

Prospects for Future Competition Between Renewable Energy Sources and Fossil Fuels in the Global Energy Markets Basra University of Oil and Gas

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Abstract

The global energy system is witnessing the beginnings of a transitional phase, from a state of total dependence on fossil fuel sources to a new era in which other energy sources play an important role in compensating for the continuous increase in energy demand, despite the fact that alternative sources of fossil fuels face a major challenge represented in the abundance of Fossil fuels. Lower costs. Ease of production and use, but this abundance may fade as a result of continuous intensive use and costs increase with decreasing reserves, and according to theories of depletion, this matter is soon due to the increasing use of fossil fuels, and for this reason and other reasons. This led to the rush of many industrialized countries to search for alternative energy sources that meet their needs. And to ensure the provision of energy in the future, especially after the emergence of the theory of depletion of fossil fuel resources represented in coal, gas and oil, and the guarantee of industrialized countries. The possibility of achieving the economic, political and environmental goals that you plan to reach in the future. Despite the variety and multiplicity of alternative or renewable energy sources and their spread in different regions of the world, the process of exploiting them on a large scale faces many obstacles, including technological and economic limitations, and although technological progress has overcome many obstacles in the field of energy renewable, but economic hurdles remain. One of the most important economic obstacles is the issue of high costs, which determined the tendency of countries to choose alternative energy sources. It is worth noting that the development of the use of alternative sources will directly affect the countries that produce fossil energy sources, especially in the economic aspect, as most of those oil countries depend on the revenues achieved from the sale of oil, gas and coal. Especially after the increasing calls for reducing environmental polluting emissions resulting from fossil fuels and their environmental damage. The research discusses in a focused and accurate manner the expected future competition in the global energy markets between fossil fuels and other renewable sources, which are less harmful to the environment and are inexhaustible, being renewable.

Keywords: *Fossil fuel, Renewable Energy, Energy shifts, Energy security, Energy markets.*

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Introduction

When discussing the issue of energy alternatives and their replacement of fossil fuels, this matter is not related to the existence of a shortage of fossil fuels, but rather to the orientation of countries in general and industrialized countries in particular to energy alternatives, due to the presence of several problems related to fossil energy sources, including political problems related to the desire of industrialized countries to prevent restrictions. Obtaining fossil energy (oil and gas) at low prices, in order to reduce the costs of producing goods and services and increase competitiveness between producers. The other is related to environmental pollution and the pollutants left by fossil fuels that are thrown into the environment, causing severe harm to life.

It should be noted that the process of sustainable development requires some important matters that must be placed at the forefront of the priorities that planning authorities take into consideration, the first of which is reducing the demand for depleted energy sources and promoting sustainability. And striving to find energy sources that contribute to ensuring energy supplies for all, especially clean and sustainable sources, because oil is still at the forefront of energy sources compared to other types, whether depleted or renewable sources, but due to various factors and variables such as low proven reserves and environmental effects resulting from combustion. Fossil fuels, many countries tended to develop and diversify energy sources, and began to shift towards the use of renewable energy to achieve sustainable development and enhance energy security, because most of the problems that the world faces are suffering from and we are witnessing at the present time in the issue of obtaining energy sources, means of supply and methods of transportation, This is due to the role of energy in developing the economies of countries and its general role in advancing development. and raise growth rates.

The world may witness a move towards other sources due to the presence of indications of this, including raising investment rates in alternative energy industries by many industrialized countries, and stimulating scientific and research centers to strive to reduce the costs of producing alternative energy. And the preparation of specialized studies on the process of moving to those sources, and this process is moving at an accelerated pace, but the transition process needs time in order to adapt industries and equipment based on alternative sources using appropriate technologies and equipment.

Research importance:

The importance of the research lies in its connection to energy sources and their role in human life, as well as highlighting the concepts of renewable energy and explaining its economic, environmental and social importance, and the need to keep pace with the changes taking place in the global energy system and the gradual introduction of renewable energies in multiple uses.

Search goal:

The research aims to:

1- Analyze the reality of the current energy system, which is led by fossil fuels, and the possibility of continuing this system in light of the challenges

faced by fossil fuels, which may, over time, lead to a decrease in its role and importance in the hierarchy of energy sources in the world

and its decline with other alternatives.

2- Statement of the role and importance of renewable energy sources, with reference to the importance of the global transition towards renewable energy.

Research problem:

The global energy system, which is based on (fossil fuels) or what is called depleted resources, faces

problems and challenges represented by the inability to meet the energy needs of the global economy without harming the environmental system, especially in light of the increasing demand for energy.

Research hypothesis:

The research stems from the hypothesis that fossil fuels represented by oil, gas and coal face great challenges, the most important of which are the challenges of depletion and pollution, which will lead to a decline in demand for them over time and the world. It may leave the time of fossil energy and go towards alternatives that are less polluting and pay attention to the economic and environmental aspects of the alternatives.

Search limits:

The research discusses the spatial aspect of all countries of the world, while the time aspect is determined by the period from 2008-2022.

Research Methodology:

The researcher uses the descriptive analysis method based on the data taken from its official sources with some quantitative aspects and the preparation of brief tables.

Research Structure:

To support and prove the research hypothesis, the research was divided into three sections:

The first topic: the researcher deals with the theoretical aspect of the concepts of fossil fuels, represented by coal, gas, and oil, with an explanation of some statistics on global reserves and their locations.

The second topic: This topic was devoted to discussing the issue of alternative energy sources, the concepts associated with them, their advantages and disadvantages, their locations in the world, and the most important countries that exploit them.

The third topic: This topic discusses the reality of the transformation of fossil energy fields into renewable energy, and an explanation of the concepts of this transformation and its relationship to sustainable development and energy security.

Previous studies

1- Emad Tikawasht, (2012), The reality and prospects of renewable energy and its role in sustainable development in Algeria, master's thesis, Hajj Lakhdar University.

The researcher seeks to clarify some concepts related to renewable energy and sustainable development, and discusses the role of renewable energies in

Achieving sustainable development by studying the situation in Algeria, and among the findings of the researcher:

- Renewable energy sources can reduce the quantities of oil and gas used in the production of electricity, and therefore these quantities can be utilized in areas that achieve greater profits.

The economic return from the use of renewable energy is sometimes twice the return that can be obtained from fossil fuels, and this is despite the fact that the cost of exploiting renewable energies is still relatively high.

2- Hallam Zaouia, (2013), The role of the economics of renewable energies in achieving sustainable economic development in the Arab countries, University of Setif.

The researcher provided an explanation of the role played by renewable energies in achieving the goals of sustainable economic development in the Arab countries. The study reached a set of results, including:

- There are optimistic expectations in the field of exploration, extraction and refining because technological developments will translate into more reserves, which means increased reliance on fossil fuels.

Renewable energies have an important role in achieving the dimensions of sustainable development, and their development projects contribute to achieving economic gains, improving social conditions, and preserving the environmental heritage for future generations.

- Foreign investment is the best way to support the course of energy transitions in the Arab countries, by improving productivity, contributing to lower prices, optimal use of available resources, importing skills and expertise to host countries, and transferring modern technology.

3- Sybil Raquel, Julia Pfaff, (2021), Sustainable Transformation in the Iraqi Energy System, Al-Bayan Center for Studies and Planning.

The two researchers presented a study on the energy system in Iraq and the transition process towards a sustainable energy system. Among the most important findings of the two researchers are:

- Iraq is lagging behind the surrounding countries in terms of interest in renewable energy technologies and does not have any future planning on directing some investments in order to develop the renewable energy sector.

- The process of transitioning into a sustainable energy system helps Iraq secure electricity as an existing problem in a streamlined manner and at lower costs, and push the wheel of economic development in the long run.

- The political instability in Iraq, the abundance of oil and its dominant role in the economy led to Iraq's delay in the issue of renewable energy.

4- The study of Barkeley and Dann Kammen, (2006), issued by the University of California, under the title The Economic Impact of Renewable Energy.

The study discusses the economic effects of closing one of the paper mills in the city of New Hampshire in the United States of America due to the inability to bear the operating costs, which led to the deprivation of hundreds of workers from work, the decline in tax revenues and the deterioration of the social condition of the population. The wind in the factory, where the station provided more than 400 direct job opportunities, and the costs of the factory fell more than it was if it relied on polluting energies. Renewable energy sources.

The first topic: Fossil fuels, concept and types

First: the concept of fossil fuels

Fossil fuels include crude oil, natural gas, and coal, and that these types are extracted from the ground, and they are called non-renewable energies because they are depleted materials, and according to the depletion theories that discussed in detail the depletion of those resources and that their reserves are limited and at risk of depletion.

Opinions differed about the source of fossil fuels. Some see that they are the remains of living organisms such as plants and animals that settled under the layers of the earth and were exposed over time to very high temperature and pressure, which led to the formation of fossil fuels. Others see that they are chemical reactions between the elements in the

ground, and there are those who see Oil is of mineral origin, formed from the exposure of metal pellets present in the ground to water vapor, and with this difference on the origin of the formation of oil, everyone agrees that oil is present in huge quantities in specific places in the world.

The term petroleum refers to all naturally occurring hydrocarbons.

Second: fossil fuel consumption

Energy in its various forms is one of the necessities for the continuity of human life and the achievement of its well-being, and modern life actively needs energy because it is a basic element for industry and the economy, as the use and consumption of energy has increased significantly in recent decades, and as a result of the tremendous developments in science and technology in various aspects, so energy sources have evolved and diversified Over time, especially with the trend towards using renewable energy to preserve the environment.

Fossil fuels are among the most widely used energy sources over the past decades, as they accounted for 86.2% of the total energy consumption in the world during the period 2009-2020, and the following table shows this.

Schedule (1)

Fossil fuel consumption (2009-2020)

power source	The amount of energy consumed. (TW h)	Percentage of total energy consumption
oil	509.800	34.3%
for coal	434.800	29.2%
Natural gas	339.300	22.8%

Source: Table prepared by the researcher based on: Energy Consumption Statistical Report of the Research Center www.ourworldindata.org/energy

It is noted from the above table that the consumption of fossil fuels in the world represents the highest percentage of the total energy consumption, as oil consumption reached (34.3%) of the total energy consumption, and this is due to the relatively low costs compared to other sources and the ease of transportation and storage, which makes it a preferred option for producers And consumers, while coal occupied the second position with (29.2%) of total energy consumption, as some countries depend heavily on it due to its availability and low costs, and natural gas constituted (22.8%) of total energy consumption.

Third - Types of Fossil Fuels:

1- Oil

A- The concept of oil:

The word petroleum is of Greek origin consisting of two words, the word Petro means rock and the word Oleum means oil, meaning that the meaning of the two words is rock oil, and man has known petroleum since ancient times in Egypt and Persia, where it was used for heating, lighting and road paving purposes, but the petroleum industry in its modern form did not Known until the middle of the nineteenth century, when Drake drilled the first well in search of oil in the US state of Pennsylvania.

There are several definitions of oil, of which it is generally called hydrocarbon materials that are formed in nature, but in the sense that is used in trade, it is called crude oil (liquid materials) and has properties that differ according to its types. Some are viscous and heavy, while others are light and less viscous and have a strong smell and color Mostly black and greenish, although there are types that differ in their colors and the degree of specific weight according to the percentage of sulfur they contain, and oil is divided into

two types, there is heavy and has an asphalt base, and there is light oil and its base is waxy, and the oil is usually mixed with natural gas, and used by the Pharaohs in embalming operations. There are several different theories about the origin of the formation of oil, and these theories agree that oil is a depletable substance. Oil is defined as a group of liquid hydrocarbons that have a special and distinctive smell, and it consists of a large group of organic compounds of up to 200 compounds and some hydrocarbons, with different and varied combinations. from him.

B - global oil reserves

As a result of the movement of scientific development and the discoveries made in the techniques of the oil industry, it has become possible to reach the places where oil is collected in the depths of the earth and estimate the existing quantities, which are called reserves, including what can be extracted economically and called the extractable reserve, which can be used and there is the confirmed reserve, which is meant. The reserves are actually present and in quantities that have been accurately counted. The processes for calculating the reserves differ according to the methods used in measurement and their extent of development. The reserve constitutes an important element in the oil industry and is a source of wealth. In the light of that reserve, the potential of the oil countries is estimated. The importance in calculating the oil reserves differs from the producing countries and oil companies. For example, oil companies benefit from it in predicting its life span, while producing countries benefit from it in future planning processes and setting the economic policy that will be followed in the production or export process.

Schedule (2)

Proven world oil reserves for 2020 (billion barrels)

Country	Confirmed reserve 2020	percentage of global reserves%	reserve-to-production ratio (R/P)
Venezuela	303.8	17.5	313.9
Saudi Arabia	297.5	17.2	73.6
Canada	168.1	9.7	89.4
Iran	157.8	9.1	139.8
Iraq	145.0	8.4	96.3
Russia	107.8	6.2	27.6
Kuwait	101.5	5.9	103.2
The UAE	97.8	5.6	73.1
America	68.8	4	11.4
Libya	48.4	2.8	339.2
OPEC	1214.7	70.1	108.3
the world	1732.4	100	53.5

Source: Table prepared by the researcher based on:

BP Annual Statistical Report, 2021, pg. 16

It is noted from the above table that the proven global oil reserves are estimated at (1732.4) billion barrels, and Venezuela ranks first with reserves amounting to (300) billion barrels, at a rate of (17.5%) of the global reserves, and the Kingdom of Saudi Arabia comes in the rank with total reserves amounting to (297 billion) Barrels, which constitutes (17.5%), and Canada ranks third with (9.7%) of the world's reserves. As for the reserve-to-production ratio (R / P), which expresses an estimate of the number of years that production will continue before the available quantities in the subsoil run out. The earth, it is worth noting, shows that the world's oil reserves will run out after approximately 53 years, based on the current world production reality

C- Oil pricing

The price of crude oil refers to the monetary value of a barrel of oil, which is equal to the US standard of 42 gallons, expressed in US dollars. There are several types of rates.

Affected by sulfur content, geographical location, or degree of density. There is the reference price, which is the standard price that is measured according to the type of oil and the place of its production compared to the oil produced in some places. It is used to reduce the competition of oil produced in some places in the world to oil produced in the United States. It is dealt with in free markets, as well as the nominal price, which expresses the cash value of a barrel for some products, such as the OPEC price, and there is the real price, which is the nominal hardship minus the rate of inflation, and there are forward prices used for payment in future contracts Pricing is done on the basis of a set of arrangements and systems established by the seven major international companies (sisters), which have developed indicators to ensure their interests in order to reduce competition with the oil produced by them. There are many factors that affect the pricing process, such as the volume of reserves, costs of industrial oil, demand and supply, economic growth rates, exchange rates and prices. Discount and speculation as well as political and climatic factors.

2- Natural gas

Natural gas is considered a clean fossil energy source because it is less harmful in polluting the environment, and man has known it for a long time and its use has evolved with the continuation of scientific development on the one hand and the evolution of human life on the other hand, and although it is a fossil fuel or non-renewable energy, the criticisms directed at it are less Of those that guide the oil, because it has some advantages that make it the best in terms of use, such as its uses. It was small, did not exceed (0.35%) in 1938, and rose to (24%) in 2013, and the reason is due to the economic and technical aspects, as oil was available in large quantities at low prices, as well as the gas industry. It needed a large amount of capital, and there was difficulty in controlling the gas, so it was burned, but now it occupies an increasing role in terms of use and trade in it.

A- The concept of natural gas

Natural gas is a colorless, odorless and flammable gas. When burning, it gives off a huge amount of energy. It is a mixture of hydrocarbon and non-hydrocarbon materials found in rocky reservoirs below the earth's surface. Methane is one of the most common gas constituents (80%), followed by propane and butane. In addition to flammable substances, it may be associated with oil, either dissolved with it or floating on the surface of the oil, or it may be independent and is called free gas.

B - global gas reserves

Gas is located in different places in the countries of the world, and the proven reserves of natural gas are the quantities that can be extracted in light of what is currently known in terms of prices and technology. The following table shows the quantities of reserves present in the world.

Table (3)

Proven global gas reserves for 2020 (billion cubic meters)

Country	Confirmed reserve 2020	percentage of global reserves%	Reserve to Production Ratio (P/R)
Russia	37.4	19.9	58.6
Iran	32.1	17.1	128.0
Qatar	24.7	13.1	144.0
Turkmenistan	13.6	7.2	230.7
United State	12.6	6.7	13.8
China	8.4	4.5	43.3
the world	188.1	100	48.8

Source: Table prepared by the researcher based on:

The annual statistical report of the British Oil and Gas Company BP, 2021, p. 34.

From the previous table, we note that the total global proven reserves of natural gas amount to (188) billion cubic meters, and Russia is the first country in the world in this field, as its proven reserves of natural gas amounted to about (37.4) billion cubic meters, or 19.9% per year. 2020 of the global reserves, followed by Iran with about (32.1 billion cubic meters) and (17.1%) of the global reserves, while the State of Qatar ranks third with (13.1%) of the total global reserves, while the ratio of reserves to production (R / P) appears The world's gas reserves will run out after about 49 years, based on current global production rates.

3- Coal

The first source of energy that man uses in his daily life is coal, and with the industrial development coal has become and remains one of the important energy sources in many countries until the previous decades were called the coal age. Some countries have large reserves of it, which makes them depend on it mainly, despite some of its defects, the high degree of pollution resulting from its uses.

A- The concept of coal

Coal is one of the fossil energy sources that was commonly used in the past centuries to mainly produce energy, and it is a sedimentary rock that is black or brown in color and is flammable, and coal. It is the remains of plants that were buried under the ground by the movements of the earth, due to pressure, intense heat, and chemical reactions, and for a long period of time they charred and froze. After being widely discovered and used, it has become economically valuable. Carbon constitutes the largest percentage of the components of coal, and it has multiple types and classifications, and the gradually higher classification is the one that contains the largest percentage of carbon and the lowest percentage of hydrogen and oxygen. On this basis, it is divided into lignite, which is of lower quality and is called brown coal. The other type is semi-continental and is mainly used as a fuel for electric power generation. There is a type called bituminous coal, which is dense coal, black in color, sometimes dark, and contains a tar-like substance called bitumen. The best quality is anthracite, as it contains (92-98%) of carbon and is mainly used for heating. When coal burns, it gives a lot of energy in the form of heat. Coal has many uses, as it is used in the production of electricity as fuel for stations, heating, and uses to run special types of engines, such as trains in the past.

b- Global coal reserves

Proven coal reserves are defined as the estimated quantities of coal that are economically viable for mining under current economic and technological conditions. (Alfred, 2012)

Schedule (4)

Proven global coal reserves for the year 2020 (billion tons)

Country	confirmed reserve 2020	percentage of the reserve Global	Reserve to Production Ratio (R/P)
United State	248.9	23.2	503
Russia	162.1	15.1	407
Australia	150.2	14	315
China	143.1	13.3	37
India	111.0	10.3	147
Germany	35.9	3.3	334
the world	1074.1	100	139

Source: The table is from the researcher's work, based on:

Institute of Earth Sciences and Natural Resources (BGR) statistics, 2021.

It is noted from the above table that the world reserves of coal amount to about (1074) billion tons, and the United States leads the global reserves of coal as it amounted to (248.9) billion tons, or 23.2%) of the total global reserves, followed by Russia with a rate of (15.1%) and then Australia ranks third with a rate of (14%) of global reserves. It is noted that coal has the highest ratio (R / P) among fossil fuels, meaning that based on current production rates, coal will run out after oil and natural gas, as the ratio shows that coal will run out after about 139 years, and this is due to the fact that coal is the most abundant source of fossil fuels.

The second topic

The concept and sources of renewable energy

First: the concept of renewable energy

Renewable or alternative energy is defined as a form of energy derived from natural sources that are renewable on their own and are inexhaustible sources, which are an alternative to fossil fuels, and include renewable energies, wind energy, sun and rain, waves and ground energy with the exception of all types of renewable energies involved in the use of resources natural without harming the environment. Usually, the purpose of using renewable energies is to solve some of the problems associated with fossil fuels. Because non-renewable energies have effects on the environment and are subject to depletion. (The Public Authority for Education and Training, 2021).

Second: renewable energy consumption

Alternative and renewable energies represented only (13.8%) of the total energy consumption in the past decade, and hydroelectric energy accounted for almost half of this percentage. Solar and nuclear.

Table (5)

Consumption of renewable energy sources (2009-2018)

power source	of total energy consumption%	The amount of energy consumed (TW h)
hydropower	6.7	99,200
Nuclear Energy	4.6	68,800
Wind Energy	1.3	18,700
geothermal energy	0.9	12,700
solar energy	0.4	5,700

Source: The table is from the researcher's work, based on:

Energy Consumption Statistical Report of the Research Center
www.ourworldindata.org/energ

From the previous table, it is noted that hydroelectric energy leads in alternative energy consumption with a rate of (6.7%) of total energy consumption, followed by nuclear energy with (4.6%) of total energy consumption in the world, while wind energy, geothermal energy and solar energy accounted for about (2.6%). of total energy consumption over the past decade, which is a very low proportion compared to fossil fuel sources such as oil and c

Third: renewable energy sources

1- Solar energy

A- The concept of solar energy: Solar energy can be considered one of the most important sources of renewable energy, and it is the most abundant and does not pose harm to the environment and it does not leave residues, because its source is light and heat emanating from the sun, and man has used it since ancient times to generate energy, and after many

attempts he was able to find the means and technologies that Help him do the job. (Hani, 2012, 96)

Solar energy is used in various fields, the most important of which are lighting and heating, and it is also used to heat water and produce steam, in addition to desalination, pumping water and generating electricity. It is expected that the importance of solar energy will increase by 2025, as solar thermal energy will contribute to the generation of 130 giga watts. Solar panels also generate electricity directly through photovoltaic cells, a technology used in power plants. (Abdul Qader, 2016, 137)

B- Exploitation of solar energy

Man used solar energy for the first time in the seventh century BC, where magnifying lenses were used for the purpose of concentrating solar radiation and igniting fire, and the Romans and Greeks used solar energy in the third century BC to light torches during their religious rituals through mirrors, and in the late eighteenth and nineteenth centuries Researchers and scientists succeeded in using solar radiation to operate furnaces on cruises, and they also used solar energy to operate steam boats. The discovery of solar cells was the product of continuous work for many years, and many scientists contributed to their discovery. This discovery was the basis on which scientists William Adams and Richard built their research, which ended with their conclusion that selenium generates electricity when exposed to sunlight in 1876, and the first solar cell was made in 1883 by the scientist Charles Fritz, and today solar cells are made of a material Silicon, not selenium, as the first solar cell was manufactured from silicon in 1954. (Richardson, 2018)

With population inflation, most countries in the world began using solar energy to compensate for the energy shortage in electricity, while a number of developed countries such as China, Germany and the United States began relying on solar energy as an alternative source of traditional energy to reduce dependence on fossil fuels, and China is the largest producer of solar energy, while India has the largest photovoltaic power station in the world with a capacity of 2,245 megawatts.

Schedule (7)

The countries that use the most solar energy 2021 (m W)

Country	total capacity	of the global total %
China	254.355	35.6
United State	75.572	10.6
Japan	67.000	9.4
Germany	52.783	7.5
India	39.211	5.5
Italy	21.600	3.0
Australia	17.627	2.5
Vietnam	16.504	2.3
South Korea	14.575	2.0
Spain	14.089	2.0

Source: Table prepared by the researcher based on IRENA – Renewable capacity statistics 2021.

From Table (7), we note that China tops the list of countries that use the most solar energy by (35.6%) of the global total. China also has the fastest solar energy program, with 49,355 megawatts of solar energy built in 2020 (Bloomberg, 2021), and occupied the United States The United States ranked second with (10%) of the global total. Annual

solar energy growth rates in the United States reached (42%) in the last decade, while Japan ranked third.

C- Advantages and disadvantages of solar energy

Solar energy is distinguished from fossil fuel sources and nuclear energy by several things, the most important of which is that it is sustainable energy, as solar energy is considered the best alternative to fossil fuel sources that include oil, natural gas and coal, because fossil fuels face many problems, the most important of which is that they are depleted sources, while solar energy is inexhaustible because it depends on sunlight, and the second advantage is that it is environmentally friendly. This is because the technology used in the production of solar energy does not affect the surrounding environment compared to fossil fuels, meaning that it is a safe and clean energy for all living organisms. Fossil fuels and nuclear energy consume or pollute a lot of water.

Despite the many positives of solar energy, there are many major disadvantages to it, including its high cost, as the initial cost of purchasing a solar system is somewhat high, and this includes paying for solar panels, batteries, wires and installation, and solar energy. The energy depends on the sun's rays that shine during the day, which results in a difference in the amount of energy collected by the solar panels according to the different seasons and the difference in time throughout the day in addition to the difference in the region. There is a huge shortage of solar energy.

2- Hydroelectric power

a- The concept of hydroelectric power

Hydroelectric energy is one of the forms of renewable energy, and it is the energy generated from the water resources stored behind dams or from the waters of the seas and oceans, and the exploitation of water as a source of energy is done by building a large reservoir in which the water is collected, then the water is left to flow at constant rates, causing the movement of turbines, which generate electrical energy. And the greater the height, the greater the energy generated from water. (Lectures on Renewable Energy, 2017)

b- Exploitation of hydroelectric energy

The idea of establishing power stations on the falls of rivers dates back to 1870, when the idea of establishing a power station in Niagara Falls was put forward, and the production capacity of the station did not exceed 3.75 megawatts, and at the same time several other stations were being established in Europe, that The amount of energy generated by these stations depends on two variables: the amount of water falling and the distance at which it falls. The higher the value of these two variables, the higher the amount of energy generated in the station. These stations operate with high efficiency, sometimes reaching 80-90 percent. (Xian, Elvi, 2008)

In the early twenty-first century, hydropower became the most widely used renewable energy source, and in 2019 it accounted for more than 18 percent of the world's total electricity generation. (Britannica, 2021)

The number of countries that produce hydroelectric energy is 150 countries, and China is the largest producer of hydroelectric energy, with an annual production rate of about 1232 terawatts per hour in 2020, while Norway has the highest percentage of electricity generation from hydroelectric energy, as hydroelectric energy generates (95%) from Norway's total electricity.

Table (8)

Most countries producing hydroelectric power in 2020 (terawatt hour)

Country	Annual production	percentage of the global total %	Contribution to local electricity production %
China	1232	28.5	17.2
Brazil	389	9.0	64.7
Canada	386	8.9	59
United State	317	7.3	7.1
Russia	193	4.5	17.3
India	151	3.5	9.6
Norway	140	3.2	95

Source: Table prepared by the researcher based on:

International Energy Agency statistics, 2020.

From the above table, it is noted that China leads the list of countries that produce the most hydroelectric power with (28.5%) of the global total, as hydroelectric energy contributes more than (17%) of the electricity produced in China, followed by Brazil with (9%) of the world total and 64.7%. Of the electricity generated in Brazil, its source is hydroelectric energy, as it ranks second in the contribution of hydroelectric energy in domestic electricity production after Norway, and Canada ranks third in hydroelectric energy production with (8.9%) of the world total, followed by the United States.

C- Advantages and disadvantages of hydropower

The world has now become dependent on hydroelectric energy as one of the most important sources of renewable energy, more than solar energy or wind energy. In 2020, hydroelectric energy generated one-sixth of the world's electricity at about 4,500 terawatts per hour, which is more than all renewable energy sources combined. (Birol, 2021)

Countries around the world depend on generating electricity from hydroelectric power, given that it is a free resource of energy, as this method uses water to generate energy, which is a free energy source, unlike fossil fuels, the price of water will remain fixed and will not fluctuate based on political and economic factors, as It is an effective source of energy generation, as about (90%) of the energy captured is converted into electrical energy, while the conversion efficiency of wind and solar energy is much lower, averaging about (59%) and (15%), respectively.

Compared to other sources of electricity such as oil, coal and nuclear energy, hydropower has environmental benefits. Although huge dams may cause environmental damage if not planned carefully, hydropower does not cause any health pollution and does not threaten the earth with great dangers such as waste. nuclear power, and carbon dioxide from the combustion of coal and petroleum. (Al-Shakil, Ramadan, 148, 1988)

But as is the case with other energy sources, hydroelectric power is not without defects, and the most prominent of these defects is the cost of its initial preparations, as the construction of dams and power stations is expensive, as the cost of building a station can reach millions of dollars, in addition to the difficulty in finding A suitable place with water supplies throughout the year, and hydroelectric power stations pose a threat to marine life, as building a dam on the river impedes the flow of water, which in turn negatively affects the organisms that live in it, and the blades of turbines in huge water dams kill fish .

3- Wind energy

A- The concept of wind energy

Wind energy is the use of air flow through wind turbines to mechanically operate generators to generate electricity. Wind energy changes significantly during the year, so it is often supported by other sources of electricity to ensure continuous power generation. (Aqua Power Company, 2020)

The wind is considered a form of solar energy, as sunlight falls in uneven amounts on different regions of the earth, which makes some parts of the atmosphere hotter than other parts, and since warm air is lighter than cold air, it rises to the upper layers of the atmosphere and is replaced by cold air, which results in The movement of air that is manifested in the form of the wind, and approximately (2%) of the sun's rays that fall on the surface of the earth are transformed into the energy of movement of the wind. (Mansour, 11, 2018)

B- Exploitation of wind energy

Wind energy began to be exploited about ten centuries ago in Europe, where it was used to grind grain or to pump water, and then it was used in land reclamation, especially in the Netherlands. These types of windmills had the ability to generate power of up to 50 horsepower, and there were some attempts Primitive in the early European immigration to America to exploit wind energy, where it was used to generate simple electrical energy for the purpose of lighting. These attempts continued until the beginning of the twentieth century, when many attempts began to design stations or windmills to exploit wind energy in a feasible economic manner.

The installed capacity of wind energy in the world in 2018 amounted to about 591,549 megawatts, an increase of (9.6%) compared to the previous year. These energies are distributed to 89 countries around the world, led by China, the United States and Germany with a percentage of (62%), and the rest is distributed to the rest of the world. . (Global Wind annual report, 2019)

C- Advantages and disadvantages of wind energy

Wind energy is one of the most widespread and growing types of renewable energy in the world, and this is due to its advantages that encourage countries to exploit it, and among these advantages is its satisfactory cost compared to its effectiveness, as wind energy is one of the lowest-priced energy sources today, in addition to the fact that it preserves the environment as it does not produce No emissions or harmful pollutants. (Mustafa, 2020)

However, the exploitation of wind energy is not without defects, on top of which is the large fluctuation in wind speed, which affects turbines or windmills, and large windmills require very large land areas, in addition to that they may sometimes cause the killing of birds, especially during the migration period. (Edward, 2014, 468)

4- Other types of renewable energies

This group includes alternative energies that are still at the beginning of their spread, either because of the unavailability of their sources such as tidal energy, or the difficulty of obtaining their own technology, and this limited exploitation is relative, as there are countries that greatly exploit these energies and seek to rely on them as an alternative to fossil fuels.

A- The underground thermal energy of the Earth

It is an alternative, clean and renewable energy source, and it is a high thermal energy of natural origin stored in the ground, and it is estimated that more than (99%) of the mass of the earth is rocks whose temperature exceeds 1000 degrees Celsius, which is equivalent to the reserve of geothermal energy at a depth of 2000 meters Under the surface of the earth produces 250 billion tons of coal. Theoretically, this amount of energy would cover the world's energy needs for the next 100,000 years. (University Theses Journal, 2016).

The geothermal energy of the earth is exploited by digging at the bottom of the earth to extend a tube with two ends in the shape of the letter U, after which water is pumped through one end of the tube towards the bottom, and then the water is pumped up to the bottom and as a result of its friction with the high temperature, the water evaporates strongly to leave the steam from The other end of the tube has enormous pressure, and at the end of the end steam comes out of it tremendously. Turbines that generate power are placed.

The total installed energies of geothermal energy in 2019 were about (15.4) giga watts distributed in 26 countries, and this type of energy is concentrated in ten countries that possess (93%) of the total installed energies, and the United States leads the world with (23.9%) global total. (Richter, 2020)

Geothermal energy is characterized by the fact that it is not affected by the change of seasons or the succession of day and night, such as solar energy and wind energy, as it is a stable and reliable source of energy to generate electricity throughout the year. In its conversion or use, in addition to its availability in very large quantities and in vast areas to most countries of the world.

Despite all the advantages of geothermal energy, it faces some problems that hinder its spread at the present time, and among these reasons is the high cost of establishing power plants using geothermal energy. very.

B- biomass energy

Biomass energy is also known as bioenergy or biofuel, and it is the energy that is obtained from the combustion of organic materials, either directly from plants or indirectly from industrial, agricultural, household and commercial products. The total bioenergy is about (14.5) million tons of equivalent barrels. And the available ones to convert it into energy are 6.6 million tons of barrels equivalent. (Mujahid, 2002, 483)

Like other energies, bioenergy has several advantages, the most important of which is that it is considered an energy available all over the world, and it is also considered an economic energy compared to fossil fuels, as it costs less than a third, in addition to that its use provides an opportunity to reuse agricultural crop residues and waste water.

However, there are some few disadvantages to this energy, including that there is evidence indicating that the consumption of plants for energy production leads to higher food prices, which has a negative impact on the poor groups in society, and bioenergy production requires large areas of land. C- Tidal energy

It is a form of water energy that converts the kinetic energy of water during tides into useful forms of energy, especially electricity. When it is close to these coasts, and the tidal phase in which a temporary drop in the water level occurs when the moon is far from these coasts or when it sets. (Abdullah, 2012, 68)

In order for tidal energy to be economically viable, the tidal height must be more than 5 meters, and therefore there are only 100 locations around the world that meet this condition, and the use of this technology in salt water exposes the metal pieces used to rust and thus requires constant care and maintenance, which It may raise the cost and thus lower the profit

The third topic

Gradual shift towards renewable energy sources

The countries of the world today, especially the industrialized countries, are striving to secure and provide their energy needs, by exploiting modern technological means in order to move towards renewable energy sources, and consider it a strategic option in the short and long term, despite the availability of fossil fuel reserves of oil and natural gas

And coal in large quantities, but continuing with the current global production rates exposes oil and natural gas to depletion during the next few decades, and this intensive exploitation caused several damages to the environment, which has become a threat to life on the planet, all these factors made many researchers, governments and international organizations seek to Reducing the exploitation of fossil fuel sources and adopting the principles of sustainable development, which stipulate the need to search for alternative sources of energy that are environmentally friendly and sustainable, so the trend towards renewable energy sources that meet all the requirements of sustainable development is added to this political aspects in the matter of securing energy supplies to restore monopoly and international problems.

First: the concept of energy transformations

The energy transition is the orientation towards the use of other sources, and the main element is the transition to environmentally friendly sources, as it refers to the transition from the current energy system (the use of non-renewable resources) to the energy mix that is mainly based on renewable resources, which implies the development of alternatives to fossil fuels, which It is considered one of the limited and non-renewable resources, in addition to some fissile fuels (nuclear fission), and the energy transition provides the gradual replacement of traditional energy by renewable energy sources, and thus the energy transition is the transition from traditional (fossil) energies to renewable energies that are characterized by their abundance and durability, For the purpose of preserving the environment and the future needs of generations, without prejudice to the energy requirements of current generations" (Abdul Razzaq, Hasnawi, 2015, 7)

Some believe that the energy transition is the transition from an energy production and consumption system based on non-renewable fossil fuels to an energy mixture with a lower carbon intensity and increasing proportions of renewable energies. One of the characteristics of the energy transition is that it differs from one country to another.

According to the mixture of energy, economic and technological capabilities, and the policies followed, which is a difficult and long path of change linked to political will, economic and environmental reality, society's culture, and transformations of fossil and alternative energy markets" (Rochu, 2018,131)

2- The motives behind energy transformations

There are three main incentives that push countries to move towards renewable energy: (Xian, Elvi, 2008, 3)

1- Energy security: as most expectations indicate that the dwindling oil and gas reserves and the current increase in global energy consumption will eventually lead to the disappearance of this vital source of energy, and therefore the need to think from now on finding other alternative sources.

2- Concern about climate change: Renewable energies can contribute to securing energy needs while reducing greenhouse gas emissions. Several sources reported that the amount of greenhouse gases, such as carbon dioxide and methane, is increasing in the thin atmosphere surrounding the globe. And that this increase in the amount of gases increases the temperature rise, and many scientists and researchers believe that this rise in temperature portends potential negative and catastrophic results, and that the current time is the correct time frame to address this imbalance, and among the appropriate measures is the use of renewable energy free of carbon

3- The cost of renewable energy: which has been declining for several decades, and the cost of certain types of renewable energies is expected to continue to decline, as the cost of generating electricity from solar energy and wind energy decreased by about (85%) and (56%), respectively, between 2010 And 2020, and the reason for the shrinking costs

of renewable energies is due to the improvement of renewable energy production technology, and this shrinkage will continue during the maturity of this industry.

3-Energy conversion mechanism

There is a disagreement about the mechanisms of energy transitions between the industrialized countries' vision of the need to accelerate it and the developing countries' vision of a gradual and smart transition through the rationalization of fossil fuel consumption with an increase in the introduction of renewable energies, which are a mixture of energy that ensures the transition to safe and clean energy.

In general, the mechanism and steps of these transformations can be summarized in three main steps: (Fawzy, 8, 2015)

1- Optimal energy consumption: This is done through

- Work to reduce the energy consumption of the heating process, by isolating buildings and developing and improving heating methods.
- Developing various means of transportation through the optimal selection of vehicles that meet the requirements of sustainable development, and reducing the consumption of fossil fuel-producing materials.

Achieving electricity savings in all areas of use: in industrial processes, electrical equipment, home, and electronic office technology.

2- Considering the energy transition as the main engine for the development process: by making the economic competition of the major energy-producing companies move towards the optimal exploitation of energy sources, which enables them to exploit renewable energies as an alternative to fossil fuels.

3- Planning the energy transformation process: This process takes place by including all officials in the field of energy, according to pre-prepared plans and programs aimed at providing all energy needs without prejudice to the environment and the rights of current and future generations.

Second: The role of renewable energies in enhancing energy security

Energy security is one of the most important goals that countries are trying to achieve through their policies regarding the energy used, and although the concept of energy security is considered one of the relatively recent concepts that have been focused on and gained great importance during the past few years, the desire of countries to secure their supplies needs Energy is not a modern thing.

1- The concept of energy security

The concept of energy security is a multifaceted concept with a multidimensional nature. The concept of energy security for consuming countries is not limited to the availability of sufficient quantities of energy sources at reasonable prices in the long term (more than 50 years), but the possibility of obtaining these energy sources in a safe and continuous manner without Interruption. As for the exporting countries, this concept means the discovery of new quantities of various energy sources that guarantee the continuation of export operations in the long term. (Dandan, 2013, 52)

Winston Churchill was the first to put forward a definition of the concept of energy security, as he indicated that "energy security lies in diversity and diversity only", in 1911 when there was a discussion among British naval men about the quality of fuel needed for ships, and coal was the primary fuel at the time due to its abundance, While oil was one of the scarce sources at that time, so all opinions focused on keeping coal and not relying on other sources, but Churchill saw the need to shift towards oil, and at that time he was criticized and described as a reckless leader, because Iran was the only source of oil supply to Britain in At that time, Churchill defended his decision in his speech, saying

that one should not rely on one type, one method, or one country to secure energy supplies, and that diversity in energy sources is the only guarantee, and from that time until now, diversity is still the governing principle of the issue of energy security. Energy security means providing adequate, reasonable and reliable supplies of energy” (Frank, 2007, 1).

However, this simple definition does not encompass the various dimensions of this concept. The concept of energy security differs according to the circumstances, purposes and parties (states, institutions, organizations) that formulate their own perception of what they mean by energy security.

Therefore, the United Nations defined energy security in 1999 as the condition or situation in which energy supplies are available at all times, in multiple forms, in sufficient quantities, and at reasonable prices.

There are concepts of energy security that are not based on linking it to achieving self-sufficiency or energy independence, but rather on the necessity of a balance between supply and demand. (Stein, Kolas, 2006, 9)

2- The role of energy transitions in ensuring energy security

The energy transition policy is a clear-cut strategy that has an effective role in achieving energy security, especially in light of the international developments of fluctuations in the prices of traditional energies, and their negative effects on the environment, in addition to being depleted energies. The energy transition process contributes to achieving energy security through: (Morshad, 2019)

1- Renewable energies are diverse and numerous, and thus it is possible to take advantage of this diversity and multiplicity by replacing them with each other, and this is the opposite of traditional energies that are characterized by their limitations, and the impact of this on energy security is shown through the indicators provided by the International Energy Agency, for example, the doubling of production Solar energy several times since 2000 to 2015, at a growth rate estimated at about (17%) annually, and is expected to double by 2030 to twenty times, while the demand for solar energy doubles about 20 times, the demand for oil hardly doubles once, Solar energy is expected to become the primary source of global energy by 2050.

2- The effects of the development of the industry appear in general on alternative energies, as research, development and investment in this field will be profitable in the long term, as it is a stand-alone industry and can create large markets, in addition to being a clean and wonderful industry. A non-polluting industry that contributes to preserving the environment, and most importantly, it is an energy that is not politicized, that is, it is not subject to considerations of international conflicts and political interests, as is the case with traditional energies.

3- Renewable energies provide sufficient guarantees to achieve the desired energy security globally, by not limiting energy production to specific sources. If traditional energy sources are available in a number of regions and countries around the world, then renewable energy sources are present in all countries of the world, even if their availability is limited. uneven.

4- Opening research centers to study the energy transition process. We transform renewable energies and gradually abandon traditional energies, which contributes to bringing about a scientific revolution in the field of renewable energies, and thus becomes a popular industry in the medium or long term, and this enables us to meet the various future energy needs as they are renewable and character

Third: The role of renewable energies in achieving sustainable development

1- Sustainable development

The concept of sustainable development combines two basic dimensions, namely development as a process of change and sustainability as a time dimension. Development is defined as “a comprehensive, continuous economic, social, cultural and political process that aims to achieve continuous progress in the lives and well-being of individuals” (Qasim, 2007,19).

As for sustainability, it is defined as “the continuity of natural resources for present and future generations and the preservation of their characteristics” (International Commission for Environment and Development, 15,1987).

The United Nations defined sustainable development through the report of the World Commission on Environment and Development in 1987 as "that development that meets the needs of the present without compromising the ability of future generations to meet their needs."

Some specialists believe that sustainable development is a set of policies and procedures that are taken to move society to a better position using appropriate technology for the environment, to achieve a balance between building natural resources and destroying them in light of a local and global policy to maintain this balance. It is the need to use non-renewable natural resources in a way that does not lead to their annihilation or diminishing the share of future generations, by preserving a stable balance of natural resources such as soil, groundwater, minerals and biomass (Khalil, 2018, 58)

From the foregoing, it can be said that sustainable development is distinguished according to the nature of the entity you know. From an economic point of view, sustainable development refers to the continuity and maximization of economic welfare for the longest possible period. From an environmental point of view, the concept of sustainable development refers to the existence of environmental limits, meaning that each natural system has certain limits that cannot be crossed by consumption, and any violation of these limits leads to irreversible deterioration in the ecosystem. On the other hand, the social perspective of sustainable development sees that the human being is the essence of development and its primary goal, and focuses on social justice, combating poverty, distributing resources, and providing social services to all those in need.

2- Renewable energies and the economic, environmental and social dimensions of sustainable development

The most important goal of sustainable development is preserving the rights of future generations to natural resources, which is the goal achieved by renewable energies, as they are sustainable energies that are not exhausted by continuous consumption. Renewable energies also contribute to achieving significant financial returns, which guarantees the economic dimension of sustainable development, in addition to the electricity connection To isolated areas through renewable energies contributes to achieving the social dimension of sustainable development

A- Renewable energies and the economic dimension of sustainable development

Many studies indicate that the volume of global reserves of fossil fuels is constantly decreasing, and that this energy wealth is inevitably depleting, which threatens the economies of countries whose revenues depend on fossil energies, and fluctuations in oil prices make these resources a renewed threat to budgets Oil-exporting countries, from this point of view, it is necessary to move towards exploiting renewable energies to diversify the sources of income of these countries and ensure their energy security, in addition to the energy transition that would achieve great economic returns, since once renewable energy stations are built, power generation does not cost anything, and this This ensures the continued availability of energy at an appropriate and regular price.

This energy transition also leads to the provision of job opportunities, as a new report issued by Canada indicates that the transition from the use of fossil fuels to renewable energies has increased job opportunities in the energy sector by (37%).

B- Renewable energies and the environmental dimension of sustainable development

The environment has become an essential dimension of sustainable development, due to the negative effects of pollution on the climate and the fact that many natural resources are non-renewable, which necessitates their exploitation according to rules that preserve their survival and rational exploitation. (Qaddy, 24, 2006)

Also, one of the most prominent environmental effects associated with the exploitation of fossil fuels is the phenomenon of global warming, which leads to a rise in the earth's temperature as a result of the increased concentration of some gases in the atmosphere, the most important of which is carbon dioxide. harmful to the environment. (Talibi, Sahel, 2008, 205)

C- Renewable energies and the social dimension of sustainable development

Among the goals of sustainable development is the achievement of social justice, through the promotion of the educational and health level of the members of society, and the fight against all social phenomena and ills that affect the unity of society and limit the guarantee of a decent life for its members, as the limited energy services lead to the marginalization of the poor groups and reduce their ability to improve conditions Living, about a third of the world's population does not have access to the necessary energy sources, while it reaches the other third in a weak way, and the dependence of the population of rural areas on fossil fuels for heating and cooking has negative effects on the environment and the health of the population, in addition to that there is still a large discrepancy between countries In terms of energy consumption rates, rich countries consume energy at a rate that is 25 times more per capita compared to poor countries, and investing in renewable energies would achieve important social dimensions by ensuring the fair distribution of wealth and energy resources and providing services to all members of society without discrimination.

Conclusions and recommendations

First: conclusions

1- Through the course of the research, the hypothesis of the research has been proven of the importance of a gradual transition towards renewable energies in light of the increasing difficulties faced by fossil fuel sources, which are described as depleted.

2- There is a close relationship between fossil fuels and energy alternatives, as the prices and quantities of fossil fuel sources affect the extent of the spread and exploitation of alternative energy sources, as high fossil fuel prices lead to increased dependence on alternative energy sources and vice versa.

3- Despite the negative effects of fossil fuels on the environment, and the constant fluctuations in global prices, it still constitutes a large percentage of energy consumption, exceeding (80%) of the total global consumption.

4- Oil is threatened with depletion before other sources of fossil fuels, due to its limited reserves and its current high production rates.

5- The oil-producing countries should develop investments in renewable energies and gradually expand their exploitation to face the post-oil era.

6- Renewable energies have the most important role in achieving the dimensions of sustainable development, as their projects contribute to achieving economic gains, improving social conditions and preserving the environment for current and future

generations. Renewable energies also contribute to enhancing energy security, whether for consuming or exporting countries.

Second: Recommendations

1- The rational behavior of any country requires that it keep pace with the changes in the global energy system, and that it strives seriously to support efforts to gradually introduce a renewable energy system within its energy production system so as not to lag behind the global development.

2- Research and scientific centers must be encouraged in the field of exploiting renewable energies, especially in oil-producing countries, in anticipation of dependence in this field on developed countries in the future.

3- Benefit from the experiences of countries in the field of renewable energies in order to apply these experiences, and seek the assistance of foreign companies that have experience in this field.

4- The oil-producing countries should rationalize oil consumption by relying on renewable energies that contribute to reducing the dominance of oil in the economy, diversifying it,

and moving away from the unilateral economy.

5- Providing financial support for the establishment of small-scale projects to generate electricity through renewable energies, especially in rural and remote areas, whose cost will be relatively low on the one hand and contribute to a partial solution to the electricity crisis on the other hand, in addition to that it will form the correct basis for acquiring the required experience when establishing Big projects in the future. Sources.

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