiesel taxation and rebates for use, import, and production [22]. Agriculture is the largest and most important sector in the development of countries in the world and the most important one. Agriculture has basic products that are used directly or sold and are of high value and importance to humans. As for the secondary products, they can be exploited in several ways and converted into complete wealth that is dependent on building cities, as did the Malaysians and Indonesians, and European countries from recycling and other chemical processes. An example of this is the thermal chemical conversion of biomass, including hydrothermal liquefaction, thermal decomposition, thermal drying, gasification, and direct combustion processes. Various types of biomass are

processed in processing plants and converted into liquid biofuels for energy purposes or to produce value-added chemicals as shown in the figure below[24] .

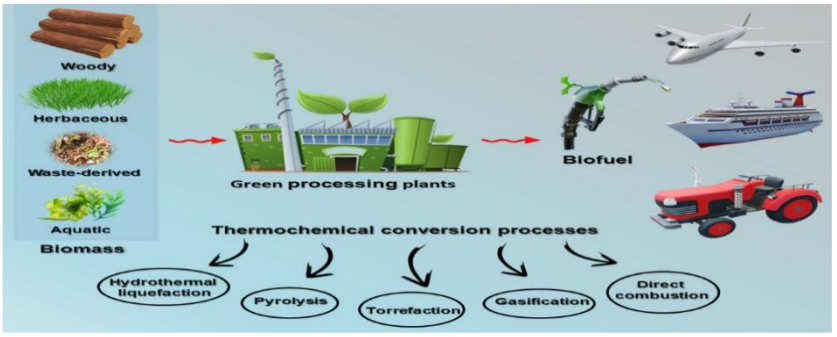

Fig. 4. Show the Conversion of biomass to biofuels and life cycle assessment [24].

In contrast, biomass leftovers and trash are byproducts of the cultivation, processing, and consumption of the raw materials that are actually employed for energy generation. There are three major categories of biodegradable waste: primary, secondary, and tertiary. Typically, primary residues, including maize stalks, stems, leaves, and straw, are created during the planting of intended food crops and forest products. In contrast, secondary residues are produced during the latter stages of food crop processing. Agricultural and food sector byproducts include woodchips, coffee hulls, rice hulls, sugarcane bagasse, and palm kernel cake. In contrast, tertiary leftovers become accessible once a product formed from biomass has been eaten by people and/or animals. These residues may first exist as municipal solid waste (MSW) before being converted to sewage sludge and/or wastewater. The generational progression of biofuels is depicted in the figure below, with an emphasis on the second-generation biofuels generated from biomass residues and waste and their respective conversion pathways to produce diverse forms of bioenergy, including syngas, bio-oil, biochar, electricity, biogas, bioethanol, biohydrogen, and biodiesel. As biomass residues and trash, wood and agricultural waste (primary and secondary biomass residues), spent cooking oil waste (tertiary biomass residues), and microalgae biomass have all demonstrated beneficial potential. [25].

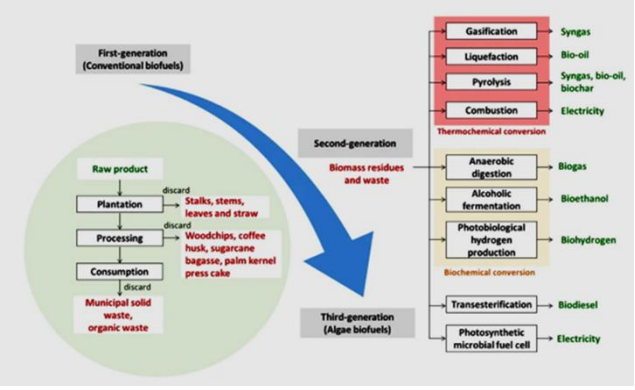

Fig. 5. Lustrates the evolution of biofuel generation, with a focus on second-generation biofuels derived from biomass residues and waste, as well as their conversion pathways to produce a wide range of bioenergy [25].

The advantages and disadvantages of biofuels for underdeveloped countries:

1. Biofuels have enormous promise, but they present obstacles that must be met with strong and consistent development policies.

2. Production of biofuels around the world has been increasing, and this trend is expected to continue. Biofuels improve energy independence, lessen pollution, stimulate rural growth, enhance vehicle efficiency, and lessen reliance on petroleum.

3. While these benefits are undeniable, they also bring up serious concerns that must be resolved before biofuels can become widely used, both globally and in Africa. Land availability and requirements, policy, information, expertise, standards, comprehension, engagement, and financial commitment are all relevant issues.

5. CONCLUSION

The following summarizes Iraq's significant successes and the authors' recommendations for renewable energy development:

1. Iraq has one of the greatest solar energy densities in the world. Furthermore, numerous places in Iraq have high wind energy potential.
2. The potential for using biomass energy for power generation is determined to be low when compared to solar and wind energy, although it could be sufficient if used correctly.
3. More research is needed into off-shore wind (in the Arab Gulf near Basra) and geothermal energy.
4. Small renewable energy pilot projects, particularly those serving people in rural areas, require government funding.
5. Financial assistance is requested for research into renewable energy in Iraq and its applications.
6. The installation of solar thermal collectors in public buildings to generate hot tap water is a first step toward reducing reliance on fossil fuel supplies.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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