Exploring the Potentials and Challenges of Renewable Energy Sources

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Abstract – Efficient methods for decreasing emissions in the energy sector include enhancing the efficacy of coal-fired power plants, augmenting the utilization nuclear energy and gas for heat and electricity generation, diversifying the application of renewable sources of energy, and allowing to consume energy in a rational manner. By adopting renewable energy sources, we not only get environmental benefits, but also strengthen the state's autonomy in fuel and energy exports. This leads to savings in foreign money and the establishment of new job possibilities. This article examines the potential, as well as limitations and challenges, of renewable sources of energy, such hydrogen, solar, wind, and biogas. This article research different factors influencing the economic viability of renewable energy potentials, including their geographical, technical, and technological characteristics. The essay also examines the benefits and drawbacks of generating biogas, wind energy, and solar thermal energy. The conclusion underlines the need of careful planning, site selection, and environmental studies to ensure the successful integration of renewable energy into the existing power system.

Keywords – Renewable Energy Sources, Solar Thermal Energy, Wind Energy, Biogas Production, Economic Feasibility, Energy Potentials.

I. INTRODUCTION

Renewable or alternative energy sources serve as a supplementary option to traditional types of energy. While they play a considerable role in production of energy in certain industrialized countries, they have not yet become the primary energy resource in the field. Alternative types of energy play a vital part in thermal energy production, in summation to generating electricity. Renewable methods of power and heat production are environmentally friendly since they do not release greenhouse gases. Additionally, they allow for the conservation of finite fossil resources for future use. The primary catalyst for the escalating usage and investment of sources of sustainable energy is this. The rise in adoption of another energy sources is a result of the expanding economic progress of particular nations (the categorization of the United Nations Development Program, International Monetary Fund, or the World Bank, may be used as a measure of economic advancement).

Conversely, the establishment and use of alternative energy facilities foster the advancement of novel energy technology, the promotion of entrepreneurial endeavors, and eventually, the overall economy, affirming the reciprocal influence on one another. When examining renewable energy sources, the current body of research highlights several benefits and drawbacks associated with their overall use. According to Owen [1], the use of renewable energy necessitates a sustainability analysis that relies on three key factors: funding and economics, externalities costs, and ecosystem consequences. In their study, Cuesta, Castillo-Calzadilla, and Borges [2] identified many worldwide advantages of renewable energy generation, classifying them into environmental, economic, technical, social, and political dimensions. Furthermore, they suggested a method for developing the renewable energy industry and outlined the obstacles to deploying renewable energy technologies. In addition, Liu et al. [3] identified several drawbacks of China's renewable energy development policy. These include a lack of policy consistency and coordination, weaknesses and gaps in the incentive system, an incompletesystem financing for projects of sustainable energy, and insufficient investment in technical research and advancement for sustainable energy.

Conversely, Wu et al. [4]investigated the impact of sustainable energy policy in China and proposed a plan for its advancement. Guan et al. [5] examined the favorable and unfavorable economic impacts of renewable energy technology. Renewable energy technologies have been shown to have a multiplier impact in encouraging the growth of not just the field of energy, but also all the other actions that support this industry. Furthermore, technological progress facilitates a reduction in the prices of renewable energy technologies. Reducing investment costs also encourages competitiveness in the renewable energy industry. Moreover, the presence of competition in the renewable energy industry once again influences the decrease in costs and the effective functioning of energy firms. It is essential to highlight that most research analyze each renewable energy source individually, without evaluating them together. In [6], there is a significant dearth of study in the topic of sources of renewable energy, including its benefits and drawbacks. Hence, this research aims to broaden the current body of knowledge and enhance our thorough comprehension of the attributes of renewable energy sources.

This paper presents a thorough examination of the justification for using renewable energy sources, like hydrogen, solar, biogas, wind, and hydroelectric power. The text examines the geographical, technical, and technological capabilities of different energy sources and investigates their advantages and disadvantages. The report further emphasizes the obstacles and constraints linked to the incorporation of renewable energy into the electrical grid, while also discussing the matters of energy efficiency, capacity factor, and cost-effectiveness. In summary, the article highlights the need of meticulous planning, meticulous site selection, and thorough environmental research to guarantee the effective integration of sustainable sources of energy and the reliability of the power industry. The remaining sections of the paper have been organized as follows: The second section defines renewable energy potentials and sources. In the third section, a discussion of the advantages of renewable energy source utilization is provided. In this section, various sources of energies are provided: solar energy, wind energy, bioenergy, and hydrogen as fuel. The fourth section presents a review of the limitations and challenges of the utilization of renewable energy sources. Lastly, the fifth section summarizes the findings of the paper.

II. DEFINING RENEWABLE ENERGY POTENTIALS AND SOURCES

Dependent on a review of De Vries, Van Vuuren, and Hoogwijk [7], we categorize renewable energy potentials into the following descriptions: Three:Geographic potential pertains to the maximum quantity of energy that may be taken from locations that are considered suitable and easily accessible for this purpose. These areas lack any other land uses or cover that would be incompatible, and there are no constraints placed on local features such as smallest mean wind velocity or elevation.There are two categories of potential: the technical potential, which refers to the spatial potential after accounting for losses incurred during the conversion of secondary energy forms (such as fuel or electricity), or carriers from (such as fuel or electricity), and the technological potential, which must be achieved at a projected cost of production of the secondary energy for it to be competitive with a particular, local alternative. The economic potential can only be evaluated at that point.

The long-run supply cost curve (LSCC)is a flexible depiction of economic potential that illustrates the relationship between energy production capacity and production cost. Although impartiality is claimed, most of the potentials are significantly affected by assumptions on trends and average figures. The spatial potential inherently incorporates assumptions on the availability of resources and land suitability. During the stated time period, certain factors such as soil quantities, solar radiation, and wind speed are included.Availability of land and theimportance offarming land for food production exemplify socio-cultural and politico-economic notions. The technical potential may be determined by considering the geographical potentials and assumption made about the growth of conversion efficiency. To create solar-PV electricity, it is necessary to forecast the future conversion efficiency, which might vary from the present 10% to much higher values.

Finally, to evaluate the economic viability, it is necessary to ascertain the standard expenses associated with generating the secondary energy carrier (such as gasoline or electricity) in a certain area. These factors, such as the expenses associated with available technology, worker wages and expertise, interest rates for borrowing, and many other techno-economic variables, are responsible for determining this outcome. The evaluations of geographical, technological, and economic potential are based on many assumptions. These assumptions impact the pace and probability of realizing a potential, specifically the potential for implementation in a given year. Furthermore, cultural perspectives and laws (such as feed-in tariffs and subsidies) together with the perceived gravity of challenges like climate change and import reliance will all exert influence. The difference between implementation potential and economic potential may be rather ambiguous. The economic potential of our region is contingent upon the quantity of energy derived from WSB (Waste-to-Sustainable-Bioenergy) that can be generated at a certain expense.

The manufacturing costs are only one of the several factors in Table 1 that influence the feasibility of adoption. While the potentials are clearly specified, additional assumptions about context are required for accurate assessments, particularly for the geographical and implementation potentials.

Table 1. Conditions 'against' and 'in support of' Utilizing Renewable Energy

FACTORS 'IN SUPPORT'	FACTORS 'AGAINST'
ECONOMIC	
Demand	
Decrease of personal income taxes	Own services required contribution
Subsidies under the EU and the national programmes	The potential beneficiaries decision making is limited by the subsidy level
Decreasing the disruptions risk in supply of energy in hinterlands	Power grids dominance depending on fuels of fossil

Monthly energy bills reduction	The cost of power per unit bases on area and infrastructure; costs change accordingly for each sustainable source of energy
An important role is played by RES in reduction of fossil fuels; availability of energy advances the life quality and stimulates local economic advancement	Dependance on coal as one of the main sources of heating of energy for rural areas farms
Supply	
Biogas production possibly throughout an annum due to raw materials availability (especially waste from crop products and production of animal)	Lack of continued supply not always available and challenging to forecast in some cases of sustainable sources of energy (wind sun)
Unlimited and free access to some locally available sources of sustainable energy (water, wind, sun)	It takes a lot of time to recuperate the costs of installation (modernization costs and high initial capital)
Afforestation as a lon**g-term** investment	Limited availability of funds for subsidies and land for afforestation
Raw materials availability at local level (wood biomass)	The production of RE cost is related to raw materials availability and regulations
Poor quality arable land usage (class VI and V) for uses of installation (wood biomass, windmills, PV farms)	RES installations` high initial costs
Households from rural areas being enabled to become suppliers of energy	The absence of financial advantages from electricity sale
ENVIRONMENTAL / ECOLOGICAL	
Local cooling effect is produced by forests by shading	-
Surface water, soil, air pollution reduction and climate change and greenhouse effect mitigation	Rural landscape interference, cause effect on the ecosystem and landscape
Sequestration of carbon is a significant advantage resulting from the poor quality agricultural land	-
Sources unlimited resources	Energy production (sun, wind, water) depending on atmospheric conditions
-	Installations problematic recycling i.e. Wind mills, PV panels, solar connectors)
SOCIAL	
Independence of energy leads to the advancement of living standards by decreasing conventional energy consumption	-
Creation of local jobs mostly in service companies and installation (solar energy)	Capable beneficiaries' awareness about using sustainable energy (advisory services and training in education are recommended)
Promoting the eco-trend, care for future generations, ecological awareness	-
Common public solar energy acceptance	Demonstrations against some of the sources of RE (plants, biogas, windmills), due to their allegedly bad effect on the resident's health
LEGAL AND INSTITUTIONAL	
-	Legal issues in case of capable sustainable energy installations of water
An important function of commune self-states in implementing projects of investment	The transparency in availability and bureaucracyfor gaining helpful funds discourage beneficiaries
TECHNOLOGICAL / TECHNICAL	
Energy provision to regions without network	Legal and formal restrictions
New technologies, sustainable energy installations diversity	Challenges in adaption of most of the old residential buildings to the sustainable sources ofpower installations
The ability to sell energy	Possible technological obstacles (underdeveloped transmission network)

III. ADVANTAGES OF RENEWABLE ENERGY SOURCES UTILIZATION

Solar energy

Solar energy is the mostplentiful source of renewable energy, accessible in both indirect and direct forms. Energy is released by thesun at a rate of 3.8 × 1023 kilowatts, while the Earth absorbs around 1.8 × 1014 kilowatts of this energy. There is a wide range of opportunities to harness the abundant solar energy for various thermal purposes, including crop drying, water heating, cooking, and more. The easiest and straightforward use of solar energy is solar cooking. Solar energy has great potential to become a prominent energy source for cooking, according to Shahsavari and Akbari [8]. The market offers a range of solar cookers, among which the box type solar cooker (see **Fig 1**) is extensively used worldwide. A comparative analysis was carried out in both Costa Rica and globally to assess the benefits and drawbacks of solar ovens in comparison to traditional wood-burning and electric stoves.

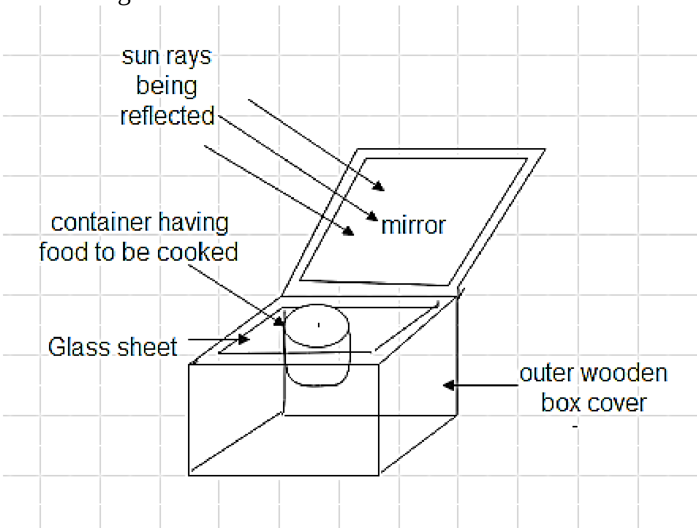

Fig 1. Box Type Solar Cooker

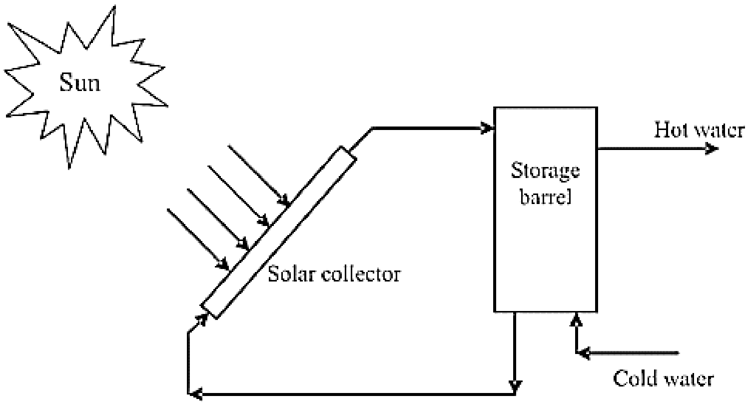

Fig 2. An Average Solar Water Heater for a Home

The payback time for a typical hot box solar oven, assuming it is utilized for 6-8 months annually, is around 12-14 months. Additionally, this oven has the potential to save nearly 16.8 million firewood tons and avoid the carbon dioxide 38.4 million tons emission per year [9]. A residential solar water heater, designed to provide the majority of hot water requirements for a household of four, has substantial environmental benefits and should be used wherever feasible to promote a sustainable future [10]. According to Kakaza and Folly [11], a household solar system of heating water (see **Fig 2**) with a volume of 100 liters per day may save around 1237 kg of emissions of CO_2 per year while operating at 50% capacity. In hot and sunny regions, this reduction can be around 1410.5 kg.

The use of the technology of solar-drying provides an alternative method for processing vegetables and fruits under circumstances that meet both national and international requirements for cleanliness, hygiene, and sanitation, all without incurring any energy expenditures. The use of this technology results in energy and time savings, reduced space requirements, enhanced product quality, increased process efficiency, and environmental protection. Chen et al. [12] calculated the amount of CO2 generated by a drying system that uses 100 kWh of energy per day, operating for 25 days per month, and running for 11 months per year. The total amount of CO_2 emitted each year was around 14.77 tons. Additional research was undertaken to investigate the possibility of solar crop drying and its impact on CO2 emissions. According to Goggins et al. [13], an aperture area of $1m^2$ may reduce carbon dioxide emissions by 463 kg throughout its whole lifespan.

Wind energy

Among the several renewable energy methods used for generating electricity, wind energy holds the second position in terms of installed capacity, after only hydroelectric power. Furthermore, wind energy is now undergoing significant expansion. India is a very favorable country for the development of wind power, ranking among the most promising nations globally. The increase in installed capacity of wind energy is positioned to have a crucial impact on mitigating 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.

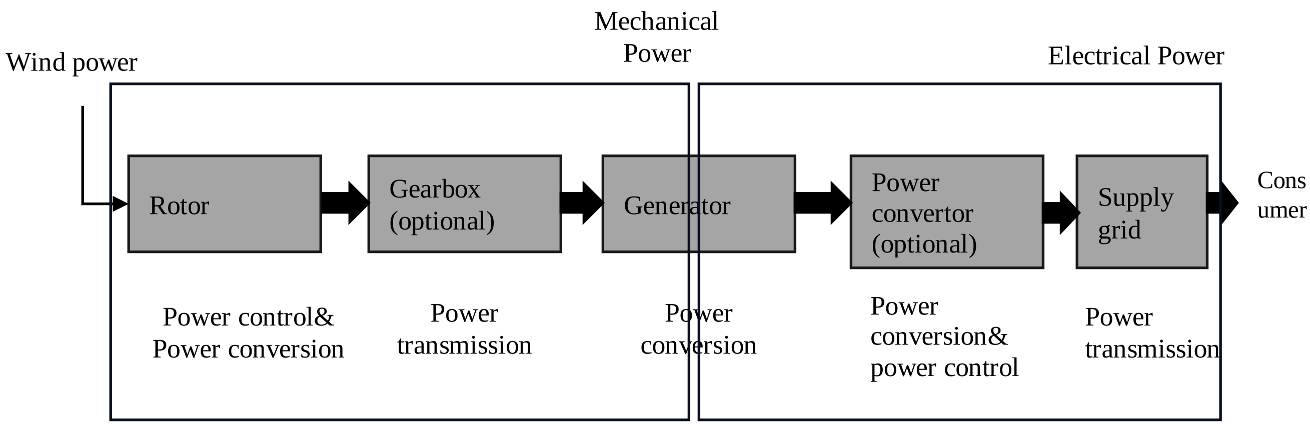

Fig 3. The process of converting wind energy into electrical energy in a wind turbine

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.

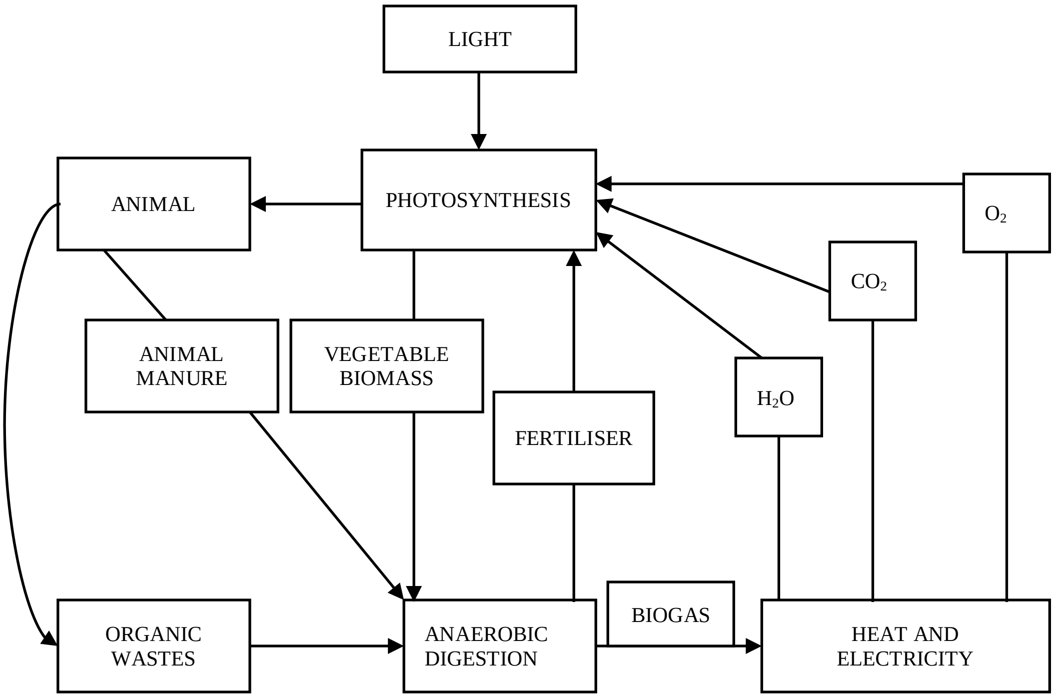

Fig 4. Illustration Depicting the Renewable Process of Anaerobic Co-Digestion of Organic Wastes and Animal Dung

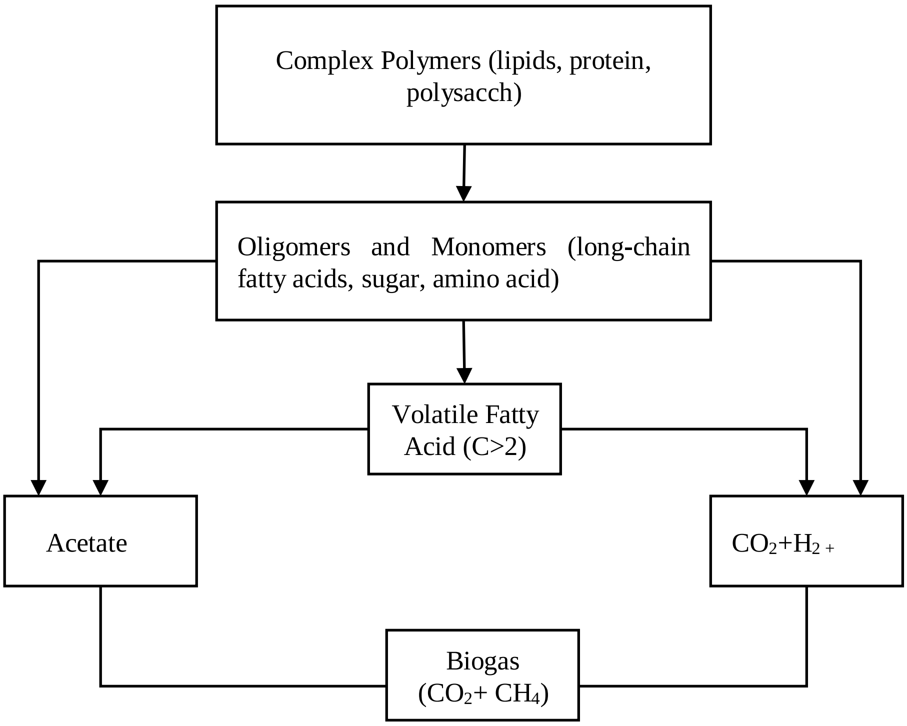

Fig 5. The Sequential Phases of The Methane Agitation Procedure

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.

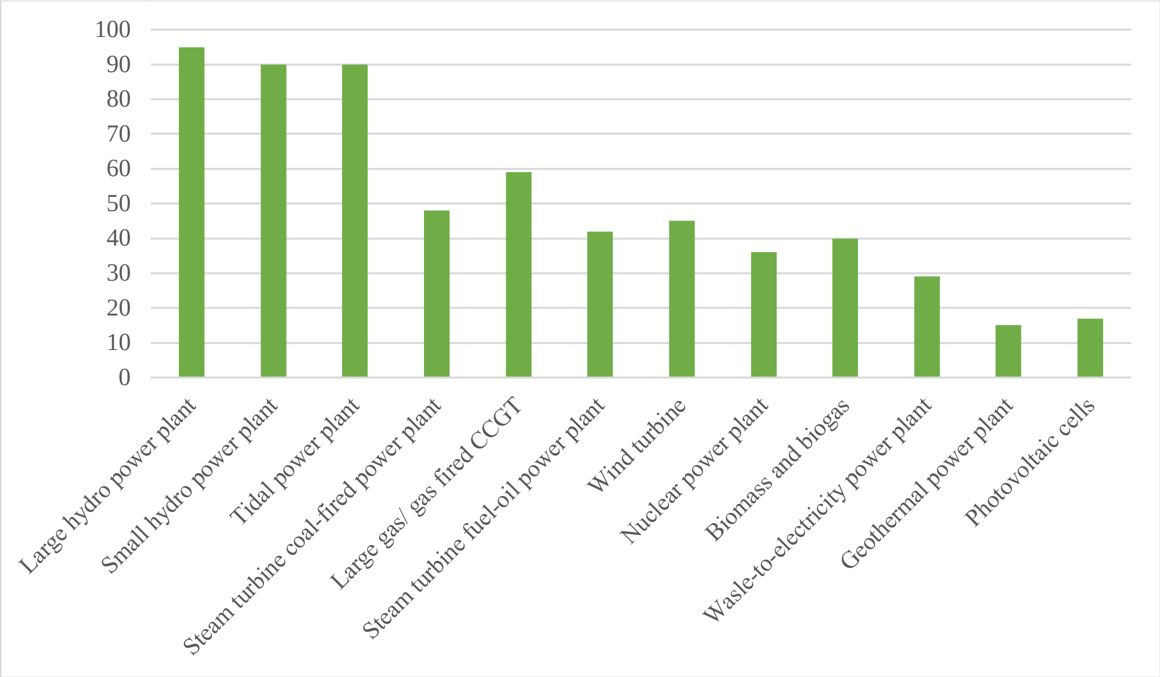

Fig 6. Efficiency of Various Methods in Generating Electricity (%)

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.

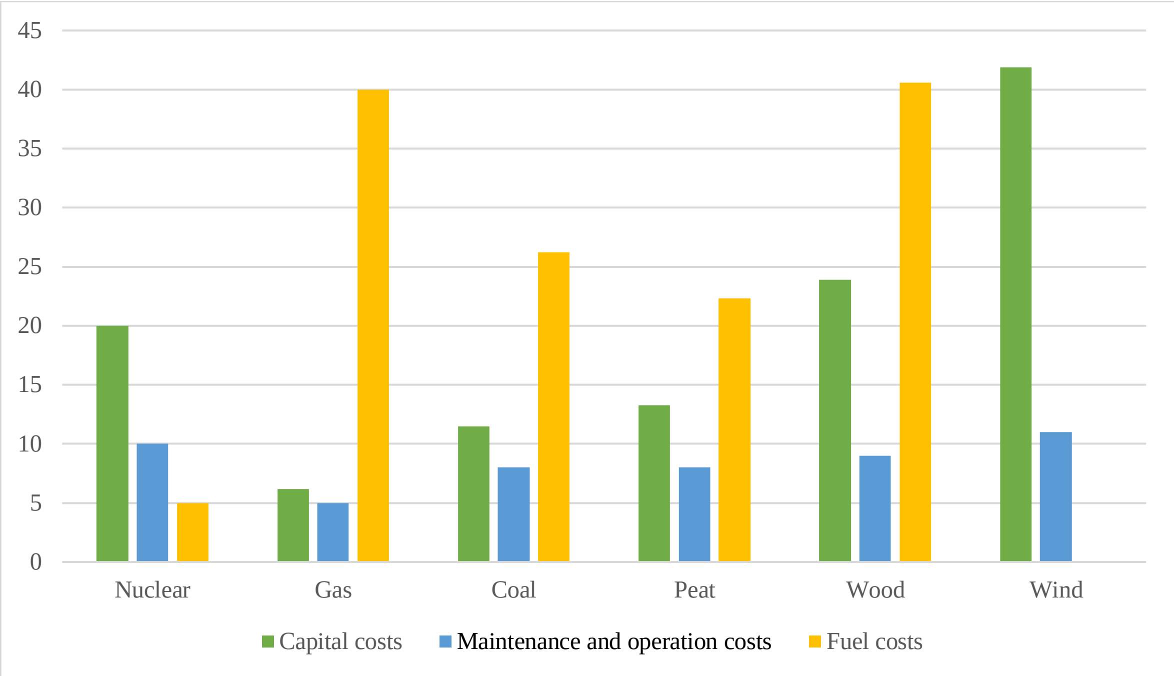

Fig 7. Electricity generating costs and structure of various power plants, excluding emission trading in €/MWh

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**).

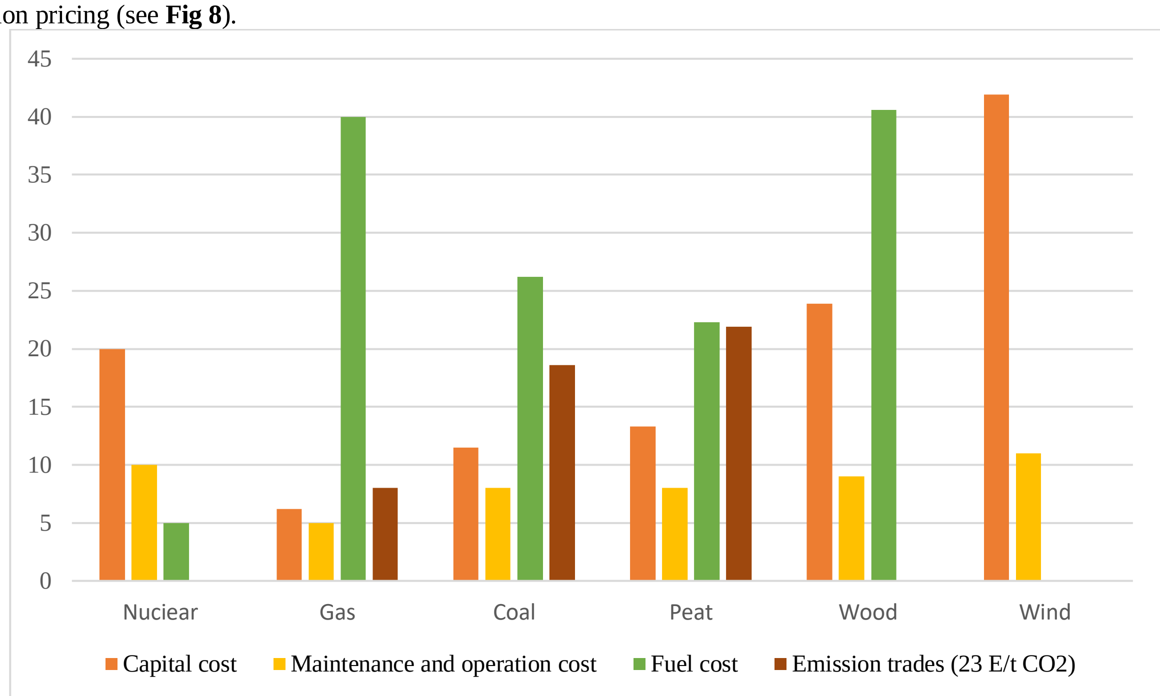

Fig 8. Electricity generating prices of several power stations, including associated carbon trading prices in €/MWh

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.

Funding

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Competing Interests

There are no competing interests.

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