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# DEVELOPMENTS OF GREEN ENERGY

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**ABSTRACT:** Green energy is any energy type that is generated from natural resources, such as sunlight, wind or water. It often comes from renewable energy sources although there are some differences between renewable and green energy. The key with these energy resources are that they don't harm the environment through factors such as releasing greenhouse gases into the atmosphere. In order to be deemed green energy, a resource cannot produce pollution, such as is found with fossil fuels. This means that not all sources used by the renewable energy industry are green. For example, power generation that burns organic material from sustainable forests may be renewable, but it is not necessarily green, due to the CO<sub>2</sub> produced by the burning process itself. Green energy sources are usually naturally replenished, as opposed to fossil fuel sources like natural gas or coal, which can take millions of years to develop. Green sources also often avoid mining or drilling operations that can be damaging to eco-systems.

**KEYWORDS-**green,energy,developments,renewable,ecosystem,environment

## I. INTRODUCTION

The main sources are wind energy, solar power and hydroelectric power (including tidal energy, which uses ocean energy from the tides in the sea). Solar and wind power are able to be produced on a small scale at people's homes or alternatively, they can be generated on a larger, industrial scale.

The six most common forms are as follows:

### 1. Solar Power

This common type of renewable energy is usually produced using photovoltaic cells that capture sunlight and turn it into electricity. Solar power is also used to heat buildings and for hot water as well as for cooking and lighting. Solar power has now become affordable enough to be used for domestic purposes including garden lighting, although it is also used on a larger scale to power entire neighbourhoods.[1,2]

### 2. Wind Power

Particularly suited to offshore and higher altitude sites, wind energy uses the power of the flow of air around the world to push turbines that then generate electricity.

### 3. Hydropower

Also known as hydroelectric power, this type of green energy uses the flow of water in rivers, streams, dams or elsewhere to produce electricity. Hydropower can even work on a small scale using the flow of water through pipes in the home or can come from evaporation, rainfall or the tides in the oceans.

Exactly how 'green' the following three types of green energy are is dependent on how they are created...

### 4. Geothermal Energy

This type of green power uses thermal energy that has been stored just under the earth's crust. While this resource requires drilling to access, thereby calling the environmental impact into question, it is a huge resource once tapped into. Geothermal energy has been used for bathing in hot springs for thousands of years and this same resource can be used for steam to turn turbines and generate electricity. The energy stored under the United States alone is enough to produce 10 times as much electricity as coal currently can. While some nations, such as Iceland, have easy-to-access



geothermal resources, it is a resource that is reliant on location for ease of use, and to be fully 'green' the drilling procedures need to be closely monitored.

#### 5. Biomass

This renewable resource also needs to be carefully managed in order to be truly labelled as a 'green energy' source. Biomass power plants use wood waste, sawdust and combustible organic agricultural waste to create energy. While the burning of these materials releases greenhouse gas these emissions are still far lower than those from petroleum-based fuels.

#### 6. Biofuels

Rather than burning biomass as mentioned above, these organic materials can be transformed into fuel such as ethanol and biodiesel. Having supplied just 2.7% of the world's fuel for transport in 2010, the biofuels are estimated to have the capacity to meet over 25% of global transportation fuel demand by future.[3,5]

## **II. DISCUSSION**

Green energy is important for the environment as it replaces the negative effects of fossil fuels with more environmentally-friendly alternatives. Derived from natural resources, green energy is also often renewable and clean, meaning that they emit no or few greenhouse gases and are often readily available.

Even when the full life cycle of a green energy source is taken into consideration, they release far less greenhouse gases than fossil fuels, as well as few or low levels of air pollutants. This is not just good for the planet but is also better for the health of people and animals that have to breathe the air.

Green energy can also lead to stable energy prices as these sources are often produced locally and are not as affected by geopolitical crisis, price spikes or supply chain disruptions. The economic benefits also include job creation in building the facilities that often serve the communities where the workers are employed. Renewable energy saw the creation of 11 million jobs worldwide in 2018, with this number set to grow as we strive to meet targets such as net zero.

Due to the local nature of energy production through sources like solar and wind power, the energy infrastructure is more flexible and less dependent on centralised sources that can lead to disruption as well as being less resilient to weather related climate change.

Green energy also represents a low cost solution for the energy needs of many parts of the world. This will only improve as costs continue to fall, further increasing the accessibility of green energy, especially in the developing world.

There are plenty of examples of green energy in use today, from energy production through to thermal heating for buildings, off-highway and transport. Many industries are investigating green solutions and here are a few examples:

#### 1. Heating and Cooling in Buildings

Green energy solutions are being used for buildings ranging from large office blocks to people's homes. These include solar water heaters, biomass fuelled boilers and direct heat from geothermal, as well as cooling systems powered by renewable sources.

#### 2. Industrial Processes

Renewable heat for industrial processes can be run using biomass or renewable electricity. Hydrogen is now a large provider of renewable energy for the cement, iron, steel and chemical industries.[7,8]



### 3. Transport

Sustainable biofuels and renewable electricity are growing in use for transportation across multiple industry sectors. Automotive is an obvious example as electrification advances to replace fossil fuels, but aerospace and construction are other areas that are actively investigating electrification.

Green energy has the capacity to replace fossil fuels in the future, however it may require varied production from different means to achieve this. Geothermal, for example, is particularly effective in places where this resource is easy to tap into, while wind energy or solar power may be better suited to other geographic locations.

However, by bringing together multiple green energy sources to meet our needs, and with the advancements that are being made with regards to production and development of these resources, there is every reason to believe that fossil fuels could be phased out.

We are still some years away from this happening, but the fact remains that this is necessary to reduce climate change, improve the environment and move to a more sustainable future.

Understanding the economic viability of green energy requires a comparison with fossil fuels. The fact is that as easily-reached fossil resources begin to run out, the cost of this type of energy will only increase with scarcity.

At the same time as fossil fuels become more expensive, the cost of greener energy sources is falling. Other factors also work in favour of green energy, such as the ability to produce relatively inexpensive localised energy solutions, such as solar farms. The interest, investment and development of green energy solutions is bringing costs down as we continue to build up our knowledge and are able to build on past breakthroughs.

As a result, green energy can not only become economically viable but also the preferred option.

Efficiency in green energy is slightly dependent on location as, if you have the right conditions, such as frequent and strong sunlight, it is easy to create a fast and efficient energy solution.

However, to truly compare different energy types it is necessary to analyse the full life cycle of an energy source. This includes assessing the energy used to create the green energy resource, working out how much energy can be translated into electricity and any environmental clearing that was required to create the energy solution. Of course, environmental damage would prevent a source truly being 'green,' but when all of these factors are combined it creates what is known as a 'Levelised Energy Cost' (LEC).

Currently, wind farms are seen as the most efficient source of green energy as it requires less refining and processing than the production of, for example, solar panels. Advances in composites technology and testing has helped improve the life-span and therefore the LEC of wind turbines. However, the same can be said of solar panels, which are also seeing a great deal of development.

Green energy solutions also have the benefit of not needing much additional energy expenditure after they have been built, since they tend to use a readily renewable source of power, such as the wind. In fact, the total efficiency of usable energy for coal is just 29% of its original energy value, while wind power offers a 1164% return on its original energy input.

Renewable energy sources are currently ranked as follows in efficiency (although this may change as developments continue):

1. Wind Power
2. Geothermal
3. Hydropower
4. Nuclear
5. Solar Power



Green energy provides real benefits for the environment since the power comes from natural resources such as sunlight, wind and water. Constantly replenished, these energy sources are the direct opposite of the unsustainable, carbon emitting fossil fuels that have powered us for over a century.[9,10]

Creating energy with a zero carbon footprint is a great stride to a more environmentally friendly future. If we can use it to meet our power, industrial and transportation needs, we will be able to greatly reduce our impact on the environment.

As we touched upon earlier, there is a difference between green, clean and renewable energy. This is slightly confused by people often using these terms interchangeably, but while a resource can be all of these things at once, it may also be, for example, renewable but not green or clean (such as with some forms of biomass energy).

Green energy is that which comes from natural sources, such as the sun. Clean energy are those types which do not release pollutants into the air, and renewable energy comes from sources that are constantly being replenished, such as hydropower, wind power or solar energy.

Renewable energy is often seen as being the same, but there is still some debate around this. For example, can a hydroelectric dam which may divert waterways and impact the local environment really be called 'green?'

However, a source such as wind power is renewable, green and clean – since it comes from an environmentally-friendly, self-replenishing and non-polluting source.

Green energy looks set to be part of the future of the world, offering a cleaner alternative to many of today's energy sources. Readily replenished, these energy sources are not just good for the environment, but are also leading to job creation and look set to become economically viable as developments continue.[11,12]

The fact is that fossil fuels need to become a thing of the past as they do not provide a sustainable solution to our energy needs. By developing a variety of green energy solutions we can create a totally sustainable future for our energy provision, without damaging the world we all live on.

TWI has been working on different green energy projects for decades and has built up expertise in these areas, finding solutions for our Industrial Members ranging from electrification for the automotive industry to the latest developments in renewable energy.

## DISCUSSION

The global renewable energy landscape is changing rapidly. Green energies reduce greenhouse gas emissions, diversify the energy supply, and lower dependence on volatile and uncertain fossil fuel markets. The future looks promising for green energy sources, which are taking on an increasingly important role, especially in the current context, as governments are trying to identify viable solutions to the energy crisis and reduce dependence on fossil fuels. Worldwide, there is a growing interest in and support for green energy sources, a factor that could help accelerate the current energy transition. Despite these positive developments, much remains to be done globally to make the energy transition a reality. In this respect, the European Union member states have committed to a wide neutrality target by establishing an increase in the total share of energy from renewable sources to 55% (by 2030) and, at the same time, reducing the net greenhouse gas effect emissions by at least 55% until 2030 to reach the neutrality target by future. Green energy sources are essential for long-term efforts to mitigate climate change and will play an important role in improving energy security and accessibility. The efforts of every country to strengthen the energy sector through the development of green energies will reduce geopolitical risks and disproportionate external costs for society. The large-scale use of green energies will contribute to sustainable development. The objective of our research is to review the literature on green energy in the context of sustainable development by analyzing research conducted by various authors and international organizations on these topics. The period considered for this study is 2011–2020. Our research focused on the EU 27, but the review also took into account the results obtained by other countries worldwide, such as China, the USA, Norway, and Iceland. The main research method used was the analysis of scientific papers, studies developed by international organizations, and a wide set of agreements and political commitments assumed by different states for developing green energy as a solution for sustainable development. The obtained results show an interesting international debate about green energies and how they can contribute to sustainable development. This

results also show that in 2019 at the global level, low-carbon energy sources, including nuclear power and renewable energy, accounted for 15.7% of primary energy (solar, wind, hydropower, bioenergy, geothermal and wave and tidal), while in 2020, for the EU 27, the share of energy from renewable sources reached 22%. According to international statistics, more than 90% of the governments of many countries are making investments to efficiently capitalize on green energy sources and to design new models of sustainable economic and social development, in order to lower pollution levels, reduce the dependence on fossil fuel imports and limit the climate change impact.[13,15]

### III. RESULTS

In the current international context that is strongly marked by the energy crisis and international tensions, the study of various authors led us to the conclusion that green energy solutions from renewable sources offer alternatives for global sustainable development. Unlike other studies this paper views green energy sources as a strategic option for sustainable development. This overview contributes to the literature by identifying RGEs as a fundamental element of sustainable development. The researchers show that it is essential to place RGEs at the center of the sustainable development paradigm as a means of meeting the international agreements and SGD 7 challenges.

The paper points out the evolution of RGEs and their main advantages, showing policymakers some steps that can steer the energy system in the direction of a long-term sustainable development route. It can help decisionmakers to identify which strategies and initiatives are ineffective for achieving the various goals related to the economy, energy, sustainability, and climate change. The prospect of the switch to RGEs must be achieved through the promotion of international collaboration in science, science-policy interaction, and information transfer.

This review identified a number of barriers that slow the growth of RGEs, including the following: (1) high investment prices; (2) underdeveloped infrastructure; (3) legislative gaps; (4) difficulties implementing environmental policies; and (5) bureaucracy, among others. However, through collaborative efforts from the public and private sectors, all states may increase the use of RGEs and can achieve better outcomes for the environment, energy security, and for sustainable development.

As shown in this paper, there is an urgent need to intensify the efforts of the states to capitalize on renewable energy sources for the generation of green energy and for sustainable development. Governments must adopt clear strategies to increase the share of their energy supply from green sources. The main aspects derived from the investigated literature [154], which should be carefully analyzed and included in these strategies, refer to the following actions: (1) increasing the level of responsibility that is placed on renewables in international agreements; (2) providing organizational support to the green energy movement; (3) raising awareness of the importance of RGEs in the achievement of SD goals (marketing); and (4) increasing cooperation at the local, national, and international levels in domains such as research and development, in order to improve and create new and cheaper technologies that facilitate the exploitation of green resources in a sustainable manner.

The limits of this review refer to the vast specialized literature that addresses the topic of renewable resources, green energy resources, the energy sector, and green technologies, but also the main international or regional agreements that regulate this field in the context of sustainable development. In our future research, we aim to expand the analysis of each type of green energy separately and to carry out a systematic analysis of their evolution in different states and regions to identify the best practices and key governmental actions, in order to increase the contribution of the green energy sector to their sustainable economic and social development and for the protection of the planet.

The results of this consistent and systematic overview show that in the last few decades, many countries have made significant progress in the production and integration of green energy into their economic and social systems. However, further significant investments are needed to increase the production of green energy, which is necessary to achieve sustainable economic and social development targets.[17,18,19]

### IV. CONCLUSIONS

"Green" energy is clean energy that, unlike fossil fuels, is non-polluting that comes from 100% renewable sources, meaning it does not harm the environment and is more sustainable. We tend to confuse clean energies with renewable energies. The key difference is that all renewable energies are clean, but not all clean energies are renewable. Renewable energy comes from resources provided by nature - the wind and sun being the most obvious examples. Clean energy is energy that produces little or no pollution. It includes renewables, but it also includes nuclear energy and the carbon-neutralising impact of technologies like carbon capture and sequestration (CCS). For example, nuclear energy is clean because it is decarbonised and does not emit greenhouse gases into the atmosphere. However, this energy is not renewable because uranium, its fuel, is a limited resource. There are several types of renewable energy from obtaining natural resources such as wind, water or the sun.[20,21,22]



Types of green energy			
Green Energy	Source	Technology	Use
Solar energy	Sun	Photovoltaic, thermo solar	Electricity, heating, cooling
Wind power	Wind	Wind turbines	Electricity
Hydroelectric energy	Water	Hydroelectric plants	Electricity
Geothermal energy	The Earth	Surface geothermal systems and heat pumps	Electricity, heating and cooling
Bioenergy	Biomass	Biomass combustion, biogas plants, biofuels	Electricity, heating and cooling, transportation

- Solar energy is a renewable energy produced from sunlight, so it is also an intermittent energy. It takes advantage of solar energy in two ways: with photovoltaic technology and with thermal technology. Photovoltaic solar energy converts the sun's rays into electricity through the use of photovoltaic plates or panels, while solar thermal energy is generally used to heat fluids, such as domestic water heaters.[21,22,23]
- Wind energy depends on the strength of the wind. It comes from turbines, called wind turbines or air turbines, which convert the kinetic energy of the wind into energy.
- Hydraulic or hydroelectric energy transforms the kinetic energy of water into electricity through hydroelectric plants. Like wind or solar power, hydropower is intermittent: it depends on the flow of water (dams, rivers, streams, etc.) and on rainfall. In other words, the drier the year, the less hydroelectric energy will be produced and vice versa.
- Geothermal energy is a process that takes advantage of the Earth's natural heat and converts it into energy. It is one of the only renewable energies that is not intermittent and therefore does not depend on atmospheric conditions.
- Biomass is used to produce electricity and fuel (for example, biogas) from the heat released by the combustion of organic plants or animal waste, or from their fermentation. The energy from plant waste has the advantage of being carbon neutral. In fact, burning plant waste produces as many CO<sub>2</sub> emissions as it absorbs during photosynthesis. It is important to know that biomass is only considered a renewable energy source when its consumption is less than its regeneration. Its two main production techniques are as follows:
  1. Biomass by combustion to produce electricity: during its combustion, organic waste (wood, agricultural waste, household waste) produces heat and electricity.
  2. Biomass by methanation to produce biogas: during its fermentation, organic waste (domestic, agricultural, agro-industrial) is transformed into biogas.

Renewable energy generated by wind, sunlight, water and wood made up 42% of the UK's electricity in 2020, according to climate think tank Ember. Although renewable energy overtook fossil fuels in the final months of 2019, last year was the first time that renewables were the main source of the UK's electricity over a 12-month period.[25,27,28]

Advantages of green energy

Green energy has many advantages including:

- Clean energy;
- Inexhaustible energy source;
- No carbon emissions or greenhouse gases;
- Energy independence;
- Self-sufficient;
- Sustainability;



- Environmentally-friendly and slows down climate change.

In addition to contributing to the protection of the environment, using green electricity and green gas can also help you make savings on your bills.

There are many ways to have green electricity at home. Among you options of green energy suppliers in the UK are:

1. Large companies that, despite continuing to generate non-renewable energy, offer their customers green energy rates.
2. Small companies specialised in renewable energies;
3. Renewable energy cooperatives (the user must become a member by paying a monthly fee).

If the client has a non-renewable energy contract and wishes to switch to a 100% green energy rate, they simply need to contact the company that offers this rate and switch tariffs.[29,30]

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