INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 21, No. 4, p. 101-108, 2022
http://www.innspub.net

REVIEW PAPER OPEN ACCESS

# Organic refuse-derived fuel (ORDF) is an alternative fuel for the Pakistan's domestic use in the post-Covid-19 green recovery

**Nadir Buksh[*1, 2], Suraiya Jabeen[1], Akhtar Shareef[3]**

[1]*Institute of Environmental Studies, University of Karachi, Pakistan*

[2]*Fuel Research Center, PCSIR-Karachi, Pakistan*

[3]*Center of Environmental Studies, PCSIR-Karachi, Pakistan*

Article published on October 15, 2022

**Key words:** Covid-19, Gross calorific value, Organic refuse derived fuel, Energy crises

**Abstract**

In Karachi, around 18,000 tons of solid wastes are generated each day, of which 40% can be turned into Organic Refuse-derived Fuel (ORDF). It can be considered the best alternative energy source for domestic and commercial sector due to lowering greenhouse gases emissions and promoting regional and social progress by making full use of inexpensive and abundant organic waste. This issue will not only promote the motto of reducing, reusing, and recycling waste materials for maximum benefit, but it will also reduce the transportation load of civic agencies as well as their expenses, including a reduction in the use of landfill sites and progressive response in sustainable development. Clean and efficient household energy will improve health, gender equality, sustainable urban environments, climate action, and green recovery post-COVID-19. ORDF would be a life-changing product for end-users, influencing their social, economic, and financial lives, increasing sales and stability, resulting in more jobs and taxes for the government, and improving Pakistan's economy.

***Corresponding Author:** Nadir Buksh ✉ nadirbuksh@yahoo.com

**Introduction**

Energy problems are occurring over the world as a result of rising population, improving living standards, and industrialization. The developed nations are concerned because commercial energy sources, which are primarily generated from petroleum and natural gas, have become highly uncertain (Akor, 2003). Developing countries are concerned because their goal of increasing productivity and providing an acceptable quality of living for their citizens will be impossible to achieve if petroleum supplies become restricted or more expensive. As a result, there has been a surge in interest in alternative energy research (Akor, 2003).

Waste management is one of the most critical challenges that face urbanization around the world. Energy recovery from waste is becoming more essential in fostering "low carbon" energy and reaching sustainability goals. ORDF is widely produced and used in the world's most advanced economies, including European Countries, England, China and United States (Gendebien *et al*., 2020). Some developing countries, such as India, Indonesia, Thailand, Mozambique, and Namibia, have expressed interest in energy recovery from organic waste as an ORDF (Lee, 2019; Yang *et al*., 2021). In India, for example, ORDF (heating value > 4000 kcal/kg) generates roughly 7.5 MW of electricity as of 2017 (Shukla, 2017). In the England, ORDF production in waste-to-energy plants has resulted in a 50% reduction in municipal solid waste landfills in the last decade (Brew, 2021). In 2019, England exported 2.6 million tons of ORDF and it is regarded as a significant alternative renewable energy source (Brew, 2021).

Karachi is the largest urban and industrial city in of Pakistan with a population of approximately 24 million (Paracha, 2014), and the second-largest Islamic city in the world (Cox, 2014). It is located on the south coast and is considered to be the business center of Pakistan (Jilani, 2007; Shahid *et al*., 2014; Sharif & Raza, 2016). Every day, around 18,000 tons of urban solid waste is generated in Karachi. (Alam, 2020).

According to The News International (2021)., the country confronts a gas shortage every winter since Pakistan's natural gas fields are depleting at a rate of about 9% per year, and imported liquid natural gas (LNG) is highly expensive. The gas crisis in Karachi is taking its toll, with load shedding affecting 75% of the city during meal times all day. Some areas have been without gas for three days, and hotels have raised their rates to meet the additional demand. Due to high prices, gas cylinders and refilling are also out of reach for most individuals. Sui Southern Gas Company had already interrupted gas supplies in certain districts of Karachi as part of its load management plan.

This critical issue has pushed authorities to choose between bailing out polluting enterprises and utilizing that leverage to demand environmentally-conscious reforms, or allowing them to resume their carbon-intensive activities as an economic quick fix. The greatest option is to contribute to addressing the climate change catastrophe, but a paradigm shift in cooking energy would be a huge step toward green recovery, particularly in Karachi-Pakistan (Rym, 2020; ICIMOD, 2020; Clauser, 2021).

Wood, agricultural residues and coal constitute the solid cooking fuels used by about 40 percent of humanity today (Smith & Sagar, 2014). For the large most part in urban areas of Karachi and the provincial zones of Sindh, most families rely mainly on firewood or charcoal for their kitchen and other necessities of life (Ahmed *et al*., 2015; Aized *et al*., 2018; Abdel-Shafy & Mansour, 2018). This has led to deforestation across the country with the issue of desertification and other features being reduced, for example, a dangerous environmental deviation and the inevitable loss of biodiversity (Khan, 2009; Ali, *et al*., 2018). According to the Ajimotokan (2019) and WHO (2020)., household air pollution is the most essential environmental health risk globally. The adaptation of organic fuel pellets as an alternative cooking fuel source would significantly improve the health and wellbeing of women and children (Ibrahim MS & Ibrahim A, 2020).

It is generally known that fossil fuels around the world are both vulnerable in the short term and limited in the long term; thus, worldwide searches for sustainable and renewable energy resources have been conducted to meet a significant portion of the world's energy demand in the future.

Organic waste resources have received increased interest due to their ability to be turned into a variety of fuels and chemicals. Environmental issues, such as air pollution and greenhouse gas emissions, are also important in the use of renewable biomass resources, as biomass is environmentally beneficial and $CO_2$-neutral. (Sansaniwal *et al.*, 2017; Saeed *et al.*, 2020).

Organic waste is abundant and widely dispersed in Pakistan; it is a crucial subject of our country, due to the rapid growth of urbanization caused by the increased waste every day. This waste can be divided into five forms; animal waste, agricultural waste, forest residue, wastewater, and municipal waste.

Unfortunately, we do not have sufficient and suitable planning for the disposal of the huge amount of this waste. There is no significant strategy for the assortment, transportation, and disposal of waste. Due to the inadequate collection, it spreads into the environment and is mainly burned openly, causing serious health and medical-related issues. These wastes are dumped openly at the sides of the landfill without any segregation and treatment, causing contamination of the soil and groundwater reservoir (Shahid *et al.*, 2014; Rym, 2020).

The contribution of such a solid waste to the energy option "waste-to-energy" is the fruitful solution globally, energy generation from organic waste offers the potential to reduce the greenhouse gas emission issue from fossil fuel and it also can guarantee of energy security and tackle environmental issues (Sawadogo *et al.*, 2018; Trubetskaya *et al.*, 2019). According to Sharma (2020) and Saeed (2021)., the use of organic waste as a fuel can overcome the wastage of valuable products by obeying the concept of 3R (reduces, reuse, recycle).

*Benefits of utilizing organic waste include*

It's a carbon-based polymer made up of a mix of organic molecules that contain hydrogen, oxygen, and minor amounts of other atoms.

*Simple availability*

Biomass resources are plentiful, yet they are underutilized. Agricultural waste and residue are produced in multitudes but are not used as fuel. Frequently, these are disposed-off by burning. Forest waste, in addition to agricultural waste, can be utilized to produce biomass. Municipal garbage is another frequent source that can be used to generate bio-fuel in huge numbers.

*Low-emissions and carbon-neutral*

Many of these sources are carbon neutral because they are made from plants. The quantity of carbon dioxide removed from the atmosphere by plants during their lifecycle is equal to the amount of carbon dioxide released during bio-fuel combustion. In addition, bio-fuels do not produce the toxic chemicals that coal and other fossil fuels generate.

*Runs on existing equipment*

With minor adjustments and alterations, equipment developed for traditional fossil fuels can also be used for biomass, avoiding the need for large capital investment in new equipment and infrastructure.

*Organic refuse-derived fuel (ORDF)*

It is also called white coal; solid fuel pellets are one of the costs effective approaches to address the hazardous environmental outcomes related to solid waste generation and its disposal (Suberu *et al.*, 2012; Tamilvanan, 2013; Arry *et al.*, 2016; Kpalo *et al.*, 2020).

The Kyoto Protocol aims to reduce greenhouse gas emissions, reduce reliance on fossil fuels, and promote renewable energy production and its use. It also strengthens collaboration between developed and developing countries to achieve long-term development through the use of clean development mechanisms (CDM). Organic refuse-derived fuel (ORDF) production aims to redirect combustible fractions from organic

waste into fuel, which can subsequently be used as a replacement or supplementary energy source. In this aspect, ORDF use qualifies as a CDM and complies with the Kyoto Protocol.

This technique may be favorable for the use of discarded waste for energy drive; this technology has been widely used worldwide for both domestic and industrial applications. It is a significant solid waste recycling system that has always helped to offset forest and fossil fuel emissions, manage bio-residues, and reduce hazardous emissions from incomplete carbonization in addition to energy production development. It is one of the orthodox densification processes used to manufacture solid fuels (Kumar *et al*., 2017; Schwarzbock *et al*., 2018; Saeed, 2020) and also significantly reduce the unnecessary use of landfills, avoiding huge transportation charges to dumping sites as well. In this light, the conversion of waste to energy would be an economically and environmental friendly way to address both waste management and energy option (Chaiklangmuang *et al*., 2008; Yu H *et al*., 2009; Omari, *et al*., 2014; Sansaniwal *et al*., 2017, Saeed, 2020).

In Pakistan especially in Karachi city, there is currently no ORDF manufacturing to serve as a supplementary fuel for industry and household use. This is owing to a scarcity of information for decision-makers and investors interested in establishing an ORDF manufacturing plants (Aized *et al.,* 2018). A financial analysis of the cost of this valuable production vs. market demand is required to make this project possible.

*Benefits on a social and economic level*

It has a wide range of benefits, with the social benefit outweighing the private profit in the case of ORDF pellets, as there are currently hundreds of farmers in Pakistan who will gain profit for sealing their waste for valuable fuel pellets (ORDF). This comprehensive development provides an additional source of income for farmers when they are out of season, allowing them to feed their families, and for the community, it raises awareness of the incident environmental and societal hazards of using other sources such as wood, as well as the realization of the positive facts of economic values, particularly when considering forestry issues. (Elbehri *et al*., 2013).

Adoption of ORDF pellets as an alternative cooking fuel source would significantly improve the health and well-being of women and children, particularly in marginalized communities, while also providing such communities with abundant natural resources and green cover, reducing greenhouse gas emissions from logging and other natural resource-extraction activities (Ibrahim MS & Ibrahim A, 2020).

The main advantages of ORDF are its domestic origin, the potential for reducing total dependence on the oil and gas economy, energy security and waste management, job creation and source of revenue for the government and rural farmers, as well as benefits of regional development and social structure, especially in developing countries like Pakistan.

Its high calorific value, along with the fact that organic wastes are widely available, makes it more efficient and lowers manufacturing costs. As a result, ORDF pellets are more inexpensive, saving household's money on firewood that could be better spent on nutrition, health, and education (Onuegbu *et al*., 2011).

*Advantages for the environment*

It is a renewable fuel and energy source; plenty of raw materials are available on earth, which can be turned into bio-pellets. Agricultural or forestry waste can be used in this way. Rising energy demand is a serious concern facing Pakistan's teeming population today, given that the majority of Pakistanis live below the poverty line of $1.88 per day (World Health Organization, 2020). The growing demand for clean energy, the increased focus on climate change implications, and the urgent need to reduce GHG emissions are all key challenges for new energy sources, and Pakistan isn't an exception. Biofuels' environmental sustainability is described primarily in terms of $CO_2$, Methane, and $N_2O$ (GHG) emissions mitigation (reduction), as well as other emissions, such as in agriculture (Elbehri *et al*., 2013).

Furthermore, converting forests to agricultural land for biomass generation has a different GHG mitigation potential than biomass generation from previously existent agricultural land. So far, research on biomass and GHG emissions suggests that land usage remains constant. Globally, new rules are being established to limit field burning activities. As a result, techniques for disposing of and utilizing agricultural wastes such as rice straw and rice husk, bagasse, maize stalk, leaves, etc. have switched to the global waste to resource agenda (Ferronato *et al.*, 2019). Furthermore, employing biomass pellets will significantly contribute to sustainable forest management by reducing $CO_2$ emissions by approximately 60% and lowering sulfur emissions (which usually cause acid rain).

*ORDF's Benefits*

The following are the primary benefits of organic refuse-derived fuels:

1. ORDF fires are relatively smokeless.
2. Combustion qualities could be adjusted to a significant extent.
3. It can be made in a variety of sizes and shapes to meet the needs of users.
4. It is more widely accepted than coal since it is more environmentally friendly.
5. It is used for domestic heating.
6. It is also maintaining the most favorable temperature in poultry farms.
7. It is also cheaper than coal.
8. No-fly ash when burning.
9. Because ORDF contains more volatile matter than coal, combustion is more uniform, and boiler response to changes in steam requirements is faster.
10. It can replace conventional fuels like Kerosene, Coal, Furnace Oil, Firewood, and Diesel that are used in mass quantities.

## Conclusion

As a result, organic refuse derives fuel (ORDF) is a viable waste management solution that can address both waste management and energy constraint for Pakistan domestic use. Household clean energy is a solution for enhancing human health, reducing the effects of climate change, and saving hundreds of millions of people. Clean and efficient household energy will promote health, gender equality, sustainable urban environments, climate action, and green recovery after COVID-19, helping to achieve a progressive response to the sustainable development goals. The use of energy derived from said fuel would help to improve end-user access and adoption of life-changing products, as well as sales and stability, which would result in more jobs and taxes for the government, thus improving our country's economy. It would also help to improve the standard of living and productivity of end-users, while also protecting the environment for future generations.

## Recommendations

It is essential to fund research in order to provide various sustainable raw materials for pellets production with high calorific value, fund Small and medium enterprises producing pellets by providing soft loans of equipment to support mass production to cater for the domestic energy needs, and create grassroots awareness on the urgent need to combat climate change and its impacts, as well as the need to protect the environment.

## References

**Aized T, Shahid M, Bhatti AA, Saleem M, Anandarajah G.** 2018. Energy security and renewable energy policies analysis of Pakistan. Renewable and Sustainable Energy Reviews **84,** 155-169.

**Ajimotokan HA, Ibitoye SE, Odusote JK, Adesoye OA, Omoniyi PO.** 2019. Physico-mechanical characterisation of fuel briquettes made from blends of corncob and rice husk. Journal of Physics. Conference Series **2,** 1-12.

**Akor AJ.** 2003. Briquette Technology: A Potential Dollar Field of Biodust. Retrieved from http://www.dipu.com/ok/solid fuel.htm

**Alam MM.** 2020. A study for the better solid waste management in Karachi: A case study. Retrieved from http:// www.c40.org/case_studies/karachi-sum-udy

**Ali M, Marvuglia A, Geng Y, Chaudhry N, Khokar S.** 2018. Energy based carbon foot printing of household solid waste management scenarios in Pakistan. Resources Conservation and Recycling **131,** 283-296.

**Arry YN, Yuda CH, Hasanah W.** 2016. Endeavoring to Food Sustainability by Promoting Corn Cob and Rice Husk Briquetting to Fuel Energy for Small Scale Industries and Household Communities. Agricultural and agricultural Science Procedia **9,** 386-395.

**Brew M.** 2018. What's on the Horizon for Refuse-Derived Fuel as Brexit Looms and Production Evolves?. Retrieved from https://www.recycling wasteworld.co.uk/in-depth-article/as-brexit-looms-and-production-evolves-whats-on-the-horizonfor-refuse-derived-fuel/172555/

**Chaiklangmuang S, Supa S, Kaewpet P.** 2008. Development of fuel briquettes from biomass-lignite blends. Chiang Mai Journal of Science **1,** 43- 50.

**Clauser NM, González G, Mendieta CM, Kruyeniski J, Area MC, Vallejos ME.** 2021. Biomass Waste as Sustainable Raw Material for Energy and Fuels. Sustainability **13,** 794. Retrieved from https://doi.org/ 10.3390/su13020794

**Cox W.** 2014. Largest World Cities. Retrieved from http://www.newgeography.com/content/004280-largest -world-cities-2014.

**Elbehri A, Segerstedt A, Liu P.** 2013. Biofuels and the sustainability challenge: a global assessment of sustainability issues, trends and policies for biofuels and related feedstocks. Food and Agriculture Organization of the United Nations (FAO). Retrieved from https://www.fao.org/sustainable-food-value-chains/library/details/en/c/266086/

**Ferronato N, Rada EC, Portillo MAG, Cioca LI, Ragazzi M, Torretta V.** 2019. Introduction of the circular economy within developing regions: A comparative analysis of advantages and opportunities for waste valorization. Journal of Environmental Management **230,** 366-378.

**Gendebien A, Leavens A, Blackmore K, Godley A, Lewin K, Whiting KJ, Davis R, Giegrich J, Fehrenback H, Gromke U.** 2020. Refuse Derived Fuel, Current Practice and Perspectives. Available online: https://www.undrr.org/organization/ European -commission-directorate-general-environment

**Ibrahim MS, Ibrahim A.** 2020. Biomass briquettes as an alternative source of cooking fuel toward green recovery post COVID-19. Saudi Journal of Engineering and Technology **6,** 285-290.

**ICIMOD.** 2020. COVID-19 impact and policy responses in the Hindu Kush Himalaya. Kathmandu: International centre for integrated mountain development. Retrieved from https://lib.Icimod.org

**Jilani S.** 2007. Municipal solid waste composting and its assessment for reuse in plant production. Pakistan Journal of Botany **1,** 271-277.

**Khan SR.** 2009. Assessing poverty-deforestation links: Evidence from swat, Pakistan. Ecological Economics **10,** 2607-2618.

**Kpalo SY, Mohamad FZ, Latifah AM, Ahmad MR.** 2020. A Review of Technical and Economic Aspects of Biomass Briquetting. Sustainability **11,** 1-30.

**Kumar MV, Vithyasagar T, Rajavel R.** 2017. Analysis of biomass briquettes by using different agricultural wastes analysis of biomass briquettes by using different agricultural wastes. Proceedings of International Conference on Technological Advances in Mechanical Engineering (ICTAME 2017), 1-12.

**Lee RD.** 2019. Evaluating Uganda's Waste Management System for the Production of Refuse-Derived Fuel (ORDF) and Its Potential Implementation in the Country's Growing Cement Industry.

**Omari AM, Kichonge BN, John GR, Njau KN, Mtui PL.** 2014. Potential of municipal solid waste, as renewable energy source: A case study of Arusha, Tanzia. International Journal of Renewable Energy Technology Research **6,** 1-9.

**Onuegbu TU, Ekpunobi UE, Ogbu IM, Ekeoma MO, Obumselu FO.** 2011. Comparative studies of ignition time and water boiling test of coal and biomass briquettes blend. International Journal of Research and Reviews in Applied Sciences **2,** 153-159.

**Paracha N.** 2014. Visual Karachi: From Paris of Asia, To City of Lights, To Hell on Earth. Retrieved from http://www.dawn.com/news/1134284

**Rym A.** 2020. Time for a decisive coordinated response to a costly global Covid-19 systemic crisis: Towards a resilient global system. Euro Mediterranean Economists Association (EMEA). Retrieved from https://euromed-economists.org /time-for-a-decisive-coordinated-response-to-a-costly-global-covid-19-systemic-crisis-towards-a-global-resilient-system/

**Saeed AAH, Harun NY, Sufian S, Afolabi HK, Al-Qadami EHH, Roslan FAS, Rahim SA, Ghaleb A.** 2021. Production and Characterization of Rice Husk Biochar and Kenaf Biochar for Value-Added Biochar Replacement for Potential Materials Adsorption. Ecological Engineering and Environmental Technology **22,** 1-8.

**Saeed AAH, Harun NY, Sufian S, Siyal AA, Zulfiqar M, Bilad MR, Vagananthan A, Al-Fakih A, Ghaleb AAS, Almahbashi N.** 2020. Eucheuma cottonii Seaweed-Based Biochar for Adsorption of Methylene Blue Dye. Sustainability **24,** 1-15.

**Sansaniwal S, Pal K, Rosen M, Tyagi SJR.** 2017. Recent advances in the development of biomass gasification technology: A comprehensive review. Renewable and Sustainable Energy Reviews **72,** 363-384

**Sansaniwal S, Pal K, Rosen M, Tyagi SJR.** 2017. Recent advances in the development of biomass gasification technology: A comprehensive review. Renewable and Sustainable Energy Reviews **72,** 363-384.

**Sawadogo M, Kpai N, Tankoano I, Tanoh ST, Sidib S.** 2018. Cleaner production in Burkina Faso: Case study of fuel briquettes made from cashew industry waste. Journal of Cleaner Production **195,** 1047-1056.

**Schwarzbock T, Aschenbrenner P, Spacek S, Szidat S, Rechberger H, Fellner J.** 2018. An alternative method to determine the share of fossil carbon in solid refuse-derived fuels – Validation and comparison with three standardized methods. Fuel **220,** 916-30.

**Shahid M, Nergis Y, Shamin MS, Afzal FC.** 2014. Environmental impact of municipal solid waste in Karachi city. World Applied Science Journal **12,** 1516-1526.

**Sharif A, Raza SA.** 2016. Dynamic relationship between urbanization, energy consumption and environmental degradation in Pakistan: Evidence from structure breaks testing. Journal of Management Sciences **1,** 01-21.

**Sharma D, Saini A.** 2020. Introduction to Lignocellulosic Ethanol. In Lignocellulosic Ethanol Production from A Biorefinery Perspective. Springer Singapore 1-21.

**Shukla P.** 2017. Utilization of Refuse–Derived Fuel (ORDF) as an Alternative Energy Resource in India. International Journal of Innovative Research in Science, Engineering and Technology **6,** 7537-7542.

**Smith KR, Sagar A.** 2014. Making the Clean Available: Escaping India's Chulha Trap. Energy Policy **75,** 410-14.

**Suberu MY, Mokhtar AS, Bashir N.** 2012. Renewable power generation opportunity from municipal solid waste: A case study of Lagos Metropolis (Nigeria). Energy Technologies and Policy **2,** 1-14.

**Tamilvanan A.** 2013. Preparation of Biomass Briquettes using Various Agro- Residues and Waste Papers. Journal of Biofuels **2,** 47-55.

**The news international.** (2021). Retrieved from https://economictimes.indiatimes.com/news/international/world-news/karachi-faces-gas-crisis-with-other -pakistan-cities/articleshow/ 87952338. cms? From =mdr

**Trubetskaya A, Leahy JJ, Yazhenskikh E, Müller M, Layden P, Johnson R, Stahl K, Monaghan RFD.** 2019. Characterization of woodstove briquettes from torrefied biomass and coal. Energy **171,** 853-865.

**World Health Organization.** 2020. Air Pollution, percentage of population using biomass fuels, Millennium Indicators Database, United Nations, Department of Economic and Social Affairs, Economic and Social Development, Statistics Division. Retrieved from http:// millennium indicators.un.org/unsd/mi/mi_series_results.asp?

**Yang Y, Liew RK, Tamothran AM, Foong SY, Yek PNY, Chia PW, Tran TV, Peng W, Lam SS.** 2021. Gasification of Refuse-Derived Fuel from Municipal Solid Waste for Energy Production a Review. Environmental Chemistry Letters **19,** 2127-2140.

**Yu H, Huang GH.** 2009. Effects of sodium as a pH control amendment on the composting of food waste. Bioresource Technology **6,** 2005-11.