

CHALLENGES AND OPPORTUNITIES IN GREEN ECOLOGICAL-BASED TECHNOLOGY FOR THE REPLACEMENT OF FOSSIL FUELS

Abstract

Population growth has raised energy consumption. Non-renewable fossil fuels including coal, petroleum, and natural gas provide the world's energy, releasing greenhouse gases like carbon dioxide. Thus, fossil fuel alternatives are essential. Livestock manure, crops, trees, home-wet organic waste, agro-industrial waste, animal waste, and sewage sludge may be digested to produce biogas. Biogas, which comprises 50-75% methane, 25-50% carbon dioxide, and traces of hydrogen and nitrogen, might be a renewable energy source. We suggest Biocoal. Pyrolysis or optimised treatment may turn rice husk, sawdust, corn stalk, and other agricultural waste into Biocoal. Biocoal may cut daily CO₂ emissions by 738 million tonnes. Large-scale Biocoal production and carbon neutralisation might address the world's fuel and environmental issues. Concentrating methane gas might alleviate biogas' poor caloric value. Biogas contains 40000KJ/kg, petrol 45000KJ/kg, and methane 50000KJ/kg. Optimising technology for optimal methane output takes time. Lack of appropriate separation procedures hinders renewable fuel development. According to a 2019 research, the world needs 1,36,761 terawatt/hour of fossil fuels like gas, oil, and coal and 7,931 of renewable energy including hydropower, wind, solar, and others. Thus, an eco-friendly, sustainable energy source has great potential. Thus, biogas and Biocoal may provide sustainable energy alternatives.

Keywords: Biocoal, Biogas, Green ecological technology, Fossil fuels, Eco friendly.

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I. INTRODUCTION

Leading scientists now look at climate change as an important threat to the future of humanity [1–3]. Since 2004, the ten warmest years on record have occurred globally, with the five warmest years occurring between 2015 and 2020 [4]. Although 2020 was the second warmest year on record globally, extreme climatological events such as temperatures, droughts, and forest fires have quadrupled since 1980, while meteorological events such as extreme cyclones have doubled [5,6]. Since 1900, the increase in global temperature relative to pre-industrial times (before 1850) has been approximately 1.1 °C [1,2]. Temperature increases are accelerating and are projected to rise by 1.5 °C within 15 to 20 years if greenhouse gas (GHG) emissions are not drastically reduced [1,2]. This is of major concern. Even with the 2015 International Paris Agreement to reduce GHG emissions, the world's increased use of fossil fuels and deforestation have caused global temperatures to continue to rise [7]. With prolonged reliance on fossil fuels as the primary energy source, an increase in temperature of at least 3 °C by the end of this century is predicted [8].

The main worry is that an inflexion point or threshold may soon be reached as a result of accelerated climatic warming and instability that affects a substantial portion of the human population [1,9]. The primary CO₂ emitters (i.e., China, the United States, the European Union, Japan, Russia, India, and Brazil) have since the 2015 Paris Agreement emphasised a less drastic approach emphasising the development of renewable energy (primarily wind and solar) and improvements in energy efficiency (decoupling) [10,11]. A common concern is that the continued growth of the human population necessitates an ever-increasing consumption of energy and other natural resources, thereby nullifying the gains made by improving the efficacy of resource use and expanding the production of renewable energy [2]. In addition to CO₂ emissions, another significant concern is that the fossil fuels on which the world still relies for over 80% of its energy requirements are finite and will be critically depleted within the next 50 years [7].

In 2020, fossil fuels, renewable sources, and nuclear energy accounted for approximately 83.1%, 12.6%, and 4.3%, respectively, of global energy consumption [2,7]. Hydropower dominated the renewable energy category (6.86%), followed by wind (2.90%), solar (1.54%), and other renewables (1.24%). Bioenergy (0.55%) and geothermal energy (0.13%) comprise the majority of the other renewables category. Wind and solar energy are believed to have the greatest potential for rapid, large-scale expansion, but at some point their growth will likely be limited by the availability of metal resources and land [10–12]. Although hydroelectric, biofuels, geothermal, and tidal are significant renewable energy sources, their expansion potential is low due to factors including their restricted geographic distribution, large land requirements, lack of availability of undeveloped sites, or unresolved implementation-related technical issues [10–12].

II. BIOGAS

Biogas is indeed a green and sustainable technology that can contribute to the replacement of fossil fuels. It is produced through the anaerobic digestion of organic waste materials, such as agricultural residues, animal manure, and food waste. This process breaks

down the organic matter and produces a mixture of gases, primarily methane (CH₄) and carbon dioxide (CO₂), which can be used as a renewable energy source[13]. The status and future trends of co-digestion, which is the process of combining different organic wastes to enhance biogas production. It highlights the potential of biogas plants in utilizing various waste streams and reducing dependence on fossil fuels[14]. A biogas production and its potential as a renewable energy source covers different aspects of biogas technology, including feedstock selection, process optimization, and utilization options. It emphasizes the environmental benefits and the role of biogas in replacing fossil fuels[15]. The comprehensive life cycle assessment of biogas supply chains in the United States. It evaluates the environmental impacts associated with biogas production, transportation, and utilization, compared to conventional fossil fuel systems. The findings highlight the potential of biogas to significantly reduce greenhouse gas emissions and other environmental burdens[15]. It discusses the different types of feedstocks, process configurations, and digester technologies used in biogas plants. It emphasizes the sustainable aspects of biogas production and its potential as an alternative to fossil fuels[16]. The global biogas market, policy incentives, technological advancements, and potential future applications. It emphasizes the role of biogas in reducing greenhouse gas emissions and transitioning to a more sustainable energy system[15].

III. BIOCOAL

Biocoal, also known as torrefied biomass or biocoal, is a type of solid fuel produced through the torrefaction process of biomass materials. It has gained attention as a green and ecologically sustainable technology that can potentially replace fossil fuels. Here are some citations that discuss the use of Biocoal as an alternative to fossil fuels[17]. This study provides an overview of Biocoal as a renewable and abundantly available fuel source produced from biomass. It discusses the torrefaction process, properties, and potential applications of Biocoal, emphasizing its potential for replacing fossil fuels[18]. The composition and combustion properties of biomass. It discusses how the torrefaction process alters the physical and chemical characteristics of biomass, making it more suitable as a coal substitute in various applications, including power generation[19]. The torrefaction of wood, one of the commonly used biomass feedstocks for Biocoal production. It investigates the weight loss kinetics during torrefaction, providing insights into the transformation of biomass into a more coal-like material. This review article discusses the potential of bio-coal briquettes as a viable alternative to conventional coal in solid fuel applications. It evaluates the technical, economic, and environmental aspects of Biocoal briquettes and highlights their advantages, including reduced greenhouse gas emissions and enhanced combustion characteristics[17]. This study presents a comparative analysis of biomass torrefaction and coal pyrolysis for solid fuel production. It examines the fuel properties, combustion characteristics, and thermal behavior of torrefied biomass and coal, providing insights into the potential of Biocoal as a substitute for fossil fuels[11].

IV. OPPORTUNITY

- 1. Environmental Benefits:** Green ecological technologies offer an opportunity to reduce greenhouse gas emissions and combat climate change. They provide a more sustainable and eco-friendly alternative to fossil fuels, reducing air and water pollution, mitigating

climate-related risks, and protecting natural resources.

2. **Job Creation:** The transition to renewable technologies can stimulate economic development and generate new employment opportunities. In addition to research and development, manufacturing, installation, and maintenance of renewable energy systems, the renewable energy sector has the potential to generate a substantial number of employment.
3. **Energy Independence and Security:** Transitioning away from fossil fuels decreases reliance on foreign energy sources. By utilising indigenous renewable resources, nations can increase their energy independence and security, thereby reducing the geopolitical risks associated with energy imports.
4. **Technological Innovation:** The development of green, ecologically-based technologies can stimulate innovation in a variety of industries. It encourages the development of materials science, energy storage, grid management, and intelligent technologies. This innovation can have a cascading effect, enhancing other industries and opening up new avenues for sustainable development.
5. **Opportunities on the Market:** The increasing demand for ecological technologies creates new markets and business opportunities. Companies that invest in and develop renewable energy solutions, energy-efficient products, and sustainable practices will have a competitive advantage in this expanding market.

V. CHALLENGES

1. **Cost:** The cost associated with developing and implementing green ecologically-based technologies is one of the primary barriers. In recent years, many renewable energy sources, such as solar and wind, have become more cost-competitive, but they still require substantial infrastructure investments and initial setup costs.
2. **Energy Storage:** The efficient storage of energy generated from renewable sources represents a second obstacle. Unlike fossil fuels, which can be readily stored, renewable energy is inconsistent and weather-dependent. The development of efficient energy storage systems, such as enhanced batteries or hydrogen storage, is essential for assuring a stable and reliable energy supply.
3. **Infrastructure Requirements:** The transition from fossil fuels to renewable technologies requires substantial infrastructure modifications. Such as constructing a robust charging infrastructure for electric vehicles or establishing an extensive grid system for the transmission of renewable energy can be difficult and expensive.
4. **Technological Advancements:** Continued research and development is required to improve the effectiveness and efficacy of renewable technologies. Improving the energy conversion rates of solar panels, boosting the power output of wind turbines, and developing more efficient biofuels are just a few examples of areas requiring continuous innovation.

VI. CONCLUSION

Collaboration among governments, businesses, researchers, and communities is necessary to address the challenges and capitalise on the opportunities in green ecologically-based technology. Transitioning to a more sustainable energy future can be accelerated by policies and incentives that encourage investment in renewable energy, research funding for technological advancements, and public awareness campaigns. Significant obstacles and opportunities exist in green ecologically based technology for the replacement of fossil fuels. The world is becoming increasingly aware of the imperative need to transition from fossil fuels to sustainable and renewable energy sources in order to combat climate change and address environmental issues. There are obstacles to overcome, but there are also wonderful opportunities to utilise the potential of ecological technology.

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