

Renewable Energy Scenario Around the World

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Abstract - Renewable energy sources have been in great demand over the past few years to meet our energy needs. But our existing energy sources churns pollution and depletes our environment. Different renewable energy sources are used to overcome these problems, and some have proven to be effective and efficient. Renewable energy sources are inexhaustible, and they can be used to meet our annual needs. Some of them are fully developed, while some are at the infancy stage. But with some research and development into their respective fields, they all can be used as a proper alternative for our energy needs. In this research paper, different types of renewable energy sources and their current scenarios worldwide have been discussed, along with the benefits of renewable energy sources.

Key Words: Renewable energy, Geothermal Energy, Solar energy, Wind energy, Hydropower, Bioenergy

1. INTRODUCTION

One-third of greenhouse gas emissions worldwide come from sources such as coal, oil, and natural gas. Over the recent years, the usage of electrical and electronic devices has been exponentially increasing due to the progress in technology. This has increased the power usage, and now there's a need to produce extra power apart from the present, to fulfill our needs. A safe answer to an ever-decreasing energy demand had to be renewable sources. Different kinds of renewable energy are currently being explored as a prospective source for energy extraction to produce this excess energy. Some of the renewable energy sources are currently being used globally, and some are in the R&D stage. In the year 2020, renewable energy extraction way far more than any other years in the recent past. China and the United States saw a significant increase in renewable energy expansion. Most of the other countries continued to increase renewable capacity at a similar rate to previous years. Global renewable generation capacity amounted to 2799 GW by the end of 2020. Renewable energy generation capacity increased by about 260 GW in the year 2020, increasing approximately 10.3%. The highest energy expansion was seen in Solar energy, with an increase of 127 GW, which is an increase of about 22%, the subsequent most increase was seen in wind energy with 111 GW, which is an increase of about 18%. Hydropower capacity increased by 20 GW, which is only about 2%, and bioenergy by 2 GW, which is also about 2%. Geothermal energy increased by 164 MW. Solar and wind energy continued to be the most prominent sources for renewable capacity expansion, and they jointly accounted for 91% of all net renewable additions in the year 2020 [1].

Renewable energy comes from sources that can be regenerated or naturally replenished.

The primary sources are:

- Water
- Wind
- Solar
- Biomass
- Geothermal

All sources of renewable energy are used to generate electric power. In addition, geothermal steam is used directly for heating and cooking. Biomass and solar sources are also used for space and water heating. Ethanol and biodiesel (and, to a lesser extent, gaseous biomethane) are used for transportation. Renewable energy sources are considered to be zero (wind, solar, and water), low (geothermal), or neutral (biomass) concerning greenhouse gas emissions during their operation. A neutral source has emissions that are balanced by the amount of carbon dioxide absorbed during the growing process. However, each source's overall environmental impact depends on its overall lifecycle emissions, including manufacturing equipment and materials, installation, and land-use effects [2].

1.1 Factors Affecting Renewable Energy Deployment

Factors affecting renewable energy deployment include market conditions (e.g., cost, diversity, proximity to demand or transmission, and resource availability), policy decisions (e.g., tax credits, feed-in tariffs, and renewable portfolio standards), as well as specific regulations. Businesses with sustainability goals also drive renewable energy development by building their facilities (e.g., solar roofs and wind farms), procuring renewable electricity through power purchase agreements, and purchasing renewable energy certificates (RECs). As a result, renewable energy has entered a virtuous cycle of falling costs, increasing deployment, and accelerated technological progress. For example, solar PV module prices have fallen by around 90% since 2009, while wind turbine prices have fallen by 55-60% since 2010.

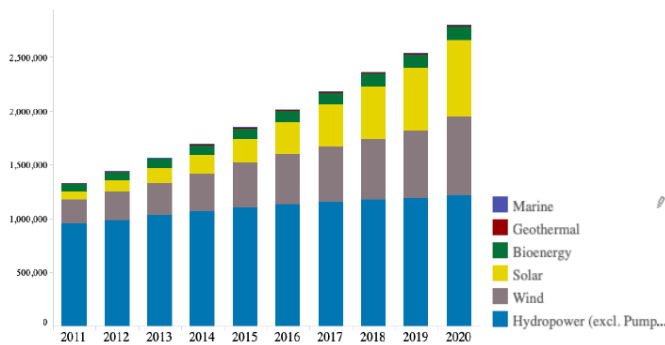


Chart -1: Total installed capacity trends of different renewable energy sources around the world

2. Benefits

Renewable energy sources have numerous benefits in addition to being inexhaustible and having almost no pollution. Some of these benefits include:

- **Employment** - The renewable energy sector employs a large number of people, and the numbers are on the rise. Around 10.3 million people were employed in the renewable energy sector worldwide in 2017, and this was due primarily to the growth of investments. In addition, this was due to rapidly falling costs, technological advancements, and government policies promoting the use of renewable energy sources.

- **Health** - There is little or no air pollution produced by wind, solar, and hydropower. Some renewable energy technologies, such as biomass and geothermal, emit air pollutants, but much at a lower rate than conventional fuels. In many developing nations, where approximately 2.9 billion people still rely on wood, coal, and charcoal to cook and heat their homes, air pollution has become a critical issue. Cleaner options exist within this context, including biomass and solar technologies, which can play an essential role in improving current conditions.

- **Resilience** - Several renewable energies are deployed in a distributed, modular fashion, making them less prone to large-scale failures. Due to this, there is no need to construct elaborate and time-consuming infrastructure during severe weather events or complex emergencies. Instead, the technology can be deployed quickly wherever needed, delivering electricity to people without the time and cost involved in installing conventional grids.

- **Access to energy** - The lack of electricity affects over one billion people globally, while another billion suffer from an unreliable supply. For 80% of rural dwellers and the populations of small island states without access to power grids, standalone and mini-grid renewable electricity solutions are becoming increasingly viable because of increased reliability, declining technology costs, and supportive policies. Among the most persuasive arguments

supporting off-grid solutions is that they are decentralized, and since development activities occur at a local level, jobs are also localized.

3. Different kinds of Renewable Energy sources

There are various kinds of renewable energy sources. The following section describes the current status of the various renewable energy sources that have been discussed above.

3.1 Solar Energy

Solar Energy is the energy derived directly from the sun's rays. This energy is one of the most significant sources of electricity generation in the world and is used throughout the world. There are two main ways in which solar energy is generated:

- **Photovoltaics (PV)**, also called solar cells, are electronic devices that convert sunlight directly into electricity.
- **Concentrated solar power (CSP)** uses mirrors to concentrate solar rays. As a result of these rays, fluid is heated, creating steam to drive a turbine and generate electricity. Large-scale power plants use CSP to generate electricity [3].

The use of solar energy is increasing across the globe as countries are switching to renewable sources to reduce greenhouse gas emissions. As of the end of 2019, a total of 627 GW of solar power had been installed worldwide. A third of the total solar energy output came from China as of the beginning of 2020, the world's largest producer of solar energy. In addition, there were 37 nations around the world with a PV capacity greater than one gigawatt by 2020. With an increase of about 22% in solar energy production in 2019, solar energy was the second-largest renewable energy technology growth, behind only wind energy [4].

Top 5 countries producing solar energy as of 2019 [5]:

- China – 205 GW
- United States – 76 GW
- Japan – 63.2 GW
- Germany – 49.2 GW
- India – 38 GW

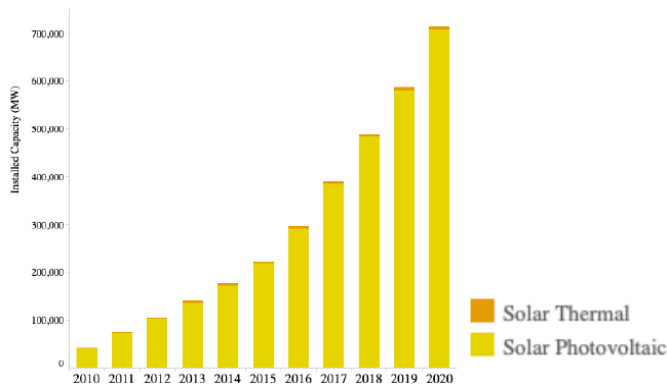


Chart -2: Installed capacity trend of Solar Energy around the world

3.2 Wind Energy

The wind power industry is one of the fastest-growing in the renewable energy sector. From 7.5 gigawatts (GW) in 1997 to 564 GW in 2018, the installed wind capacity onshore and offshore has increased by a factor of almost 75 in the past two decades. Since 2009, the amount of wind electricity created has doubled, generating 16% of the electricity on the grid in 2016. Costs are falling around the globe, which is driving up usage. Many parts of the world are blessed with strong winds, but remote locations are sometimes the best places to generate wind power. In addition, offshore wind power offers tremendous potential.

Today, commercial wind turbines come in capacities up to 8 MW and can have rotor diameters up to 164 meters. In 2014, the average power of wind turbines was 2 MW, increasing from 1.6 MW in 2009 [6].

Top 5 countries producing wind energy as of 2020 [7]:

- China – 288.32 GW
- United States – 122.32 GW
- Germany – 62.85 GW
- India – 38.63 GW
- Spain – 27.24 GW

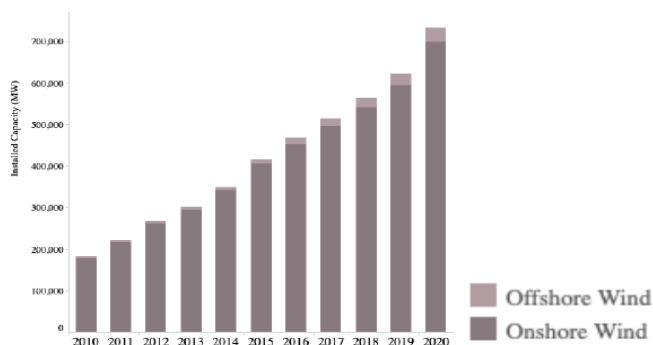


Chart -3: Installed capacity trends of wind energy

3.3 Hydropower

Hydropower uses water to power machinery or make electricity. Hydroelectric energy is generated by converting kinetic energy from water into electrical energy. A dam opens its gates to allow water from the reservoir to flow through a large tube called a penstock to generate electricity. Turbine blades spin at the bottom of the penstock when fast-moving water passes through. The turbine is connected to a generator to produce electricity. The electricity is then transported via substantial transmission lines to a local utility company [8,9].

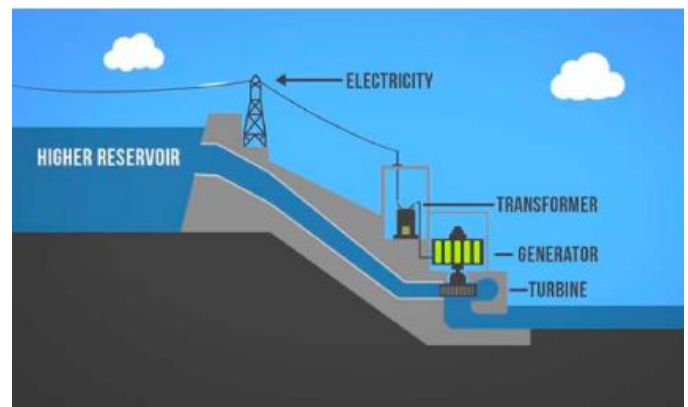


Fig -1: Diagram of Hydropower plant

Hydropower accounts for 21% of the world's electricity production. It is estimated that hydropower generation increased by more than 2% in 2019. However, the global net addition of hydropower in 2019 was only 12.7 GW, down 45% from 2018 and the lowest addition since 2001. The reason for this was the continued slowdown in China, a country that has led the global hydropower growth since 1996. By capacity and generation, hydropower is by far the most dominant renewable electricity technology. However, current growth patterns are insufficient to ensure the Full Sustainable Development Scenario (FSD) of hydropower [10].

Top 5 countries producing wind energy as of 2020 [11]:

- China – 370.2 GW
- Brazil – 109.3 GW
- US – 102 GW
- Canada – 82 GW
- India 50.5 GW

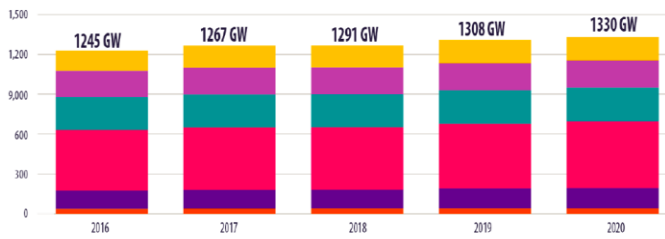


Chart -4: Installed Hydropower capacity growth from 2016-2020

3.4 Bioenergy

A bioenergy system can be divided into two categories: "traditional" and "modern. Modern Bioenergy technology includes liquid biofuels that can be produced from bagasse and other plants in addition to traditional methods of burning biomass. Traditional bioenergy refers to burning wood, animal waste, and charcoal [13].

Globally, bioenergy makes up more than three-quarters of renewable energy use, with more than half being traditional biomass. In 2015, bioenergy accounted for about 10% of global final energy consumption and 1.9% of global electricity generation.

There is significant potential for using biomass for energy production in growing nations, such as Brazil, India, and China. It can be directly burned for heating or generation of electricity or converted into gas or oil substitutes. In the transport sector, liquid biofuels are a convenient renewable alternative to gasoline [14].

Top 5 countries producing bioenergy as of 2020 [15]:

- China – 18.68 GW
- Brazil – 15.65 GW
- USA – 12.37 GW
- India – 10.53 GW
- Germany – 10.36 GW

The term "biofuel" refers to the energy gained by using fuels that are produced through the chemical process of biological carbon fixation. These hydrocarbons can be made in a relatively short period, in contrast to the formation of fossil fuels, which can require millions of years.

Top 5 countries producing biofuels as of 2018 [16]:

- USA – 1,190.2 thousand barrels/day
- Brazil – 693.2 thousand barrels/day
- Germany – 75.8 thousand barrels/day
- Argentina – 70.6 thousand barrels/day

- China – 68 thousand barrels/day

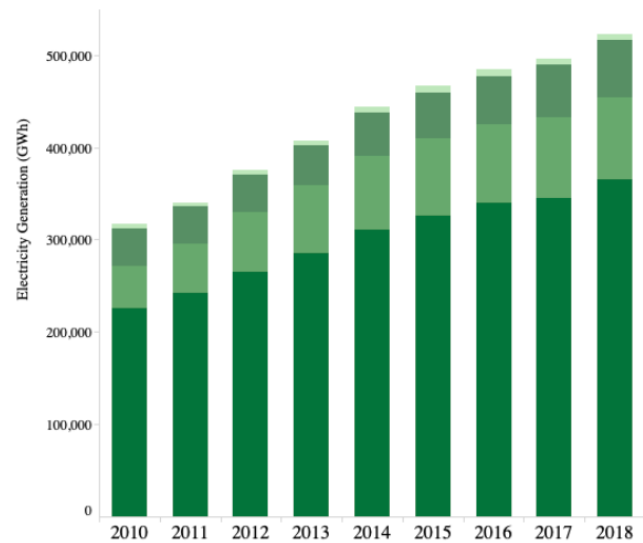


Chart -5: Global bioenergy generation trends

3.5 Geothermal Energy

Geothermal energy is energy generated from beneath the surface of the earth. It is found in rock and fluid beneath the earth's surface, as well as in the hot molten rock called magma. A mile-deep well is dug into underground reservoirs to access hot water and steam, which are then used to drive turbines that drive electricity generators. There are three types of geothermal power plants: dry steam, flash and binary [17].

In 2019, geothermal power capacity worldwide reached 15.4 gigawatts (GW), of which America accounted for 23.86 percent or 3.68 GW. Geothermal is a source of renewable energy that can supply both power and heating, and by 2050, geothermal has the potential to meet 3-5% of the world's energy demand [18].

Top 5 countries producing Geothermal energy as of 2018 [19]:

- USA – 3639 MW
- Indonesia – 1948 MW
- Philippines – 1868 MW
- Turkey – 1347 MW
- New Zealand – 1005 MW

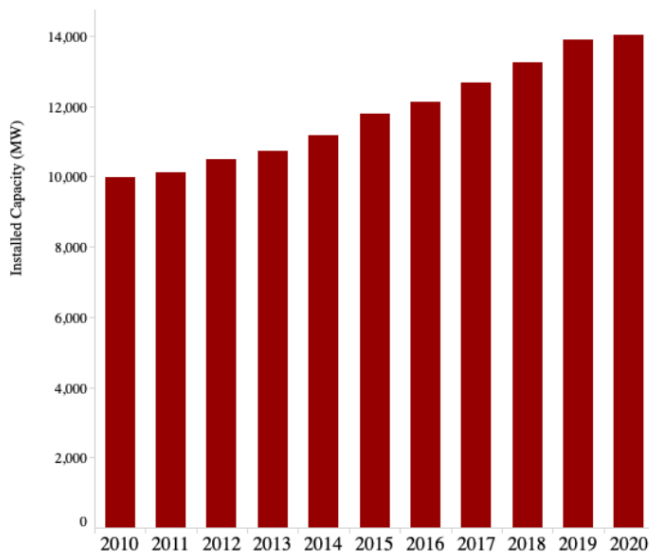


Chart -6: Installed Capacity Trends of Geothermal Energy

4. CONCLUSIONS

Since the Industrial Revolution, most countries' energy mix has become dominated by fossil fuels. Fossil fuel combustion results in around three-quarters of the global greenhouse gas emissions. This has significant implications for the global climate as well as for human health. The fossil fuel industry contributes to air pollution, which leads to at least 5 million premature deaths a year. Recent developments in technology and bitcoin mining activities have led to an exponential increase in energy consumption.

The world needs to rapidly shift to low-carbon energy sources, such as nuclear and renewable technologies, to reduce CO2 emissions and air pollution. A safe answer to an ever-decreasing energy demand had to be renewable sources. Renewable energy will play a vital role in the decarbonization of our energy systems.

A renewable energy source is a resource that is naturally replenished over time, such as sunlight, wind, rain, tides, waves, and geothermal heat. Although existing sources are used worldwide, there remains enormous scope for development and research for new sources and sustainable techniques. This type of energy source contrasts with fossil fuels, which are being used far more quickly than they are being replenished. Unlike fossil fuels, which are found mainly in a few countries, renewable energy resources are widely distributed. Even though most renewable energy is sustainable, some of it isn't; for example, some biomass isn't. The United States and China have been at the forefront of this expansion.

As a result of technological change, mass production, and market competition, renewable energy technologies are becoming more and more affordable. Globally, the cost of renewable energy is rapidly declining and is likely to be equal to or less than the cost of non-renewables like fossil

fuels, according to a 2018 report by the International Renewable Energy Agency. Solar power costs have dropped by 73% since 2010, while onshore wind costs have dropped by 23% in that same period. According to a report published last year by Bloomberg New Energy Finance, approximately 50% of the world's energy will be generated by wind and solar power by 2050, while coal-fired plant production will drop to only 11%.

Currently, renewable energy accounts for more than 20 percent of the energy supply of at least 30 nations worldwide. In the coming decade and beyond, the market for renewable energy is expected to grow strongly. Over 50 percent of electricity in 47 nations around the world is generated from renewable resources. In Iceland and Norway, all electricity is generated using renewable energy, and many other countries have set the goal of achieving 100% renewable energy in the future [20].

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