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# Renewable Energy Production in Iraq: Reality and Prospects

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**Abstract:** Iraq is one of the important countries that rely heavily on fossil fuels as an important resource for the country and a source of energy used in various fields, which has made it a focus of international interest, especially with its direct impact on climate change represented by low rainfall, low river levels and high temperatures. Therefore, voices have risen towards the use of clean alternatives, especially solar energy and hydroelectric energy, as Iraq surpasses many countries in solar brightness, which reaches about (3) thousand hours per year, in addition to the availability of the Tigris and Euphrates rivers and their tributaries, which allows the establishment of solar and hydroelectric power stations. Despite these available components, this has not been invested in the required manner, which is what the research problem represents, as despite the availability of these sources, there are obstacles and difficulties that prevent the maximum benefit from renewable energy sources for technical and financial reasons. Therefore, the research assumes that exploiting these sources and preparing well-studied scientific plans will contribute significantly to reducing dependence on fossil fuels and developing clean and environmentally friendly energy sources. The research reached the conclusion that despite Iraq's attempts to use energy alternatives, its contribution to the total energy sources is still below the level of ambition, as it did not reach (9%) at best. Therefore, the research recommends the necessity of developing the technologies used in exploiting renewable energy sources and seeking the expertise and specialized international companies to establish power stations based on these sources.

**keywords:** energy, Renewable, development.



## 1- Introduction:

Energy is the main source of all economic and service activities, but its environmental problems have become one of the most important problems facing the world, especially with the increasing population and the expansion of cities. These problems have required the development of all scientific expertise towards paying attention to renewable energy sources to reduce as much as possible these problems, especially those related to environmental pollution. Iraq is one of those countries that have faced the effects of climate change and what it causes in terms of high and low

rainfall and low river levels. Therefore, there was a need to make all efforts to overcome these problems. Some efforts were made to develop alternatives to fossil fuels, including those related to developing hydroelectric sources and others to develop photovoltaic sources. However, these attempts did not rise to the required level, as the contribution of these sources is still low compared to fossil fuel sources. Therefore, it is necessary to harness all financial resources and scientific expertise and seek the assistance of international companies specialized in this field in order to develop clean energy alternatives and reduce dependence on fuels that have a negative impact on human life as well as other living organisms.

The importance of the research was represented in showing the extent of Iraq's interest in renewable energy sources, which is an important matter in formulating an appropriate environmental policy, as the use of these sources according to sound foundations that take into account the requirements of economic and health life, would positively reflect on the lives of all members of society and reduce interest in energy sources that pollute the environment.

The research problem indicates the extent to which Iraq benefits from renewable energy sources despite their availability in large, unspecified quantities and reducing dependence on fossil fuel sources.

The research assumes that adopting a policy of relying on and developing renewable energy sources would increase their contribution to the total energy used and thus reduce dependence on other energy sources, which would contribute to reducing financial costs and doubling the production of electrical energy, as well as contributing indirectly to reducing the environmental impacts represented by the phenomenon of global warming.

The research aims to know the extent of Iraq's exploitation of renewable energy sources, as well as the size of its participation in the total energy, and whether Iraq has the material and cognitive capabilities to exploit this energy and what are the plans in place to invest in clean energy sources.

The research relied on the inductive approach using descriptive statistical methods in analyzing data on renewable energy sources.

**2- concept is renewable energy:**

Renewable energy has been defined by relevant international bodies and institutions as energy obtained from sources that are found in nature automatically and periodically. Thus, it differs from traditional energy that exists in different forms and with a fixed stock in nature and that cannot be used except after human intervention in extracting it. The United Nations also defined it as energy whose source is not fixed and specific in nature, but is renewed periodically and faster than its consumption processes and appears in different forms (water, wind, sunlight, geothermal energy, biomass).( Salman,2016) The International Energy Agency defined it as the energy that is formed from energy sources resulting from the spontaneous paths of nature and is formed in nature at a rate higher than the rate of its consumption. It was also defined as the energy derived from natural resources that cannot be exhausted and does not cause waste that pollutes the environment or harmful gases or increases global warming. What distinguishes renewable energy is its availability in all countries, which enables it to reduce dependence on imports,( Abdul Qader,2016) allowing these countries to diversify their economies and protect them from fluctuations in fossil fuel prices, in addition to driving economic growth and creating job opportunities, as every dollar invested in renewable energy produces three times the jobs created in the traditional energy sector, which generates about (30) million new jobs in the field of clean energy by 2030. These jobs are distributed between the manufacture of electric cars, high-efficiency devices, or innovative technology. What also distinguishes this energy is its low cost,( Mohammed,2015) given that we take into account the continuous decline in energy technology prices. For example, the cost of electricity generated from solar energy decreased by (85%) during the period (2010-2020), and the cost of energy generated from wind decreased by (56%) during

the same period, and it is expected that electricity generated from renewable sources will provide about (65%) of the total electricity supply in the world by the year 2030. This decrease in costs has made it more attractive in all countries, including low- and middle-income countries, which allows for the provision of renewable energy supplies from low-carbon sources, and reduces dependence on fossil fuels that have a direct impact on human health, as according to reports from the World Health Organization, (99%) of the world's population breathes unclean air, as air pollution varies by about (13) million every year.

**3- Renewable energy production rates in Iraq:**

Iraq has multiple resources for renewable energy sources, such as the sun's rays, the Tigris and Euphrates rivers and their tributaries, in addition to other resources, all of which are factors that help in benefiting from these sources and using them to generate the energy needed for various activities. Although Iraq occupies advanced positions in the reserves and production of fossil fuels and their availability in large quantities, this does not negate the need to focus on developing renewable energy sources and working to expand investment activities in this field, especially if we know that the global trend is moving towards the need to address the problem of global warming and reduce emissions of gases that pollute the environment,( Kazem,2024) which ultimately calls for reducing reliance on traditional energy sources and using other alternatives. Renewable energy sources contribute to supporting the electrical energy system in Iraq, but their contribution to the total production was weak compared to traditional energy sources, as shown in the following table:

**Table 1 : Contribution of renewable energy to total energy sources**

| Year | Renewable energy (MW) | Conventional energy (MW) | Total energy (MW) | Ratio renewable % |
|---|---|---|---|---|
| 2012 | 501 | 4734 | 5253 | 9.5 |
| 2013 | 570 | 6099 | 6669 | 8.5 |
| 2014 | 373 | 7363 | 7736 | 4.8 |
| 2015 | 328 | 8911 | 9239 | 3.5 |
| 2016 | 422 | 10080 | 10502 | 4.5 |
| 2017 | 285 | 11677 | 11962 | 4.1 |
| 2018 | 245 | 12757 | 13002 | 5.3 |
| 2019 | 604 | 13460 | 14064 | 4.2 |
| 2020 | 511 | 13725 | 14236 | 3.5 |
| 2021 | 419 | 13571 | 13990 | 2.9 |
| 2022 | 340 | 5597 | 15937 | 2.1 |

**Source**: -Republic of Iraq, Ministry of Electricity, Annual Reports.

-Ministry of Planning, Central Statistical Organization, Statistical Group

We note from the table above that the share of renewable energy in the total energy constitutes a small percentage compared to fossil energy sources, as it amounted to about (501) megawatts in 2012 compared to (4734) megawatts for traditional energy, and most of the renewable energy sources come from hydroelectric power stations, which are mostly located in the northern regions of Iraq, which became vulnerable to military operations during the period (2014-2018) after terrorist gangs took control of those areas. Which led to a decrease in the quantities produced from these stations, as it reached about (373) megawatts in 2014, and the decrease continued until it reached (245) megawatts in 2018, but production began to improve with the security stability in these areas, as it reached about (604) megawatts in 2019, and it soon improved until it began to decrease due to the decrease in water levels from Turkish dams, which directly affected the volume of energy produced from these stations, reaching about (340) megawatts in 2022, at a rate

of (2.1%) of the total energy produced, compared to an increase in fossil energy sources, which increased interest in them, especially after the increase in the number of power stations that operate on liquefied gas, so production rose to (15597) megawatts, at a rate of about (98%) of the total energy, which indicates Iraq's heavy reliance on fossil energy sources. (Yassin ,2023) The following is a presentation of the most important renewable energy sources in Iraq.

**3-1 Solar energy:**

Iraq receives approximately (5.6) kilowatt-hours per square meter per day and more than (3) thousand hours of sunshine every year, where one day in the summer reaches (14) hours of sunshine, which makes it a suitable environment for the operation of solar power stations and their use in generating electricity and contributing to supporting the energy system in general, especially with overcoming some challenges,( Suleiman,2023) including those related to the high costs associated with the technology used, which hinders investment in developing these sources. In addition, the high amount of dust and dirt that sweeps Iraq annually affects the efficiency of solar panels. The dust percentage reaches (45 g/m2) annually, and the high temperatures, which reach about (50) degrees Celsius in the summer, may also hinder the operation of these solar panels. Iraq is one of the first countries in the Middle East to be interested in solar energy. The first solar panels were installed at the Solar Energy Research Center in Baghdad in 1986. However, wars and international economic sanctions greatly affected applied research in this field until 2009, when the government worked to revive solar energy sources by installing (6) thousand solar-powered lamps in the streets of Baghdad as part of a major initiative that included spending approximately (1.6) billion dollars to add (400) megawatts of solar energy stations. This initiative faced some obstacles, including the deterioration of the security situation in 2014 and the collapse of global oil prices, which affected the government’s financial budget. However, interest in this initiative returned again in 2017 through the government's announcement of a partnership with the private sector to build about (700) megawatts of solar power plants. In addition,( Ahmed,2022) the low cost of purchasing photovoltaic units encouraged members of society to install solar panels and reduce dependence on the national system for electricity supply. The following table shows the volume of solar energy production in Iraq for the period (2012-2022):

**Table 2 The volume of photovoltaic energy production in Iraq for the period 2012-2022**

| Year | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Production volume (mw) | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 |
| Ratio Of total energy % | 0.70 | 0.55 | 0.47 | 0.40 | 0.35 | 0.30 | 0.28 | 0.26 | 0.25 | 0.26 | 0.26 |

**Source**: Renewable Energy Statistics, International Renewable Energy Agency, 2024.

It is noted from the above table that Iraq has not achieved clear progress in the field of solar energy production, as the volume of energy produced amounted to about (37) megawatts during the years extending from 2012 to 2021 and (42) megawatts during the year 2022, and this energy was mainly focused on lighting public streets through solar panels installed on light poles. These rates show that Iraq still relies to a greater extent on traditional energy sources,( Mahmoud and Ali,2020) and the failure to exploit solar energy is due to the reliance on fossil fuels in energy generation as they are available in large quantities in addition to the low costs of their production.

**3-2 Hydroelectric power:**

Hydroelectric power is one of the most important renewable energies used in generating electrical power. The Tigris and Euphrates rivers and their tributaries are important sources in generating this energy, as the amount of potential energy in them is estimated at about (68.5) billion megawatts/hour during the year,( Estepanian,2020) which contributes to the establishment of

many hydroelectric stations, especially at dams built on rivers such as the Darbandikhan Dam Station with a design capacity of (248) megawatts and the Dokan Dam Station with a capacity of (400) megawatts. These two stations are located in the Sulaymaniyah Governorate. As for Salah al-Din Governorate, it also has two stations, which are the Al-Azim Dam and Samarra Dam stations with a capacity of about (75) megawatts. There is also the Hamrin Dam station in Diyala Governorate with a capacity of (50) megawatts. As for the Haditha Dam station, it is located in Anbar Governorate with a capacity of about (660) megawatts. As for the largest hydroelectric station in Iraq,( Estepanian2020) it is located on the Mosul Dam with a capacity of about (1114) megawatts.

It is noted that hydroelectric power production in Iraq is much better than solar energy, and despite the fluctuation in production during the period (2014-2022), it constituted a significant percentage of the total production, as shown in the following table:

**Table 3 The volume of hydroelectric power production in Iraq for the period 2014-2022**

| Year | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|
| Production volume (mw) | 2933 | 2548 | 2374 | 2178 | 1820 | 4966 | 4164 | 3348 | 2653 |
| Ratio Of total energy % | 55 | 38 | 30 | 23 | 17 | 29 | 29 | 23 | 16 |

**Source**: Republic of Iraq, Ministry of Electricity, Annual Reports

It is noted from the previous table that Iraq's hydroelectric power production amounted to about (2933) gigawatts/hour in 2014, then began to gradually decline during the period (2015-2018) to reach about (1820) gigawatts/hour in 2018, for production to improve again during the years (2019) and (2020) to reach about (4966) megawatts/hour and (4164) megawatts/hour, respectively. Then the production volume witnessed a decrease during the years (2021) and (2022) to reach about (3348) and (2653) megawatts/hour. The fluctuation in the volume of production is caused by the fluctuation in the water quantities entering the Tigris and Euphrates rivers, which depends to a large extent on the amount of rainfall and on the water releases from the dams controlled by Turkey.( Guide,2021) The rise in river levels contributes to increasing the production capacity, and vice versa, in the event of a decrease in water levels, it will affect the generating stations and thus reduce the production capacity.

### 3-3 Other sources of renewable energy:

The use of other sources of renewable energy is almost non-existent despite the availability of all the elements for their use. This is due to the large availability of fossil energy sources and the low costs of their production. However, this does not negate the need to develop renewable energy sources, especially with regard to unexploited sources such as wind energy and bioenergy. Iraq's commitment to achieving the requirements of sustainable development by 2030 also requires the development of renewable energy sources. The monsoon winds and the availability of various agricultural and household wastes in large quantities,( Guide,2023) require their exploitation to ensure the sustainability of resources and achieve the goals of sustainable development by preserving the environment. Iraq seeks to establish factories that work to exploit waste and convert it into energy sources due to the availability of this waste in large quantities, which contains organic waste, in various urban and rural areas, which requires its treatment to provide energy first and to get rid of it second, due to the danger it generates to human health in addition to the uncivilized appearance it reflects on the environment.( Omran,2023) The following table shows the volume of regular waste collected for the period (2012-2021):

**Table 4 : Expected energy volume from regular waste in Iraq for the period 2012-2022**

| Year | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|---|
| Regular waste tons/year | 8304589 | 8214982 | 11631345 | 9515659 | 8987119 | 9625105 | 10593576 | 11831529 | 11173038 |
| Expected power (Mw) | 207500 | 205000 | 290000 | 237500 | 222500 | 240000 | 262500 | 295000 | 292500 |

**Source**: Prepared by the researcher based on: - Republic of Iraq, Ministry of Planning, Central Statistical Organization, various years.

We note from the table above that the volume of regular waste generated annually is very large, which allows for a great possibility of exploiting it and providing large amounts of renewable energy, especially if we know that (1100) tons of waste generate about (25) megawatts of energy, which contributes significantly to supporting renewable energy sources. Iraq is capable of producing between (200-300) thousand megawatts of energy annually, which contributes significantly to supporting the electrical energy system and reducing dependence on fossil fuels, which contributes effectively to reducing harmful gas emissions and preserving the environment. After the lifting of economic sanctions on Iraq and the improvement of the standard of living for most members of society as a result of the increase in individual incomes and the recovery of local markets with various goods, commodities and agricultural crops, the demand for these materials increased and with it the volume of waste generated as a result of the use of these materials, as the volume of waste increased and reached about (8,304,589.5) tons during the year 2013 and increased annually to reach about (11,173,038.3) tons in 2021, which is equivalent to (200-292) megawatts of energy annually.

**4- Per capita share of renewable energy:**

It is noted from Table No. (3) that the average per capita share of renewable energy is low compared to other energy sources. This is due to the abundance of fossil fuels and their adoption as a primary source of energy in various activities, especially electricity generation. It is noted that the average per capita share of the total renewable energy used in electricity generation ranged between (53-143) kilowatts/hour during the period (2012-2022). The average per capita share of renewable energy amounted to about (133) kilowatts/hour in 2013, which increased slightly to about (143) kilowatts/hour in 2013. However, the per capita share of this energy decreased to about (91) kilowatts/hour in 2014 due to the failure of many hydroelectric stations located in areas where security disturbances occurred as a result of the control of terrorist gangs over them, especially in the northern regions of Iraq. The per capita share continued to decrease until it reached its lowest level in 2019, reaching about (53) kilowatts/hour, then began to gradually improve and reached about (106) kilowatts/hour in 2020, but the decrease in water levels greatly affected the production of hydroelectric stations, so the per capita share began to decrease until it reached about (67) kilowatts/hour in 2022. In contrast, we note an increase in the per capita share of energy generated from traditional sources during the same period. After it was about (1260) kilowatts/hour, it gradually increased to reach about (1796) kilowatts/hour in 2015. Despite the increase in the population, this did not affect the average per capita share of that energy, as it increased to remain at about (2630) kilowatts/hour in 2018 due to the entry of new stations into the production line, especially stations that operate on liquefied gas, as dozens of power stations were built in various Iraqi governorates, and with them the average per capita share increased to reach about (3113) kilowatts/hour in 2022.

**Table 5 Per capita share of renewable energy for the period (2012-2022)**

| year | Renewable Energy (KWH) | Conventional Energy (KWH) | (Population (million |
|---|---|---|---|
| 2012 | 133 | 1260 | 34 |
| 2013 | 134 | 1530 | 35 |
| 2014 | 91 | 1796 | 36 |
| 2015 | 77 | 2115 | 37 |
| 2016 | 97 | 2330 | 38 |
| 2017 | 64 | 2630 | 39 |
| 2018 | 53 | 2801 | 40 |
| 2019 | 129 | 2883 | 41 |
| 2020 | 106 | 2870 | 42 |
| 2021 | 85 | 2772 | 43 |
| 2022 | 67 | 3113 | 44 |

Source: Prepared by the researcher based on: - Republic of Iraq, Ministry of Planning, Central Statistical Organization, various years.

The decrease in the per capita share of renewable energy compared to its increase in traditional energy sources is evidence of Iraq's heavy reliance on fossil energy sources and its use as a primary source of energy in power plants, transportation, and various other activities.( Faraj,2022) This calls for increasing scientific research and applied studies for the purpose of investing in renewable energy sources, especially solar energy and wind energy, in addition to biomass, and introducing them as supporting sources of energy, which enhances international measures to confront the problem of global warming by reducing the rates of environmental pollution resulting from the use of fossil fuels ( Hussein,2024).

**5- Prospects for renewable energy production:**

Iraq still relies heavily on fossil fuels as a primary source of energy, and with the exception of hydroelectric power, the participation of renewable energy in energy generation is weak and no effective steps have been taken to invest in renewable resources, despite Iraq possessing all the components of renewable energy investment,( Abdullah,2024) as it is located in the global solar belt, as every (100 km2) of desert areas has the capacity to generate energy equivalent to (30) million tons of oil equivalent annually. The availability of the Tigris and Euphrates rivers can be exploited to increase hydroelectric stations, in addition to the availability of seasonal winds and biomass that can be used to generate renewable energy. Iraq also has sufficient funding to establish projects related to renewable energy, in addition to having educated and trained human resources. Despite these capabilities, Iraq is still far from moving towards adopting renewable energy for several reasons, including:

- Obstacles related to the structural and institutional link between the relevant departments, as the use of technology related to renewable energy requires full coordination between the legislative and executive authorities and defining the roles between the relevant ministries such as the Ministry of Energy, Transport, Environment(Yousef,2024), Higher Education, and Finance, and full coordination with the aim of achieving the basic goal, which is to reach the production of renewable energy.
- Technical and technological obstacles, as most developing countries suffer from weak technical capabilities in various aspects related to renewable energy technology(Hashim and Abdul Ali,2023), as it requires high skills and advanced expertise, and its absence is an obstacle to the spread of applications of this energy.

- Lack of awareness and interest in renewable energy sources constitutes an obstacle to adopting clean energy sources in energy production and relying mainly on fossil energy sources because they are available in large quantities and at a low cost without taking into consideration the importance of preserving the environment(Obaid,2020).
- The high costs of establishing renewable energy systems with weak financing mechanisms, in addition to investment concerns resulting from the mistaken belief that investing in renewable energy is not economically attractive when compared to other investment opportunities, especially if we take into account the low social costs of traditional energy sources(Shabib and Basem,2022).
- Concerns related to climate change, such as droughts and dust storms, reduce interest in developing renewable energy sources and focus attention on traditional energy sources.

The continuation of the electricity crisis in all Iraqi governorates encouraged the Iraqi government to move towards renewable energy sources to alleviate this crisis in light of the high temperatures in the summer seasons, which sometimes reach (50) degrees Celsius in most cities of the country, which requires the continued availability of electrical energy to reduce the summer heat, as Iraq needs approximately (40) thousand megawatts to operate electricity 24 hours a day, while the actual production reaches approximately (27) thousand megawatts, which requires the use of renewable energy sources to achieve the desired goal And reduce as much as possible the dependence on traditional sources in generating electricity. Iraq uses traditional energy in generating electricity in addition to importing electricity and gas from neighboring countries, as it has acquired about (4) billion dollars annually, in return, huge amounts of associated gas are burned as a by-product in the carbohydrate sector. With the increasing pressures facing the country in an attempt to find alternative sources along with reducing carbon dioxide emissions and achieving environmental protection goals, Iraq has in recent years developed and enhanced investments in renewable energy, as the government seeks to raise the contribution of renewable energy to reach (33%) by 2030 with an increase of (6) thousand megawatts of solar energy, whose current capacity reaches (300) megawatts. Iraq has concluded agreements with international companies in this field. The following are the most prominent future plans through which the Iraqi government seeks to enhance renewable energy sources:

**5-1 Regulatory laws:**

In order to encourage and invest in renewable energy sources, the Iraqi parliament seeks to legislate a law (Renewable Energy Regulatory Law) with the aim of developing and advancing the renewable energy sector in Iraq and improving energy efficiency, in addition to establishing a national company for trading emissions and carbon returns, which will be linked to the Renewable Energy Regulatory Authority(https://iq.parliament.iq/). The law stipulates the following:

- Regulating electricity production processes from renewable energy sources.
- Contributing to combating climate change in accordance with international obligations and protecting the environment through clean energy production.
- Achieving sustainable development by preserving energy sources and their efficiency.
- Exploiting renewable energy sources and increasing their percentage of the total energy and enhancing their sustainability.
- The producing subscriber has the right to transfer the surplus energy produced to the distribution networks and the possibility of selling it to the public and private sectors, provided that the necessary conditions for connection are met. The transmission and distribution companies are responsible for connecting it to the national system.

- Expanding the transmission and distribution networks to accommodate renewable energy sources.
- Facilitating contracting for state-owned lands allocated for renewable energy investment projects, in addition to allowing the passage of energy transmission lines to the national system. - Allocating to the investor or renewable energy producer a percentage of no less than (50%) of the net carbon reduction return sold in global markets and achieved from investment projects in renewable energy.
- Issuing emission reduction certificates for every (1) megawatt of renewable energy sources equivalent to (1) metric ton of carbon dioxide equivalent.
- Establishing a Renewable Energy Authority linked to the Ministry of Electricity to regulate the work and management of renewable energy sources and support and encourage citizens and investors to produce and use energy and raise awareness of the impact of emissions on the environment and support renewable energy technology by establishing a Renewable Energy Support Fund.
- Exempting requirements related to the development of renewable energy sources from taxes and fees.

The approval of this law will contribute greatly to the generation of renewable energy and make individuals consumers and producers of that energy at the same time, given that the surplus production from those sources will be transferred to the national system, which will contribute to supporting the incomes of individuals participating in the generation process and will be an incentive to increase the exploitation of renewable energy sources.

**5-2 Future plans:**

The Iraqi government seeks to prepare strategic plans to shift towards the use of renewable energy, especially after signing the climate agreement that aims to reduce greenhouse gas emissions by preparing a plan to reduce those emissions, as the plan included financing the reduction operations by 15% and with a financing amount of up to (100) billion dollars for a period extending from 2021 to 2030. Among the goals of this plan is to reduce dependence on fossil energy sources and develop renewable energy sources as follows:

**5-2-1 Central Bank Initiative:**

In 2021, the Central Bank of Iraq launched an initiative to finance renewable energy projects, aiming to support sustainable solutions and reduce the effects of climate change by allocating (1) trillion dinars to support clean energy. Coordination took place between the Ministry of Environment and the Central Bank to support electricity production through solar energy, and to work to ensure a certain percentage of this production generated from renewable energy sources in investment residential complexes benefiting from this initiative(Central Bank of Iraq,2022), as well as working with other banks to finance the purchase of solar energy systems by citizens. The Central Bank also installed solar energy systems in the center building and called on other banks to install these systems as well. The following is the amount of loans granted to support the solar energy system:

**Table 6 Loans granted to build the solar energy system in Iraq**

| beneficiary | Residential units and small projects | | | | Medium projects | | | Residential complexes |
|---|---|---|---|---|---|---|---|---|
| Power Amount KW | 3 | 3.7 | 5 | 6 | 30 | 50 | 100 | 500 |
| Number of amperes | 11 | 16 | 22 | 27 | 135 | 225 | 450 | 2250 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Maximum loan limit (million dinars) | 7 | 10.5 | 15 | 18 | 70 | 107 | 206 | 1000 |

Source: Central Bank of Iraq, Financing Electricity Systems from Renewable Energy, 2022.

It is noted from the above table that the Central Bank has included various residential and economic units in the loan amount to encourage the use of electricity generated from solar energy, as the amount of the loan allocated to residential units amounted to about (7) million dinars to produce (3) kilowatts of electrical energy, while it granted between (7-206) million dinars to medium industrial and commercial projects to produce approximately (135-450) kilowatts. As for the largest share of the loan, it was for residential complexes and large industrial projects to produce approximately (500) kilowatts with a loan amounting to (1000) million dinars. To encourage borrowing and support these projects, the Central Bank grants these loans without interest and for a repayment period of approximately (5) years. Benefiting from this initiative will greatly contribute to ensuring the continuity of electricity and reducing the frequent power outages suffered by citizens, especially during the hot summer months, especially with the expansion of investment residential complexes, the number of which has increased significantly in recent years, which reduces pressure on the national electricity system and reduces the volume of imports of gas and electricity from neighboring countries, and thus will contribute to saving huge sums that can be used to develop other economic sectors and contribute to the growth of the gross domestic product.

**5-2-2 Photovoltaic energy production plans:**

Solar energy in Iraq opens a window of hope to confront the electricity crisis represented by its frequent outages, which reach about (10) hours a day. What supports the efforts are the large resources of unexploited renewable energy, including solar brightness, in which Iraq excels over many countries, including European countries(Ahmed,2020). However, the use of this energy has not risen to the required level, and therefore the government seeks to exploit solar energy in an effort to cover a third of Iraq's electricity needs, despite the difficulties it faces in reducing the focus on fossil fuels. It has sought to conclude contracts with international companies with the aim of establishing solar power stations, reducing dependence somewhat on fossil fuels, and meeting the requirements of the national system for electrical energy. The following table shows the volume of investments directed towards solar energy:

**Table 7 Planned solar energy projects in Iraq**

| Investing company | First stage capacity (MWac) | location | Total capacity |
|---|---|---|---|
| TOTAL | 1000 | Artawi | 1000 |
| Abu Dhabi Future Energy | 1000 | Amara | 100 |
| | | Ur | 450 |
| | | Ramadi 1 | 100 |
| | | Ramadi 2 | 250 |
| | | Mosul | 100 |
| SCATEC | 525 | Karbala | 300 |
| | | Alexandria | 225 |
| POWER CHINA | 750 | Samawa | 750 |
| ACWA POWER | 1000 | Najaf | 1000 |
| GULF POWER | 550 | Abu Al-Khaseeb | 100 |
| | | Al-Batha | 200 |
| | | Al-Islah | 250 |

| | | | |
|---|---|---|---|
| PHANSA | 150 | Al-Khader | 50 |
| | | Ramla | 50 |
| | | Jassan | 50 |
| European- Jordanian | 80 | Sawa 1 | 30 |
| | | Sawa 2 | 50 |

Source: Republic of Iraq, Ministry of Electricity, Department of Studies and Planning, Solar Energy Report, 2021.

It is noted from the table above that the government distributed investment projects related to solar energy in all regions of Iraq to include the largest possible number of photovoltaic energy. The French company (Total) will build solar panels in southern Iraq for the regions of (Artawi and Al-Amari) with a capacity in the first phase of up to (1000) megawatts. As for the Emirati company (Abu Dhabi Future Energy), its investments were distributed in the regions of (Amara, Ur, Ramadi, Mosul) and it is planned to produce about (1000) megawatts in the first phase. As for the Norwegian company (Scatec), it is expected to invest in solar energy in the regions of (Karbala and Alexandria) with a capacity of (525) megawatts. The company (Acwarower) will focus on Najaf Governorate with a capacity of (1000) megawatts. As for the company (Guif Power), it will focus on the regions of (Abi Al-Khaseeb, Al-Batha, and Al-Islah.).With a production capacity of up to about (550) megawatts as a first phase, while the (Phansa) company will be in the areas of (Al-Khader, Ramila, Jassan) with an initial production capacity of up to about (150) megawatts, and finally the European Jordanian company will invest in solar energy in the Sawa areas in Al-Muthanna Governorate with a production capacity of (80) megawatts. The total that can be produced from these stations will reach about (5000) megawatts, which constitutes a quarter of the current production of total energy and will contribute to providing power stations with clean energy for the environment and does not leave behind environmental pollutants, which contributes to increasing the number of hours of electrical operation for various residential and economic sectors and will directly contribute to implementing the requirements of the climate agreement.

**5-2-3 Other energy plans:**

The development of energy sources was not limited to solar energy only, but also included water energy. Despite the existence of hydroelectric power generation projects, the Ministry of Electricity seeks to add other generating stations to join the already established projects, most of which are located in the northern governorates, as their production capacity amounts to (69%) of the total hydroelectric power in Iraq(Hassan,2024). The Ministry of Electricity has prepared a roadmap for renewable energy projects in partnership with major international companies specialized in this field. The projects include the establishment of hydroelectric power stations for water dams, as shown in the following table:

**Table 8 Planned hydroelectric power stations in Iraq**

| Dams | Bakhma | TICK TICK | The guesser | Badush | Baghdadi | mandao | Azim |
|---|---|---|---|---|---|---|---|
| Power size (mw) | 1500 | 300 | 24 | 171 | 300 | 620 | 27 |

**Sources** : Duaa Marzouq Hassan, The Role of Crude Oil in the Global Energy Balance and Alternative Energy Strategies, Al-Qadisiyah University, 2024.

The planned projects constitute a significant addition to the electrical energy system. If completed, they will contribute significantly to supporting this system and reduce dependence on fossil fuels. They will also contribute to raising the level of Iraq's contribution to hydroelectric power, as Iraq ranks second among Arab countries producing hydroelectric power with a production capacity of about (2,436) gigawatts, which makes Iraq one of the important countries in producing this energy

and contributing an important role in reducing climate change resulting from global warming associated with the use of fossil fuels.

In addition to these sources, Iraq seeks to exploit biomass sources to generate electricity, as Iraq seeks to establish a waste incineration project using the integrated grid incineration method and produce electricity, which contributes significantly to investing in renewable energy and achieving sustainable development of resources. The project will be established in the city of Nahrawan in Baghdad, where (3000) tons of waste will be treated daily by the method of complete incineration, which does not cause any air pollutants according to an advanced technology that is considered fourth generation with almost zero emissions, to contribute first to supporting the electrical energy system(Mohammed,2021), as it will generate an amount of (75-80) megawatts/hour, which can be increased through the future development of the technologies used, as the increases may reach double. The second benefit of this project is to stop the deterioration of areas of land, as this waste consumes the equivalent of (2) dunums of land, and thus it will reduce the areas allocated for this waste and it is possible to make them green spaces that are friendly to the environment. For the same purpose, a contract was signed with the Chinese company (Camce) to establish a waste recycling and electricity generation plant in Diwaniyah Governorate, which will contribute to improving the economic situation by providing job opportunities, in addition to the main objective of this plant, which is to produce electricity.

**6- Results:**

Iraq has multiple renewable energy resources, such as the sun's rays, the Tigris and Euphrates rivers and their tributaries, in addition to other resources, all of which are factors that help in benefiting from these resources and using them to generate the energy necessary for various activities. Despite these available components, this has not been invested in the required manner, as Iraq still relies heavily on fossil fuels as a primary source of energy, as the percentage of reliance on them constitutes 98% of the total energy produced. After signing the climate agreement that stipulates reducing greenhouse gas emissions, and in an effort to increase electricity, signs of interest in developing renewable energy sources began to appear on the horizon, especially with the preparation of plans set by government agencies in this field by concluding partnership contracts with a group of international companies specialized in the field of renewable energy development, as the plan included financing the reduction operations by 15% and with a financing amount of up to (100) billion dollars for a period extending from 2021 to 2030. The total that can be produced from these stations will reach about (5000) megawatts of hydroelectric power and (2000) megawatts of hydroelectric power, which constitutes a quarter of the current production of total energy, which contributes to providing electric power stations with clean energy for the environment.

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