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A comprehensive review of biofuel utilization for household cooking in developing countries: Economic and environmental impacts

Author links open overlay panelJoseph O. Dirisu [a], Sunday O. Oyedepo [b], Olukunle C. Olawole [c], Tobiloba E. Somefun [d], Nkolika J. Peter [e], Damilola Babatunde [f], Collins N. Nwaokocha [g], Anthony O. Onokwai [b], Enoch Obanor [a], Md Mahbub Alam [h], Sandip A. Kale [i]

[a] Department of Mechanical Engineering, Covenant University, Ota, Nigeria

[b] Department of Mechanical/Biomedical Engineering, Bells University of Technology, Ota, Nigeria

[c] Department of Physics, Covenant University, Ota, Nigeria

[d] Department of Electrical and Electronics Engineering, Covenant University, Ota, Nigeria

[e] Department of Building Technology, Covenant University, Ota, Nigeria

[f] Department of Chemical Engineering, Covenant University, Ota, Nigeria

[g] Department of Mechanical Engineering, Olabisi Onabanjo University, Ibogun Campus, Nigeria

[h] Center for Turbulence Control, Harbin Institute of Technology (Shenzhen), Shenzhen 518055, China

Department of Mechanical Engineering, Trinity College of Engineering and Research, Pune, India

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Abstract

The global energy consumption for household cooking is substantial, comprising approximately 90 % of total household energy usage worldwide. Research indicates that in 2002, food-related energy consumption averaged 340 million BTU (approximately 359 million J) per person. With the current global population exceeding 7 billion, this translates to an estimated annual energy consumption for cooking of 2.380×10^{18} BTU (2.519×10^{21} J). A significant portion of this energy is derived from the combustion of firewood, contributing to deforestation, CO_2 emissions, and the release of toxic gases, which in turn, exacerbates environmental pollution and poses health risks. Household cooking, heating, and lighting activities in developing countries account for about 58 % of the black carbon emissions globally. Recognizing clean cooking as a crucial solution to mitigate climate change, there is growing interest in utilizing biomass as a source for biofuels and bioenergy. The comparative diminishing in greenhouse gas emissions from renewable fuels compared to conventional fossil fuels, along with the sustainable nature of these technological advancements, has spurred increased research into biofuel technology. To address energy poverty, achieve the Sustainable Development Goals, and align with the goals of the Paris Agreement, comprehensive and expedited efforts are needed to expand and enhance access to clean cooking solutions. Consequently, this article explores the potential of biofuels as viable alternatives to conventional fossil fuels for household cooking, focusing on their economic and environmental implications.

Graphical Abstract

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Introduction

There are profound implications when over one-third of the world still uses primitive cooking methods exposing themselves to destructive emissions generated by the combustion of coal, charcoal, firewood, agricultural residues, and animal waste. Every year, 3.7 million people die prematurely due to unhealthy cooking practices, with women and children being especially at risk (Khavari et al., 2023). Women are more likely than males to suffer the harmful effects of simple cooking while having fewer options to switch to healthier methods. Hours spent gathering firewood and other fuel sources result in lost production and a significant economic expense. Deforestation is frequently a result of simple cooking techniques that use wood and charcoal. Households in developing countries employ solid types of fuel for cooking. This fuel type emits noxious pollutants from carbon, responsible for a significant death rate of 3 million annually (Shen et al., 2021, Manisalidis et al., 2020). There has been increasing research on providing clean and efficient energy for household cooking. Renewable energy technologies are gaining significant attention and momentum as viable alternatives for household cooking, motivated by the urgent need to reduce dependence on traditional cooking fuels sourced from firewood, charcoal, and fossil fuels (Alfa et al., 2021, Oyebanji et al., 2023). These conventional fuel sources contribute to deforestation, air pollution, and greenhouse gas emissions, pose health risks due to indoor air pollution (Ukaogo et al., 2020, Nnodim et al., 2022 Onokwai et al., 2022a).
Consequently, there is an increasing acknowledgement of the necessity of transitioning to sustainable and cleaner cooking methods (Onokwai et al., 2023a). The exploration and implementation of renewable energy technologies in household cooking hold immense promise for mitigating environmental impacts and improving the well-being of communities (Onokwai et al., 2022a, Oyebanji et al., 2023). These technologies offer a channel towards a more reliable and resilient cooking sector by harnessing the power of renewable sources, such as sunlight, organic waste, and water (Sovacool, et al., 2021). This paper reviews biofuel utilization for household cooking in developing countries and their economic and environmental impact on users.

Section snippets

Availability of biomass resources in the Sub-Saharan Region

In the context of Sub-Saharan Africa, the significance of biomass resources for household cooking cannot be overstated. The Sub-Saharan region is endowed with various biomass resources that hold the utmost importance for household cooking. Traditional sources such as wood and crop residues and innovative options like energy crops collectively contribute to the energy landscape, playing a pivotal role in everyday cooking practices (Ogunleye and Raji, 2021, Elasu et al., 2023). Given that

Energy sources in domestic cooking

Pohekar et al. (2005) stated that cooking energy is crucial to sustainable energy management. There are several ways to satisfy end-user requirements through commercial and non-commercial energies. The use of conventional fuelwood needs to be reduced with improved biomass, and biogas development being better dispersed. This will reduce the amount of work that humans must perform. Improved use of different cooking energy sources, including solar cookers, can yield significant socio-economic

Renewable energy technologies in household cooking

Renewable energy technologies are gaining significant attention and momentum as viable alternatives for household cooking, driven by the urgent need to reduce dependence on traditional cooking fuels sourced from firewood, charcoal, and fossil fuels (Alfa et al., 2021, Oyebanji et al., 2023). These conventional fuel sources contribute to deforestation, air pollution, and greenhouse gas emissions pose health risks due to indoor air pollution (Ukaogo et al., 2020, Nnodim et al., 2022; Onokwai et

Economic impacts of utilization of bioenergy cooking technologies

The deployment of biofuel cooking technologies has what it takes to positively affect both the household and the nation's economies. This means reducing energy costs, creating new job opportunities, and encouraging long-term economic growth. However, economic challenges must be addressed to achieve the adoption of these technologies.

Therefore, this review examines the economic consequences of using bioenergy cooking technologies, including cost comparisons, investment prospects, and policy

Environmental impacts of biofuel utilization in cooking

The utilization of biofuels for cooking in developing nations has the potential to revolutionize energy consumption patterns, offering a better alternative to traditional fuels. The environmental impacts of Biofuel utilization in cooking however cannot be overlooked.

Prospects and hindrances to development of biofuel in household cooking in developing nations

Biofuels offer a sustainable and locally sourced alternative to traditional cooking fuels, potentially reducing deforestation and greenhouse gas emissions. They can enhance energy security and create economic opportunities through local production and supply chains. However, the widespread adoption of biofuels faces challenges such as high initial costs, lack of infrastructure, and limited awareness. Additionally, competition with food production and land use for biofuel crops can pose

Conclusion and recommendation

This paper examined the use of biofuels for household cooking in developing countries, focusing on the economic and environmental impacts on users.
The World is becoming more aware of the necessity of promoting essential measures aimed at developing alternatives and reasonably carbon-neutral energy sources as a result of an attempt made to realize the unsustainable nature of fossil fuels, the release of significant amounts of greenhouse gases, and the current necessity.
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CRediT authorship contribution statement

Tobiloba Somefun: Writing – review & editing, Writing – original draft. **Sunday O. Oyedepo:** Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. **Olukunle C. Olawole:** Writing – review & editing, Writing – original draft. **Enoch Obanor:** Writing – review & editing. **Md Mahbub Alam:** Writing – review & editing. **Sandip A. Kale:** Writing – review & editing. **Joseph Osekhoghene Dirisu:** Writing – review & editing, Writing – original draft, Formal analysis,

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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