

Renewable Energies as a Future Strategic Trend to achieving the Environmental Sustainability: Solar energy and Wind energy as a model

الطاقات المتجددة كإتجاه إستراتيجي مستقبلي لتعزيز الإستدامة البيئية: الطاقة الشمسية و طاقة الرياح نموذجاً

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Abstract:

In light of the increasing global demand for energy, with the possibility of depletion of these traditional energies on the one hand, and in light of the increasing deterioration of environmental systems as a result of the accumulation of waste and the increase in toxic gas emissions on the other hand, the energy transition has become a major trend in the modern world, and the supply of renewable, clean and safe energy has become a must to achieve the dimensions of sustainable development, especially the environmental dimension.

In this context, the current study aimed to highlight the role of these renewable energies as inexhaustible and environmentally friendly in achieving environmental sustainability, by focusing on solar energy and wind energy as a cornerstone. Both solar and wind energy are growing rapidly, which can contribute significantly to achieving goals set by many countries to reduce greenhouse gas emissions, as these energies were responsible for more than 10% of global electricity for the first time in the past year.

Key words: Renewable Energies, Environmental Sustainability, Solar energy, Wind energy.

الملخص:

في ظل تزايد الطلب العالمي على الطاقة بشكل كبير ، مع احتمالية نضوب هذه الطاقات التقليدية من جهة ، و في ظل التدهور المتزايد للأنظمة البيئية نتيجة تراكم المخلفات وزيادة انبعاثات الغازات السامة من جهة أخرى ، أضحت التحول الطاقوي اتجاهاً رئيسياً في العالم الحديث ، وأصبحت إمدادات الطاقة المتجددة النظيفة والأمنة أمر لا بد منه لتحقيق أبعاد التنمية المستدامة خاصة البعد البيئي منها.

في هذا الإطار، هدفت الدراسة الحالية إلى إبراز دور هذه الطاقات المتجددة بإعتبارها طاقات غير ناضبة و صديقة للبيئة في تحقيق الإستدامة البيئية ، بالتركيز على الطاقة الشمسية و طاقة الرياح كحجر زاوية. إذ أن كل من الطاقة الشمسية و طاقة الرياح تنمو بسرعة، مما يمكن أن يسهم بشكل كبير في تحقيق الأهداف التي حددتها العديد من البلدان للحد من انبعاثات غازات الاحتباس الحراري، بحيث كانت هذه الطاقات مسؤولة عن أكثر من (10٪) من الكهرباء العالمية لأول مرة العام الماضي.

الكلمات المفتاحية: الطاقات المتجددة، الإستدامة البيئية، الطاقة الشمسية، طاقة الرياح.

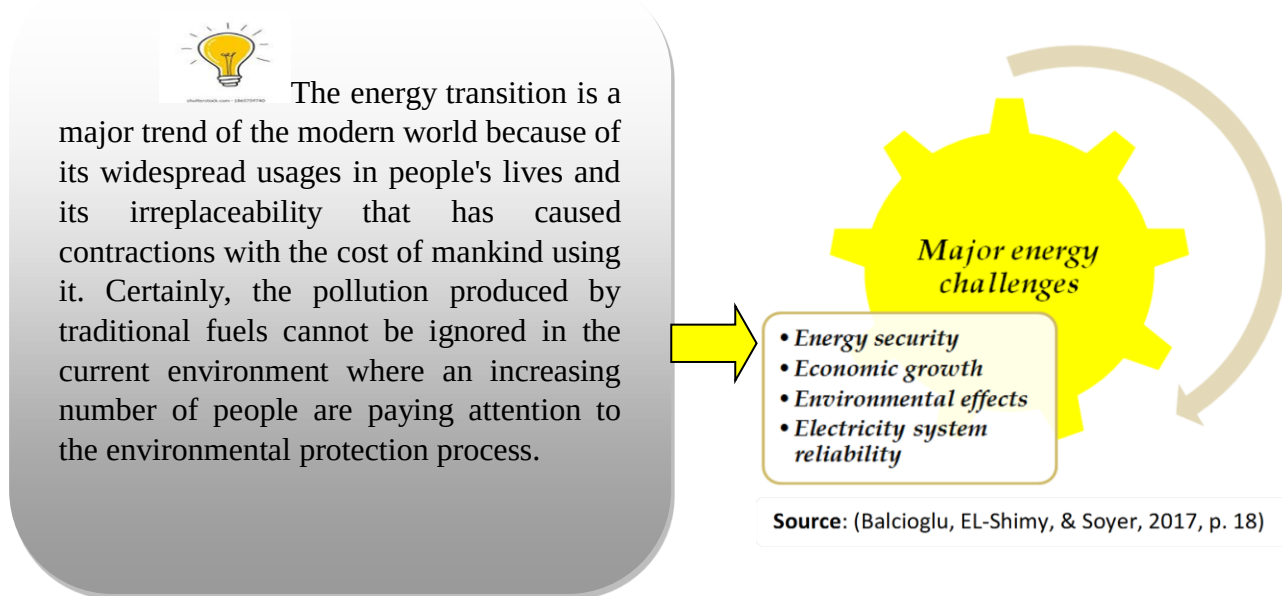
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1. INTRODUCTION

The main task of the most countries in the current century has become to search for sustainable and environmentally friendly sources of energy, in this context, various countries of the world have rushed to search for alternative energy sources that do not harm (or less harmful) the environment and are more conserving of its resources, so attention was drawn to "Renewable energies (or inexhaustible), which express clean and inexhaustible primary energy resources, which they include: solar energy, wind energy, hydroelectric energy, hydro energy, biomass, marine energy,...

So in light of the increasing deterioration of environmental systems due to the accumulation of waste, and the increase in emissions of toxic gases polluting the air as waste of traditional energy sources adopted in many countries of the world, it has become necessary to promote investment in this renewable energy as a strategic option for an inexhaustible resource on the one hand, and as an environmentally friendly alternative to traditional energy On the other hand.

Fig.1.Energy challenges



In context, this research paper is an attempt to shed light on the role of renewable energy resources to achieving the environmental dimensions of sustainable development .So we will address this in three main axes:

- Renewable energy versus Non Renewable energy: an overview
- Solar energy and Wind energy.
- Renewable energies and environmental sustainability\

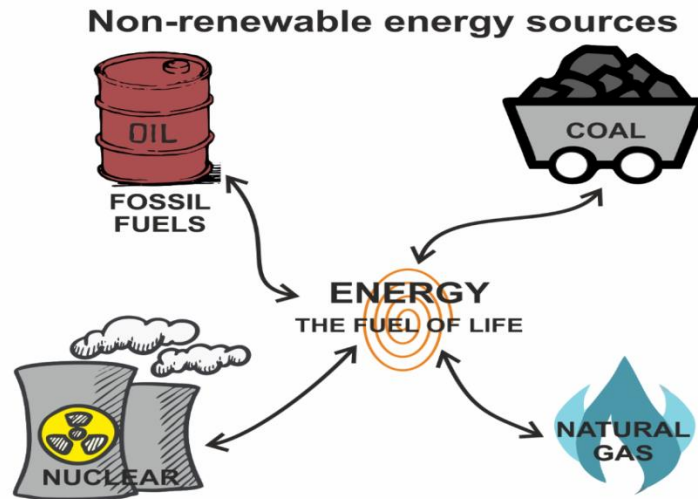
2. Renewable energy versus Non Renewable energy: an overview.

2.1. Non Renewable energy- traditional energy:-

Non-renewable energy is a source of energy that will eventually run out.

Non renewable energy resources are the most consumed energy sources in the world, they are finite, cannot be easily replaced on human timescales, and we are exploiting them faster than they are being made. There are two main types of non-renewable energy: fossil fuels and nuclear energy. See figure (2)

Fig.2.Non Renewable energy sources



Source: (indiaenergyportal.org, 2022)

2.1.1. Fossil fuels:

There are three types of fossil fuels (energyenvoys):

- ✓ **Coal** is a solid fuel which is mined from seams sandwiched between layers of rock in the Earth. Coal is the most abundant fossil fuel and supplies are expected to last longer than for other fossil fuels.
- ✓ **Oil** is a carbon-based liquid formed from fossilized animals. Reservoirs of oil are found sandwiched between seams of rock in the Earth. Pipes are sunk down to the reservoirs to pump the oil out.
- ✓ **Natural gas** comes in the form of methane and some other gases which are trapped between seams of rock under the Earth's surface. Pipes are sunk into the ground to release the gas. Natural gas is the most efficient, cheap and clean fossil fuel to convert to energy.

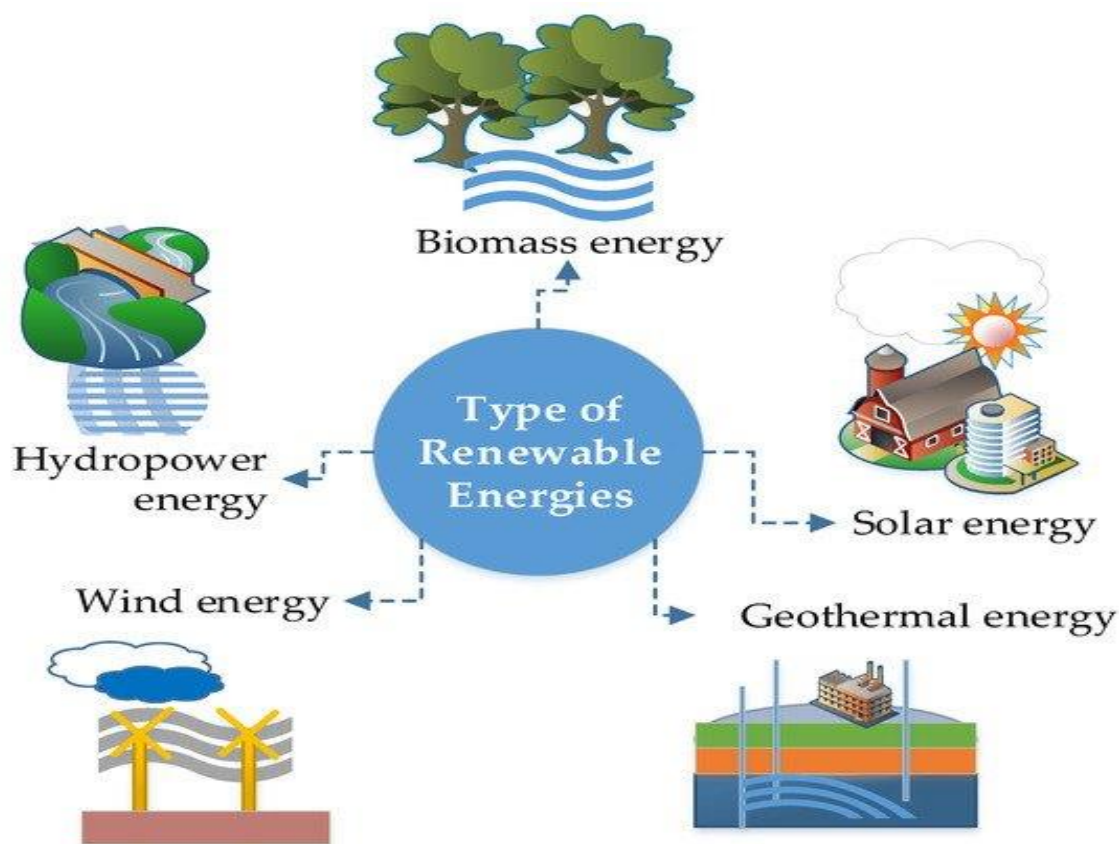
2.1.2. Nuclear energy:

Nuclear energy is the energy in the nucleus, or core, of an atom. Nuclear energy can be used to create electricity, but it must first be released from the atom. (htt3)

2.2. Renewable energy:

Renewable energy is energy that is collected from renewable resources, which are naturally replenished (inexhaustible), and doesn't harm the environment .Its principle resources are: solar energy, hydropower energy, wind energy, geothermal energy, as show in figure 3.

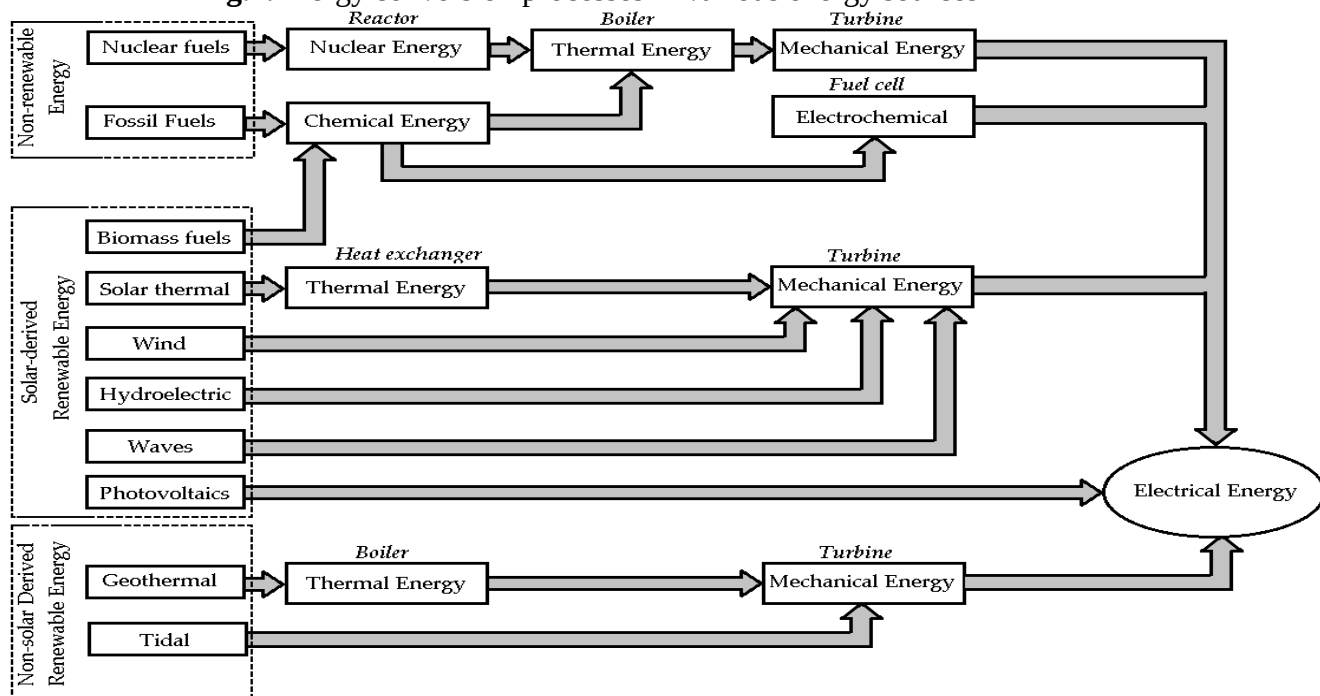
Fig.3. Renewable energies types



Source: (Ram Avtar, Netrananda Sahu , Ashwani Kumar Aggarwal, Shamik Chakraborty, Ali Kharrazi, Ali P. Yunus, Jie Dou and Tonni Agustiono Kurniawan, 2019, p. 2)

- **Solar energy:** the energy produced and generated by the sun that reaches the Earth in the form of solar radiation.
- **Wind energy:** Wind energy is a form of solar energy. Wind energy (or wind power) describes the process by which wind is used to generate electricity
- **Geothermal energy:** is the energy that can be obtained by the use of heat inside the Earth.
- **Hydropower energy:** Hydropower or hydroelectricity refers to the conversion of energy from flowing water into electricity.
- **Biomass Energy:** Biomass refers to all organic matter existing in the biosphere, whether of plant or animal origin, as well as those materials obtained through their natural or artificial transformation (Miguel-Angel Perea-Moreno , Esther Samerón-Manzano , and Alberto-Jesus Perea-Moreno, 2019, p. 2).

Fig.4.Energy conversion processes in various energy sources

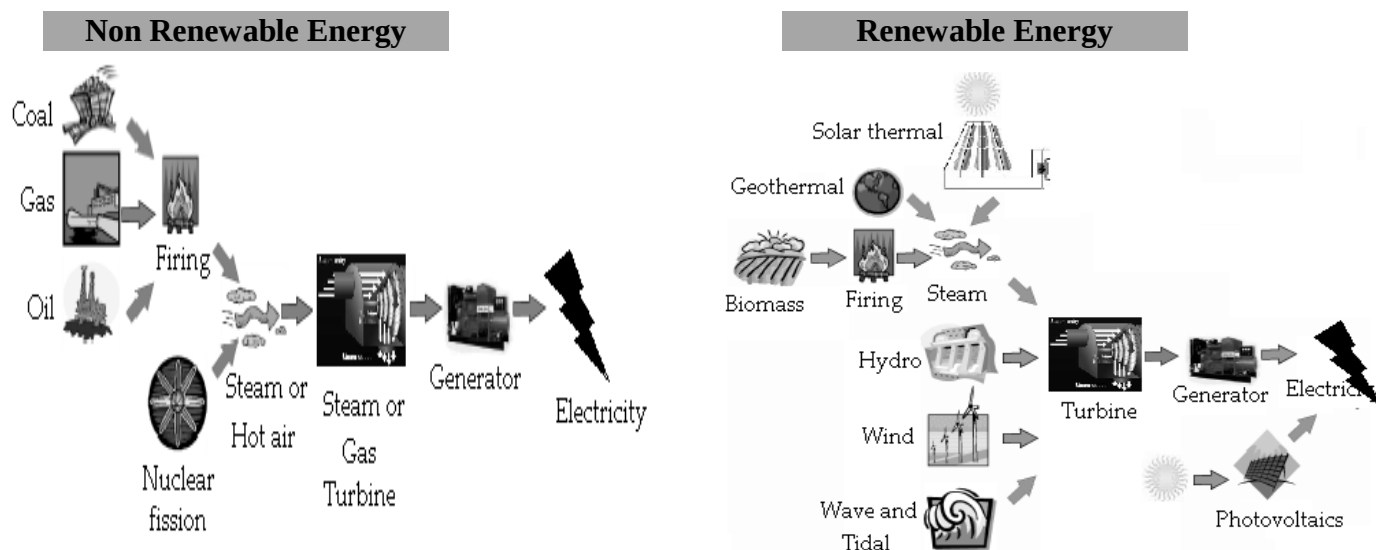


Source: (Balcioglu, EL-Shimy, & Soyer, 2017, p. 23)

For a specific energy conversion process,
many technologies are available



Fig.5.Generic energy technologies



3. Solar energy and wind energy:

3.1. Solar energy:

Solar energy is one of the purest and clean forms of energy we receive on earth.

Is quite simply the energy produced directly by the sun and collected elsewhere, normally the Earth. The sun creates its energy through a thermonuclear process that converts about 650,000,000 tons of hydrogen to helium every second.

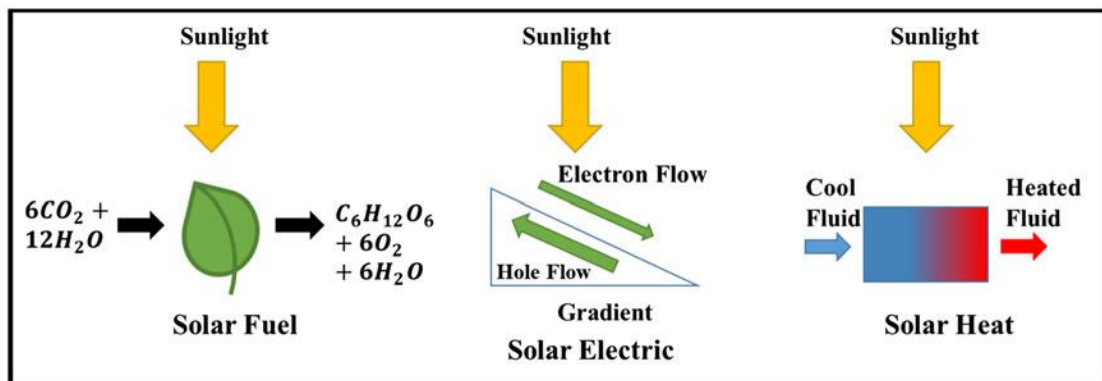
- ✓ Solar energy is a clean and renewable energy source.
- ✓ Once a solar panel is installed, solar energy can be produced free of charge.
- ✓ Solar energy causes no pollution
- ✓ Its cost is considered small if compared to the volume of production in the long run.

There are several ways to benefit of solar energy, some of which depend on the light from the sun and others depend on the heat generated by the sun. (Eldakhkhny, 2020, p. 8)

Three ways of converting solar energy into other forms of energy-see figure (6) (Hayat, Danish, Monyake, & Alagha, 2018, p. 2):

- (a) : producing chemical fuel via artificial photosynthesis
- (b) : generating electricity by exciting electrons in a solar cell
- (c): concentrating sunlight to produce heat

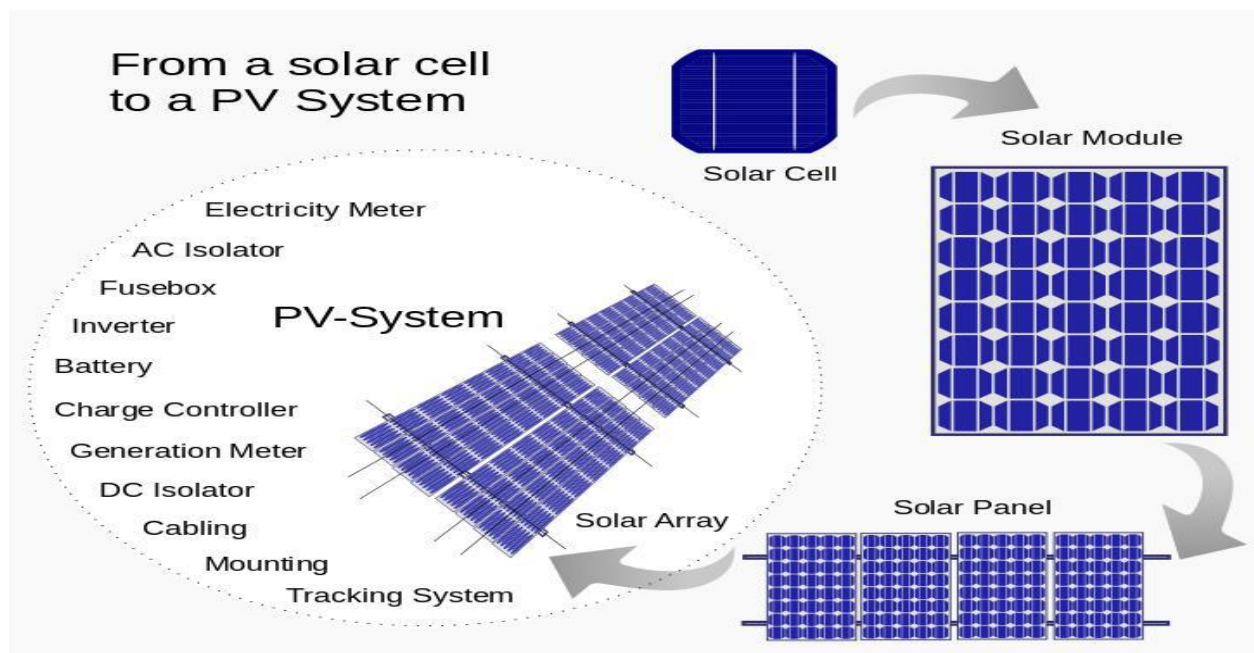
Fig.6. Solar energy converting forms



Source: (Hayat, Danish, Monyake, & Alagha, 2018, p. 2)

Solar cells are the easiest form of direct conversion from solar energy to electrical energy. But it is not only placed alone, but rather is part of the system, but it is the main and most important factor in it. As we see in figure (7), a large number of solar cells combine together to form the model or units and the group of them is called the solar panel, then a group of panels to be called the matrix and a group of matrices to be called a system of solar energy. (Eldakhkhny, 2020).

Fig.7.Solar energy systems

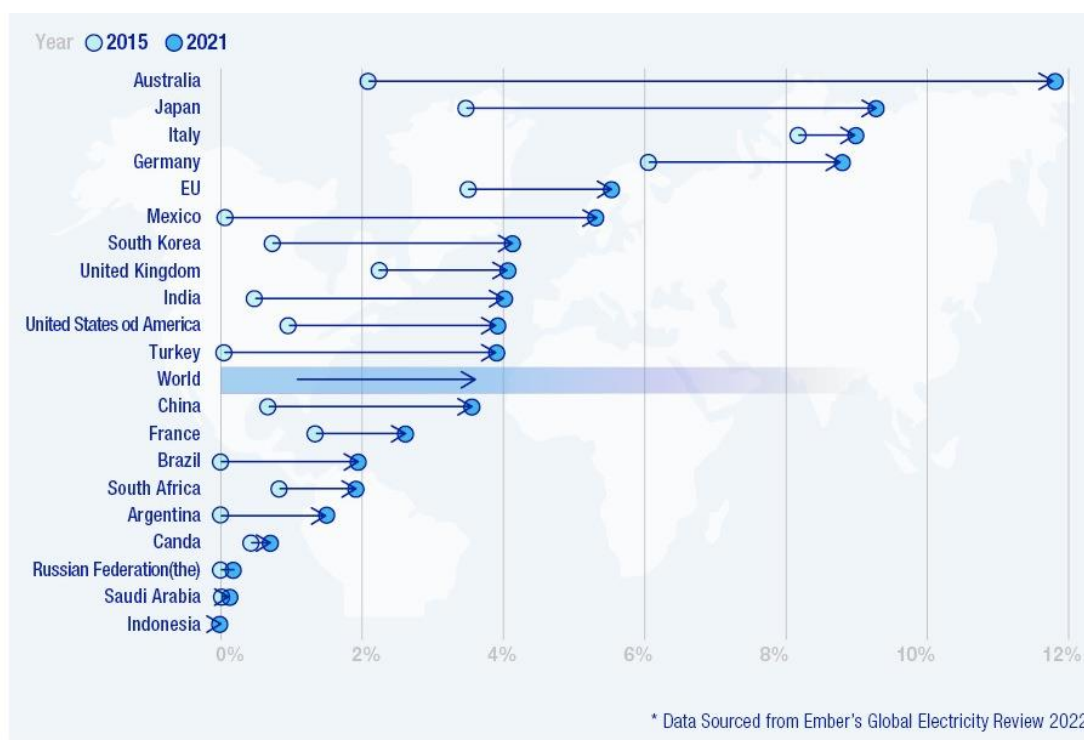


Source: (Eldakhakhny, 2020, p. 30)

Solar and wind energy were responsible for more than (10%) of global electricity for the first time last year, according to the Global Electricity Review 2022, which showed that solar generation in particular rose 23 percent last year. Solar generated (3.7 %) of the world's electricity in 2021 (Ember's Electricity Review 2022), Australia is an example, as its share of electricity made up by solar energy rose from barely 2 percent in 2015 to a G20-leading 11.79 percent in 2021.see figure(8).

All clean power is now 38% of supply, but demand growth rebounded, leading to a record rise in coal power and emissions.

Fig .8.Solar share of electricity generation for G20 countries



Source: (Ember's Electricity Review 2022)

II. 2. Wind energy

Wind power or wind energy describes the process by which the wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water), or can be converted into electricity by a generator. (energy.gov)

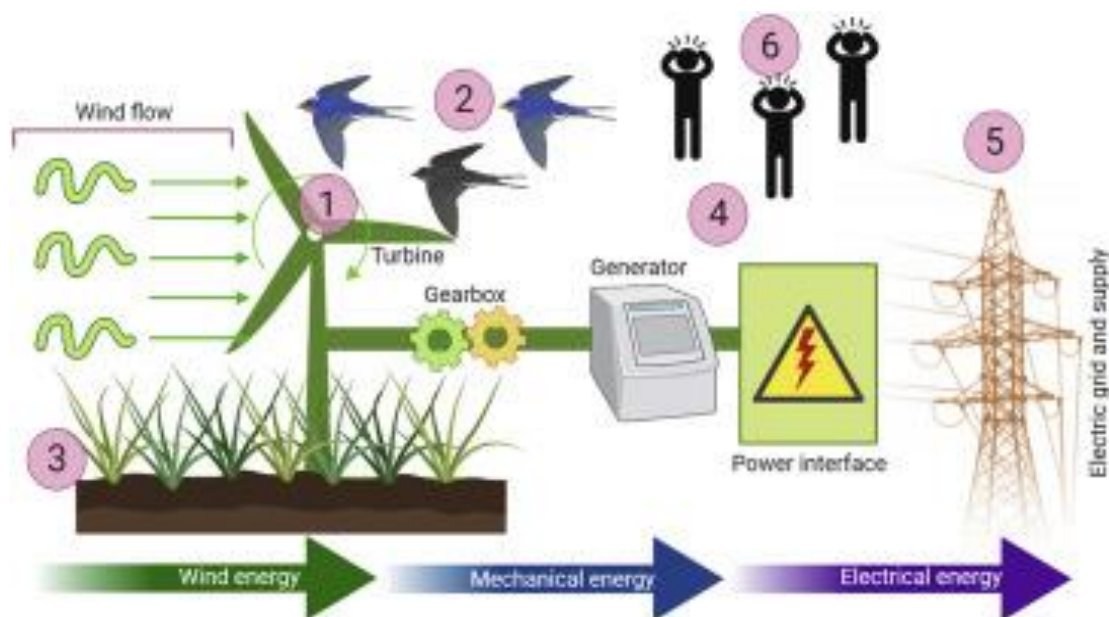
Wind turbines work on a simple principle: instead of using electricity to make wind—like a fan—wind turbines use wind to make electricity. Wind turns the propeller-like blades of a turbine around a rotor, which spins a generator, which creates electricity.

Wind is a form of solar energy caused by a combination of three concurrent events: (energy.gov)

1. The sun unevenly heating the atmosphere
2. Irregularities of the earth's surface
3. The rotation of the earth.

Wind turbines are mechatronic equipment that generate electricity from wind by first transforming wind power into mechanical power and then to electric power-see figure (9).

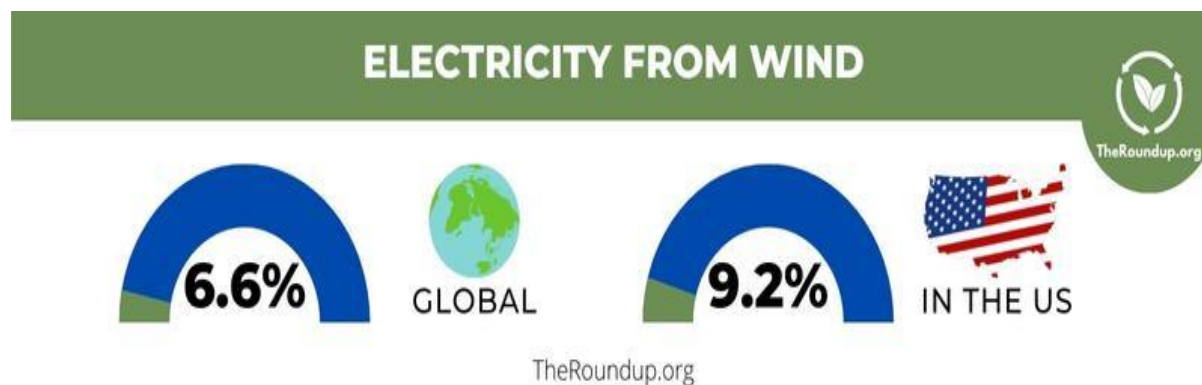
Fig.9.Electricity generation process from wind power



Source: (Muhammad Shahzad Nazir ;, Nisar Ali ;Muhammad Bilal; Hafiz M.N. Iqbal , 2020)

Global wind generation rose 14% in 2021, rising by 227 TWh to 1,814 TWh. This was the highest % growth rate in 4 years, and the highest absolute increase ever. It was the fastest-growing source of electricity after solar. Wind generated 6.6% of the world's electricity in 2021 (Ember's Electricity Review 2022) –Fig10-. China was without doubt the wind leader of 2021. 65% of the growth in global wind generation in 2021 was in China (China's previous highest proportion was 37% of global growth in 2020).

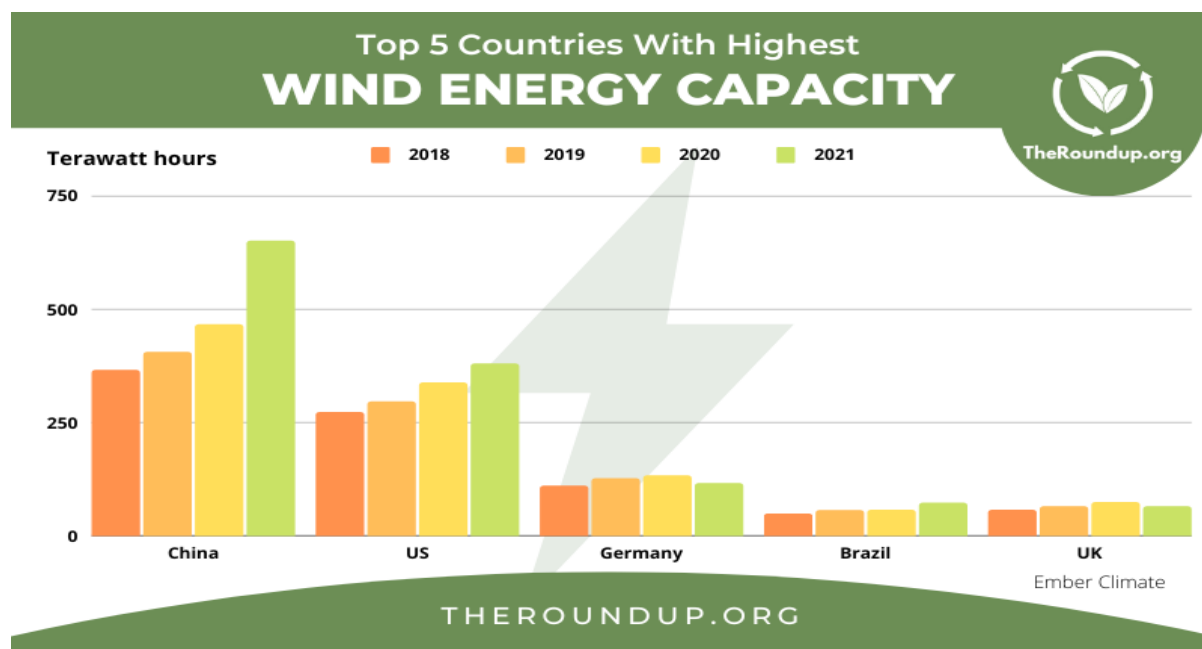
Fig.10.Wind share of electricity generation



Source: (theroundup.org)

China (650.6 TWh) produces more electricity from wind energy than any other country; just as it does from solar. The United States (379.8 TWh) is the second biggest wind energy producer. The US had led the way until 2016, but since then China's rapidly increasing wind sector has more than doubled its output.-see Figure 11-

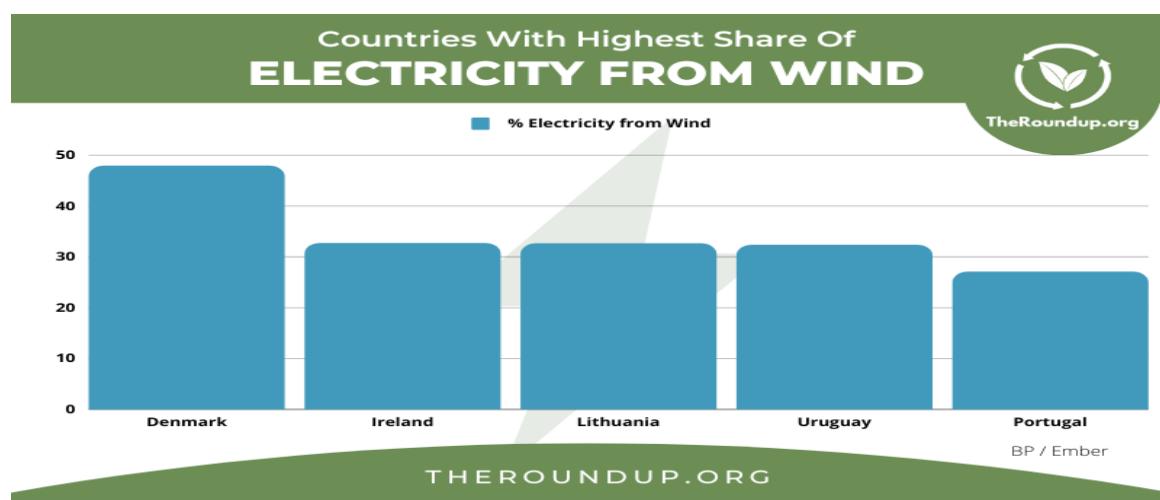
Fig.11.Top five countries with highest wind energy capacity



Source: (theroundup.org)

Denmark (47.9%) generated the most wind energy as a percentage of its overall consumption in 2021. Ireland (32.7%) and Uruguay (32.3%) were also very reliant on wind. -See figure 12-.

Fig.12.Countries with highest share of electricity from wind



Source: (theroundup.org)

4. Renewable energies and environmental sustainability

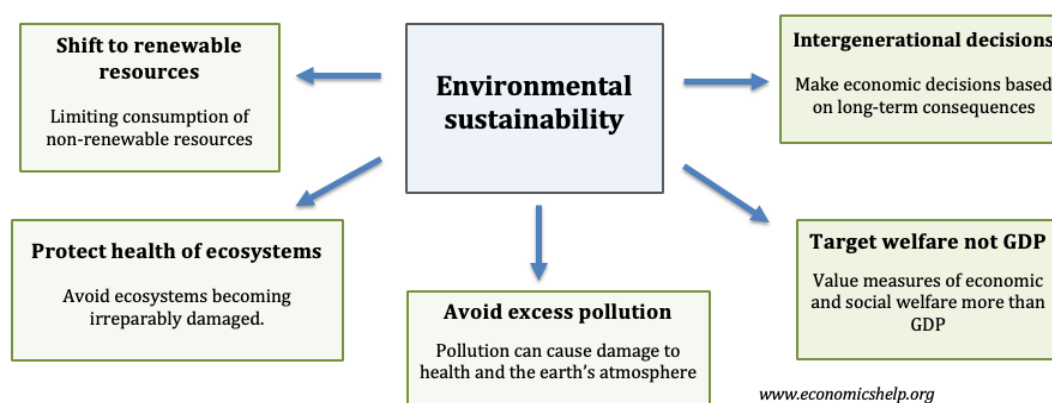
4.1. Environmental Sustainability:

The Environmental Management System (EMS) has two areas of focus: environmental compliance and environmental sustainability. (energy.gov)

Environmental sustainability is the process of maintaining development without compromising the future of our environment. Exploitation of resources, technological development, improving infrastructure, or any other development should be done in a way that does not exhaust the earth's resources. (Fesmina Faizal, 2019)

Environmental sustainability is concerned with whether environmental resources will be protected and maintained for future generations. (Tejvan Pettinger, 2018)

Fig.13.Environmental sustainability issues

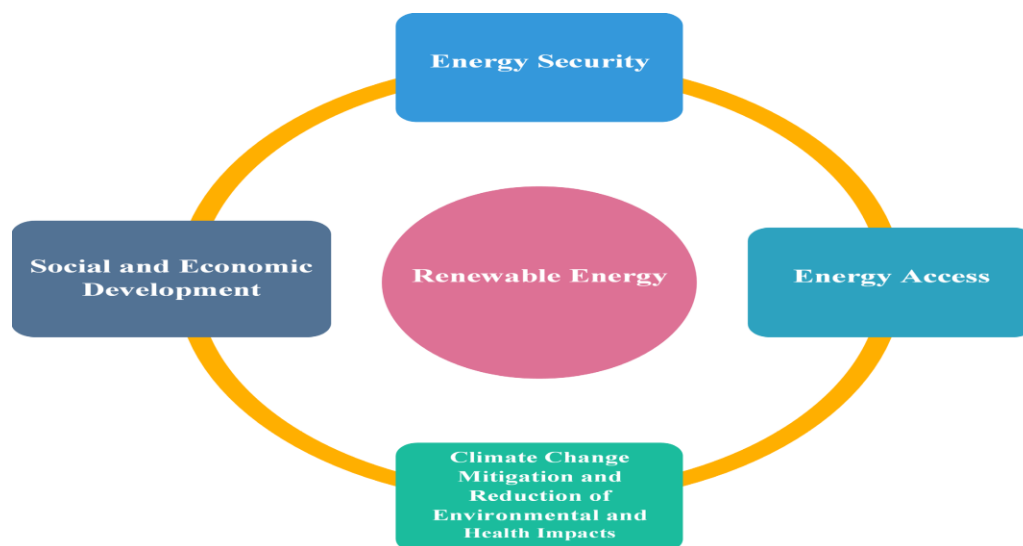


Source: (Tejvan Pettinger, 2018)

4.2. Link between renewable energy and environmental sustainability

Renewable energy has a direct relationship with sustainable development through its impact on human development and economic productivity. Renewable energy sources provide opportunities in energy security, social and economic development, energy access, climate change mitigation and reduction of environmental and health impacts .Figure (14) shows the opportunities of renewable energy sources towards sustainable development. (Phebe Asantewaa Owusu;Samuel Asumadu Sarkodie, 2016, pp. 7-8).

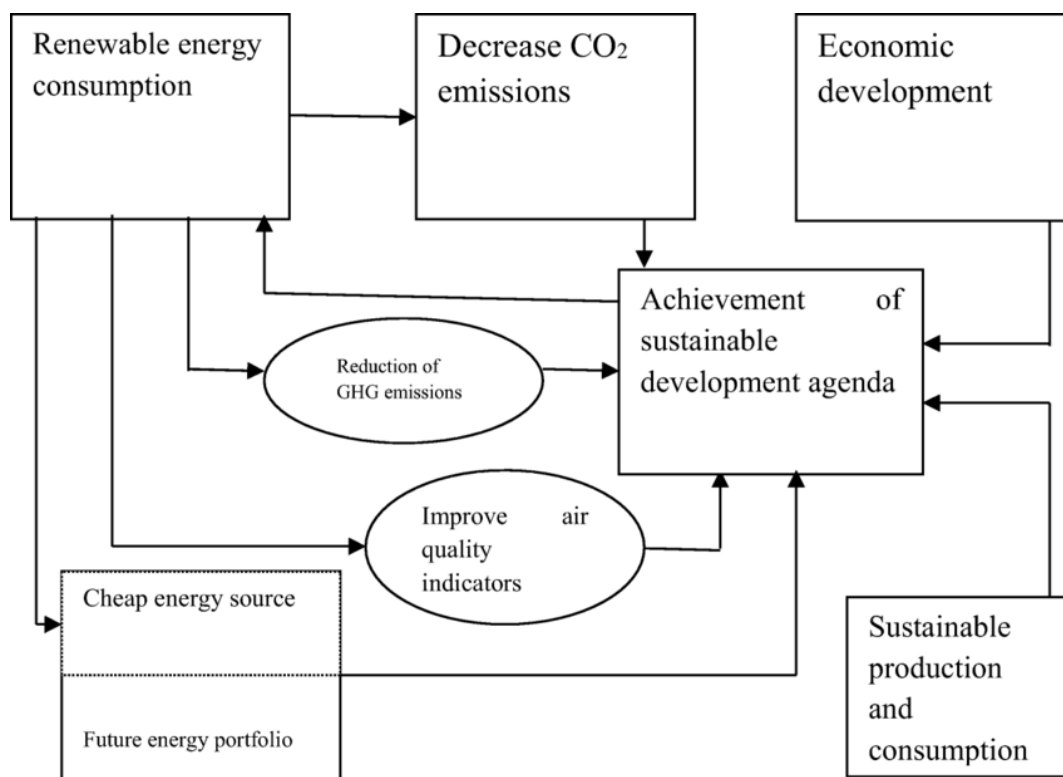
Fig.14.The opportunities of renewable energy sources towards sustainable development.



Source: (Phebe Asantewaa Owusu;Samuel Asumadu Sarkodie, 2016, p. 8)

Renewable energy technologies provide an excellent opportunity for mitigation of greenhouse gas emission and reducing global warming through substituting conventional energy sources.

Fig .15.Linkages between renewable energy consumption and environmental sustainability agenda



Source: (Naz, Sultan, Zaman, Aldakhil, Nassani, & Qazi Abro, 2019).

4.2.1. Solar energy and Environmental sustainability:

The sun provides a tremendous resource for generating clean and sustainable electricity without toxic pollution or global warming emissions.

The potential environmental impacts associated with solar power: land use and habitat loss, water use, and the use of hazardous materials in manufacturing can vary greatly depending on the technology, which includes two broad categories: photovoltaic (PV) solar cells or concentrating solar thermal plants (CSP).

As the scale of the system ranging from small, distributed rooftop PV arrays to large utility-scale, PV and CSP projects also plays a significant role in the level of environmental impact. (Environmental Impacts of Solar Power , 2013)

4.2.2. Wind Power and Environmental sustainability:

Overall, using wind to produce energy has fewer effects on the environment than many other energy sources. Wind turbines do not release emissions that can pollute the air or water (with rare exceptions), and they do not require water for cooling. Wind turbines may also reduce the amount of electricity generation from fossil fuels, which results in lower total air pollution and carbon dioxide emissions. (U.S. Energy Information Administration, 2021)

Compared with other technologies, wind power does well in terms of carbon emissions. By comparison, solar power plants emit 33 grams CO₂ for every kWh generated. (Gero Rueter, 2021)

Overall, a rapid expansion of wind power will help reduce CO₂ emissions, slowing global warming and biodiversity loss.

Yet some environmentalists have demanded that wind power plants not be installed in natural reserves or in migratory bird stopover sites so as not to endanger animals. And to mitigate this impact, an increasing number of large-scale wind power plants are also being equipped with cameras and software technology that aim to avoid collisions with birds by switching off the turbines before they come too close. (U.S. Energy Information Administration, 2021).

5. CONCLUSION:

In today's climate energy needs and increasing environmental concern, alternative to the use of non renewable energy have to be investigated. One such alternative is renewable energy, which is essential to the environmental sustainability that is concerned with whether environmental resources will be protected and maintained for future generations.

Renewable energy has a direct relationship with sustainable development through its impact on human development and economic productivity. Renewable energy technologies provide an excellent opportunity for mitigation of greenhouse gas emission and reducing global warming through substituting conventional energy sources.

Solar energy and wind energy can be regarded as the most viable renewable energy sources of the future .Moreover, the environmentally friendly nature of these energies make them the ultimate energy source for humanity, the Solar generated (3.7 %) of the world's electricity in 2021, Australia was an example, as its share of electricity made up by solar energy rose from barely 2 percent in 2015 to 11.79

percent in 2021. While wind generated 6.6% of the world's electricity in 2021, 65% of the growth in global wind generation in 2021 was in China. The both of these energies were responsible for more than (10%) of global electricity for the first time for last year according to the global electricity review 2022.

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