© June 2026 | IJIRT | Volume 13 Issue 1 | ISSN: 2349-6002

Waste-To-Energy in Urban Waste Management: A Circular Economy Approach for Berhampur Municipal Corporation

Subhalaxmi Pradhan[1], Bhabani Shankar Sa[2], and Shreeparna Sahoo[3]
[1]*PG Scholar, School of Infrastructure and Planning, OUTR, Bhubaneswar*
[2]*Assistant Professor, School of Infrastructure and Planning*
[3]*Lecturer, School of Infrastructure and Planning*

***Abstract*—Rapid urban expansion and demographic growth in Berhampur have intensified municipal solid waste generation, thereby increasing the strain on conventional disposal practices, including open dumping and landfilling. This study investigates Berhampur's municipal solid waste management practices and assesses the potential for integrating Waste-to-Energy solutions within a circular economy paradigm. Recent data indicate that despite advancements in waste collection and the recovery of a portion of waste as industrial fuel, landfill reliance remains substantial. This is primarily attributed to the inadequacy of current sorting methodologies, which leave a significant volume of bulk waste untreated. Given that the predominant fraction of Berhampur's waste comprises organic, moisture-rich materials, conventional mechanical and thermal treatment processes alone present limitations for effective waste valorization. Anaerobic digestion emerges as a promising pathway, capable of transforming this wet organic waste into biogas, serving as a source of clean energy, and digestate, suitable for agricultural applications. Integrating anaerobic digestion with established recycling and Refuse-Derived Fuel recovery systems could substantially mitigate the city's reliance on landfilling, decrease greenhouse gas emissions, and advance towards more sustainable urban development.**

***Index Terms*—Biogas, Digestate, Landfill Dependency, Municipal Solid Waste, Refuse Derived Fuel, Waste-to-Energy**

I. INTRODUCTION

Rapid urbanization and population growth have significantly accelerated global municipal solid waste (MSW) generation, rendering traditional disposal methods such as landfilling and open dumping insufficient. These conventional practices contribute substantially to environmental pollution, greenhouse gas emissions, and public health risks, simultaneously leading to the loss of valuable resources. Berhampur, an urban center in Odisha, experiences similar challenges. While the city segregates its waste and processes it at the designated facility, a considerable proportion of the treated material continues to be directed to sanitary landfills, indicating a need for enhanced resource recovery strategies.

As the global demand for sustainable energy increases, waste-to-energy (WtE) technologies offer a potential solution by concurrently addressing waste management challenges and generating electricity. Processes including incineration, anaerobic digestion, gasification, and microbial fuel cells convert organic and inorganic waste into thermal energy, biogas, and syngas. The utilization of these energy carriers mitigates reliance on fossil fuels, reduces environmental impacts, and aligns with circular economy principles through the reclamation of valuable energy from discarded materials. Despite these benefits, the deployment of WtE technologies encounters obstacles such as substantial initial capital investments, emission control complexities, and public acceptance issues. Nevertheless, ongoing advancements in waste processing and energy recovery are progressively enhancing system efficiencies. This paper examines the current solid waste scenario within the Berhampur Municipal Corporation. It evaluates the composition and generation rates of local MSW, identifies existing management challenges, estimates the waste-to-energy potential, and identifies viable WtE technologies that could support a sustainable, circular economy framework.

II. LITERATURE REVIEW

Municipal Solid Waste (MSW) management in India is governed by the Solid Waste Management Rules, 2016, which mandate source segregation and promote sustainable practices such as recycling and composting. Waste-to-Energy (WtE) is a technological process that converts non-recyclable waste into electricity, heat, or biofuels, thereby contributing to the reduction of greenhouse gas emissions and reliance on landfills. Globally, approximately 13% of municipal waste is processed in WtE facilities, contributing to cleaner energy generation. The Circular Economy (CE) model complements WtE by advocating for resource recovery through repair, reuse, and recycling, which subsequently minimizes waste generation and extends product lifecycles. Technologies such as gasification, pyrolysis, anaerobic digestion, and incineration enable efficient energy recovery from various waste types. Within the CE framework, WtE plays a critical role in managing residual waste, adhering to the principle that material recovery should precede energy recovery.

III. MEHODOLOGY

The Detailed methodology includes following steps: -

- The existing municipal solid waste generation and composition were analyzed through site visits to Berhampur city and the Mohuda Solid Waste Management Plant.
- Records of incoming and processed waste were verified using official weighing data and documentation shared by the officials and staff.
- Discussions were held with Berhampur Municipal Corporation officials and plant management to understand current practices, operational challenges, and future possibilities for waste-to-energy integration.

IV. STUDY AREA

Berhampur, located in the Ganjam district of Odisha, represents a significant urban center in southern Odisha and was selected as the study area for this research. The city falls under the jurisdiction of the Berhampur Municipal Corporation, which is responsible for municipal solid waste collection and disposal. This study assesses the potential of Waste-to-Energy as a sustainable solution for urban waste management within a circular economy framework. Berhampur experienced rapid population growth, increasing from 210,418 residents in 1991 to 355,823 in 2011, which has led to a concomitant increase in waste generation. Historically, waste was deposited near Chandania Hill, where a biomining project is currently underway to remediate approximately 150,000 metric tonnes of legacy waste spread over 13.15 acres. To enhance sanitation and reduce reliance on landfills, a modern Municipal Solid Waste Management Plant has been established at Mohuda, situated approximately 15 km from the city and occupying 31.62 acres.

V. INTERGRATED SOLID WASTE MANAGEMENT PLANT

The Solid Waste Management Plant at Mohuda, located about 15 km from Berhampur city, plays a central role in the waste management system of the Berhampur Municipal Corporation. Spread over 33.85 acres, the plant has a processing capacity of 150 tonnes per day and operates under a 20-year Operation and Maintenance contract with MGS Environ Pvt. Ltd. The plant follows the Windrow Composting methodology, with a sanitary landfill capacity of 74,000 MT to safely dispose of non-recyclable residues.

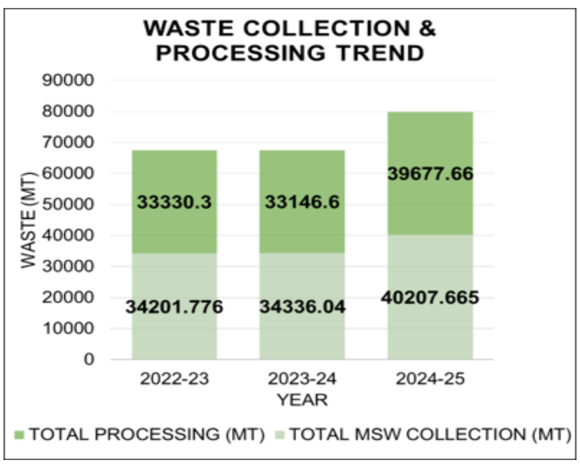
The process begins with door-to-door collection of segregated waste, which is then transported to secondary transfer stations and moved to the plant using compactors. Inside the main shed area, waste undergoes several stages:

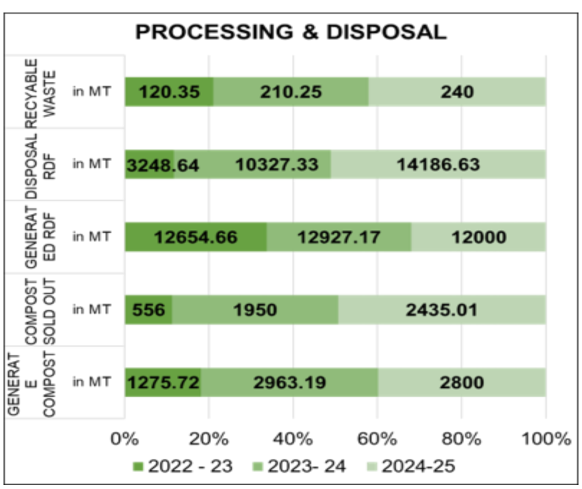
- Pre-sorting section: Fresh MSW is screened using an 80mm trommel to separate wet waste, light fractions, and RDF.
- Preparatory section: Further screening with 35mm and 16mm trommels separates organic and inorganic materials for composting and RDF recovery.
- Finishing section: A 4mm trommel produces finished compost.

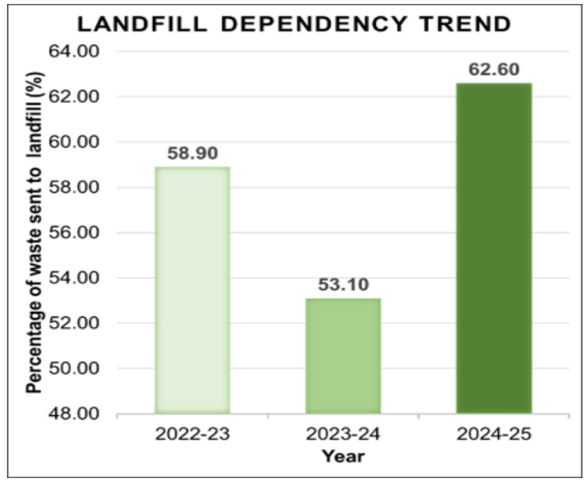
- Shredding section: RDF above 100mm is shredded and sent to cement plants, while recyclables are manually sorted and sold.
- Sanitary landfill: Rejects from processing are safely disposed of to prevent environmental hazards.

Compost is produced from organic waste, while Refuse Derived Fuel is generated from dry combustible waste and sent to cement plants for co-processing. The plant produces RDF supporting Waste-to-Energy and circular economy goals. Although Refuse Derived Fuel generation helps reduce landfill dependency, sorting limitations still lead to some residual waste being landfilled. Overall, the Mohuda plant demonstrates a structured and sustainable approach to waste management, promoting energy recovery and environmental resilience.

VI. RESULT & DISCUSSION



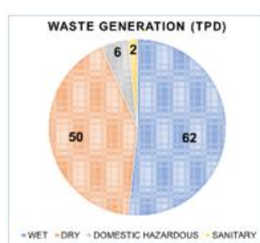




The analysis shows that Berhampur Municipal Corporation has improved its waste collection and processing between 2022 and 2025. Total waste collected increased from 34,201 MT to 40,207 MT, and processed waste rose from 33,330 MT to 39,677 MT. Most of the processed waste was converted into Refuse Derived Fuel (RDF), while compost and recyclable recovery remained lower. Landfill dependency dropped from 58.9% in 2022–23 to 53.1% in 2023–24, showing better waste recovery, but rose again to 62.6% in 2024–25, meaning more residual waste still ends up in landfills. Overall, the data highlights progress in waste processing but also the need for better energy recovery to achieve sustainable waste management. Berhampur Municipal Corporation makes RDF fuel from dry waste, with energy potential of 41–45 GWh per year. This powers cement plants, cuts landfill use, and supports clean energy goals. Although waste processing capacity improved, a considerable quantity of non-recoverable residual waste still required sanitary disposal working against the goal of reducing landfill use.

Table 1: Estimated energy of RDF generated

Year	RDF generated (MT / Year)	Estimated Energy Potential (GWh / Year)
2022-23	12,654.66	44.14
2023-24	12,927.17	45.09
2024-25	12,000	41.86



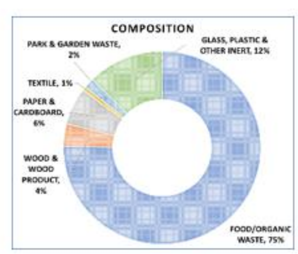
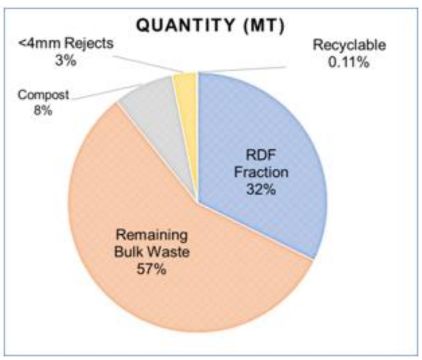


Table 2: Chemical Characteristics

Moisture content (%)	75.59
Bulk density (T/m3)	0.23
Organic Matter (%)	54.59
C/N Ratio	34.56
Net calorific Value (kCal/kg)	2264

Berhampur generates about 120 tons of waste per day, including 62 TPD wet waste, 50 TPD dry waste, 6 TPD domestic hazardous, and 2 TPD sanitary waste. The composition is mainly food and organic waste (75%), followed by plastic, glass, and inert materials (12%), paper and cardboard (6%), and smaller portions of wood, textile, and garden waste. The waste has a moisture content of 75.59%, organic matter of 54.59%, and a net calorific value of 2264 kcal/kg, making it suitable for composting and energy recovery. Overall, the high organic fraction and good calorific value show strong potential for Waste-to-Energy conversion and sustainable waste management.



Out of 3,685.76 MT total waste, the RDF fraction is already being utilized for energy recovery, while the large remaining bulk waste fraction suggests scope for improved processing efficiency. The remaining bulk fraction may provide additional potential for biological treatment and enhanced resource recovery.

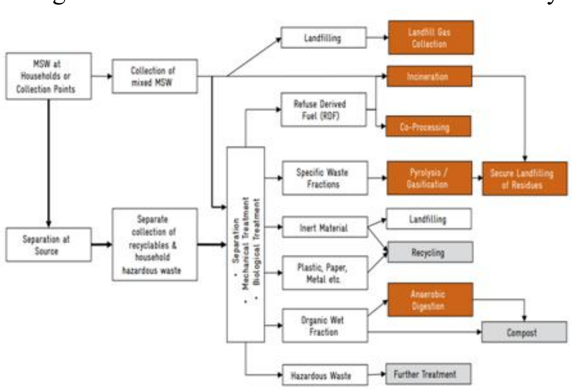


Figure 1: MSW material flow, its utilization & treatment option

Wet or bulk waste can be treated through Waste-to-Energy methods like anaerobic digestion, which produces biogas used for electricity, cooking, and heating, along with digestate that serves as organic fertilizer, and composting, which converts organic matter into nutrient-rich compost for soil improvement.

VII. CONCLUSION

By improving garbage collection, segregation, and processing as well as generating compost and Refuse Derived Fuel (RDF), which promote energy recovery and minimize landfill usage, the Mohuda plant has improved waste management in Berhampur. However, despite increased processing rates, landfill dependency is growing, necessitating the expansion and strengthening of waste-to-energy solutions. This problem is immediately addressed by anaerobic digestion, which diverts the majority of biodegradable waste from landfills by turning high-moisture organic waste into digestate for agriculture and biogas for clean electricity. Berhampur may successfully address its present landfill dependency issue by giving anaerobic digestion and RDF recovery top priority. This will convert waste into useful resources, advance clean energy, lower emissions, and encourage sustainable urban growth.

ACKNOWLEDGEMENT

Authors are thankful to School of Infrastructure & Planning, Odisha University of Technology & Research for providing the necessary facility for the work.

REFERENCES

[1] Ministry of Environment, Forest and Climate Change (MoEFCC), Solid Waste Management Rules, 2016. New Delhi, India: The Gazette of India, Government of India, 2016.

[2] Central Public Health and Environmental Engineering Organisation (CPHEEO) and Ministry of Urban Development, Municipal Solid Waste Management Plan: Step-Wise Guidance (Part 1 & Part 2). New Delhi, India: Government of India, 2016.

[3] NITI Aayog, Achieving Circular Economy in Residual Waste Management. New Delhi, India: Government of India, 2021.
[4] D. Atstaja, N. Cudecka-Purina, V. Koval, J. Kuzmina, J. Butkevics, and H. Hrinchenko, "Waste-to-energy in the circular economy transition and development of resource-efficient business models," Energies, vol. 17, no. 16, Art. no. 4188, 2024, doi: 10.3390/en17164188.
[5] F. Cucchiella, I. D'Adamo, and M. Gastaldi, "Sustainable waste management: Waste to energy plant as an alternative to landfill," Energy Conversion and Management, vol. 131, pp. 18–31, 2017, doi: 10.1016/j.enconman.2016.11.012.
[6] A. Dal Pozzo, M. Lucquiaud, and J. De Greef, "Research and innovation needs for the waste-to-energy sector towards a net-zero circular economy," Energies, vol. 16, no. 4, Art. no. 1909, 2023, doi: 10.3390/en16041909.
[7] J. Van Caneghem, K. Van Acker, J. De Greef, G. Wauters, and C. Vandecasteele, "Waste-to-energy is compatible and complementary with recycling in the circular economy," Clean Technologies and Environmental Policy, vol. 21, no. 5, pp. 925–939, 2019, doi: 10.1007/s10098-018-1610-0.