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ENERGY SOLUTIONS

Harnessing the Power of Waste

The Waste-to-Energy Landscapes in the Philippines and Sweden

February 2023

About the Publication

This publication was written by Ellinor Granström.

Verne Energy Solutions

Headquartered in Metro Manila, Verne Energy Solutions operate and implement projects all over the Philippines. We specialize in **all forms of sustainable energy**, from renewables to energy efficiency.

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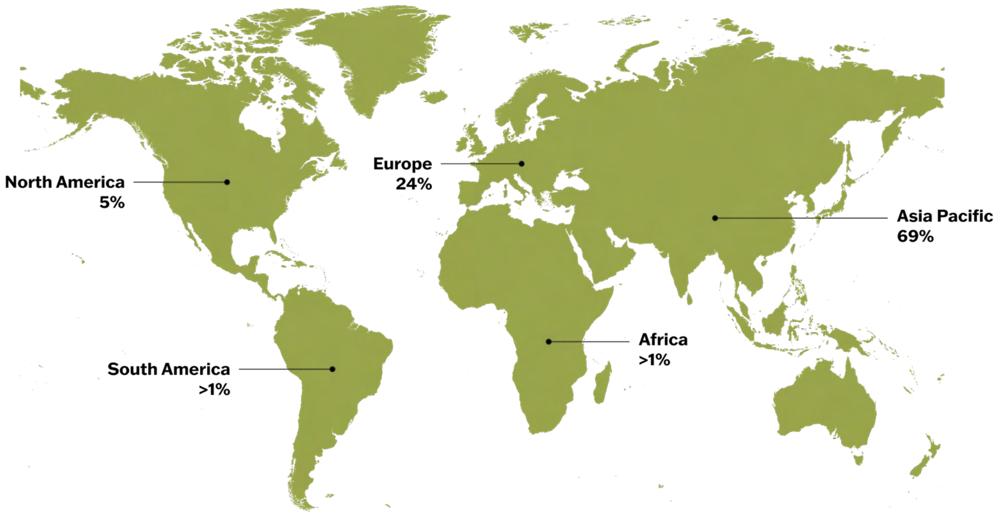
Executive Summary

This document will cover the main methods used in converting municipal solid waste to usable energy, comparing the contexts of Sweden and the Philippines. As one of the leading nations in the waste-to-energy process, Sweden illustrates how waste can support the shift away from fossil-fuel energy, whilst achieving effective waste management, and obtaining additional revenue streams. In better understanding the benefits and drawbacks of these processes, we can harness the power of waste to support the application of this value-added process within the Philippines' boundaries.

Our recommendation would be to implement incineration or gasification as the main methods of converting waste-to-energy within the Philippines' boundary. Gasification provides an effective method to convert waste to energy, with little negative environmental externalities, while incineration provides a strong business case to investors. Overall, there is large potential within the Philippine market to invest in this process as it is backed by a solid business case.

Figure 1
Waste-to-energy facilities around the world



Rediscovering Energy from Discarded Waste

Unmanaged and unsustainable urbanization is leading to an increase in the production of municipal solid waste (MSW), a growing demand for energy consumption, and added stress on the climate. As ambitious climate targets quickly approach, these problems require immediate action to integrate circular and sustainable patterns of production and consumption to decrease the negative externalities on the environment. Waste-to-energy (WTE) can be an effective cog in supporting larger sustainability efforts and the greening of energy supplies around the world.

The global WTE market is projected to grow from a value of USD 35.1 billion in 2019 to USD 50.1 billion by 2027. There are around 2,500 active WTE plants worldwide with a capacity to dispose of 420 million tons of waste per year. Six of these plants are operating within the Philippines while 34 are in Sweden, and these numbers are only projected to grow in the coming years. Its market growth can be attributed to the growing scarcity and the negative environmental impacts of dumpsites and landfills in conjunction with waste production being projected to increase by 73% by 2050. Moreover, 40% of global waste ends up in landfills that contribute to 10% of global greenhouse gas emissions.

Within Sweden, only 1% of MSW is sent to landfills, 52% gets converted into energy, and 47% gets recycled. Through these processes, over one million homes get supplied with district heating from the waste-to-energy process alone, while 250,000 homes get electricity. Within the Philippines, this market is still emerging and can potentially make a significant difference in the growth of the nation. In supplying greener energy sources to the nation's electricity grid, it can support the transition to electrification in sectors such as transportation and building systems.

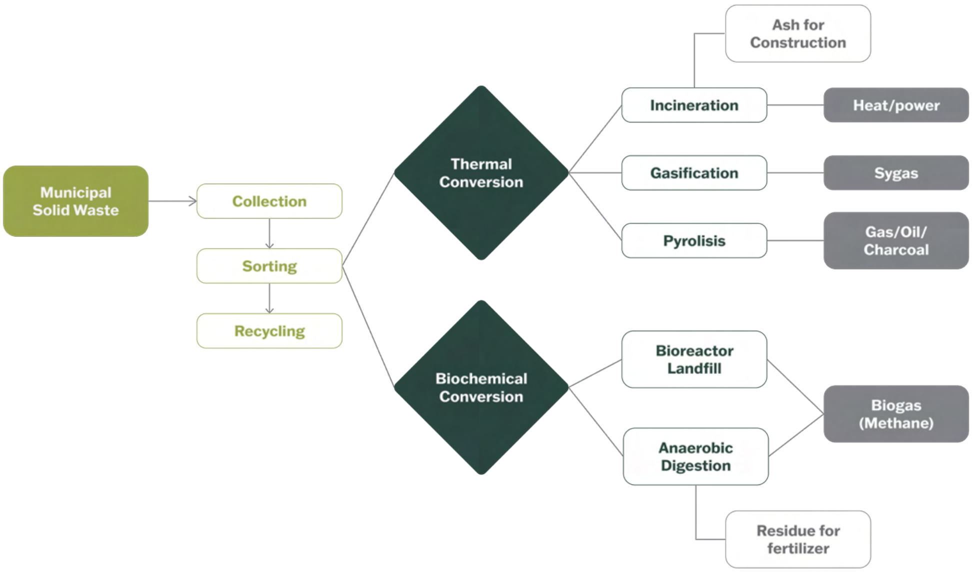
The comparison between two nations is difficult to achieve as each come with varied histories and contexts. However, there is much to learn from the Swedish WTE market that can be applied to some degree in the Philippine market to promote this transition to utilizing waste for energy.

“Waste to energy can be an effective cog in supporting larger sustainability efforts and the greening of energy supplies around the world.”

Processing Methods

MSW can be understood as any waste that is disposed of or collected within municipal borders from households, construction sites, industries, or institutions, amongst others. This waste consists of both organic and inorganic materials such as food, plastic, paper, wood, textiles, metal, and glass. MSW can be processed through multiple methods, depending upon its contents, to produce energy. Figure 1 illustrates the different methods of processing waste to energy.

Figure 2
The different waste-to-energy processing methods



Incineration

Incineration is a high-temperature process which combusts MSW to create heat, steam, and ash. It requires gathering and sorting of waste, transportation to facilities, and special incineration plants that can tolerate high heats. Throughout this process, toxic gases are released such as the oxides of carbon (COx), nitrogen (NOx), and sulphur (SOx), as well as carbon dioxide (CO_2) which either get treated to reduce emissions or get released into the atmosphere. One advantage to incineration is the ability to handle a large amount of waste at once. The disadvantages include its high operational expenditure, and its environmental emissions.

Gasification

Gasification is the process of converting organic waste into syngas, which is a mixture of gases that can be combusted to produce energy or used for chemical fuel. This process can be done by using steam, oxygen, or carbon dioxide, which produces different mixtures of gases. One advantage to gasification is its lack of emissions as this method can be easily contained to decrease pollution. One disadvantage would be the high cost and complexities of scaling up.

Anaerobic Digestion

Anaerobic digestion breaks down organic waste, with the absence of oxygen, into biogas. Like gasification, this process creates a mixture of gases which are predominantly methane (CH_4) and CO_2 and used for the same purposes as gasification. This process is best utilized on agricultural waste as well as pulp and food industrial waste. The main disadvantage to this process is the disposal of its residue as large amounts of sludge gets left behind after gases are extracted. However, this residue can potentially be used as soil fertilizers to create a more circular agricultural system.

Bioreactor Landfill

Bioreactor landfills, or bio-landfills, are landfills that use anaerobic digestion with increased moisture and liquids to speed up the decomposition of MSW. Bio-landfills differ from the conventional dry tomb landfills as they are faster in processing MSW, produce higher energy yields, and are safer for the environment. There is also no need to sort or pre-process MSW before being brought to bio-landfills. However, bio-landfills also produce sludge which creates an added step of disposal.

Pyrolisis

Pyrolysis is when heat is applied to biomass to either produce biochar and bio-oil, or biochar and syngas. Depending on the type of reactor used, some are more costly than others, while others are less flexible on the input of waste required. Overall, the advantages to this process would be its convenience in storage, transportation and flexibility in usage and energy production.

Table 1
Summary of different waste-to-energy processing methods

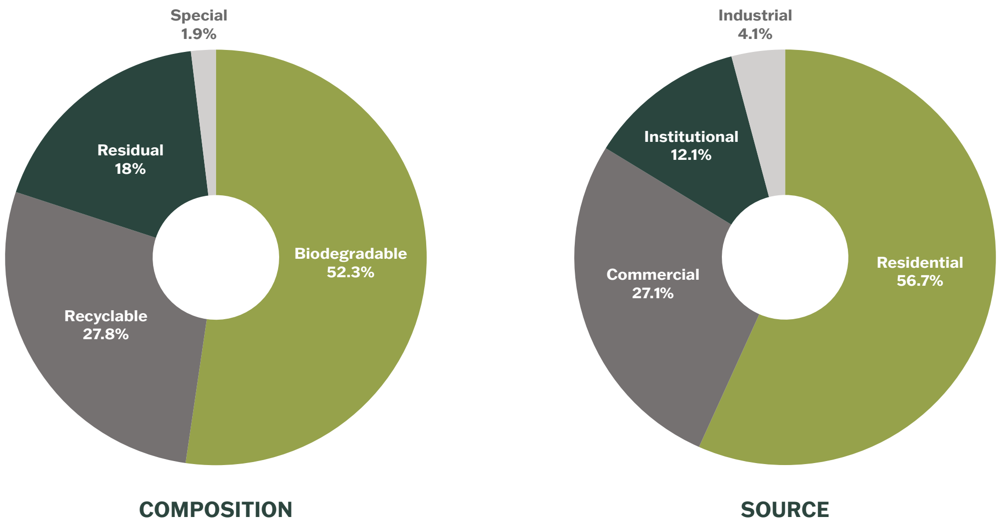
Processing Methods	Output	Advantages	Disadvantages
Incineration	– Ashes – Heat – Power	Handle large amounts of waste at once	Emissions need extra processing
Gasification	– Syngas	Produces the most amount of energy	Costly to scale up operations
Anaerobic Digestion	– Biomass (CH_4) – Residue pulp	Residue can be repurposed as fertilizer	Disposal of residue
Bioreactor Landfill	– Biomass (CH_4)	Faster than dry tomb landfills	Disposal of residue
Pyrolisis	– Gas – Oil – Charcoal	Convenient storage and transportation	Facility function is limited

Potential in the Philippines' Landscape

In the Philippines, poor waste management has led to the pollution of air, soil, and water systems. In 2020, the country produced an average of 50,000 tons of waste per day, with over half of the waste coming from the National Capital Region (NCR). Of this MSW, 70% of that gets collected and brought to dumpsites, while the 30% goes uncollected, emitting large amounts of methane which contributes to climate and environmental issues. Although changes are being made under the Ecological Solid Waste Management Act, or RA 9003, there is still a low level of compliance with certain local government units (LGUs) and private firms. Within the nation, 189 landfills are operating at full capacity which is far below what is required to maintain effective waste management in the nation. There are also 260 open dumpsites that need to shut down in compliance with the RA 9003.

Currently, 13 WTE plants are registered under the Department of Energy, with 6 being operational in the nation, and many other potential projects in the pipeline. Some successful facilities include the Montalban and Payatas landfills that have transformed into methane gas powerplants which currently produce 8.19 MW and 2.5 MW of power respectively. These facilities were transformed through the program run by the Carbon Partnership Facility and the Land Bank of the Philippines.

Figure 3
Composition and sources of municipal solid waste in the Philippines



Some projects in the works include the 36MW incineration facility located in Quezon City, being developed by Covanta Holding, Macquarie Group, and Metro Pacific Investments, that is projected to supply energy to 60,000 households by 2024 and cost over USD 420 million. Another project is the 20MW gasification facility in Naga that is aimed to be operational by 2024 and developed by CJ Global Green Energy Philippines. This project is expected to cost over USD 45 million and will process MSW through gasification to collect stored energy. These are just a few examples of the growing interest and demand for WTE facilities across the nation.

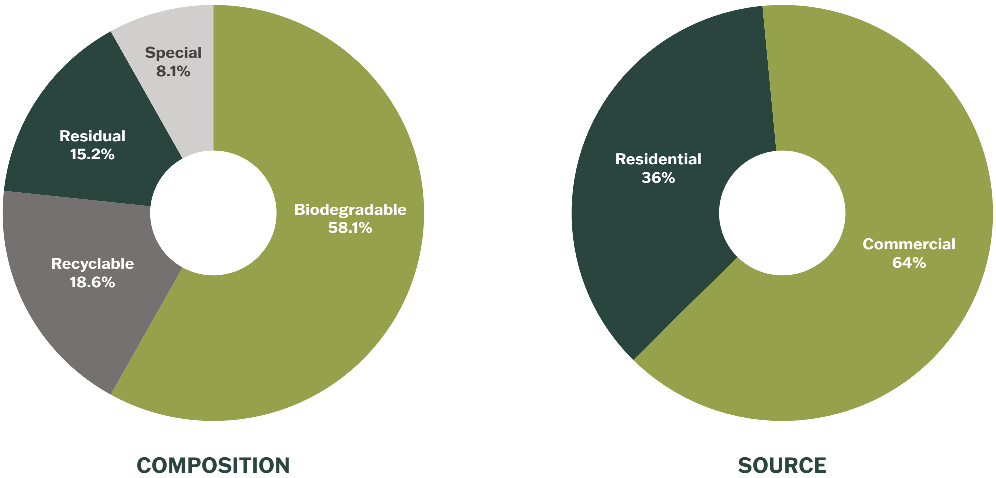
Multiple private firms have shown interest in developing a WTE facility in Cebu City in collaboration with the municipality. The city plans on creating a "Build, Transfer and Operate (BTO)" scheme where private firms get land in exchange for building WTE facilities. Ownership is then transferred over to the municipality and the private firm benefits from a 25-year contract with rent revenue from the land, and a percentage of gross income from operations. This concept is a great example of public-private partnerships (PPP) that can be possible on a national scale.

A major challenge that the Philippines faces when scaling up WTE operations is social in nature, as full residential cooperation is needed. The previous 30% of trash that goes uncollected has to be included into these waste management schemes from both the disposal and collecting perspectives. Proper infrastructure would also need to be implemented by public and private actors to support this growth. Finally, there is no cookie-cutter facility or solution to WTE that can be implemented on a national scale. Instead, each region needs to be considered to understand what type of facility fits best with the local economic activities, waste production, and infrastructure present.

Swedish Sorting Scenario

Sysav's plant based in the southern Swedish city, Malmö, is one of the most successful in the world. The plant uses incineration and converts 630,000 tons of waste per year into around 1,500 GWh of heating and 270 GWh of electricity. Using a model flue gas cleaning system which cleans the emissions from the incineration process, making it emit less toxic gases than the average incineration plant. The plant is owned by 14 different municipalities within southern Sweden and the collection and sorting of waste is also managed by themselves. In 2021, it had a turnover of over SEK 1.2 million, or USD 106,500 and employed 344 staff.

Figure 4
Composition and sources of municipal solid waste in Sweden

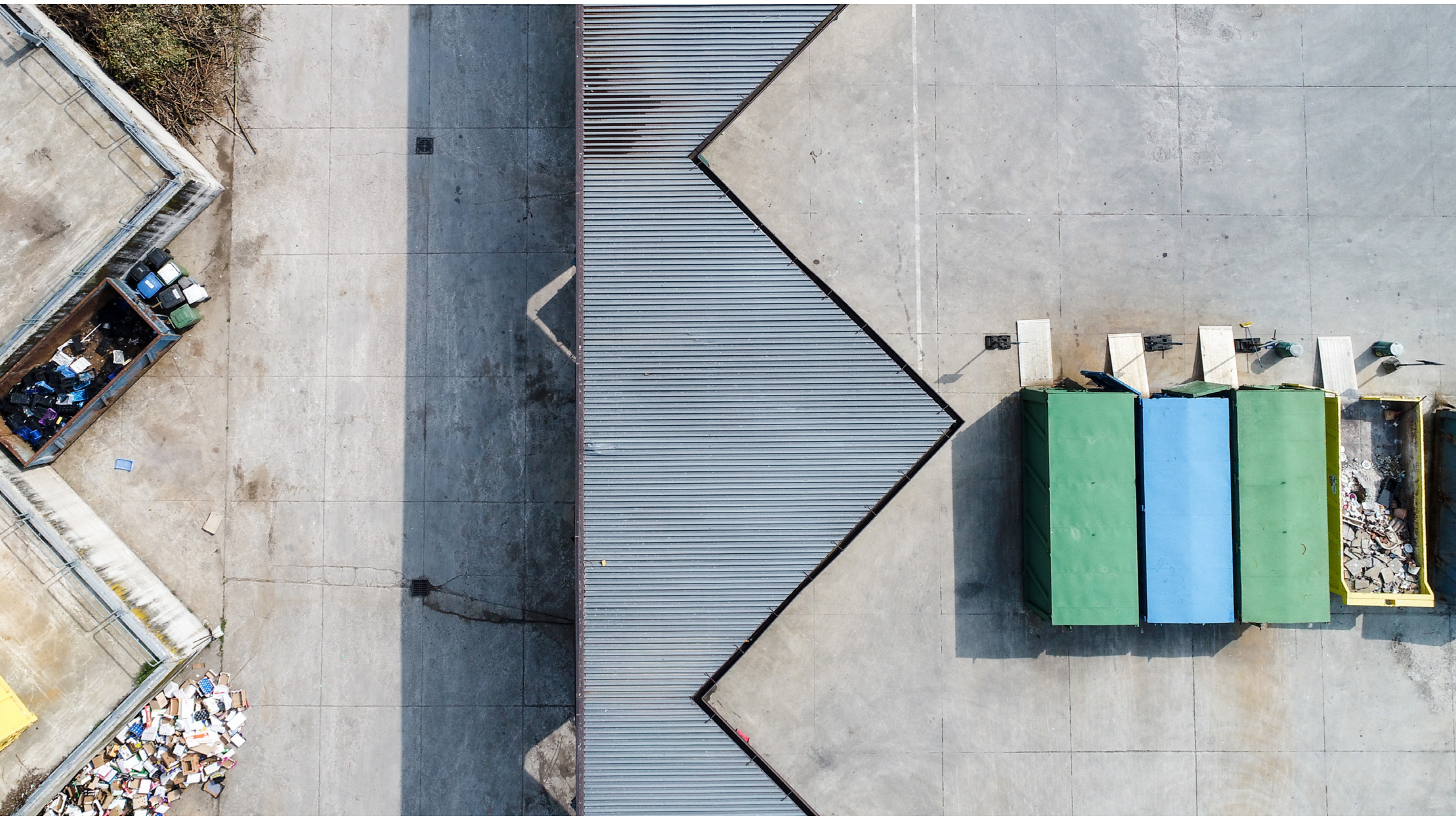


Another WTE facility in Sweden is the Värtaverket plant which is Stockholm's largest biofuel-powered combined heat and power plant (CHP). It has a capacity to produce 1,700 GWh of heat and 750 GWh of electricity each year. The plant is owned by Stockholm Exergi which is a collaboration between the City of Stockholm and Fortum. It is also located on a habour, making it easily accessible to import and export waste and biofuel.

Although Sweden is one of the leading nations in WTE practices, over the years, with the help of environmental regulations and support from public and private spheres, the production of MSW has actually decreased which has led to the fall of waste-to-energy outputs by 8%. The nation then looked towards importing waste from other European countries and now uses around 1.9 million tons of imported waste per year to feed these WTE plants.

A key driver for Sweden is the available disposal and recycling infrastructure and technology which is publicly funded. Similarly, the EPR that extends the responsibility of sorting and waste management to producers and consumers alike strong supports the WTE industry.

However, key challenges remain such as the emissions from WTE plants which make up 6% of the nation's territorial CO_2 emissions. The management of fossil content within waste is also still largely uncontrolled or regulated by the public sector, making progress difficult.



Building Blocks and Barriers to Implementation of Waste-to-Energy Initiatives in the Philippines

BUILDING BLOCKS

Effective Waste Sorting Facilities and Mentalities

To apply WTE on a larger scale in the Philippine context, a few building blocks need to be activated. The first would be the implementation of effective waste sorting in the nation, which includes both physical infrastructure and cultural shifts. Much like in Sweden, large emphases have been put on the importance of recycling and sorting waste through the Extended Producer Responsibility concept which greatly increases efficiency. To facilitate social changes, marketing campaigns with stronger regulations should be applied.

Stronger Regulations

Regulations for waste sorting and WTE facilities need to be solidified early in the process to ensure WTE is more environmentally sustainable. Many scholars and environmental advocacy groups have protested the process of waste-to-energy as they claim it is not a sustainable source of energy. They argue that by emphasizing the need for waste to feed these facilities, it promotes more consumption and production. Additionally, some combustion facilities emit toxic gases into the atmosphere which adds to the greenhouse gas effect and climate change. To change this negative impact and perception, stronger regulations for the emissions from facilities needs to be more concrete to control this market's development.

Increased Public-Private Partnerships

The third building block is to increase public-private partnerships (PPPs). As mentioned with the case of Cebu City and its build, transfer, and operate scheme, PPPs can allow WTE to scale up nationally and become a viable solution for waste management and energy production in all regions. The public sector can provide plots of land as well as access to waste streams while the private sector can provide financing and expertise for the building and operations of such facilities. In addition to this, partnering with distribution utilities, can allow sustainable energy sources to be accessed in most parts of the country, preventing the inequitable distribution of 'greener' sources of energy.

BARRIERS

Policies

One barrier, or potential opportunity, to implementing the WTE process on a large scale in the Philippine context would be the national policies, or lack thereof, in this field. Current policies such as the Clean Air Act bans incineration of municipal or hazardous waste, which is currently being contested. However, a Waste Treatment Technology Act was proposed in 2020 which could allow incineration to occur, as long as emissions are processed and free of toxins before being released into the atmosphere. The lack of regulations in this field can hinder its development, but also act as a large opportunity for the private and public sectors to shape its growth without bureaucratic obstacles in the way.

Environmental Impact

Emissions from WTE facilities need to be reduced to increase environmental sustainability. This barrier may lead to WTE being highly opposed by the stakeholders which could limit its success in the Philippines.

Strong Coordination Necessary at All Phases

The need to coordinate multiple stakeholder groups and phases of waste management poses another major barrier. Adopting a full cradle to grave approach towards MSW involves working across the entire value chain, including manufacturers, logistics, and consumers. An integrated whole-of-system approach is needed but notoriously difficult to mobilize.

The Case for the Philippines

There is a strong business case to support the shift from landfill use to WTE processing. Economically, WTE provides a return on investment on operational expenditures such as transportation and sorting which is not experienced with landfills. Additionally, it decreases GHG emissions that landfills typically produce, creating a more sustainable solution to traditional waste management methods. Therefore, investment in WTE has strong potential and depending on the method chosen, can be further amplified.

In the case of the Philippines, the most appropriate WTE method is highly contextual and specific to regions and waste streams. More than half of the nation's MSW is biodegradable and therefore has a higher moisture content, because of this, processes like incineration may not be as effective as other methods. However, the business case for incineration proves to be the strongest, as it has lower operational expenditures and a conversion efficiency rate of around 18-26%. It is the most effective in reducing waste piles as it can process large amounts at a time.

Gasification, on the other hand has conversion efficiencies ranging from 18-22% and syngas can provide more flexibility in terms of its use. This process is also backed by a strong business and environmental case as it is more efficient at producing energy with less air pollutants. However, these facilities require strong expertise in the field to both build and operate plants, which may not be accessible in the Philippines yet.

An alternative may be anaerobic digestion with the caveat that larger amount of waste sorting is required while only producing around 10-12% conversions efficiencies which is lower than both incineration and gasification. A significant upside to this process is that it is cheap to build and simple to operate, making it more accessible to different parts of the nation.

Overall, as the MSW contents and regional capacities vary across the nation, each of the three aforementioned methods can provide the Philippines with more effective waste management solutions, while supporting the shift away from fossil-fuel energy. Through strong collaboration between public and private sectors, WTE can flourish in the country and make the Philippines a leader in sustainable change.

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