climate change. Nevertheless, wind energy is vulnerable to the effects of global change of climate .The climatic evolution is expected to have both positive and negative effects on the wind energy business. The extent of these effects will vary based on the specific location being considered. While wind power might be suitable for minor power requirements in remote locations, it is advisable to combine it with other power generation technologies to assure uninterrupted supply and enhance adaptability.

Studies on wind energy capability indicate that the global wind facilities are plentiful. The global wind power potential is projected to be 26,000 TWh per year, but only 9000 TWh per year can be effectively exploited owing to economic and other constraints [14]. Currently, wind energy is an advanced and efficient technology that is widely used for power generation. It is a well-established and cost-effective method that has little impact on the environment. It is extensively employed in many regions around the globe. Technology of wind harnesses the energy present in wind and turns it into mechanical and electricity power by using wind turbines. A wind turbine's purpose is to change the kinetic energy of the wind into rotational energy, which may then be used to power a generator, as seen in **Fig 3.** Wind turbines harness the energy of the wind via specially blades` constructed and turn it into rotational mechanical energy. Mechanical power is generated by wind turbine blades by use of use of airfoils.

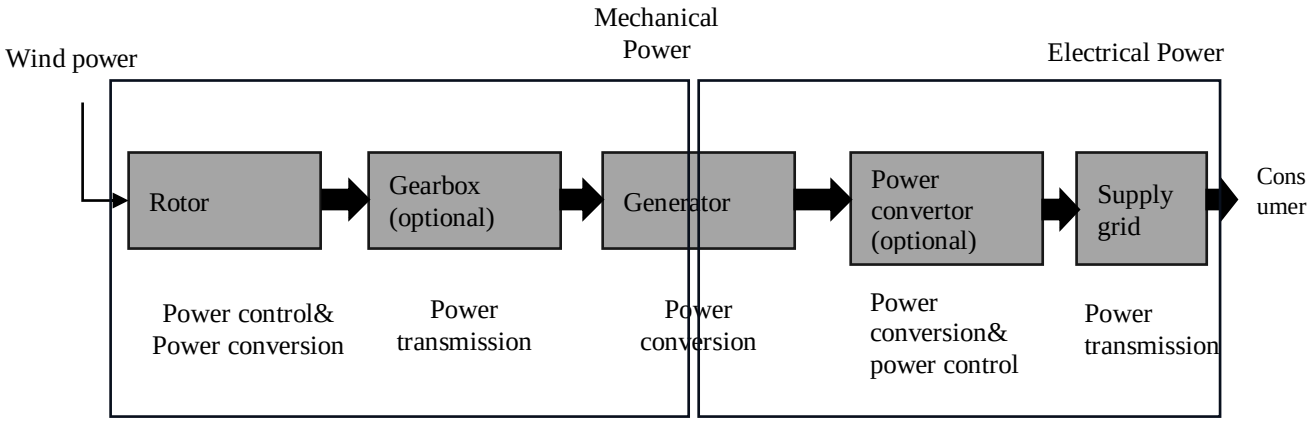

Fig 3. The process of converting wind energy into electrical energy in a wind turbine

Bioenergy

Biogas production by anaerobic digestion has notable benefits compared to other methods of bioenergy generation. It has been assessed as one of the major environmentally and energy-competence advantageous technologies for bioenergy manufacturing [15]. Various source materials and digestion procedures may be used for the generation of biogas. The diverse range of applications for biogas and its byproducts leads to significant variations in the environmental impact of different biogas structures. The source substances include organic waste from homes and the food sector, as well as agricultural waste products like manure and crop remainings and dedicated energy crops.

The substantial quantities of animal slurries and dung generated by the animal breeding industry, together with the moist organic waste streams, provide an ongoing pollution threat that might potentially harm the environment if not well handled. In order to avoid the release of greenhouse gases (GHG) and the loss of organic matter and nutrients into the natural environment, it is crucial to implement efficient recycling mechanisms that complete the loops from production to usage. This concept is shown in Figure 4. Biogas is a gas combination mostly consisting of CO_2 (30-60%), CH_4 (40-70%), and other gases (1-5%).

The biogas has a value of calorific of around 16-20 MJ m−3. As seen in **Fig 5,** methane fermentation is a complicated process that may be broken down into four stages: methananion, hydrolysis, dehydrogenation/ acetogenesis, and acidogenesis.

Hydrogen as fuel

The increasing demand of energy and depletion of resources of energy of convention necessitate the use of sustainable sources of energy. Another aspect to take into account is the environmental contamination caused by conventional energy sources in our vicinity. Over the next 10 years, there will be a rise in the use of renewable energy sources, often known as 'Green Power', with the aim of decreasing dependence on non-renewable fossil fuels and alleviating environmental degradation. The change is projected to enhance the overall quality of life and welfare of people. Energy is a fundamental factor in a nation’s development process. Considering the increasing demands of energy and the reducing supply of traditional sources of energy, it is fundamental to prioritize the application of non-traditional energy sources, including energy conversion and effective management of energy.

A vital element to consider is pollution stimulated by the sources and their impact on the surroundings. As the usage of these sources continue to include, pollution increases in the environment hence resulting to the reduction in quality of life in the globe. Hydrogen is well identified for its environmentally sustainable features, since it acts as a pristine source of energy, which does not generate any form of pollution. Hydrogen is the most available element and is also known for its

low density as a fuel option. Moreover, hydrogen has a high energy density, meaning it contains a significant quantity of energy per unit mass. It is easily storable and may be produced by extracting it from water. In addition, hydrogen has the capability to be immediately transformed into electrical, mechanical, and thermal energy, as seen in **Table 2**. Scientists worldwide are aggressively pursuing the commercial availability of hydrogen as an energy source owing to its known viability and ecologically advantageous characteristics.

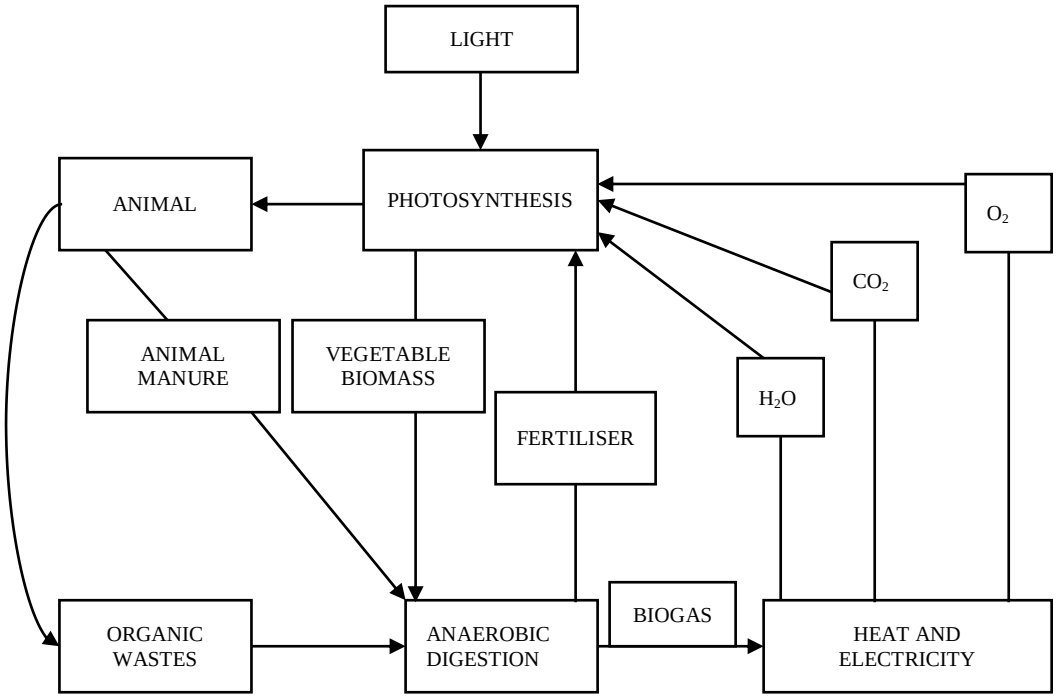

Fig 4. Illustration Depicting the Renewable Process of Anaerobic Co-Digestion of Organic Wastes and Animal Dung

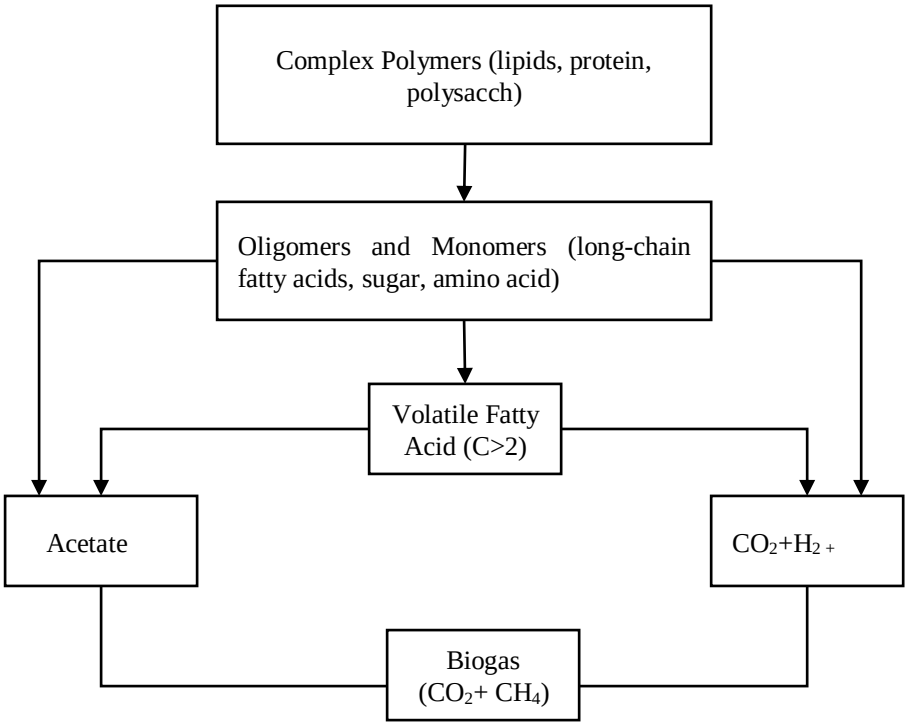

Fig 5. The Sequential Phases of The Methane Agitation Procedure

Table 2. Combustion of Heat of Various Fuels

Energy	Amount
Fuel	Energy (Kcal/g)
Petroleum	10–9.79
Castor oil	9.41
Wood	4.21
Graphite (Coal)	7.79
Paraffin	10.29-8.39
Hydrogen	34.1

However, it is crucial to recognize that renewable energy sources may not always be the most efficient solution for producing and distributing bigger quantities of electricity. The subsequent segment will delineate the precise constraints and difficulties linked to its incorporation into the electrical system.

IV. LIMITATIONS AND CHALLENGES OF RENEWABLE ENERGY SOURCES USAGE

Although renewable energy sources provide several advantages, they also present certain obstacles and limitations in their practical use. The reliance of renewable sources on atmospheric conditions and geographical location is mostly ascribed to their intrinsic natural characteristics. The volatility and unpredictability of these sources of energy pose a vital challenge in electricity production. To effective address this challenge, individuals can utilize critical planning measure and careful site selection processes for a certain renewable energy source, alongside the applications of accurate measurements and understanding of the environment. In addition, in view of daily variations in electricity viability utilize in the generation of power, it is fundamental to review the viability aspect of integrating renewable sources into the present power framework. The status of installed energy capacity of different power plants could be employed in maintaining an efficient reserve in electrical frameworks. The main aim of this type of reserve is to offset any challenges, which might occur when particular sources are not available.

In addition, the electrical grid system at a particular location has a restricted capacity to effectively management energy without being subjected to any potential risks of instability or overload of the power framework. The primary impediments to grid integration of electricity come from wind businesses, majorly as a result of the substantial capacity of their integrated wind plants. Hence, it is essential to restrict their authority inside each power system to guarantee the secure and steady functioning of the whole electrical sector [16]. When comparing traditional fossil energy sources to sources of clean energy, it is clear that renewable sources have a restricted capacity to provide power. They are unable to generate energy on the same scale as power stations that use fossil fuels. To address this limitation, it is imperative to allocate more resources towards the advancement of technology of renewable energy, as well as enhance the energy facilities construction.

Furthermore, sources of renewable energy exhibit a reduced ratio of planted station power or electricity output to various areas of power plants, in contrast to fossil fuel power stations. Consequently, in order to generate a same quantity of renewable electricity facilities, electricityneed a much bigger land area compared to thermal power stations. Sources of renewable energy, save for wind farms and water resources, often have inferior energy competence while meeting the required surface area. Efficiency in electricity production refers to the proportion of useable electrical output produced by a producing entity during a certain time period, in relation to the value of energy of the assets supplied to the entity during the same period. The efficacy of various technologies, namely different kinds of energy assets used in power stations, is shown in Figure 6. The provided figures of energy efficiency for various production systems indicate the lowest and highest levels of efficiency achievable for a certain power station.

Renewable sources of energy, referred to as “clean” energy, are represented by the color green. Large hydropower facilities, which have a substantial impact on the ecology, are shown by the color blue. Nuclear and thermal power plants are represented by the color brown. The efficiency of energy of oil-fired plants of thermal power ranges from 38% to 44%, while plants of coal-fired power have a competence of 39% to 47%. Gas thermal power plants, on the other hand, have acompetence of up to 39%. However, if we base on gas thermal stations in an aggregated procedure, which includes both a steam-turbine part and gas-turbine, the overall energy competence increases significantly to reach up to 58%. This is because the combined process allows for simultaneous production of electricity and thermal energy. Additionally, it is noted that the nuclear power station has a very modest competence of energy ranging from 33 to 36%. With the exception of hydro power plants, sources of renewable energy generally have inferior energy competence. Furthermore, biogas and biomass power plants exhibit a competence ranging from 30 to 40%, waste power stations have acompetence between 22 and 28%, geothermal and whilst solar power stations exhibit the lowest competence of energy of 15% [17].

However, it is worth noting that major hydropower plants achieve an impressive energy efficiency of 95%. Despite using renewable water assets, they are not officially categorized as sources of renewable energy. Large hydropower facilities use the most competent technologies for generating energy. Similarly, renewable power facilities that rely on water assets, like tidal power stations and small hydro power stations, have very high competence levels of up to 90%. While the average energy efficiency of a typical wind power plant is said to be about 35%, the latest advancements in wind

turbine technology have enabled some of the most contemporary turbines to achieve efficiency as high as 45%. Furthermore, the maximum achievable amount of wind power consumption in a wind turbine is defined by the Betz limit and Betz rule, which is 59.3%. It is not now possible for any advanced wind turbine to achieve energy efficiency greater than the specified 59.3% [18]. Wind power facilities are only able to harness less than 50% of the wind's kinetic energy into usable electricity.

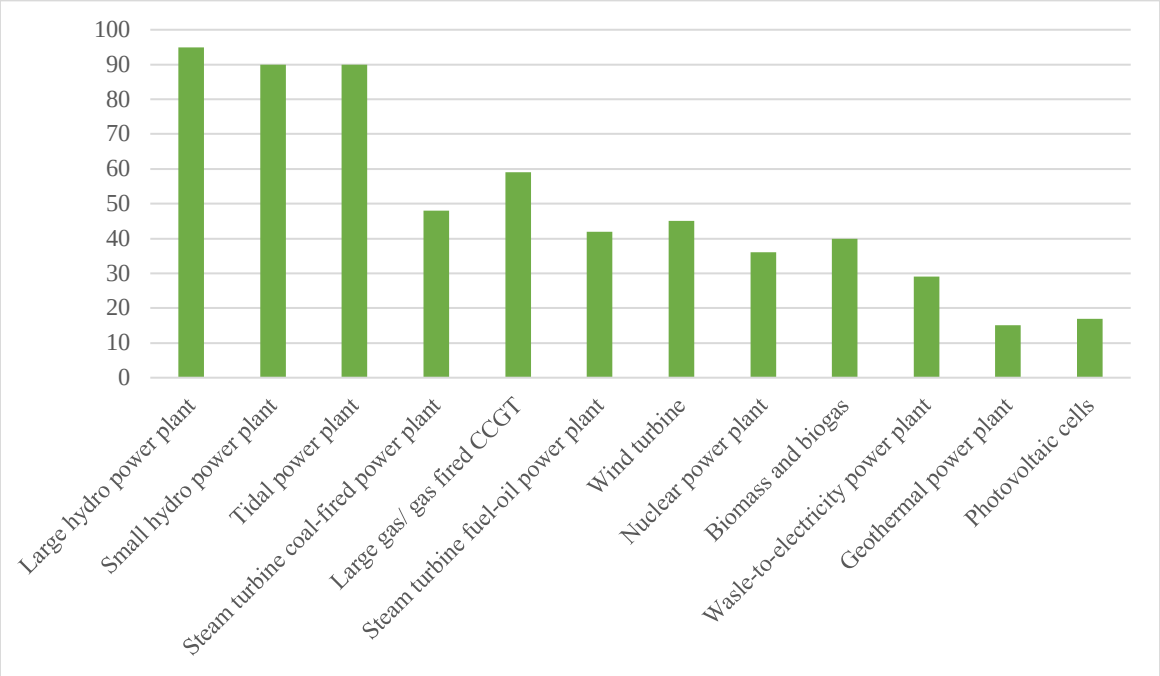

Fig 6. Efficiency of Various Methods in Generating Electricity (%)

Renewable energy sources often have a shorter annual duration of full power operation, compared to fossil fuel power stations, due to their power output and intrinsic properties. According to Weitemeyer et al. [19], renewable energy sources like wind or solar power have a maximum operating capacity of about 2000 hours per year. In contrast, power plants that rely on coal, gas, or nuclear power may run at full capacity for up to 7,500 hours per year. Due to high wind velocities and less wind turbulence, offshore wind power installations may operate at maximum capacity for around 4,000 hours annually, in contrast to onshore plants which typically run for 2,000 to 2,500 hours per year. For a whole year, the power plant operated only at its maximum installed capacity. It is realistic to expect that the power plant will have a longer yearly working duration, even if it is not functioning at its maximum capacity.

It is important to mention the capacity factor indicator, which is comparable to this one but measures the proportion of the actual energy supplied to the electrical grid to the maximum power that might be generated if the power station operated at full volume for all 8,760 hours in an annum. The volume factor of fossil fuel power plants is much larger than that of renewable energy sources, indicating the number of hours they operate at maximum power in a year. For instance, conventional power plants typically achieve an electricity generation capacity factor of approximately 60%. In contrast, wind power plants, due to factors like, geographic positioning, wind patterns and the technical specifications of wind turbines, typically achieve a lower electricity generation capacity factor ranging from 20% to 35% [20]. The use of renewable energy sources is hindered by their comparatively elevated power producing expenses, which constitutes a significant disadvantage.

Renewable energy facilities are purportedly more costly to build in comparison to fossil fuel power plants. Marine energy power plants, in particular, face significant cost barriers due to their expensive technology. Additionally, the exact site requirements of these plants result in a very little contribution to the total electricity produced. The intricate nature and exorbitant expenses associated with the technology used in the production of solar panels are key factors contributing to the elevated costs of constructing photovoltaic systems [21]. When comparing renewable and non-renewable power sources, there are various factors that affect the calculation of energy generating costs, resulting in different predictions. Illustrated below is an example that effectively illustrates this principle. A comparative analysis was conducted in [22] to assess the economic feasibility of electricity generation from several power plants using distinct fuel sources. The plants mentioned include a wind power plant, nuclear power plants, biomass plants using wood and peat, coal-fired power systems and gas-fired integrated power and heat plants. The goal is to identify a cost-efficient method to enhance power generation in non-functional conventional power plants.

Fig 7 presents projections from the start of 2008, focusing on pricing levels such as power plant building costs and fuel prices. When comparing renewable energy sources to fossil fuel plants, it is evident that the production of electricity from

renewable sources incurs greater costs (measured in €/MWh) in three specific categories: capital expenses, power plant management and maintenance costs, and fuel prices. An exception to this rule exists in the case of biomass plants that use peat as a fuel source.

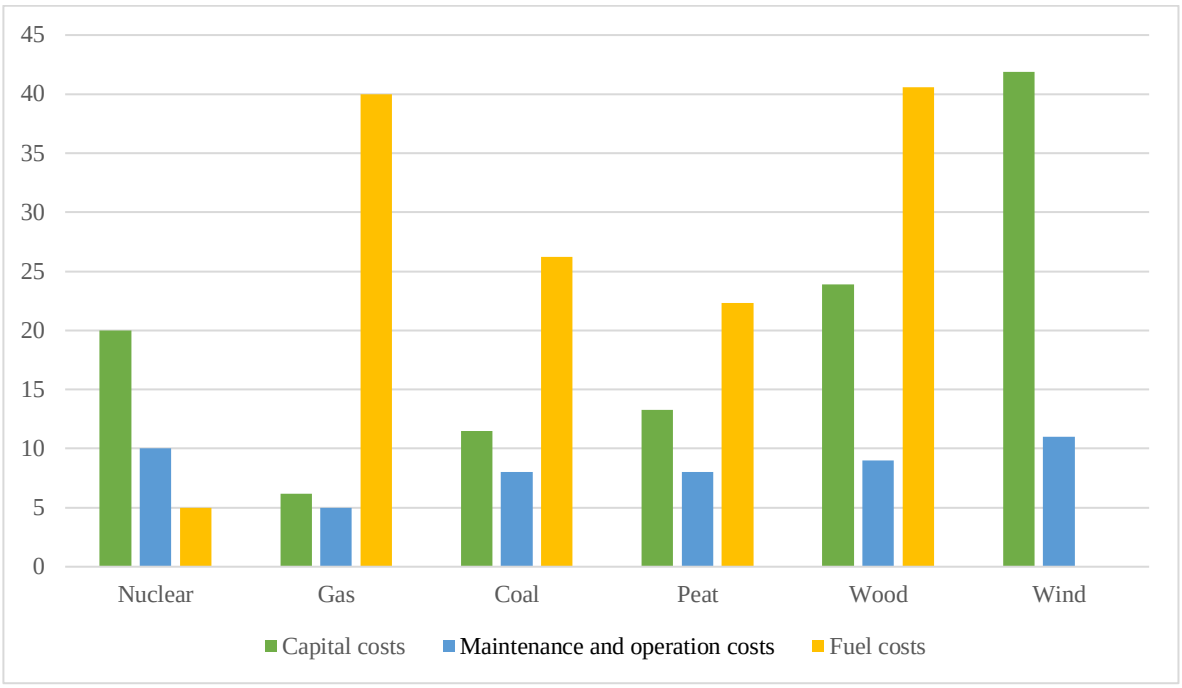

Fig 7. Electricity generating costs and structure of various power plants, excluding emission trading in €/MWh

The reason for this is the significant initial costs, namely connected to the wind farms` construction, which make up 41.9% of the overall expenditures related to the infrastructure. Additionally, biomass plants, which get their fuel from wood, also incur similar costs, accounting for 40.6% of the total expenses. Wind power stations are the only kind of power plants that do not need fuel charges. They use the abundant and inexhaustible energy resources of the wind. During the whole period under investigation, fuel expenditures for gas plants remain consistently high, comparable to those of wood biomass plants, although other costs are significantly less. Renewable energy sources have the potential to rival conventional fossil fuel power plants if the costs of carbon dioxide (CO2) emissions are included into the electricity generation pricing (see **Fig 8**).

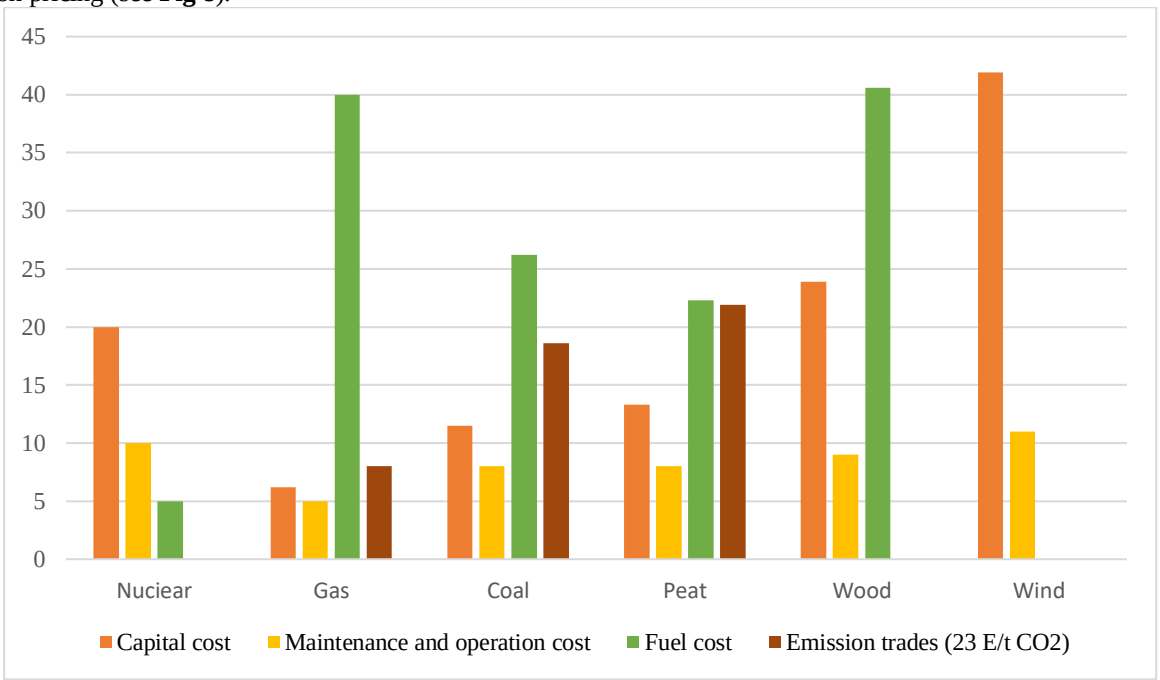

Fig 8. Electricity generating prices of several power stations, including associated carbon trading prices in €/MWh

When evaluating the environmental consequences of power generating, it is crucial to acknowledge that peat plants, coal, and gas (the first coal generation form) all raise electricity production expenses due to the emission of detrimental substances into the atmosphere. Vital energy. The emission certificates, priced at around 23 €/t CO_2 at the time of the survey's publication in 2008, are used to restrict the release of greenhouse gasses. The current market price for the environmental certificate (emissions trading) is 30.92 €/t CO_2, which is an increase compared to yesterday's pricing on December 14, 2020 [23].

The exchange of ecosystem certificates emission between EU countries started in 2005, with the aim of reducing greenhouse gas emissions [24]. The purchasing of the certification was established as an option to failed attempts to create a solitary tax on environmental pollution. The certification process includes the quantification and control of emissions of greenhouse gases into the atmosphere, along with other compounds that have deleterious effects on the ozone layer. Various gases are measured in CO2 equivalents [25]. When considering the trading of ecosystem certificates of emission, the cost of producing electricity from fossil fuels exceeds that of running a wind farm. Therefore, it is essential to include and incorporate the whole operational costs of the power station while producing electricity, toevaluate the efficiency of its operations precisely and thoroughly.

V. CONCLUSION

This article aims to provide a comprehensive introduction to the different sources of renewable energy and the factors that influence their acceptance. The study aims to highlight the opportunities and challenges associated with renewable energy by examining the technical, geographical, and technological aspects of its potential. Furthermore, via the analysis of instances like solar thermal energy, wind energy, and biogas generation, the piece seeks to provide a thorough comprehension of the disadvantages and advantages of various sources of renewable energy. Using sources of renewable energy may help reduce environmental deterioration and meet the world's energy demands. Understanding the many elements influencing the renewable energy implementation potentials is aided by the categorization of these potentials into geographical, technological, and technological categories. Technical potential takes into consideration energy conversion losses, while geographic potential considers the highest quantity of energy that may be gathered from accessible areas. Achieving competitive production costs for renewable energy sources is the main goal of technological potential. Although the long-run supply cost curve offers a suitable way to visualize economic capability, most potentials are heavily impacted by assumptions about average trends and values. The appraisal of renewable energy potentials is impacted by several factors, including socio-cultural and political-economic factors, land availability, and agricultural demands. The availability of technology, labor costs, interest rates, and other techno-economic variables are some of the elements that determine economic viability. Two well-known renewable energy sources are solar thermal energy and wind energy. There is a lot of promise for solar thermal power in areas like crop drying, water heating, and cooking. Solar ovens and cookers are extensively used worldwide.

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Data Availability

No data was used to support this study.

Conflicts of Interests

The author(s) declare(s) that they have no conflicts of interest.

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Competing Interests

There are no competing interests.

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