International Journal of Trend in Research and Development, Volume 12(2), ISSN: 2394-9333
www.ijtrd.com

Renewable Energy: An Overview

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Abstract: In this modern society, energy is indispensable; it powers almost everything we use. The energy industry is undergoing an unparalleled transformation which is directly associated with the uptake of renewable energy. Renewable energy (or green energy) is energy derived from natural sources that are naturally and constantly replenished at a higher rate than they are consumed. It is energy that comes from a source that will not run out. It is natural and self-replenishing and usually has a low- or zero-carbon footprint. This includes hydroelectric power, solar energy, wind energy, fuel cell, geothermal energy, and biomass energy. Renewable energy sources are plentiful and all around us. Renewable energy is a rapidly growing industry with immense potential. This paper presents an overview of renewable energy.

Keywords: *Energy, Green Energy, Clean Energy, Brown Energy, Renewable Energy, Renewable Energy Policy*

I. INTRODUCTION

Energy may be defined as the capacity to do work. There are various types of energy: electrical energy, chemical energy, nuclear energy, thermal energy, gravitational energy, potential energy, etc. Energy is crucially important in the economic and social development of any society. The use of energy is evident in our everyday lives. We need energy in lighting, heating, cooling, transport, communication, systems, domestic appliances, and battery-powered devices to mention but a few. The conventional type of energy is fossil-based energy, which generally includes coal, petroleum, natural gas, etc. Energy that comes from these conventional means is called "brown energy." Another type of energy is "green energy" or "renewable energy which is clean source of energy with a lower environmental impact compared to conventional sources [1].

Energy is critically important for economic growth and social progress in the modern society. Since the energy crises in the 1970s, the development of renewable energy has received great attention [2]. Although world energy demand is growing, conventional energy sources are limited. In the 21st century, the energy sector faces by two challenges: sustainable economic development and global climate change [3]. To avoid catastrophic damage to our planet, it is advisable to move to an environment with sustainable energy sources.

Renewable energy (also known as green energy or sustainable energy) is energy from renewable natural resources that are replenished on a human timescale. Fossil fuels - coal, oil and gas - on the other hand, are non-renewable resources that take hundreds of millions of years to form. Generating renewable energy creates far lower emissions than burning fossil fuels. Renewable energy generates over 20% of all US electricity, and that percentage continues to grow. It helps prevent the depletion of natural resources to conserve them for future generations.

II. CONVENTIONAL ENERGY

Energy resources help in creating wealth and improving living standards. The availability and affordability of energy sources are crucial for the overall economic development of a nation. Conventional sources of energy are from non-renewable fossil fuels (coal, oil, gas, petroleum, etc.) and nuclear power [4]. Fossil fuels have been used as a common source of energy for centuries. Petroleum springs and coal mines are not inexhaustible but are rapidly diminishing in many places. A lot of attention has focused on the environmental impacts of conventional energy sources, particularly fossil fuels. As shown in Figure 1, conventional energy sources cause pollution, which affects public health [5].

Figure 1: Conventional energy sources cause pollution [5].

Energy that comes from these conventional means is called "brown" (carbon-intensive) energy. Grid power is a mixture of brown and renewable energies. It is regarded as a kind of brown energy source because utilities produce much of their power by burning carbon-intensive fossil fuels, such as coal and natural gas. Most brown energy sources (such as fossil fuel power, gas turbine, coal, and oil) are able to adjust their output power on demand through tuning the power generator. If brown energy must be used, the scheduler selects times when it is cheap.

To reduce the harmful effects of brown energy, renewable or green energy sources need to be applied. Although each country has both traditional power plants and green energy plants, there is a need for a change in the energy consumption pattern. Earth resources are limited and are increasingly depleting. This compels governments and environmental activists all over the world to emphasize the need to switch from conventional resources to alternative renewable sources [6]. As the costs of brown or non-renewable energy grow, renewable energy becomes more widely used.

III. WHAT IS RENEWABLE ENERGY?

The history of renewable energy can be traced back to ancient civilizations, who used the power of the sun, wind, and water for a variety of purposes. There are four major forms of energy utilization: electricity, gas supply, heat supply, and fuel. As its name suggests, renewable energy can be renewed, i.e. it

is infinite in nature and can keep being used without running out. Renewable energy comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (naturally replenished) forms of energy. It relies upon the natural forces at work on the earth. It is often inexhaustible in duration but limited in the amount of energy available per unit time. Renewable energy often displaces conventional energy in four important areas: electricity generation, water cooling/ heating, transportation, and rural energy services [7,8].

The terms "green energy," "clean energy," and "renewable energy" are often used interchangeably, but they do mean exactly the same thing. Clean energy produces electricity without emissions. Green energy comes from totally natural sources, which have low or no environmental impact in their creation or use. They can both be renewable, which essentially means that they come from a source that cannot be depleted. While most green energy sources are renewable, not all renewable energy sources are considered green [9].

The main difference between renewable and nonrenewable energy is that there is a finite amount of nonrenewable energy while renewable energy is unlimited because the source of its power is regenerative. Renewable power is always free of carbon emissions while nonrenewable energy always emits carbon dioxide. Renewable energy sources are attractive option because they have limited negative environmental impact when compared to fossil fuels. Energy from fossil fuels such as coal, peat, oil, and gas is nonrenewable because it draws on finite resources that will eventually dwindle. Concerns for climate change, rising oil prices, and enormous pressure on both governments and industries are driving increasing renewable energy legislation and commercialization.

IV. TYPES OF RENEWABLE ENERGY

Renewable energy sources can be the major energy supply option in low-carbon energy economies. Renewable energy options include solar energy, wind energy, biomass, and hydroelectric energy, geothermal energy,and wave energy [10-13]:

- *Solar Power:* This is the most readily available and free source of energy since prehistoric times. Sunlight is one of the planet's most freely available energy resources. Almost 174-petawatt (PW) worth of energy falls on the earth's atmosphere in the form of sunlight and is equivalent to 10,000 times the energy consumed by humans. Solar power involves converting the energy of sunlight directly into electricity using solar cells. Solar technologies convert sunlight into electrical energy either through photovoltaic panels or through mirrors that concentrate solar radiation. Solar-thermal technology uses tracking mirrors to concentrate sunlight onto a receiver, which may be centralized or distributed. The receiver absorbs solar energy as heat which drives a turbine generator. Solar technologies can deliver heat, cooling, natural lighting, electricity, and fuels for a host of applications. Figure 2 shows a typical solar power generation [14].
- *Wind Power:* Wind energy harnesses the kinetic energy of moving air by using large wind turbines located on land (onshore) or in sea- or freshwater (offshore). Wind turbines typically consist of rotor blades mounted on a tower and connected by gears to a drive shaft that spins a generator. The energy derived from wind is very sensitive to wind velocity and varies with the square of the velocity. Many parts of the world have strong wind speeds, but the best locations for generating wind power are sometimes remote ones. Wind powers is widely used for electric power generation in remote areas. Figure 3 shows a typical wind power generation [9].
- *Bioenergy:* Biomass refers to all the earth's living matter. Bioenergy is produced from a variety of organic materials, called biomass, such as wood, charcoal, dung and other manures. Biomass resources include material derived from growing plants or from animal manure, such as wood wastes, waste paper, sawdust, grass, etc. Carbon dioxide is emitted whenever biomass materials are burned. Plant biomass can be used as energy supply to small-scale industries. A biogas filling station is displayed in Figure 4 [15].
- *Hydropower:* Hydropower harnesses the energy of water moving from higher to lower elevations. The power plant uses falling water to generate electricity. This implies the conversion of dynamic energy into electricity. Using water wheels to harvest the energy flowing in streams, rivers, and waterfalls is old. The first hydroelectric plant was built at Niagara Falls in 1879. Hydropower reservoirs often have multiple uses - providing drinking water, water for irrigation, flood and drought control, navigation services, as well as energy supply. Figure 5 shows a typical hydroelectric power generation [14].
- *Wave Energy:* Wave or ocean energy derives from technologies that use the kinetic and thermal energy of seawater - waves or currents for instance - to produce electricity or heat. The wave energy depends strongly on wind speed of ocean waves. This irregular energy source uses pneumatic systems to pressurize air, which is then passed through an air turbine to generate electricity. This form of energy is not common because the investment is too large to justify the savings in energy. It is still at an early stage of development, with a number of prototype wave and tidal current devices being explored.
- *Geothermal Energy:* As the name implies, geothermal energy is heat energy from the earth itself. In other words, geo means "earth" and thermal means "heat" in Greek. Geothermal energy is the heat energy within the earth. Below the earth's crust possesses a massive amount of thermal energy generated by the decay of radioisotope of elements, such as uranium and thorium. The temperature of the earth steadily increases with depth. Geothermal power plants harness the heat sources to produce electricity, which is cost effective, reliable, sustainable, and non-polluting or eco-friendly. A major challenge with this energy source is that plants are expensive to build. For example, geothermal energy may be used for heating/cooling office buildings or manufacturing plants. Unlike solar and wind, which are intermittent, geothermal energy can be generated 24/7. Figure 6 shows geothermal energy generation [15].

Figure 2: A typical solar power generation [14].

Figure 3: A typical wind power generation [9].

Figure 4: A biogas filling station [15].

Figure 5: A typical hydroelectric power generation [14].

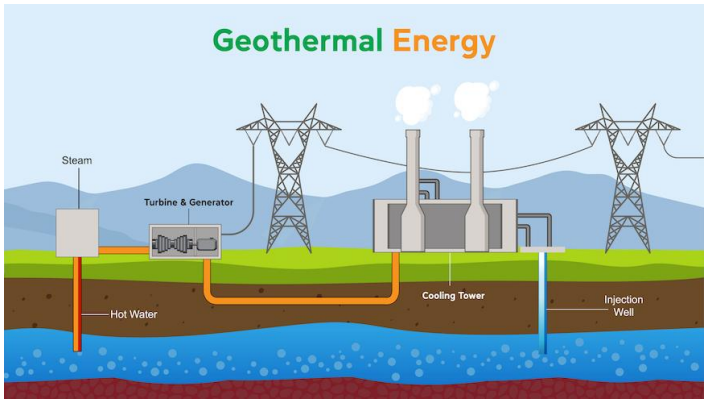

Figure 6: Geothermal energy generation [15].

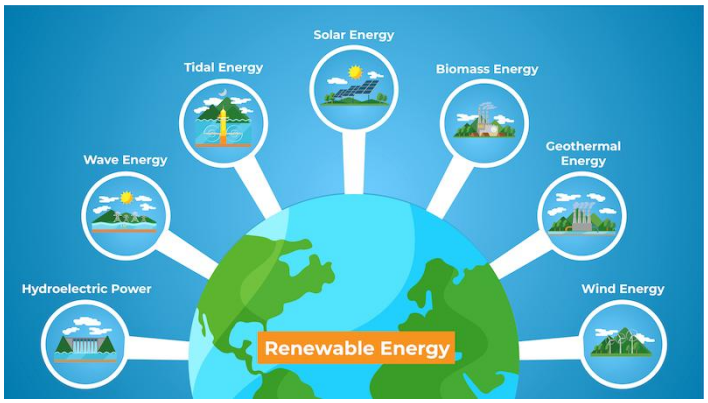

Figure 7: Different types of renewable energy [15].

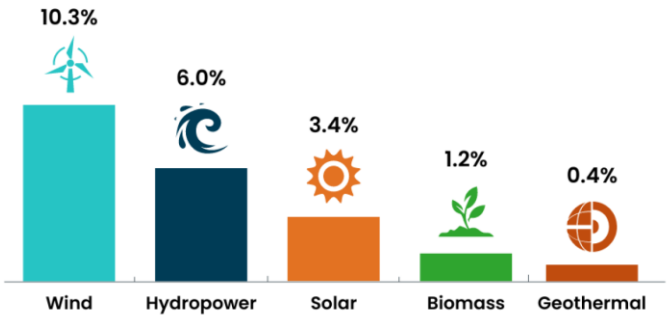

Figure 8: Shares of total electricity production in 2022 in the US among the types of renewable power [16].

No single renewable energy source is perfect for all scenarios. The choice of technology should consider the local availability of resources, energy needs, budget constraints, and environmental considerations. Figure 7 shows different types of renewable energy sources [15]. Figure 8 breaks down the shares of total electricity production in 2022 in the US among the types of renewable power [16].

V. APPLICATIONS OF RENEWABLE ENERGY

Renewable energy can be utilized in various sectors to provide power and heat. By leveraging renewable energy in these sectors, we can reduce greenhouse gas emissions, enhance energy security, and promote sustainable development. Common areas of application of renewable energy include the following [17]:

- *Smart Home:* Home energy consumption, such as electricity, heating, and cooling, has been an important environmental and economic issue for decades.

Constraints such as renting, safety, and unsupportive household members affect energy use and energy saving

behaviours of customers [18]. A smart home provides optimum living conditions required naturally. Renewable energy source (such as solar panel) has been utilized in generating power for all the smart appliances used to sustain the smart home. Solar heat energy has been used to generate hot water and do the cooking. Using the renewable energy source in smart home can reduce energy cost and minimize wastage of energy [19]. A typical solar energy generation at home is shown in Figure 9 [20].

- *Businesses*: Reducing energy usage is not limited to household. : In residential and commercial buildings, renewable energy sources such as solar panels, wind turbines, and geothermal systems can be used to generate electricity and provide heating and cooling. For businesses, it is important to effectively reduce electricity consumption and environmental pollution. Switching to renewable energy can actually bring many different benefits to a business. The benefits include lower energy bills, boosting public relations, creating jobs, and great return on investment [21].
- *Data Centers*: Data centers are known for consuming an enormous amount of electricity. Mega data centers (such as those of Apple, Microsoft, and Google) have emerged due to the soaring demand for IT services. Data center operators are constantly under pressure to minimize the carbon footprint. To achieve this requires powering data centers by on-site generation of renewable energy. Renewable energy integration lowers the cost of designing fault tolerant distributed data centers with reduced carbon footprint [22]. To reduce costs and environmental impacts, modern datacenters operators, such as those of Google and Apple, are beginning to integrate renewable energy sources into their power supply [23].
- *Mobile networks*: These are among the major energy guzzlers. The growing energy consumption leads to a significant rise of carbon footprints. Therefore, greening mobile networks is becoming a necessity for economic and environmental sustainability. Renewable energy is a promising energy alternative for future mobile networks [24].
- *Cellular Networks*: The increase in a number of mobile users and their diverse data applications is compelling cellular network operators to install more base stations (BSs). Concerns about increasing number of BSs with high energy consumption have prompted cellular operators to deploy renewable energy sources in BSs. This helps reduce the on-grid consumption and operational expenditure. Powering cellular networks with renewable energy sources is a promising alternative for reducing global carbon footprint [25].
- *Industry*: Renewable energy can be integrated into industrial processes through the use of biomass, solar thermal energy, and wind power. These sources can provide electricity for machinery and production lines, as well as heat for processes like drying, melting, and steam generation.
- *Agriculture:* In agriculture, renewable energy sources can be used to power irrigation systems, greenhouses, and farm equipment. Solar energy can be utilized for drying crops and powering livestock operations, while biogas from organic waste can provide heat and electricity for farms.
- *Transportation:* The transportation sector can benefit from renewable energy through the use of biofuels, electric vehicles (EVs), and hydrogen fuel cells. Biofuels, derived from organic materials, can replace conventional fossil fuels in internal combustion engines. EVs can be charged using electricity generated from renewable sources like solar and wind. Hydrogen fuel cells, powered by renewable hydrogen, can provide a clean and efficient alternative for transportation.

Other applications include buildings, cognitive radio networks, cyber–physical systems, and for battlefield.

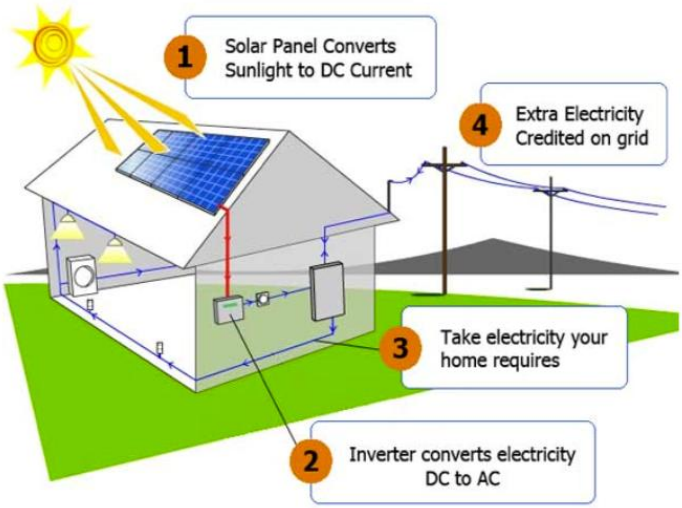

Figure 9: A typical example of solar energy generation in a home [20].

VI. RENEWABLE ENERGY EFFICIENCY

Renewables have come a long way, but the current renewable energy system is still not as efficient as fossil fuel counterparts. Improving energy efficiency at homes, businesses, offices, schools, governments, and industries is cost-effective way to address the challenges of high energy prices and energy. Sometimes energy efficiency may mean changing behaviors, such as drying clothes on a clothesline instead of a dryer. Better ways to produce solar photovoltaic panels are lowering panel production cost.

Governments can promote energy efficiency by setting energy efficiency standards. Products that meet high-efficiency standards should receive the Energy Star label. Efficiency labels inform consumers about the energy efficiency of different products. Unfortunately, even with informative labels, some consumers do not purchase high-efficiency products because the upfront costs may be higher than regular [26].

VII. BENEFITS

Renewable energy offers numerous economic, environmental, and social benefits. The two major advantages of renewable energy are that it is infinitely replenishable and free of greenhouse gas emissions, which are both game-changing attributes. Other major benefits of renewable energy include local availability, no need for elaborate arrangements for transport, environment- friendly, less pollution, less greenhouse gas emission, energy security, job creation, business opportunities, sustainable development, a diminished share from fossil fuels, etc. Some of these benefits are explained as follows:

- *Inexhaustible Energy:* Renewable energy sources are omnipresent and inexhaustible. Renewable energies are regarded a constant, clean source of energy and can be exploited for the current generations. Strong winds, sunny skies, abundant plant matter, heat from the earth, and fast-moving water can each provide a vast and constantly replenished supply of energy.
- *Poverty Alleviation:* Renewable energy can alleviate poverty by providing energy for the household and contribute to education by providing electricity to schools. The huge potential of renewable energy sources is enough to meet the global energy demand many times. Renewable energy has the potential to lift the poorest nations to new levels of prosperity since it is rapidly becoming more efficient and cheaper. It is particularly suitable for developing nations.
- *Reduced Emissions:* Renewable energy helps in reducing greenhouse gas emissions. It reduces carbon emissions and air pollution from energy production. Renewable energy resources such as solar or wind energy can be used to provide off-grid electrification to remote areas. Some non-renewable sources of energy, such as nuclear power, generate almost no emissions, while some renewable energy sources can be very carbon-intensive, such as the burning of biomass if it is not offset by planting new plants.
- *Reduced Water Pollution:* Unlike fossil fuel power plants, renewable energy systems do not produce toxic waste or require large amounts of water for cooling, keeping our water sources clean.
- *Sustainability:* Renewable energy is also known as green or clean energy as it ensures sustainability. It is great for the environment and people. Reduced air pollution from renewable energy means fewer cases of asthma, bronchitis, and other respiratory diseases. Renewables are often touted as the most sustainable energy sources. Choosing green power is a prudent step towards more sustainable operations and practices and a demonstration of environmental stewardship. Corporate sustainability initiatives hold newfound significance. Consumer adoption of green practices signifies a societal shift towards environmental consciousness.
- *Improved Public Health:* Environmental pollution affects everyone. The air and water pollution emitted by coal and natural gas plants is linked with breathing problems, neurological damage, heart attacks, cancer, premature death, and a host of other serious problems. Most of these negative health impacts come from air and water pollution that clean energy technologies simply do not produce. Wind, solar, and hydroelectric systems generate electricity with no associated air pollution emissions.
- *Climate Change:* Concerns about climate change and global warming are driving increasing renewable energy legislation. Green or renewable energy is a form of energy that does not contribute to climate change or global warming. It uses energy sources that are continually replenished by nature. As the world grapples with climate change concerns, the renewable energy sector is set for significant growth.
- *Affordability:* Renewable energy is providing stable and affordable electricity. According to the International Renewable Energy Agency (IRENA), renewables were the world's cheapest energy source in 2020. Renewable energy systems have rapidly become more efficient and cheaper over the past 30 years. Renewable energy sources, such as solar and wind power, have seen significant cost reductions over the past decade, making them more competitive with traditional fossil fuels. Many homeowners can sell excess solar or wind energy to their utility companies. This way, they can pay off their energy investments quickly.
- *New Jobs:* The renewable energy industry is more labor intensive and supports thousands of jobs. The renewable energy sector creates jobs in manufacturing, installation, maintenance, and research, boosting local economies. Renewable energy already supports thousands of jobs in the United States. In India and other developing nations, the renewable energy sector is expected to create millions of jobs as it expands.
- *Energy Security:* Human beings have ingeniously utilized all natural resources in a variety of ways to meet the demands posed by their ever-growing population. Renewable energy seems to be the best alternative and sustainable solution to address energy security issues in novel ways and meet the growing energy demands globally in the future.

VIII. CHALLENGES

Though the positives are undeniable, there are still downsides to renewable energy. Challenges persist in the form of unequal geographical adoption of renewables, rising cost of capital that deters investment, and underinvestment in related areas such as grid and storage. Other barriers include lack of subsidies in renewable, high initial capital cost, inadequate legal frameworks for renewable energy power sources, a lack of access to credit for both consumers and investors, and the lack of sufficient technical, geographical, and/or commercial information by market participants to make informed decisions. Other challenges include the following [27]:

- *Politics:* The greatest barrier to the widespread adoption of renewable energy is political, not technological or economic. The success of renewable energy policy is largely dictated by the national commitments and strategies. Local governments can lead by example by producing renewable energy on-site, buying green power, or investing in renewable energy projects. By using renewable resources available locally, communities can reduce their dependence on imported fuels, enhancing their energy security. Political will is necessary to accomplish the transition from conventional to renewable energy.
- *Cost:* One of the most contentious issues surrounding renewable energy is its cost. A major challenge is the high initial cost associated with the renewable energy implementation. Renewable energy technology has sometimes been regarded as expensive by critics, and affordable only in the affluent developed world. Reducing the energy price to a competitive level is challenging. Noneconomic factors, such as regulatory, statutory, behavioral, and cultural factors, hinder the adoption of renewable energy technologies. Another challenge is reducing the price of renewable energy to a competitive level.
- *Economic Constrain:* This is a challenge, as substantial investment is needed to implement renewable energy. Investment in green energy depends on the availability of finance. Developed

economies dominated the financing of renewable energy. In developing economies, investing in green energy technology is difficult because of the high cost of financing and also because obtaining financing at affordable rates is a major challenge.

- *Intermittent Nature:* Renewables such as wind and solar are intermittent, making them inherently unreliable without massive storage capacity. Renewable energy from sources is sometimes criticized for being variable and not available 24/7. The intermittent nature of renewable energy leads to a mismatch between when these sources generate energy and when the energy is needed. It is challenging to use these sources because they are not always available. Their intermittency causes variability in electricity generation and technical issues impairing power grid stability and supply reliability.
- *Geographical Inequality:* While investment in renewables has seen a notable rise, it is notably imbalanced due to geographic disparities. Large parts of the world, especially the emerging and less developed economies, are clearly lagging behind. Figure 10 depicts a protest for making solar power available to everyone [28].

Figure 10: A protest for making solar power available to everyone [28].

IX. GLOBAL ADOPTION OF RENEWABLE ENERGY

Renewable energy is a global phenomenon and is the future energy demand. The priorities and collaborative decisions made by international political leaders, policymakers, investors, and the scientific community will determine the future deployment of green renewable energy. All over the world, initiatives are being taken to minimize carbon emissions and the impacts of climate change. The trade in electricity between countries is less prone to political tension than trade involving oil and gas. Naturally, some countries have more energy resources than others, but differences in electricity resources are smaller than those relating to fossil fuel reserves. Achieving decarbonization in developing countries is complex and requires effective renewable energy policies. In the world of decarbonization and increasing focus on sustainable solutions, renewable energy solutions have increased globally.

A global trend of searching for renewable energy as the primary energy source has become a growing concern to mitigate the several issues and threats of non-renewable resources. Developing renewables as a critical player in the global energy sector is essential to promote an environmentally friendly and sustainable energy future. Governments around the globe are recognizing this pressing issue and are taking decisive action to promote renewable energy adoption. Governments need to address physical, administrative, and procedural hurdles that will help to reduce risk — and thereby reduce cost. Supporting policies for green energy across nations is an impetus for gaining energy independence and boosting the economy. Investors, financiers, and developers need to respond with faster and better funded renewables development. The financial sector participants, particularly development banks – whether domestic, bilateral, or multilateral – need to step up by providing more support to local financing at preferential rates whenever possible. That holds the potential to accelerate renewable growth globally.

The geopolitical impact of the growing use of renewable energy is a subject of ongoing debate and research. Many fossil-fuel producing countries, such as Qatar, Russia, Saudi Arabia, and Norway, are currently able to exert diplomatic or geopolitical influence as a result of their oil wealth. Conversely, nations abundant in renewable resources, and the minerals required for renewables technology, are expected to gain influence. Countries with large uninhabited areas such as Australia, China, and many African and Middle Eastern countries have a potential for huge installations of renewable energy. Developed countries and China account for more than 80% of the total investment to date in renewables. China alone represents a significant portion, contributing 52% of the global investment in clean energy, along with 42% in solar and 55% in wind capacity additions in 2022. By some accounts, China is a leader in renewable energy effort. It has a massive presence in solar power, with more solar power installations than that for all other countries combined [29].

Examples of renewable energy options include: concentrated solar power with molten salt heat storage in Spain; wind energy in South Africa; the Three Gorges Dam on the Yangtze River in China; biomass energy plant in Scotland. Geothermal energy can be either used directly to heat homes, as is common in Iceland where almost all of its energy is renewable. Hydroelectric power is used in more than 150 countries and makes up the majority of total electricity generation in countries such as Canada and Norway. With the UK and US aiming to reach net zero by 2050, using electricity that comes from renewable sources is essential to help reduce our carbon emissions. Wind power is the largest producer of renewable electricity in both the UK and the US.

X. FUTURE OF RENEWABLE ENERGY

In our rapidly changing world, the urgent need for sustainable and clean energy solutions has become undeniable. The evolution of renewable energy has exceeded all expectations locally and globally. The extent of the eventual integration of renewable energy sources into existing energy supply systems is not easy to foresee. Energy will play an important role in the world's future. The future of energy lies in the implementation of renewable resources, primarily, wind, sunlight, water, and geothermal. Combined global efforts in the intelligent application of these natural resources can help planet Earth remain green [30].

The renewable energy sector has been experiencing exponential growth, and the future looks even brighter. Technological advancements in solar, wind, hydroelectric, and geothermal power have made these sources more efficient and cost-effective. Renewable energy is now a formidable competitor against traditional fossil fuels. In the future, renewable energy will provide abundant energy with extremely low levels of emission of harmful substances into the environment.

In the future, the integration of the technological development made in the ongoing fourth industrial revolution may establish the sustainable green energy industry as a thriving global industry. However, it is crucial to consider the different factors, such as environmental, social, economic, technical, plan and policy, subsidy, geographical, and market availability, to develop the global renewable energy sector.

Millions of renewable energy jobs will be available for qualified workers over the coming decade. Training and education are essential in preparing workers to take advantage of these opportunities. More education about renewable energy is necessary for the general public, students, and engineers to be aware of the new field. Due to a large demand for engineers with skills in this field specially in developing countries, colleges should integrate renewable systems in their curricula [31,32].

CONCLUSION

Renewable energy sources are sources of energy that are constantly replenished through natural on-going processes. Renewable energy technologies are rapidly becoming more efficient, more economical, and cheaper due to technological advances, the benefits of mass production, and market competition. The growing demand for renewable energy technologies results in new employment markets [33].

Renewable energy systems are rapidly becoming more efficient and cheaper. The market for renewable energy will keep growing. There is an incentive to use 100% renewable energy to help confront issues related to climate change, energy security, and the escalation of energy costs. Each country should have renewable energy as an important component of their energy planning. Government policies are important in ensuring that the energy sector produces sustainable energy. Policy instruments such as taxes, regulations, and subsidies can stimulate the adoption of green energy technologies.

The renewables are the energy sources of the future. For more information on renewable energy, one should consult the books in [26,34-45] and the following related journals*:*

- *Renewable Energy*
- *Energy*
- *Energies*
- *Energy Policy*
- *Solar Energy*
- *Green Energy & Environment*
- *Energy Sources Renewable and Sustainable Energy Reviews*
- *IEEE Transactions on Sustainable Energy*
- *International Journal of Green Energy*
- *Journal of Fundamentals of Renewable Energy and Applications.*

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