BIHAR SHODH SAMAAGAM
Multidisciplinary, Multi-Lingual, Peer Reviewed /Refereed Open Access Journal
Vol. 3, Issue 3, July-September, 2025
Available online : https://www.biharshodhsamaagam.com/
ISSN : 3048-6971

Assess innovative waste management systems, such as waste-to-energy and composting, and their impact on urban sustainability.

Subhash Kumar
Research Scholar
University Department of Economics
BRABU, Muzaffarpur
(Dr.) Alok Pratap Singh
Professor , PG Department of Economics
R.D.S College, Muzaffarpur

Abstract

Waste-to-energy (WtE) and composting are two examples of innovative waste management techniques that contribute significantly to urban sustainability. WtE technologies use municipal solid waste to generate renewable energy, reducing reliance on fossil fuels and lowering greenhouse gas emissions. Composting effectively manages organic waste, reducing landfill volume while improving soil health and biodiversity. Cities that integrate these technologies can manage trash disposal issues and increase resource recovery, thereby contributing to a circular economy. This study will assess the impact of WtE and composting on urban sustainability utilizing secondary data from recognized academic databases such as Google Scholar, Shodhganga, Research Gate, Scopus, and Academia.edu. A systematic evaluation of the available literature, including peer-reviewed articles, case studies, and reports, will give comprehensive data on the efficacy of various WtE systems for converting municipal solid waste to electricity. The combination of WtE technologies, including incineration, anaerobic digestion, and gasification, dramatically decreases landfill trash while producing energy. Composting promotes sustainable agriculture by increasing soil health and decreasing organic waste. Both systems have economic benefits, such as lower waste management costs and higher revenue from energy and compost sales. Municipalities that invest in WtE and composting can meet long-term environmental goals while also fostering economic sustainability, resulting in improved urban resilience and ecological balance.

Keywords: Waste-to-Energy (WtE), Composting, Urban Sustainability, Renewable Energy, Greenhouse Gas Emissions, Circular Economy, economic Sustainability

Introduction

Human activities continually produce garbage, which has been a cause of concern since prehistoric times. In recent decades, the rate and quantity of garbage generation have increased dramatically, as has the volume and variety of waste.

Historically, garbage was considered as a nuisance that needed to be disposed of rather than a serious environmental issue. This viewpoint was largely practicable because to the smaller population and abundance of land, which allowed the environment to absorb garbage without significant degradation. However, a dramatic shift happened in the sixteenth century, when the industrial revolution caused a massive migration from rural to urban regions. This migration caused a population explosion in cities, resulting in a significant increase in both the volume and variety of trash generated. Metals and glass become abundant in municipal trash streams.

The growing urban population contributed to widespread trash and the construction of open dumps, resulting in unclean conditions and breeding grounds for pests such as rats. These poor waste management procedures posed serious public health hazards, causing frequent epidemics and high mortality rates.

Recognizing the risks of unmanaged garbage disposal, public officials in the nineteenth century began implementing more systematic and controlled waste management techniques to protect public health. These early efforts paved the way for modern waste management practices, emphasizing the importance of appropriate garbage treatment and disposal as populations expanded and urbanized. Today, waste management is a complex issue that necessitates long-term policies to reduce environmental consequences and maintain public health in an increasingly populated globe.

Most industrialized countries have gone through a developmental phase marked by severe environmental concerns, notably those connected to garbage generation. Today, several of these countries have effectively reduced the health and environmental risks connected with garbage management. In striking contrast, emerging countries are currently dealing with fast urbanization and growth, which is causing a return of historical issues previously addressed by industrialized countries. This arrangement raises an important question in current trash management: What precisely is waste? Waste is typically characterized as a worthless consequence of human activity that contains the same ingredients as beneficial goods. It can also be defined as any product or substance judged useless by the manufacturer.

Dijkema et al. (2000) define waste as stuff that individuals want to dispose of, even if doing so incurs costs. While waste is an unavoidable outcome of human undertakings, it frequently reflects inefficiencies in industrial processes, resulting in the constant accumulation of what might be called wasted resources.

This concept emphasizes the subjective nature of trash: what one person considers rubbish may be considered as a useful resource by others. As a result, a substance is classified as waste mostly according to the owner's designation. This subjectivity needs a clear definition of waste, as this classification serves as the foundation for legislation aimed at protecting public health and the environment in places where trash is processed or disposed of.

Developing a thorough understanding of waste is critical, especially as the dynamics of global waste management shift. With rising urbanization and industrialization in emerging economies, a comprehensive framework for waste classification is essential. This paradigm informs not only regulatory rules, but also recycling and resource recovery practices. As these countries face waste management difficulties, recognizing the dual nature of materials—viewing trash as both a problem and a potential resource—will be critical for establishing sustainable strategies that reduce environmental impact while increasing economic efficiency. (Amasuomo & Baird, 2016)**, (Odhiambo, 2022)**

Objectives

- Assess the effectiveness of various waste-to-energy technologies in converting municipal solid waste into energy. This includes examining the energy output, carbon emissions reduction.
- Investigate the environmental advantages of composting organic waste, including its impact on reducing landfill volumes, enhancing soil health, and decreasing greenhouse gas emissions.
- Explore the economic implications of implementing waste-to-energy and composting systems in urban settings, including cost-effectiveness, potential revenue generation, and long-term

savings on waste disposal.

Methodology

The methodology for evaluating innovative waste management systems, particularly waste-to-energy and composting, and their impact on urban sustainability will be based on secondary data gathered from reputable academic databases such as Google Scholar, Shodhganga, ResearchGate, Scopus, and Academia.edu.

The project will conduct a systematic evaluation of current literature, including peer-reviewed articles, case studies, and reports, to collect comprehensive data on the efficacy of various waste-to-energy methods for turning municipal solid waste into electricity. This assessment will look at energy output, carbon emissions reduction, and overall efficiency when compared to typical garbage disposal methods.

Furthermore, the study will look into the environmental benefits of composting organic waste, including its role in reducing landfill volumes, improving soil health, and lowering greenhouse gas emissions. Furthermore, the economic consequences of adopting waste-to-energy and composting systems will be investigated, including cost-effectiveness, possible revenue generation, and long-term waste disposal savings in urban environments. Data extraction will entail categorizing data based on the study objectives and combining insights to reach conclusions regarding the contributions of these innovative waste management methods to urban sustainability. This approach will ensure a thorough and evidence-based study, allowing for the identification of best practices and informing future policy recommendations.

Result and Analysis

The effectiveness of various waste-to-energy technologies in converting municipal solid waste into energy. This includes examining the energy output, carbon emissions reduction.

The effectiveness of waste-to-energy (WtE) technology in converting municipal solid waste (MSW) into electricity is gaining traction as a long-term solution to both waste management and energy generation concerns. With growing worries about natural resource depletion and the increasing volume of garbage in metropolitan areas, WtE technologies provide a dual benefit: they reduce waste's environmental impact while also contributing to the energy mix. Various technologies, such as incineration, anaerobic digestion, gasification, and landfill gas recovery, provide variable degrees of energy output, carbon emission reductions, and efficiency, with each having distinct advantages over traditional waste management methods.

Energy Output

One of the key advantages of WtE technologies is their capacity to create electricity from garbage that would otherwise go into landfills. Incineration is one of the most extensively used WtE technologies, because to its ability to generate power and heat from the burning of MSW. Incineration saves landfill space by dramatically lowering the volume of waste produced. However, its energy production is a major reason pushing its appeal in energy generation, with studies indicating that incineration can generate significant amounts of electricity and heat energy **(Traven, 2023).**

Anaerobic digestion, on the other hand, provides a unique mechanism for energy recovery. This method generates biogas from the microbial breakdown of organic waste, which can then be transformed into power. Notably, anaerobic digestion has a high exergetic potential, which refers to its ability to convert waste into usable activity, making it an effective alternative to organic waste

(Amulah et al., 2024).

Another interesting WtE technology is gasification, which has the potential to reduce carbon emissions when compared to traditional energy sources. It entails the thermal breakdown of waste in a low-oxygen atmosphere, resulting in syngas—a mixture of carbon monoxide and hydrogen—that can be utilized to generate power or as fuel. According to recent research, substituting coal with syngas produced by gasification can reduce carbon dioxide emissions by up to 40%, providing a considerable environmental benefit **(M K et al., 2023).**

Carbon Emission Reduction

Reducing greenhouse gas emissions is an important goal in the implementation of WtE technology. Landfill gas recovery, which recovers methane emissions from decaying organic waste in landfills, provides a feasible alternative for reducing methane emissions, which are a strong greenhouse gas that contribute considerably to global warming. By capturing and converting methane into energy, this method efficiently decreases the environmental impact of landfill waste while also producing useable energy.

Gasification is also significant in terms of carbon emissions reduction. Gasification minimizes the amount of garbage that would otherwise end up in landfills by transforming it into synthetic gas. This, in turn, lowers the carbon footprint associated with landfill operations. Studies show that gasification can cut landfill trash by more than 50%, making it an environmentally friendly waste management solution **(M K et al., 2023), (Traven, 2023).** Both technologies support worldwide efforts to tackle climate change by reducing dependency on fossil fuels and lowering waste-related emissions.

Overall efficiency

When assessing the overall efficiency of WtE technologies, anaerobic digestion and gasification appear as extremely efficient choices because to their high exergy efficiency. Exergy efficiency is the efficiency with which a system transfers energy from one form into usable work, taking into account the irreversibility of processes like heat generation. Both anaerobic digestion and gasification have high levels of energy conversion efficiency, making them preferred in cases where increasing energy output is critical.

While incineration is excellent at reducing waste and producing energy, it is criticized for its environmental impact, particularly in terms of emissions. Although modern incineration plants use complex filtration technologies to reduce harmful emissions, they nevertheless emit carbon dioxide and other pollutants. This makes incineration less environmentally favorable than options like gasification and anaerobic digestion **(Amulah et al., 2024), (Mertzanakis et al., 2024).**

Global Data Table on Waste-to-Energy Technologies

Technology	Energy Output (TWh/year)	Carbon Emissions Reduction (kg CO_2eq/kWh)	Notes
Incineration	140 - 340	0.664 - 0.951 (before system expansion)	Incineration reduces landfill methane emissions and generates heat/electricity. Potential to be carbon-neutral when accounting for biogenic emissions **(Down, 2024), (Pfadt-Trilling et al., 2021).**

Gasification	Varies	-0.280 to 0.593 (after system expansion)	Converts organic materials into syngas, which can be used for electricity generation or as a chemical feedstock. Can significantly reduce emissions compared to traditional methods **(Wienchol et al., 2020).**
Anaerobic Digestion	20-Oct	Varies based on feedstock	Converts organic waste into biogas, which can be used for heating or electricity. It effectively reduces methane emissions from landfills and can produce renewable natural gas **(Institute, 2024).**
Plasma Gasification	Emerging Technology	Potentially carbon-negative	Uses extreme heat to convert waste into syngas and slag. High energy recovery efficiency and minimal emissions, but still under research for widespread implementation **(Wienchol et al., 2020).**
Biogas Production	5-Feb	Significant reduction due to methane capture	Focused on organic waste; captures methane that would otherwise contribute to greenhouse gas emissions **(Institute, 2024).**

The environmental advantages of composting organic waste, including its impact on reducing landfill volumes, enhancing soil health, and decreasing greenhouse gas emissions.

Composting organic waste is increasingly recognized as a vital practice with numerous environmental advantages, especially concerning landfill volume reduction, soil health enhancement, and greenhouse gas emission decreases. By converting organic materials into nutrient-rich compost, this sustainable approach transforms waste into a valuable resource while fostering ecological balance. As the global population continues to grow and urbanization accelerates, the need for effective waste management solutions becomes more pressing. Composting emerges as a practical solution to manage organic waste, benefiting both the environment and society.

Reducing Landfill Volumes

One of the most significant benefits of composting is its ability to divert organic waste from landfills. By managing food scraps, yard waste, and other organic materials through composting, communities can significantly reduce the volume of waste that requires disposal. Research indicates that composting can reduce landfill waste by up to 30%, alleviating the pressure on waste management systems. This is particularly crucial in an era where landfills are reaching capacity and new sites are becoming increasingly difficult to find. By decreasing landfill volumes, composting not only prolongs the life of existing landfills but also mitigates the negative environmental impacts associated with landfill operations, such as leachate production and habitat destruction. **(HASSAN et al., 2023)**, **(Abbas & Flayeh, 2024)**

Enhancing Soil Health

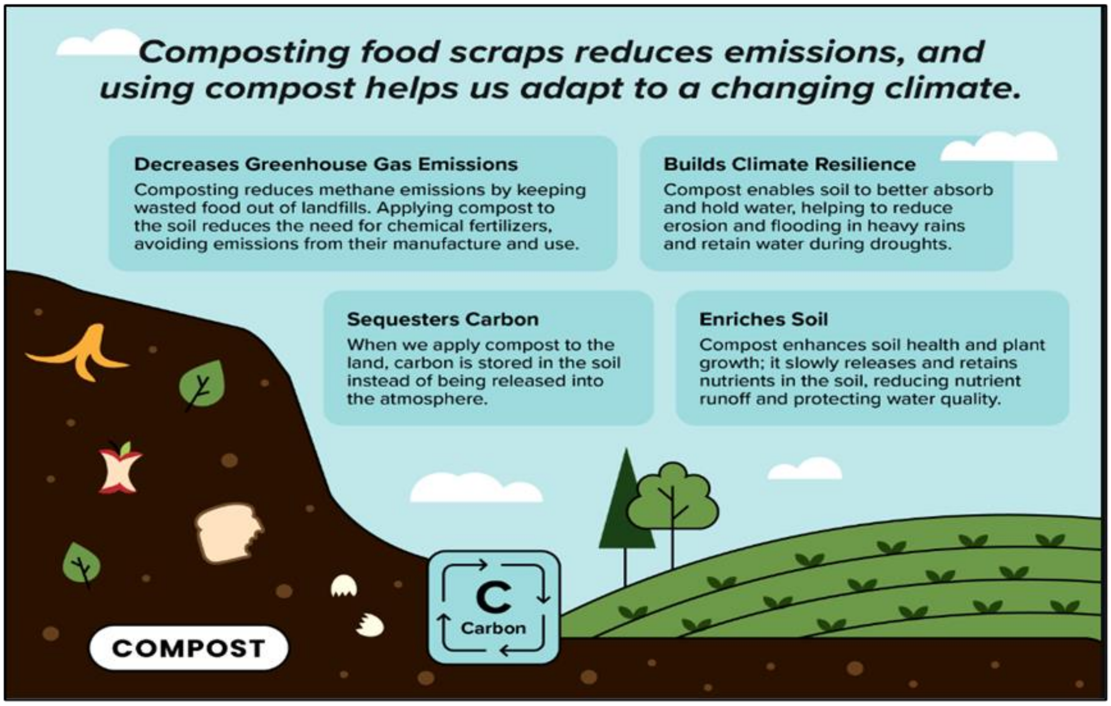
In addition to waste reduction, composting plays a pivotal role in enhancing soil health. The addition of compost enriches soil by increasing organic matter content, improving nutrient availability, and enhancing soil structure **(Khadim et al., 2024).** These improvements lead to better water retention, aeration, and microbial activity, all of which are essential for healthy soil ecosystems. Numerous studies have demonstrated that compost application can lead to higher crop yields and increased resilience against diseases, thanks to improved soil **conditions (Taneja et al., 2024).** By enhancing soil fertility and productivity, composting supports sustainable agriculture and food security, ultimately benefiting farmers and consumers alike.

Furthermore, healthy soils contribute to greater biodiversity and ecosystem resilience, which are vital for maintaining ecological balance. Composting encourages the growth of beneficial microorganisms and earthworms, which are crucial for nutrient cycling and soil aeration. In this way, composting not only enhances agricultural productivity but also promotes a healthier environment overall.

Decreasing Greenhouse Gas Emissions

Another compelling advantage of composting is its role in decreasing greenhouse gas emissions. Organic waste in landfills generates methane, a potent greenhouse gas that significantly contributes to climate change. Composting, by promoting aerobic decomposition, reduces the production of methane, thereby mitigating its harmful environmental effects **(Manea et al., 2024).** In contrast to anaerobic processes prevalent in landfills, composting harnesses oxygen to break down organic matter, resulting in fewer greenhouse gas emissions.

Additionally, the composting process sequesters carbon in the soil, contributing to climate change mitigation efforts **(HASSAN et al., 2023).** By storing carbon in the soil, composting helps combat atmospheric carbon dioxide levels, a key factor in global warming. This carbon sequestration potential underscores the importance of adopting composting practices as part of a broader strategy to address climate change.



Source: https://www.epa.gov/sustainable-management-food/composting

The economic implications of implementing waste-to-energy and composting systems in urban settings, including cost-effectiveness, potential revenue generation, and long-term savings on waste disposal

Implementing waste-to-energy (WtE) and composting systems in metropolitan areas has substantial economic ramifications, with the potential to alter municipal waste management methods. By stressing cost-effectiveness, possible revenue generation, and long-term savings, these systems make a strong case for towns aiming to manage waste while promoting economic growth and sustainability.

Cost-Effectiveness

Initial Investment and Operating Costs

The building of WtE facilities necessitates significant capital expenditure (CapEx) for infrastructure development, such as incinerators, anaerobic digesters, or gasification plants. These expenses can range from millions to tens of millions of dollars, depending on the technology used and the facility's size. For example, a large-scale anaerobic digestion facility may have starting expenses that are prohibitively expensive for municipal budgets. However, it is crucial to note that operating costs (OpEx) can fall over time as facilities refine procedures and benefit from automation. As these systems become more efficient, they can manage higher amounts of garbage, resulting in cheaper per-unit processing costs. **(Hampel-Milagrosa & Castro-Wooldridge, 2023)**

Reduced landfill costs

Both WtE and composting provide municipalities with a way to dramatically reduce their dependency on landfills, which are typically costly to manage. Landfill disposal can take up to 20% of municipal budgets in some areas, putting enormous financial strain on local governments. Municipalities can significantly reduce their disposal costs by diverting organic and other trash from landfills through WtE and composting programs. This reduction not only relieves financial pressure, but it also extends the life of current landfill sites, delaying the need for expensive new landfill complexes. **(Toshiaki Sasao, 2020)**

Revenue Generation

Energy Sales:

Waste-to-energy systems enable communities to generate electricity or heat, which may then be sold to power providers. This generates a new revenue stream that can greatly outweigh both the original investment and continuing operational expenditures. The opportunity to generate revenue from energy sales is a significant motivation for communities to install WtE technologies. Municipalities can negotiate contracts with energy providers, generating predictable revenue that can be reinvested in community services or waste management efforts.

Compost Sales:

Similarly, composting organic waste produces nutrient-dense compost, which can be sold to farmers, landscapers, and gardeners. The increased demand for sustainable agricultural goods assures that towns will be able to generate more cash. Selling compost not only helps to offset some of the costs associated with waste disposal, but it also promotes sustainable agriculture practices in the community. By converting garbage into a marketable product, towns can stop the loop on organic waste management, resulting in an economically viable circular economy. **(Futuramo, 2024), (Hampel-Milagrosa & Castro-Wooldridge, 2023)**

Long-term Savings

Environmental Advantages and Cost Savings:

Both WtE and composting systems play an important role in lowering greenhouse gas emissions and generating financial benefits through carbon credit trading. As these technologies reduce methane and carbon dioxide emissions, towns may create carbon credits that can be traded in environmental markets. The commercialization of these credits provides an extra economic incentive for communities to implement WtE and composting policies, allowing them to reap cash benefits from their environmental stewardship efforts.**(Matheson, 2019), (Hampel-Milagrosa & Castro-Wooldridge, 2023)**

Sustainability and Lower Waste Management Costs:

Investing in WtE and composting contributes to broader sustainability goals by fostering community education and increasing recycling activities. As citizens get increasingly involved in sustainable behaviors, these systems have the potential to reduce overall trash creation over time. As towns increase their waste management efficiency, the costs of waste collection and disposal are expected to fall dramatically. A more sustainable approach to trash management improves the environment while also producing economic returns that may be reinvested in community programs. **(Matheson, 2019), (Earth, 2024)**

Discussion

The ability of waste-to-energy (WtE) technology to convert municipal solid waste (MSW) into electricity is developing as a possible solution to both waste management and energy generating issues. WtE technologies, such as incineration, anaerobic digestion, gasification, and landfill gas recovery, not only minimize waste's environmental impact but also contribute to the overall energy mix. One of the most extensively used technologies is incineration, which efficiently generates power by burning MSW, considerably lowering the amount of waste that would otherwise be landfilled. Its capacity to create both power and heat makes it a popular alternative, but concerns about pollutants remain despite sophisticated filtration systems. Anaerobic digestion, which generates biogas from the microbial decomposition of organic waste, is a highly effective technology with a distinct advantage in terms of exergy efficiency, transforming trash into useful energy while being more environmentally benign than typical waste management practices.

Gasification stands out for its ability to minimize carbon emissions by producing syngas, a mixture of carbon monoxide and hydrogen that may be used to generate electricity or fuel. This technology can reduce carbon emissions by up to 40% when compared to typical energy sources, making it a viable choice for lowering the carbon footprint of trash disposal. Furthermore, landfill gas recovery provides an essential alternative for reducing methane emissions, a potent greenhouse gas that contributes to global warming, by capturing and converting methane from decomposing organic waste into electricity. The reduction of greenhouse gas emissions is a top priority for WtE technology deployment, with gasification and landfill gas recovery providing significant environmental benefits.

Composting, another waste management approach, is gaining popularity for its ability to reduce landfill volumes and improve soil health. Composting, by removing organic waste from landfills, helps to reduce leachate production and habitat loss related with landfill operations. Furthermore, composting enhances soil by increasing water retention and nutrient availability, promoting sustainable agriculture. This approach also minimizes methane emissions by fostering aerobic decomposition, which does not release methane, as opposed to anaerobic processes in landfills. Composting also sequesters carbon in the soil, which helps to mitigate climate change by lowering atmospheric CO2 levels.

From an economic standpoint, both WtE and composting technologies have the potential to alter municipal waste management policies. Although the initial capital expenditure for WtE facilities may be considerable, long-term operational costs will fall as technologies grow more efficient, generating electricity and reducing reliance on costly landfill management. The energy created by WtE can be sold to power companies, providing new cash streams for communities. Similarly, composting produces nutrient-rich compost that may be sold, so fostering more sustainable agriculture methods. WtE and composting have combined environmental and economic benefits, including potential revenue from carbon credit trading, making them critical components in tackling waste management concerns while supporting sustainability and economic growth.

Conclusion

The effectiveness of waste-to-energy (WtE) technology, along with composting, provides major solutions to modern waste management and energy generation concerns. WtE technologies such as incineration, anaerobic digestion, and gasification give two benefits: they reduce the amount of waste sent to landfills and contribute to the energy mix. Incineration, the most extensively used WtE process, creates power while simultaneously reducing landfill area. Anaerobic digestion and gasification, with their high exergy efficiency, emerge as viable options, notably for lowering carbon emissions and increasing energy output from organic waste. Landfill gas recovery emphasizes the environmental benefits of WtE by capturing methane emissions for electricity production while reducing the harmful greenhouse gasses associated with landfills. However, incineration, despite its success in waste reduction and energy production, has been criticized for emitting pollutants. Composting provides an alternate strategy, especially for organic waste, lowering landfill trash by up to 30% while improving soil health. The technique not only decreases environmental impact, but it also promotes sustainable agriculture by replenishing soil with necessary nutrients and increasing biodiversity. The economic impact of WtE and composting is also significant. Municipalities can reduce landfill dependency, cutting waste management expenses, and generate cash by selling energy and compost. Carbon credits earned from lower greenhouse gas emissions further encourage the usage of these technology. Municipalities that invest in WtE and composting can achieve long-term environmental goals while also generating economic rewards. The integration of these technologies provides a comprehensive, efficient solution for urban waste management, promoting both ecological balance and economical sustainability.

References

1. Abbas, R. I., & Flayeh, H. M. (2024). Aerobic Composting of Organic Waste, Alternative and an Efficient Solid Waste Management Solution. *Asian Journal of Water, Environment and Pollution*, *21*(4), 101–111. https://doi.org/10.3233/AJW240051
2. Amasuomo, E., & Baird, J. (2016). The Concept of Waste and Waste Management. *Journal of Management and Sustainability*, *6*(4), 88. https://doi.org/10.5539/jms.v6n4p88
3. Amulah, N. C., Oumarou, M. Ben, & Muhammad, A. B. (2024). Exergy Analysis of Waste-to-Energy Technologies for Municipal Solid Waste Management. *Environment and Natural Resources Journal*, *22*(3), 1–12. https://doi.org/10.32526/ennrj/22/20240023
4. Down, D. (2024). *Waste to Energy*. https://drawdown.org/solutions/waste-to-energy
5. Earth, D. to. (2024). *Costs and benefits of India's waste disposal options*. https://www.downtoearth.org.in/waste/costs-and-benefits-of-india-s-waste-disposal-options-5623
6. Futuramo. (2024). *Maximizing Revenue with Effective Waste Management*. https://futuramo.com/blog/maximizing-revenue-with-effective-waste-management/
7. Hampel-Milagrosa, A., & Castro-Wooldridge, V. (2023). Using Ex-Ante Cost–Benefit Analysis to Improve Waste Management in the Pacific. *ADB BRIEFS*. https://doi.org/http://dx.doi.org/10.22617/BRF2XXXXX
8. HASSAN, N. Y. I., EL WAHED, N. H. A., ABDELHAMID, A. N., ASHRAF, M., & ABDELFATTAH, E. A. (2023). COMPOSTING: AN ECO-FRIENDLY SOLUTION FOR ORGANIC WASTE MANAGEMENT TO MITIGATE THE EFFECTS OF CLIMATE CHANGE. *Innovare Journal of Social Sciences*, 1–7. https://doi.org/10.22159/ijss.2023.v11i4.48529
9. Institute, E. and E. S. (2024). *Fact Sheet | Biogas: Converting Waste to Energy*. https://www.eesi.org/papers/view/fact-sheet-biogasconverting-waste-to-energy
10. Khadim, M. D., Wesal, A. B., & Peezhand, A. W. (2024). Overview of the Impact of Compost on Bulk Density, Aggregate Consistency and Cation Exchange Capacity of Soils and its Consequential Effect on Crop Productivity. *Cognizance Journal of Multidisciplinary Studies*, *4*(6), 344–359. https://doi.org/10.47760/cognizance.2024.v04i06.021
11. M K, A., Kantak, G. K., & Wadhwa, B. (2023). Waste-to-Energy: Reviewing Gasification of Municipal Solid Waste. *2023 International Conference on Power Energy, Environment & Intelligent Control (PEEIC)*, 1213–1217. https://doi.org/10.1109/PEEIC59336.2023.10451061
12. Manea, E. E., Bumbac, C., Dinu, L. R., Bumbac, M., & Nicolescu, C. M. (2024). Composting as a Sustainable Solution for Organic Solid Waste Management: Current Practices and Potential Improvements. *Sustainability*, *16*(15), 6329. https://doi.org/10.3390/su16156329
13. Matheson, T. (2019). Disposal is Not Free. *IMF Working Papers*, *19*(283). https://doi.org/10.5089/9781513521589.001
14. Mertzanakis, C., Vlachokostas, C., Toufexis, C., & Michailidou, A. V. (2024). *Closing the Loop*

between Waste-to-Energy Technologies: A Holistic Assessment Based on Multiple Criteria. https://doi.org/10.20944/preprints202405.1023.v1

15. Odhiambo, G. (2022). *waste management system*. https://www.researchgate.net/publication/360835841_waste_management_system
16. Pfadt-Trilling, A. R., Volk, T. A., & Fortier, M. O. P. (2021). Climate Change Impacts of Electricity Generated at a Waste-to-Energy Facility. *Environmental Science and Technology*. https://doi.org/10.1021/acs.est.0c03477
17. Taneja, T., Kumar, M., Sharma, I., Kumar, R., Sharma, A., & Singh, R. (2024). Composting of Agro-Phyto wastes: An Overview on Process, factors and Applications for Sustainability of Environment and Agriculture. *Current World Environment*, *19*(1), 35–45. https://doi.org/10.12944/CWE.19.1.4
18. Toshiaki Sasao. (2020). *Cost Efficiency of Regional Waste Management and Contracting Out to Private Companies*. https://www.ide.go.jp/library/English/Publish/Reports/Ec/pdf/202010_ch04.pdf
19. Traven, L. (2023). Sustainable energy generation from municipal solid waste: A brief overview of existing technologies. *Case Studies in Chemical and Environmental Engineering*, *8*, 100491. https://doi.org/10.1016/j.cscee.2023.100491
20. Wienchol, P., Szlęk, A., & Ditaranto, M. (2020). Waste-to-energy technology integrated with carbon capture – Challenges and opportunities. *Energy*, *198*, 117352. https://doi.org/10.1016/j.energy.2020.117352