Proposal for Sustainable Municipal Solid Waste to Energy (Fuel, Gas & Fertilizer) Project

Waste Technologies

Cleaning Earth, Saving Environment

A complete one stop solution of waste

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1. Introduction

Municipal Solid Waste (MSW) is the abridgement of the waste generated from domestic, commercial and construction activities that is collected and treated by municipalities. In general, this term is known as garbage consisting of kitchen waste, products packaging, furniture parts, waste plastics, paper, clothes, glass, food scraps, appliances etc.

The agitated race of human society towards modern urban life around the world generates tremendous amount of municipal solid waste (MSW), because the generation rate is mounting even faster than the rate of urbanization. Around the worlds' cities 2.01 billion tons of waste is generated, amounting to the footprint of 0.74 kg/person each day which predicts the increase by 70% as 3.4 billion tons in 2050.

Tremendous amount of MSW generation with the vast increase of population is a threat for the developing countries like Bangladesh. Improper management of MSW constitutes a growing concern for cities in developing nations. The urban area of our country generates approximately 20 thousand tons of MSW per day which adds up to over 5.8 million tons annually[1]. It is projected that the amount will grow up to 47 thousand tons per day and over 17 million tons per year by 2025; due to the rapid increase rate of population leading to faster MSW generation. Based on present urban population in Bangladesh, per capita waste generation is found at 0.41 kg/person/day.

However, the rapid growth of population is a threat, the persuasion of village people moving toward cities for work and better life style. This results in the major increase of MSW generation rate in the major city corporations. Furthermore, the lack of public awareness is also liable for the mismanagement of MSW in our country. This unmanageable situation will lead to worse circumstances for living beings, climate change and our mother nature.

For instance, increasing Methane generation impacts the air quality for being worse than CO_2 generation. Existing management systems like incineration, open dumping and aerobic digestion also pollute our surrounding environment which results in health hazard. Besides, occupied land and nearby water bodies are also highly contaminated that risk soil quality and the life of marine animals respectively. In short, faster generation of MSW and the mismanagement is now a red alarm for the lives and nature of our homeland. To save our life, it's our duty to implement effective management technology that will not only be environment friendly but also feasible and economically viable.

2. Aim

The aim of the paper is to lay down the details of a Project Proposal having emphasis on highlighting the technical and financial advantages that WTL possess.

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[1] Hindawi, Volume 2016, Article ID 1712370

3. Policy Guidelines

3.1 Introduction of The 3Rs (Reduce, Reuse and Recycle)

We cannot stop waste production entirely, but everyone can make a significant contribution. It saves energy and natural resources, helps to reduce pollution and reduces the need for landfill. Have you ever heard the term the "3Rs"? If you have, you might have wondered what it meant. 3Rs refers to three terms often used when talking about waste: Reduce, Reuse, and Recycle.

- **Reducing** is cutting back on the amount of trash we make
- **Reusing** is finding a new way to use trash so that we don't have to throw it out, and
- **Recycling** is using trash to remake new goods that can be sold again.

3.2 Importance of the 3Rs of Waste Management

The importance of 3Rs of waste management elements is to help:

- Cut down on the waste disposals.
- Conserve natural resources, landfill spaces, and energy.
- Save land and money that communities use to manage wastes.
- Reduce air pollution and contribute to a healthier planet.

3.3 Objectives of the National 3Rs Strategy [2]

The main objective of this 3Rs strategy is to delineate ways and means of achieving national 3Rs goals through providing a uniform guideline for all stakeholders. Specific objectives of this strategy are to:

- Address the key issues and challenges of waste management acting as a barrier for promotion of 3Rs in the country;
- Define the roles of various actors to promote 3Rs in the country; and
- Guide the creation of enabling conditions for success regarding implementation of 3Rs in the country.

3.4 Priority Sectors for 3Rs [3]

Following sectors are identified by the government as priority sectors:

- Municipal Solid Waste,
- Industrial Waste,
- Biomedical Waste,
- Institutional and Commercial Waste and
- Agricultural Waste.

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[2] http://www.doe.gov.bd/site/publications/322bf6c9-e23e-401f-864a-73efb078cd29/National-3R-Strategy-for-Waste-Management

[3] http://www.doe.gov.bd/site/publications/322bf6c9-e23e-401f-864a-73efb078cd29/National-3R-Strategy-for-Waste-Management

3.5 Resource Management within a Circular Economy

3.5.1 What is the Circular Economy?

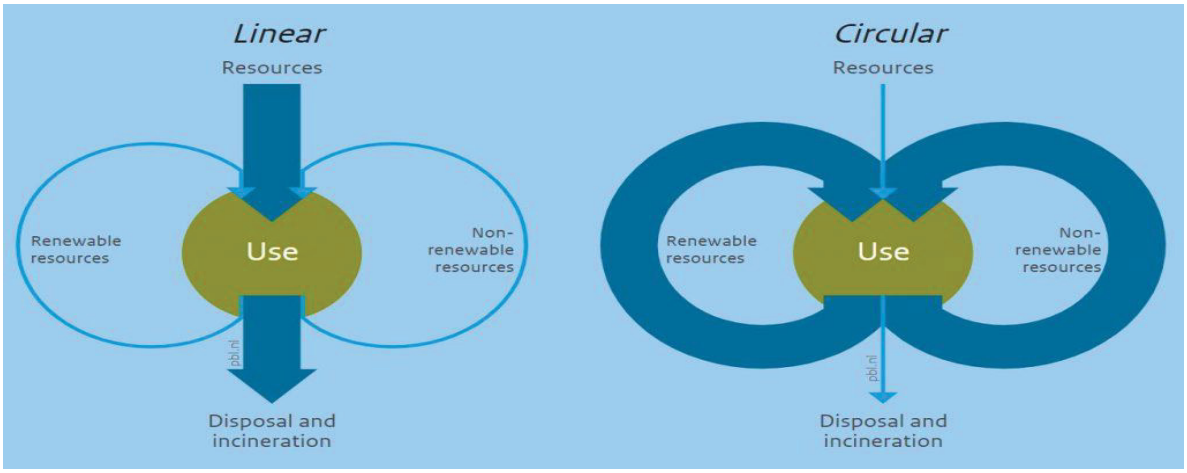


Figure 01: Linear & Circular Economy

The Circular Economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended. The following Circular Economy System diagram model relies on large quantities of cheap, easily accessible materials and energy.

3.5.2 The difference between a Linear and a Circular Economy

Parameter	Linear Economy	Circular Economy
Step plan	Take-make-dispose	Reduce-Reuse-Recycle
Focus	Eco-Efficiency	Eco-Affectivity
System Boundaries	Short term, Single Time Life Cycle	Long Term, Multiple Life Cycles
Reuse	Down Cycling	Up cycling, Cascading and High Grade Recycling.

3.5.3 Opportunities of Circular Economy

Potential opportunities moving towards a more circular economy has both an environmental and economic rationale. Potential opportunities include:

3.5.3.1 Reduced pressures on the environment: A Circular Economy would significantly reduce greenhouse gas (GHG) emissions through better waste management and reduced use of resources (such as energy, water, land and materials) materials could help reduce landscape and habitat disruption as well as marine littering, which would in turn help to limit biodiversity loss.

3.5.3.2 Enhanced security of supply of raw materials: A Circular Economy would mitigate risks associated with the supply of raw materials, such as price volatility, availability and import dependency.

3.5.3.3 Increased competitiveness: A Circular Economy could bring savings to businesses and consumers through improved resource efficiency.

3.5.3.4 Innovation: A Circular Economy could trigger a large innovation drive across sectors of the economy because of the need to redesign materials and products for circular use.

3.5.3.5 Growth and jobs: A Circular Economy could strengthen growth and create new jobs. It is estimated that the transition would increase GDP by 1 to 7 percentage points by 2030.

3.6 Integrated Sustainable Waste Management

Integrated Solid Waste Management (ISWM) refers to the strategic approach to sustainable management of solid wastes covering all sources and all aspects, covering generation, segregation, transfer, sorting, treatment, recovery and disposal in an integrated manner, with an emphasis on maximizing resource use efficiency. The concept as described by Van De Kluendert, not only takes technical or financial economic, sustainability into account as in conventionally done, but it also includes socio cultural environmental institutional and political aspects that influence overall sustainability of waste management. Info graph below shows the basic schematic framework of Integrated Sustainable Waste Management.

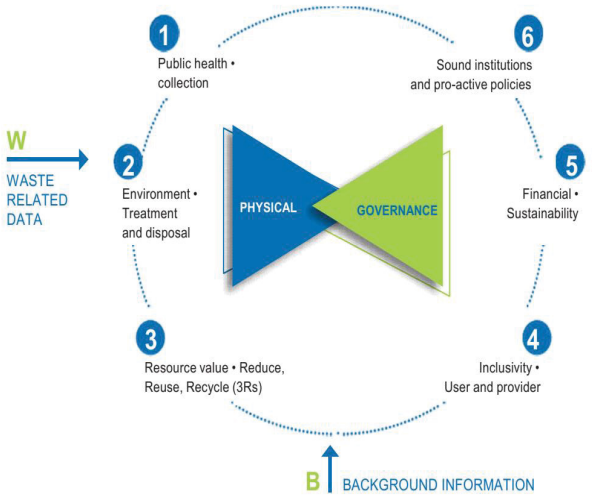


Figure 02: Integrated Solid Waste Management

3.6.1 Purpose of integrated Solid Waste Management

Integrated Solid Waste Management (ISWM) is a comprehensive waste prevention, recycling, composting, and disposal program. An effective ISWM system considers how to prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment.

4. Problems with Unmanaged MSW and its Impact

4.1 Existing Municipal Solid Waste Generation and Composition in Dhaka City

According to the statements provided by the Waste Management Departments of DNCC and DSCC [4], about 3500 tons of municipal solid waste are produced every day in Dhaka City, among these 1800 tones are collected and dumped by the city corporation, 900 tons are landfilled in backyards, 400 tons are left at roadside and open spaces, 300 tons are collected by the tokais and recycled.

In 2017-18, 21.93 percent rise in waste was estimated in the DNCC area where total waste generated in 2016-17 was 8,52,390 tons. The 52.88 acres' landfill at AMINBAZAR is used by the DNCC that absorbs 6,000 tons of MSW per day and already the piles have been nine meters high. Additionally, the DSCC uses the 100 acres MATUAIL landfill which already has piles of garbage about 20 meters high. In 2018, DSCC alone dumped about 10 lac tons of waste, filling up seven acres of its landfill. Besides, in 2016, the government extended the city corporations areas but including 16 unions in the DNCC and DSCC, leading to a rise in the volume of waste to be dealt with.

4.2 Baseline Composition of Collected Solid Waste

Over time, municipal solid waste is not only increasing but the composition is also changing. The organic wastes are decreasing and the paper and plastics are increasing in the waste stream, indicating the growing preference for consumption of packaged food in recent years.

The average waste composition for the entire waste estimated from field survey (2013) and fractions, the biodegradable fraction (organic matter) is normally very high which is about 55%. The share of other fraction combined from all locations was about 14.7% plastic, 12.6% paper, 4.73% textile and wood, 1.54% leather and rubber, 1.56% metal, 1% glass and ceramics, and 8.81% other waste.

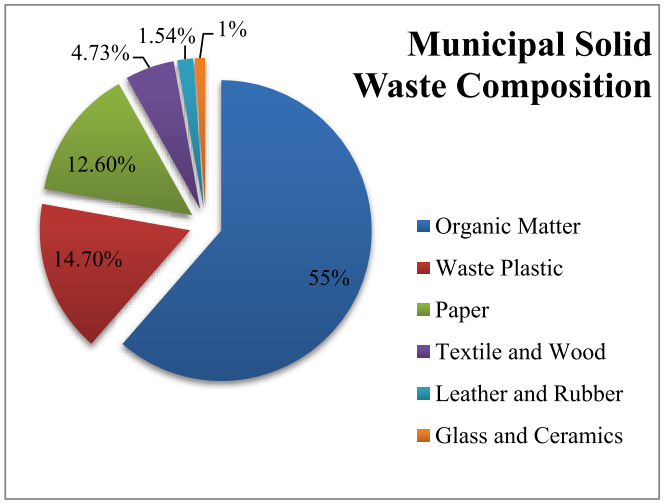


Figure 01: Municipal Solid Waste Consumption

[4] The Daily Star (April 21, 2019)

Several studies have been conducted by different authors to determine the composition of MSW generated in Dhaka city. Different studies were conducted earlier on municipal waste composition, as reported, organic matters varied over a wide margin ranging from about 62% to 88% during 1993-2005 in Dhaka city whereas paper and plastic varied from about 1% to 11% and 1% to 7% respectively[5].

4.3 Impacts of Improper Management

From the above statistics, we can suspect the over country. Besides, the management steps

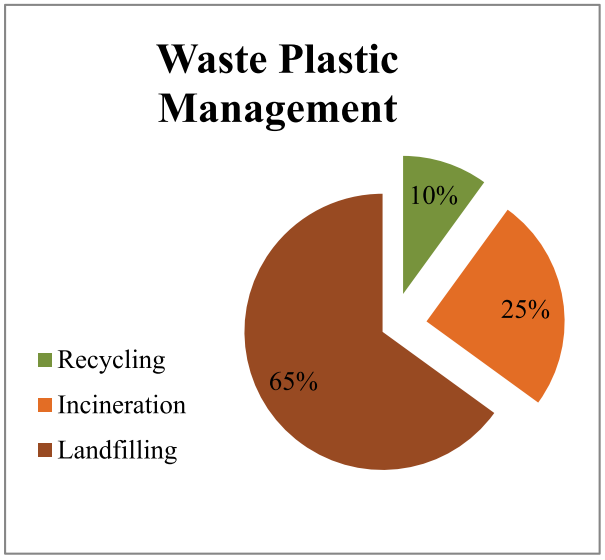


Figure 02: Waste Plastic Management[6]

The municipal solid waste management practices in Bangladesh can be listed as-

The municipal solid waste management practices in Bangladesh can be listed as-

4.3.1 Landfill

4.3.2 Incineration

4.3.3 3Rs Policy

4.3.4 Composting of Organic Matters

On the left, waste plastic management processes are shown that indicates vividly the mismanagement and its red alarm for our nature.

This faster rate of Municipal Solid Waste (MSW) generation and lack of effective management troubling our national economy growth, endangers also human life, and other living beings polluting the environment as below-

4.3.5 Landfills: Initially the generated MSW are collected and disposed to the certain dumping sites. Safety precautions aren't taken seriously while transportation and waste handling. This affects the worker's physical health and also pollutes nearby locality.

4.3.6 Sewerage System Blockages: Non-biodegradable waste plastics, miscellaneous and leachate from MSW runs down to the sewerage system and creates blockage. This results in water

[5] Journal of Bangladesh Institute of Planners, ISSN 2075-9363, Vol. 8, 2015, pp. 35-48

[6] Plastic Feed Stock Recycling Book

clogging during monsoon and floods the area. Each year, a massive amount of money is to input for the cleaning of sewerages, and pre and post flood management.

4.3.7 Hazardous Gas Emission: Long term residence of these wastes form highly combustible methane (CH_4). Increased generation of methane alarms the world to take proper initiative for the sustainable management of MSW, because it is 34 times stronger than carbon dioxide (CO_2).

4.3.8 Water Contamination: The leachate generating from the municipal solid waste seeps to the nearby groundwater and highly contaminates reducing REDOX potential and increasing the mobility of toxic metals.

4.3.9 Endangered Marine Life: Waste plastic, paper and other waste when wash to the water bodies also create huge impact on marine animals. Besides, MSW of coastal areas are more unmanaged than those of city corporations. Waste plastics due to being non-biodegradable, pollutes the water and hampers highly the marine lives.

4.3.10 Incineration: Wood, paper, clothes, single use plastic and other miscellaneous wastes are generally burnt that create air pollution. Moreover, Incineration technology is followed for the reduction of MSW and produce heat and energy at present in our country. But this highly pollutes the environment and risks the life of human and other livings.

4.3.11 Health Risk: The residences close to the dumping sites and incinerators get higher risk of air-borne diseases due to the VOCs (Volatile Organic Carbon), particulates and smog.

4.3.12 Recycling: Around 10% of generated waste plastics are recycled under 3R policy. Moreover, miscellaneous waste is also segregated and recycled for further use but these are of trace amount. Larger portions are kept leftover or incinerated after segregation. This becomes warning for the sustainability of environment.

4.3.13 Economic Problems: For the lack of proper waste handling, incineration and landfilling, national economy faces trouble for a notable amount of money engaged here but the solution is not that much worthy of feasibility.

To utilize the dumpsite garbage and convert the waste to energy; incineration and landfill gas recovery projects were planned to execute. In 2015 a field survey report and static data were prepared depending on the cases for DCC & Ctg CC [7].

[7] Hindawi, Volume 2016, Article ID 1712370

Since these management processes aren't that much effective, rather enhance environment pollution, sustainable and cost-effective management technology has to be adopted as a savior.

5. Advantages of Adopting Effective Waste Management System

5.1 Procedure: Efficient and environment friendly management procedure can be pioneer of sustainable and cleaner world.

5.2 Source Reduction: More than 90% solid waste can be reduced through recycling and conversion technologies. These also can add value to the national economy.

5.3 Raw Materials Cost: Since MSW are collected from municipality and open dumpsite for further processing, raw materials are almost free of cost.

5.4 Landfill Elimination: Existing open dumping spaces can be gradually eliminated and later can be utilized effectively for different purposes.

5.5 Healthy Environment: Noteworthy reduction of air-borne disease due to open dump can be achieved by adopting eco-friendly technology. Besides, CH_4 emission shrinks with the help of closed or semi-closed loop technology.

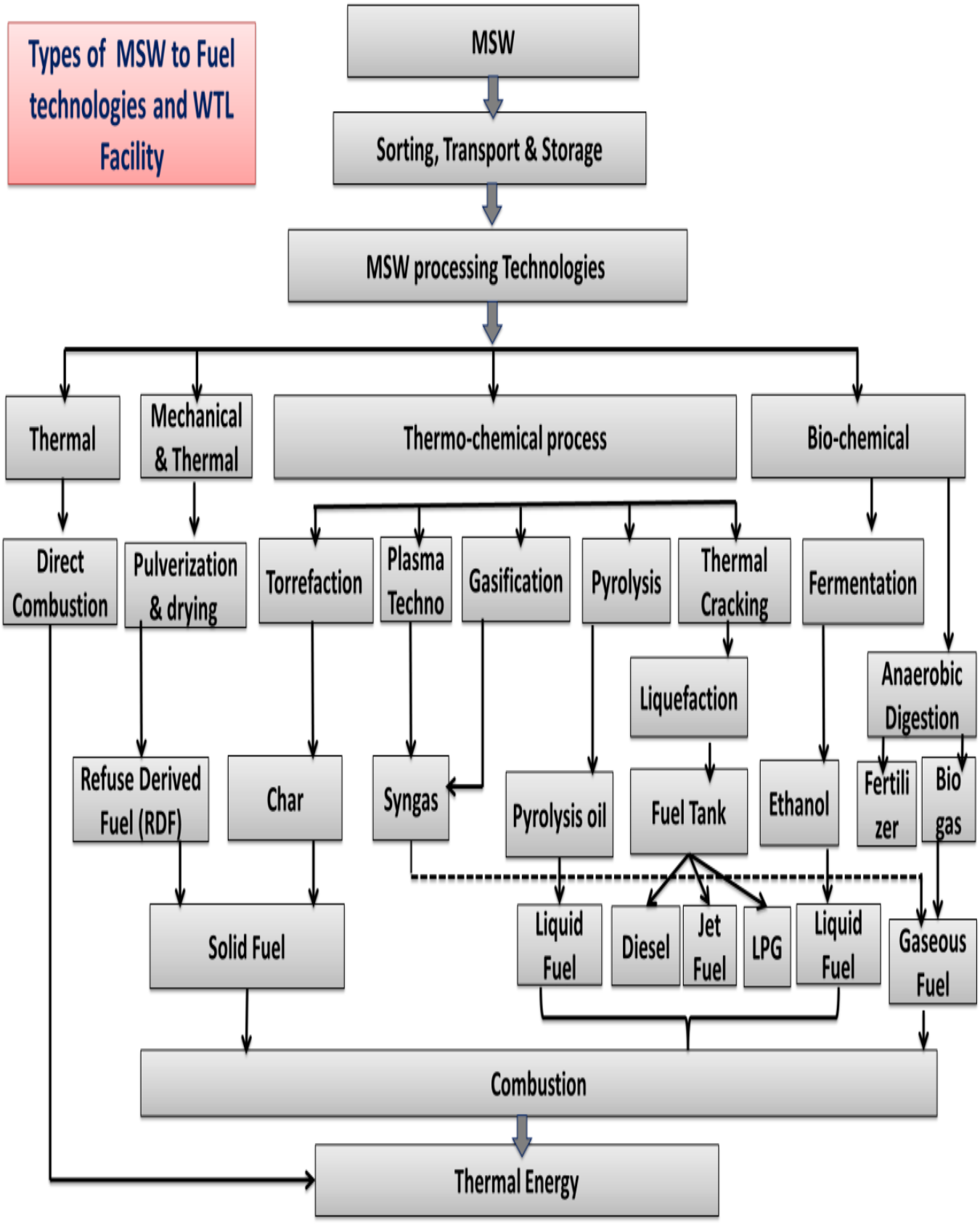
5.6 Waste- Plastic Free Earth: Plastic recycling or conversion to valuable product can save the Earth from the threat of waste plastic as well as put contribution to national economy.

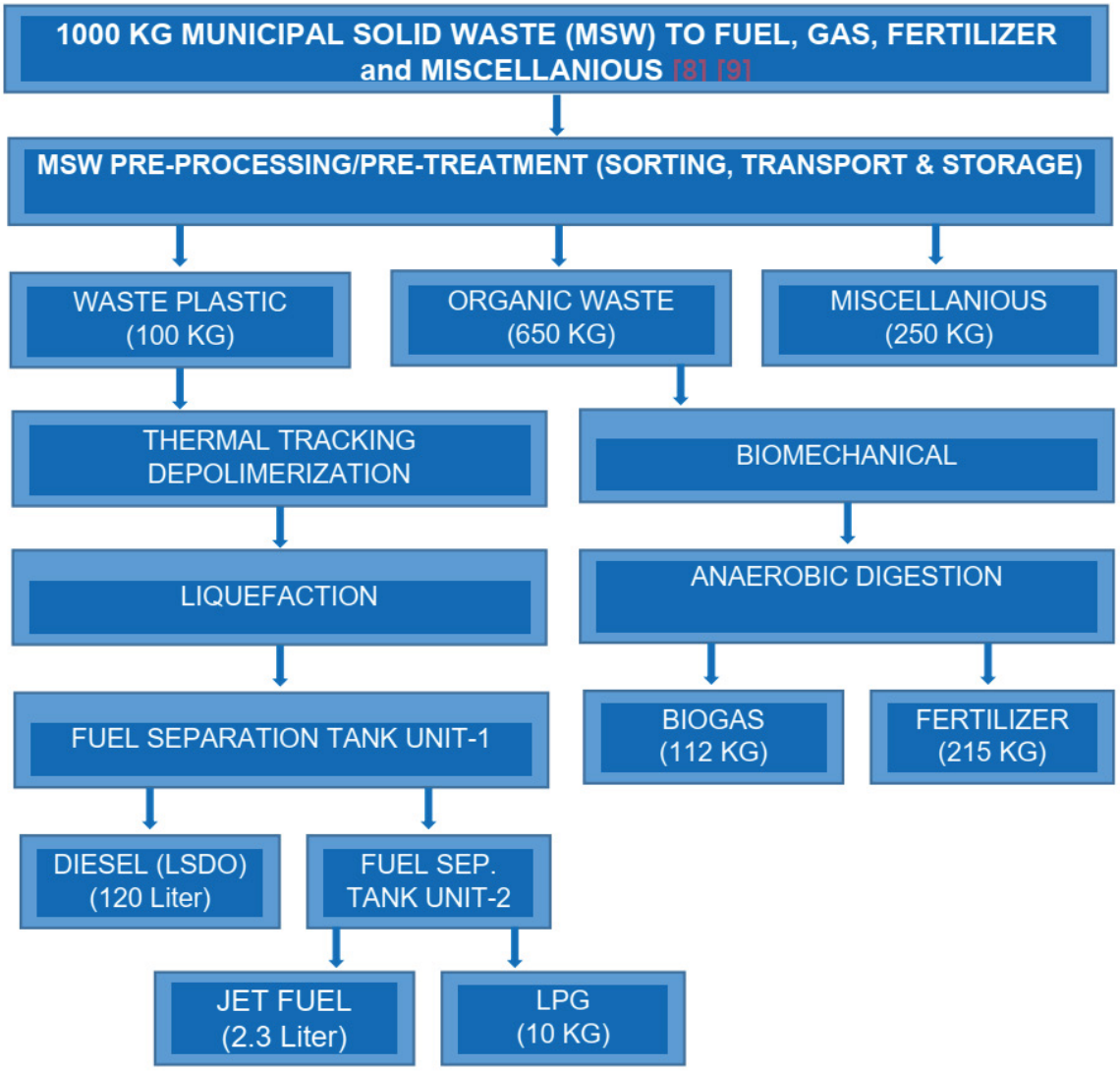
5.7 Marine Life Savior: Sustainable management system prevents water contamination leading to safe and sound marine lives.

5.8 Reducing Unemployment: 3R policy and conversion technology implementation provide great opportunity of job creation that can positively assist in unemployment problem and add value to national economy.

6. Global Municipal Solid Waste (MSW) Management Technologies

Municipal Solid Waste (MSW) or Waste to Energy (WtE) to refers to a variety of treatment technologies that convert MSW to Fuel, Gas & Fertilizer to Electricity, heat, fuel, compost fertilizer or other usable materials, as well as a range of residues including fly ash, sludge, slag, boiler ash, waste water and emissions, including greenhouse gases. Based on its following energy conversion processes flow, MSW to FGF to energy is classified into four (4) categories: Thermal, Mechanical & Thermal, Thermo-Chemical and Bio-chemical.


Types of MSW to Fuel technologies and WTL Facility
MSW
Sorting, Transport & Storage
MSW processing Technologies
Thermal
Mechanical & Thermal
Thermo-chemical process
Bio-chemical
Direct Combustion
Pulverization & drying
Torrefaction
Plasma Techno
Gasification
Pyrolysis
Thermal Cracking
Fermentation
Anaerobic Digestion
Liquefaction
Refuse Derived Fuel (RDF)
Char
Syngas
Pyrolysis oil
Fuel Tank
Ethanol
Fertili zer
Bio gas
Solid Fuel
Liquid Fuel
Diesel
Jet Fuel
LPG
Liquid Fuel
Gaseous Fuel
Combustion
Thermal Energy



Source: [8] [9]

7. About Waste Technologies LLC (WTL)

7.1 Background

Waste Technologies LLC (WTL) is a USA based solid waste management research & development and equipment manufacturing company. The founder, Chairman & CEO of WTL is Dr. Moinuddin Sarker, PhD, MCIC, FICER along with his working partner, Dr. Anjuman Shelly,

[8] https://drive.google.com/file/d/1sKznm9pbh9qJOd7K40FqeEM7d9TadYIw/view?usp=sharing
[9] https://drive.google.com/file/d/1-O1xYsVapTFsveFBfAAEcc8N3UHHVM4p/view?usp=sharing

PhD is the leaders and the entrepreneurs who have conceived the concept of clean environment and are the driving force of WTL. Under their leadership WTL continues Research and Development to achieve automatic and system integration system. After a prolonged research of 15 years on waste management, the unique machineries are on the way of installment and operation in USA, Europe and Asia. Dr. Moinuddin Sarker has achieved a "patented" breakthrough in the waste plastic disposal arena. Dr. Sarker is the inventor of the technology and product entitles: "Method for converting waste plastics to lower – molecular weight hydrocarbons, particularly hydrocarbon fuel materials and the hydrocarbon material produced thereby." (Patent # US 8,927,797 B2) and other patents are pending in USA and PCT having title: "METHODS AND SYSTEMS FOR CONVERTING PLASTIC TO FUEL". He has six (6) more patents some are already granted and few are in pending stage. Necessary papers are attached herewith as Annexure.

Dr. Moinuddin Sarker being a Scientist and Researcher always focused to achieve Integrated Sustainable Waste Management System. He also had his attention on National 3Rs Strategy and endeavored to manage resources within a Circular Economy. As a result, High-income countries are increasingly moving away from land filling and incineration and going towards Thermal Cracking De-polymerization, the technology invented by Dr. Sarker. You might have noted the news heading published few days back – ***'Planning application for UK's first waste to jet fuel plant given green signal.'*** In brief, WTL's business revolves around following-

7.1.1 Sources / Raw Material

Municipal Solid Waste (MSW), Industry Waste, Liquid Waste, Hazardous Waste, Sea Waste, Market Waste etc.

7.1.2 Core Business

MSW to FGF (Fuels, Gas and Fertilizer).

7.1.3 Deals with turnkey projects

BOO / BOT / BOOT (Build-Owned-Operate-Transfer) on turnkey basis focus on detailed basic engineering design, building projects and operational tasks, sustainability etc.

7.1.4 Finished Products

Diesel, Aviation fuel, LPG, Biogas, Fertilizer, Waste ferrous, non-ferrous, stone, Hardboard etc.

7.1.5 Present Business Facilities and Ventures

7.1.5.1 International Headquarters: 1376 Chopsey Hill Road, Bridgeport, CT-06606, USA.
TEL: +1-203-231-5300 (Direct); TEL: +1-203-956-7501 (Work)
e-mail: info@wastetechnologiesllc.com and msarker@wastetechnologiesllc.com

7.1.5.2 Afro-Asian Headquarters: House No- 951 (4th Floor), Road No- 14, Avenue 2, Mirpur DOHS, Dhaka-1207, Bangladesh

7.1.5.3 Factory Facility at USA: _____

7.1.5.4 Completed Projects: _____

7.1.5.5 Ventures under Progress: _____

7.1.5.6 Business Partners of WTL: _____

7.1.5.7 Chairman's Vision

Dr. Moinuddin Sarker, PhD, MCIC, FICER and Dr. Anjuman Shelly, PhD (husband & wife) are the expatriate Bangladeshis residing in USA but having full devotion and love for his/her motherland. They dream to establish the complete industry in Bangladesh. The activity of WTL is the step forward in fulfilling the dream in future.

8. WTL and its Capabilities

8.1 Patentee of plastic to fuel: Dr. Moinuddin Sarker, Chairman and CEO & Dr. Anjuman Shelly, Cofounder are patentee for discovering Plastic to Fuel.

8.2 Maximum Efficiency: WTL is maximum efficiency based waste plastic to liquid fuel generation equipment manufacturer.

8.3 Turnkey Project: WTL has a unique capability for the design, engineering, manufacturing, construction, testing, commissioning and servicing to implementing the waste to fuel, gas, fertilizer and miscellaneous project.

8.4 Helping to attain the SDG goal: WTL is differentiation, innovation, consistency, social, economic and environment friendly technology. That's why it will indirectly helping to attain the SDG goal.

8.5 Assistance in foreign investment: WTL has a good relation with the renowned investment company in the world that's why WTL is able to arranging a project loan.

9. WTL's Pre-Treatment and Treatment Process Flow Chart and Schematic Diagram

9.1 WTL's Process Flow 3D Lay-out for Sorting out Waste Plastic, Organic Waste and Miscellaneous like as Ferrous, Non Ferrous, Stone, Paper, Leather Card Board, Glass etc from MSW.

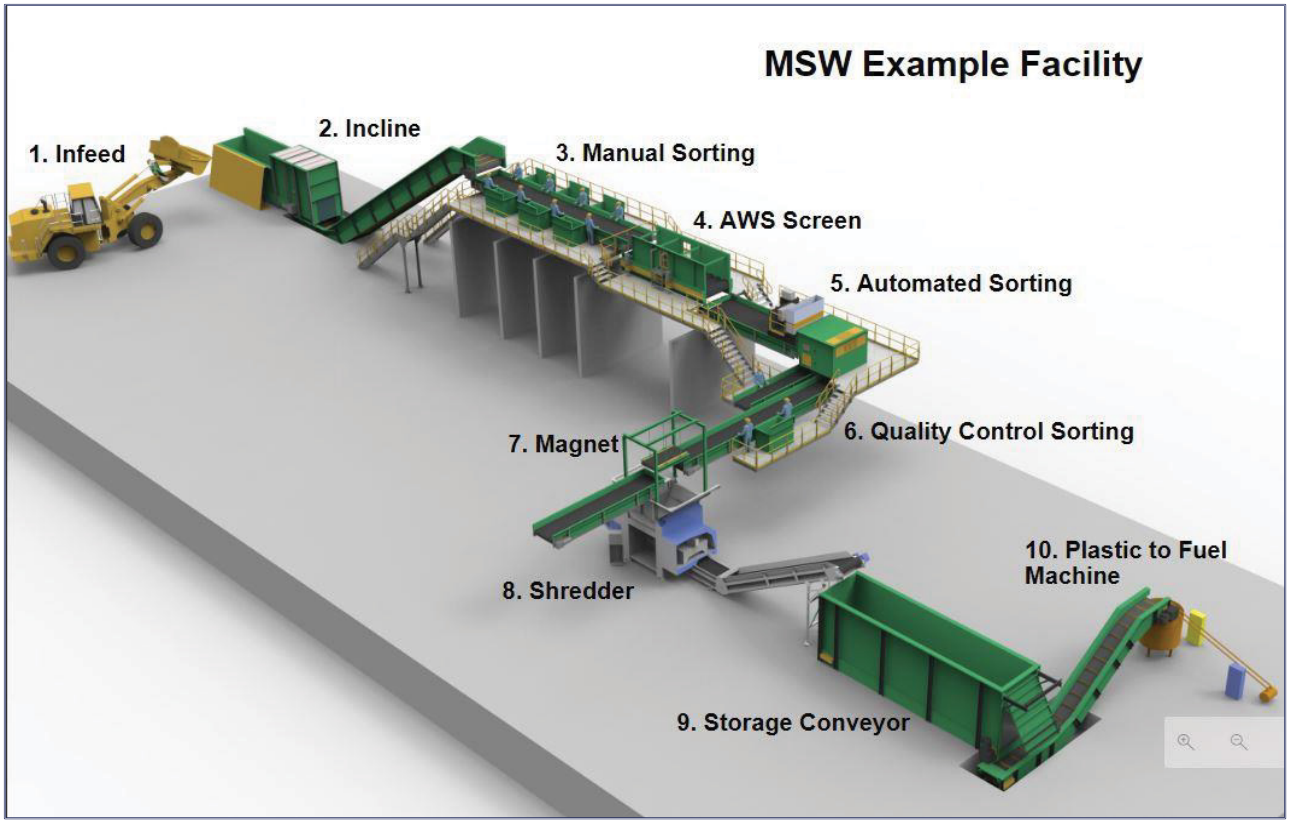


Figure:1 MSW Sorting-out process flow diagram

9.2 WTL's Flow Chart and for converting Waste Plastic to Diesel, LPG and Jet Fuel.

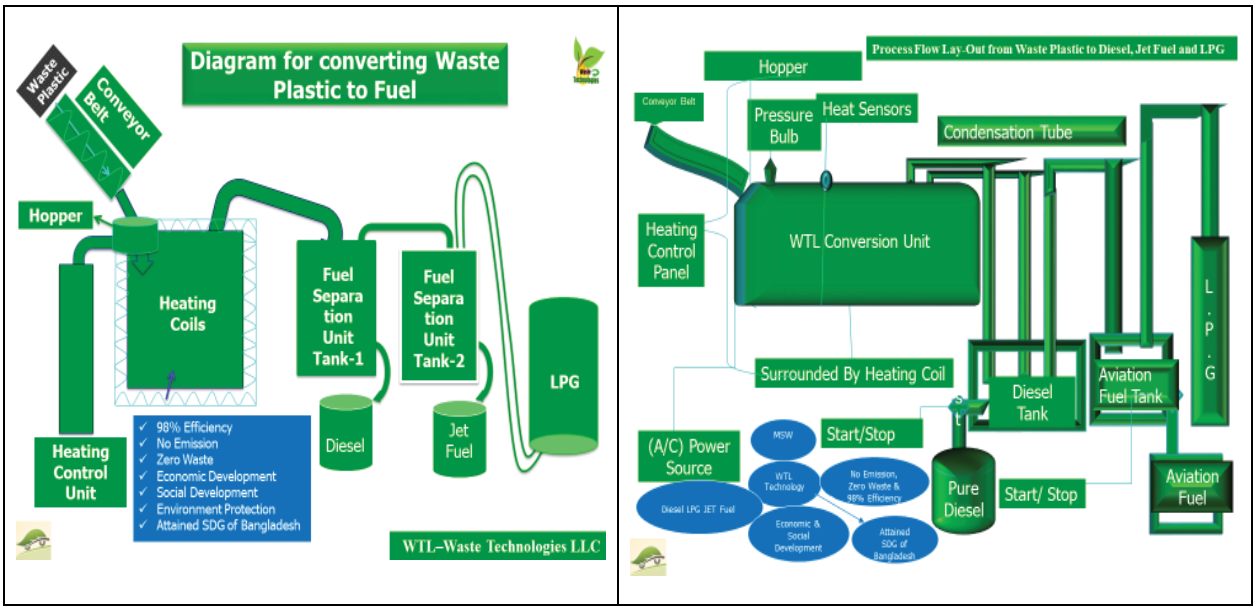


Figure: 2 Process flow diagram for converting waste plastic to fuel

9.3 WTL's Diagram for Converting Organic Waste to Biogas & Compost Fertilizer

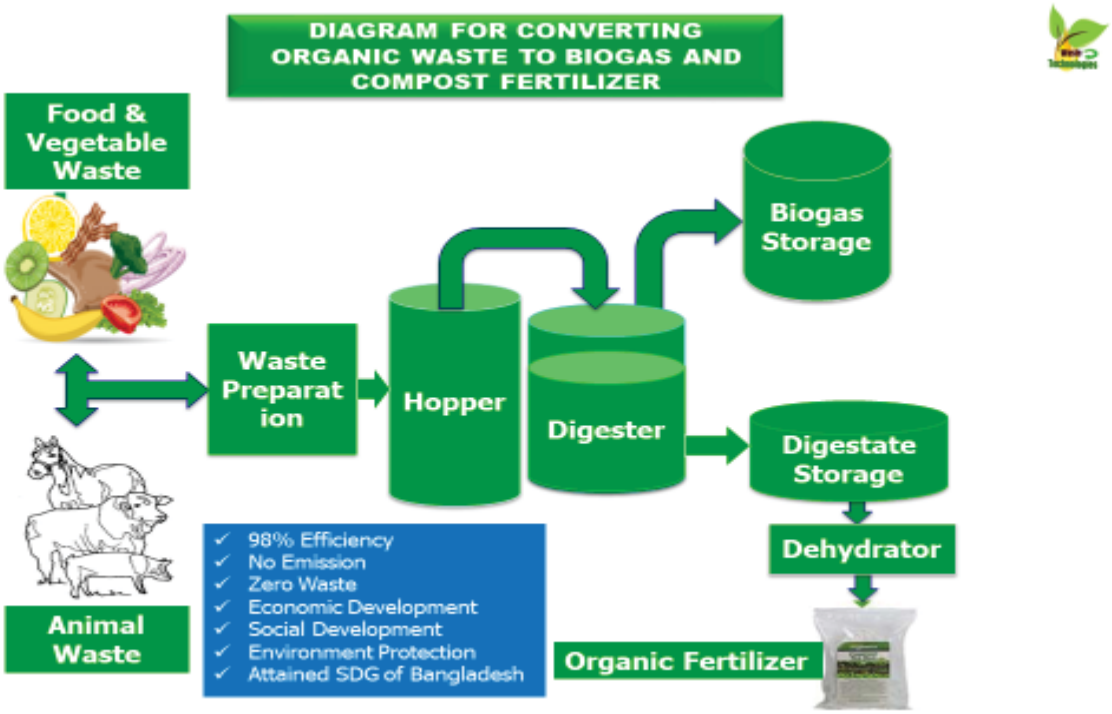


Figure: 3 Process flow diagram for converting organic waste to compost fertilizer

10. Advantages of WTL Technology and Product

10.1 **Efficiency:** Average Efficiency of WTL technology is 70-75%. To differentiate, Waste Plastic to Fuel efficiency is 132.3%, Organic Waste to Biogas & Fertilizer efficiency is 50.3% and Miscellaneous Efficiency (Leather, Rubber, Paper, Ferrous & Non Ferrous, Glass etc.) is 98-100%.

10.2 **Cost Effective:** This breakthrough technology requires production cost of USD 140-150/MT MSW to FGF conversion process.

10.3 **Sustainability:** The production of fuel, gas & fertilizer stands in no need of any pollutant emission which is why this can be titled as “Environment Friendly Technology”. It’s proven that 98-100% environment protection system is ensured.

10.4 **Commercially Viable:** WTL Technology offers low investment with high return facility. The financial breakdown of the production of MSW to FGF provides net profit margin of 31%, payback period of 6 years and IRR of 22.29%.

10.5 **Zero Waste Discharge:** WTL plants reduce Greenhouse Gas Emission (GHG) by diverting waste from landfills and incinerators and by replacing municipal solid waste to Fuel, Gas & Fertilizer; leading to incentives for Bangladesh to achieve climate goals. ***(No negative impact on climate change which is assisted to achieve a climate goal of Bangladesh)***

10.6 **Beneficiary to Health Protection:** In Bangladesh, waste is often disposed in open dumpsites. A shift to WTL technology could improve hygienic and environmental conditions in Bangladesh. Zero waste emission to the environment of WTL technology protects the public health and environment.

10.7 **Input in Power Sector:** The energy value in fuel (i.e., diesel, jet fuel) and biogas can be utilized to generate electricity and heat. The high quality fuel from the MSW to FGF conversion can not only add reduction of fuel import, but also can be converted to Electricity and contribute to a portion of National Grid power demand. Such renewable energy and power generation can keep value in national growth of economy.

10.8 **Enhance Land Space:** WTL Technology is able to reduce about 100% waste volume reducing the demand for landfill space. Since Zero Waste drives to landfill, there's no need to landfill disposal. Moreover, dumping in existing landfills can also be cleaned and freed for future effective use by land development.

10.9 **Job Creation:** This noble invention offers not only environment protection but also will create jobs engaging huge manpower for the MSW to FGF production plants.

10.10 **Easy Segregation Work Facility:** The latest groundbreaking technology provides easy to work with existing recycling and city waste facilities. Besides while segregation, there's no need to sort out waste plastics (except PETE and PVC) from garbage.

10.11 **SDG-2030:** The implementation of MSW to FGF technology will assist in attaining a SDG-2030 goal of Bangladesh.

10.12 **Project Duration:** The turnkey projects under WTL technologies need 12-18 month to Design, Build, Operate and Transfer of the plants to the clients.

We are dedicated to finding effective, integrated sustainable solutions to* preserve *the environment for future generations.

11. Prospective Clients of WTL

WTL is primarily focused to manage municipal solid waste and presenting a green environment to the humanity. In the process of managing it turns MSW into a useful product. As such it has two different clients prospective as under:

11.1 MSW Perspective. These are the organizations responsible dealing with MSW in Bangladesh:

(1) Local Government Division (LGD).

(2) City Corporations.

(3) Pouroshavas.

11.2 Product Perspective.WTL converts MSW to Fuel, Gas & Fertilizer. All these products need to be sold to the clients. As such from products perspective the clients are:

(1) Bangladesh Petroleum Corporation (BPC).

(2) Bangladesh Agriculture Development Corporation (BADC) under Agriculture Ministry.

(3) ACI Limited.

(4) Bangladesh Power Development Board (BPDB), -If fuel and Gas is utilized to produce power.

12. Municipal Solid Waste or Waste to Energy (WtE) Technologies

There are about four types of Municipal Solid Waste or Waste to Energy (WtE) technologies in the world. They are Incineration Technology, Gasification Technology, Pyrolysis Technology and Anaerobic Digestion Technology. This is discussed in detail below.

12.1 Municipal Solid Waste Incineration

Incineration is a method of waste treatment involving the burning organic materials found in waste. Incineration and other high-temperature waste management processes [10] are called "thermal treatment". Particularly, it involves converting waste materials into ash, flue gas, and heat. Municipal solid waste incineration (MSWI) is the burning of waste in a controlled process within a specific facility that has been built for this purpose. The primary goal of MSWI is to reduce MSW volume and mass and also make it chemically inert in a combustion process without the need of additional fuel (autothermic combustion). As a side effect it also enables recovery of

[10] https://www.conserve-energy-future.com/sources-effects-methods-of-solid-waste-management.php

energy, minerals and metals from the waste stream [11]. There are always about 25% residues from incineration in the form of slag (bottom ash) and fly ash. Bottom ash is made up of fine particulates that fall to the bottom of the incinerator during combustion, whilst fly ash refers to fine particulates in exhaust gases which must be removed in flue gas treatment. These residues need further attention and, in the case of the hazardous fly ash, a secure place for final disposal. Let's have a look at the advantages and disadvantages of incineration.

Advantages of MSW Incineration	Disadvantages of MSW Incineration
1. Decreases quantity of waste 2. Production of heat and power 3. Reduction of Pollution 4. Incinerators have filters for trapping pollutants 5. Saves on Transportation of Waste 6. Provides better control over odor and noise 7. Prevent the production of methane gas 8. Eliminates harmful germs and chemicals 9. Incinerators operate in any weather 10. Effective Metal Recycling 11. It has a computerized monitoring system 12. Uses of ash	1. It is expensive 2. Pollutes the environment 3. The possibility of long-term problems 4. Ash waste can potentially harm people and the environment

12.2 Municipal Solid Waste Gasification Technology

Gasification of municipal solid waste (MSW) is an attractive alternative fuel production process for the treatment of municipal solid waste as it has several potential benefits over traditional

[11] EU, "Integrated Pollution Prevention and Control, Reference Document on the Best Available Techniques for Waste Incineration," European Commission, Brussel, 2006.

combustion of MSW. The so-called “syngas” obtained by gasification has several applications. It can be utilized as a gas fuel being combusted in a conventional burner or in a gas engine and then connected to a boiler and a steam turbine or gas turbine to utilize the heat or produce electricity. Also, it can be used as a building block for producing valuable products such as chemicals and other forms of fuel energy. Let’s have a look at the advantages and disadvantages of Gasification.

Advantages of MSW Gasification	Disadvantages of MSW Gasification
1. It takes place in a low oxygen environment that limits the formation of dioxins and of large quantities of SOx and NOx. 2. It requires just a fraction of the stoichiometric amount of oxygen necessary for combustion. As a result, the volume of process gas is low, requiring smaller and less expensive gas cleaning equipment 3. Reduction of Pollution 4. Incinerators have filters for trapping pollutants 5. Saves on Transportation of Waste 6. Provides better control over odor and noise 7. Eliminates harmful germs and chemicals 8. It has a computerized monitoring system 9. Gasification generates a fuel gas that can be integrated with combined cycle turbines, reciprocating engines and, potentially, with fuel cells that convert fuel energy to electricity more efficiently than conventional steam boilers.	1. Large initial investment costs relative to that of alternatives, including landfill and incineration. 2. Operational costs are high relative to that of incineration. 3. Little or even negative net energy production. 4. Wet feed stock results in less syngas production and higher energy consumption. 5. Frequent maintenance and limited plant availability.

12.3 Municipal Solid Waste Pyrolysis Technology

Pyrolysis is a process of chemically decomposing organic materials at elevated temperatures in the absence of oxygen. The process typically occurs at temperatures above 430 °C (800 °F) and under pressure. It simultaneously involves the change of physical phase and chemical composition and is an irreversible process. The word pyrolysis is coined from the Greek words "pyro" which means fire and "lysis" which means separating. Let's have a look at the advantages and disadvantages of Pyrolysis.

Advantages of MSW Pyrolysis	Disadvantages of MSW Pyrolysis
1. It is a simple, inexpensive technology for processing a wide variety of feedstock. 2. It reduces waste going to landfill and greenhouse gas emissions. 3. It reduces the risk of water pollution. 4. It has the potential to reduce the country's dependence on imported energy resources by generating energy from domestic resources. 5. Waste management with the help of modern pyrolysis technology is inexpensive than disposal to landfills. 6. The construction of a pyrolysis power plant is a relatively rapid process. 7. It creates several new jobs for low-income people based on the quantities of waste generated in the region, which in turn provides public health benefits through waste clean-up.	1) The product stream is more complex than for many of the alternative treatments; 2) The product gases cannot be vented directly in the cabin without further treatment because of the high CO concentrations.

12.4 Municipal Solid Waste Anaerobic Digestion Technology

Anaerobic digestion (AD) is the decomposition of organic matter through microorganisms in the absence of free oxygen. AD occurs naturally under oxygen deprived conditions such as some lake sediments and can be used under controlled conditions to produce biogas. For that purpose, a gas-tight reactor, a so-called anaerobic digester, is used to provide favorable conditions for microorganisms to turn organic matter, the input feedstock, into biogas and a solid-liquid residue called digestate. The digestate can be used as organic fertilizer when the feedstock is source separated and non-contaminated organic waste. Biogas is a mixture of different gases which can be converted into thermal and/or electrical energy. The flammable gas methane (CH4) is the main energy carrier in biogas and its content ranges between 50 – 75% depending on feedstock and operational conditions [12]. Due to its lower methane content the heating value of biogas is about two thirds that of natural gas (5.5 to 7.5 kWh/m3). Let's have a look at the advantages and disadvantages of Anaerobic digestion.

Advantages of MSW Anaerobic digestion	**Disadvantages of MSW Anaerobic digestion**
1. It is a net energy producing process which produces renewable energy in the form of biogas. 2. It produces a liquid and a fibrous fertilizer. 3. It sanitizes the feedstock/ waste which is put through it, as long as the temperature is held above a required temperature for a pre-defined time period.	1. In case of digesters operated under mesophilic temperatures, destruction of pathogenic organisms may be less than that in Aerobic Composting. However, several digester systems operated at high thermophilic temperatures are also available; 2. It is more capital intensive compared to composting and landfill; and 3. Not suitable for wastes containing less biodegradable matter.

[12] A. Wellinger, J. D. Murphy and D. Baxter, The Biogas Handbook. Science, Production and Applications, Cambridge: Woodhead Publishing, 2013.

Advantages of MSW Anaerobic digestion	Disadvantages of MSW Anaerobic digestion
4. Free from bad odour, rodent and fly menace, visible pollution and social resistance 5. Enclosed system enables all the gas produced to be collected for use. Greenhouse gases Emission to the atmosphere is avoided; 6. The effect of the fertilizer is longer lasting than for untreated organic waste. 7. Can be done on a small-scale 8. No external power requirement unlike aerobic treatment	4. Does not convert as large a proportion of the carbon in the biomass to biogas as can be achieved using gasification.

12.5 Comparison among Incineration, Gasification, Pyrolysis, Anaerobic Digestion and Thermal Cracking Depolymerization

Parameter	Incineration	Gasification	Pyrolysis	Anaerobic Digestion	Thermal Cracking Depolymerization
Technology Description	Direct combustion of waste between 750 and 1100ºC in the presence of oxygen. [13]	Partial oxidation of waste between 800 and 1200ºC in the presence of a controlled amount of oxygen. [13]	Thermal degradation of waste between 300 and 1300ºC in the absence of oxygen. [13]	Biodegradation of (readily degradable) organic wastes in the absence of oxygen, with anaerobic microorganisms. [13]	It is converting Waste like Municipal Solid Waste (MSW) to Low Sulfur Fuel, Jet Fuel, LPG, Bio-Gas and Organic Compost Fertilizers between 250ºC and 350 º C temperatures.

[13] http://wedocs.unep.org/bitstream/handle/20.500.11822/28413/WTEfull.pdf?sequence=1&isAllowed=y

Parameter	Incineration	Gasification	Pyrolysis	Anaerobic Digestion	Thermal Cracking Depolymerization
Energy Recovery	585 KWh/1MT MSW [14]	660 KWh/1MT MSW [14]	660 KWh/1MT MSW [14]	250 KWh/1MT MSW [14]	3116 KWh/1MT MSW [15]
Efficiency	75-90% [13; P-16]	75-90% [13; P-16]	50-90% [13; P-16]	45-50% [13; P-16]	90-98%
Plant Capacity (MT/day)	1300 [14]	900 [14]	70-270 [14]	300 [14]	50-5000
Capital Cost per ton (M US$)	0.023-0.139 [14]	0.017-0.189 [14]	0.229-0.333 [14]	0.067-0.267 [14]	0.124-0.130
O & M Cost (US$/MT)	80-120 [14]	80-150 [14]	80-150 [14]	60-100 [14]	140-150
IRR, Pay Back Period and Net Profit Margin	Net Profit Margin 3%, Pay Back Period 30 Years and No data	Net Profit Margin 2-3%, Pay Back Period 30-35 Years and No data	Net Profit Margin 2-3%, Pay Back Period 30-35Years and No data	Net Profit Margin 5%, Pay Back Period 25 Years and No data	Net Profit Margin 18.25 %, Pay Back Period 7 Years and IRR 8.84% [16]
Planning to Commissioning (Months)	54-96 [14]	12-30 [14]	12-30 [14]	12-24 [14]	18-24
Nitrogen Oxide emission to the air (gm/ 1MT) (P-229)	1600 [13]	780 [13]	780 [13]	No data [13]	0

[14] https://cleantechsolutions.wordpress.com/2011/09/24/comparison-of-different-waste-to-energy-processes/
[15] https://drive.google.com/open?id=1H_9NKf1Mf7OrqhlHPOaPQgLhrkXb1iXT
[16] https://drive.google.com/file/d/1sKznm9pbh9qJOd7K40FqeEM7d9TadYIw/view?usp=sharing

Parameter	Incineration	Gasification	Pyrolysis	Anaerobic Digestion	Thermal Cracking Depolymerization
Carbon dioxide emission to the air (gm/ 1MT) (P-229)	10,00,000 [17]	10,00,000 [17]	10,00,000 [17]	No Data [17]	0
Sulphur dioxide emission to the air (gm/ 1MT) (P-229)	42 [17]	52 [17]	52 [17]	No Data [17]	0
Hydrogen Chloride emission to the air (gm/ 1MT) (P-229)	58 [17]	32 [17]	32 [17]	No Data [17]	0
Hydrogen fluoride emission to the air (gm/ 1MT) (P-229)	1 [17]	0.34 [17]	0.34 [17]	No Data [17]	0
Carbon monoxide (gm/ 1MT) (P-229)	No data	100	100	No data	0
Pollution Control Requirement	High [17]	Medium [17]	Medium [17]	Low-Medium [17]	Not required due to no pollution emission.
Is it helpful for implementing the Integrated Sustainable Waste Management (P-15)	Low [17]	Low [17]	Low [17]	Low [17]	High

[17] http://www.bioline.org.br/pdf?st10022

Parameter	Incineration	Gasification	Pyrolysis	Anaerobic Digestion	Thermal Cracking Depolymerization
Is it helpful for implementing the Circular Economy (P-15)	Low [17]	Low [17]	Low [17]	Low [17]	Low [17]
Is it viable for Zero Waste Principle? 1	No [18]	No [18]	No [18]	No [18]	Yes [17]

The above table discusses the different MSW to FGF and MSW to Energy technologies. Moreover, the total amount of waste generated has been steadily increasing over the years and is expected to continue to rise following the country's economic and population growths. Various alternative technologies are available to treat waste in a more sustainable manner. Five (5) technologies were discussed and compared: Incineration, Gasification, Pyrolysis, Anaerobic Digestion and Thermal Tracking Depolymerization. The aspects in focus were air pollution, cost, side products, waste treatment capacity, commercial maturity, energy efficiency and type of waste treated. Without any special weight age to any of the parameters, **WTL or Thermal Cracking Depolymerization** is the most attractive option. It is a very mature technology and is able to treat any type of waste effectively. *We are dedicated to finding effective, integrated sustainable solutions to preserve the environment for future generations.*

13. Financial Breakdown of 3500 TPD MSW Process Plant (DSCC-BD)

13.1 System Details

Plant Capacity	Amount	Unit
Feed Stock: Municipal Solid Waste (MSW)	3500	Tons /Day
Waste Plastic	10%	
Organic Solid Waste	65%	
Miscellaneous	25%	
Plant operation	350	Days/ Year
3-Shift Operation	24	Hours/Day
Waste Process	1,225,000	Tons/ Year
Low Sulfur Diesel Oil (LSDO)	1200	Liter/Ton of Waste Plastic
Aviation fuel	23	Liter/Ton of Waste Plastic

[18] https://www.youtube.com/watch?v=gg4iN5sbuc8&feature=youtu.be

LPG (12.5 kg Cylinder)	8	Cylinder/Ton of Waste Plastic
Biogas	112	Kg/Ton of Organic
Fertilizer	215	Kg/Ton of MSW
Land Required	60-65	Acres
Manpower	1,290	

13.2 Economic Projection

Parameters	**Amount**	**Unit**
Production Cost of MSW Process Plant (O&M Cost)	3,637,216,211	Tk/Year
Plant and Machineries cost (CAPEX)	29,750,000,000	Tk
Total Expenditure	**36,890,000,000**	Tk

Parameters	**Amount**	**Unit**
Total Expenses	13,660,220,829	Tk/Year
Total Income	19,750,258,500	Tk/Year
Profit Before tax	6,090,037,671	Tk/Year
Income Tax (35%)	2,131,513,185	Tk/Year
Profit After Tax (18%)	**3,463,799,928**	**Tk/Year**
Net Payback Period	**5**	**Years**

14. Major benefits of Bangladesh can get through WTL technology

14.1 Expansion of Sustainable Agriculture: Waste Technologies LLC (WTL) helps in the expansion of sustainable agriculture by producing adequate compost fertilizers. For instance, according to BN Wikipedia [19], Bangladesh will generate about 1 crore 71 lakh 78 thousand 360 tons of waste every year in 2025. If processed through WTL, 36 lakhs 93 thousand 347 metric tons of compost fertilizer can be produced. As a result, Bangladesh's import costs will decrease and GDP will increase at the same time.

14.2 To assist increase GDP by reducing import dependence: If there is an opportunity to process or recycle the waste generated daily in Bangladesh through WTL technology, then it will be possible to produce large quantities of Diesel, LPG, Jet fuel and Fertilizer in Bangladesh. This will reduce Bangladesh's annual imports of Diesel, LPG, Jet fuel and Fertilizers, as well as increase

[19] https://bn.wikipedia.org/wiki/%E0%A6%AC%E0%A6%BE%E0%A6%82%E0%A6%B2%E0%A6%BE%E0%A6%A6%E0%A7%87%E0%A6%B6%E0%A7%87%E0%A6%B0_%E0%A6%AC%E0%A6%B0%E0%A7%8D%E0%A6%9C%E0%A7%8D%E0%A6%AF_%E0%A6%AC%E0%A7%8D%E0%A6%AF%E0%A6%AC%E0%A6%B8%E0%A7%8D%E0%A6%A5%E0%A6%BE%E0%A6%AA%E0%A6%A8%E0%A6%BE#cite_note-3

GDP. According to Bangladesh Petroleum Corporation [20], it has sold 45,93,486 MT of Diesel, 20,173 MT of LPG and 4,30,341 MT of Jet-A fuel in the financial year 2018-19. For instance, according to BN Wikipedia [19], Bangladesh will generate about 1 crore 71 lakh 78 thousand 360 tons of waste every year in 2025. If processed through WTL, 20,61,403 MT of Diesel, 1,71,484 MT of LPG, 39,510 MT of Jet Fuel and 36,93,347 metric tons of compost fertilizer can be produced annually. As a result, Bangladesh's import costs will reduce as well as GDP will increase at the same time.

14.3 Prevent Air Pollution: Waste releases air pollutants such as carbon monoxide, elongated particles, particulate matter 10, ozone, Sulphur dioxide, etc. Which seriously pollutes the air and causes extreme damage to our various diseases and the environment. For example, according to BN Wikipedia [19], Bangladesh produces about 26 million tons of waste every year, which emits about 41 million tons of carbon dioxide, which will cost Bangladesh about 3.75 billion a year to eliminate. On the other hand, if waste is recycled / processed through Waste Technologies LLC (WTL), none of the above mentioned air pollutants will be released into the air but will be converted into assets and GDP will increase.

14.4 Prevent water Pollution: Every day thousands of tons of liquid waste are dumped in different rivers in Bangladesh and the river water and the fish and other animals and plants here are being severely damaged. This is reducing the fish production in our country. But if the waste is recycled / processed through Waste Technology LLC (WTL), none of the above mentioned water pollutants will be released into the river/sea/pond water but it will be converted into assets and per capita income will enhance.

14.5 Assistance in increasing Foreign Direct Investment (FDI): Foreign investment is essential for Bangladesh during this time of crisis in COVID-19. Bangladesh generates about 47,048 [19] metric tons of waste every day. Reusable / processing of this waste through WTL technology alone would require a capital investment of about USD 584.00 billion. WTL will be able to play an important role in raising such investments from abroad. Which can play a vital role in accelerating the development of the country.

14.6 Mosquito Control: Most mosquitoes in cities and towns are born from garbage and dirty water. This technology is able to achieve economic development by processing both wastes and converting them into resources. To control the mosquitoes, the government had announced a budget of Tk 43.43 [21] crore for the Dhaka South City Corporation in the 2019-20 financial year alone. On the one hand, using WTL helps to save the cost of mosquito control, on the other hand, the products produced with this technology play a role in national development.

[20] http://www.bpc.gov.bd/site/page/56a9ec24-6f53-4311-b556-94d24a5d63e5/-

[21] https://www.dhakatribune.com/bangladesh/dhaka/2019/09/01/dscc-sets-3-631-40-crore-budget-for-fy-2019-20-prioritising-mosquito-control

14.7 Eliminate waterlogging: Waterlogging is caused due to garbage in urban and cities areas and people have to face extreme misery due to this. To alleviate this waterlogging, the government maintains adequate funding from the development budget for new drainage lines and drainage maintenance. These can be successfully removed through WTL technology.

14.8 Sustainable cities and communities: It is evident from the above discussion that since no environment is polluted by WTL technology, inclusive, safe, shock tolerant and sustainable cities and settlements can be built by this technology.

14.9 Decent work and Economic Growth: Creating full and productive employment and decent employment opportunities for all and achieving stable, inclusive and sustainable economic growth. For instance, Bangladesh generates about 47,048 [19] metric tons of waste every day. If the waste is recycled / processed through Waste Technologies LLC (WTL), it will create employment for about 20,000 people directly and 50,000 people indirectly.

14.10 Sustainable Production: WTL is a technology through which the cost of production is comparatively lowest, the profit is highest like about 19%, the efficiency is higher than others like 98%. That means this technology ensures sustainable production.

14.11 Role in Poverty Alleviation: Waste Technology LLC (WTL) increases employment. This eliminates poverty.

14.12 Assistance in safe food production: Organic fertilizers are produced through WTL technology. Through which farmers can produce safe food.

14.13 Affordable and green energy: WTL technologies make affordable, reliable, sustainable and modern energy systems accessible to all.

14.14 Achieving Improved Nutrition: This technology produces a lot of organic fertilizer which will enable farmers to produce quality food and which will indirectly help in achieving improved nutrition.

14.15 Development of Health Sector: When waste is recycled / processed through WTL, it plays a major role in improving health directly and indirectly through the development of soil, water, air, agriculture, economy and various other environments.

14.16 Assist in Climate Protection: Waste recycling / processing through WTL helps prevent pollution of soil, water, air, and other elements of the environment that improve climate and protect the country from various natural disasters.

14.17 Biodiversity conservation: This technology is able to manage its production without harming nature, so it plays a special role in biodiversity conservation which indirectly helps to protect the people of the country from various corona virus epidemics. For an example, Today,

it is estimated that, globally, about one billion cases of illness and millions of deaths occur every year from diseases caused by coronaviruses; and about 75 percent of all emerging infectious diseases in humans are zoonotic, meaning that they are transmitted to people by animals [22].

14.18 Below water life: This technology is able to play a key role in keeping water free from pollution. WTL technology ensures sustainable development through the conservation and sustainable use of seas, oceans and marine resources.

15. Proposal of WTL

15.1 Responsibilities of Municipal/City Corporations (CC)

15.1.1 CC will provide the necessary land for installing and operating the Plant.

15.1.2 CC will provide a temporary office space initially, at a suitable location.

15.1.3 CC will allow WTL to clean and vacate the existing dumping facility immediately upon signing the contract.

15.1.4 CC will help WTL to find local Compost Fertilizers (CF) vendors for distribution in the market.

15.1.5 CC will allow WTL to use its existing manpower and equipment involved in cleaning and collecting MSW to the site.

15.1.6 CC will help WTL to recruit local manpower as required but not limited.

15.1.7 CC will protect all WTL employees from outsider by getting help from local administration such DC, SP and other related law enforcement agency but not limited.

15.1.8 CC will work with WTL closely to avoid infringement or reverse engineering of our patent rights and machines, ideas but not limited by local vendors or strangers. If WTL report to CC such an event, CC has to report to local law enforcement agency immediately along with WTL for remedial action accordingly.

15.1.9 CC will not use the proposed plant for political gathering, meeting and motivation of any kinds or its own personal interest but not limited.

15.1.10 If CC or his designated officer / employees wants to visit WTL plant they will have to

[22] https://www.un.org/en/observances/environment-day

give written notice to WTL via E-mail or fax at least 7-10 days in advance. Only Mayor and his authorized person will be allowed to visit.

15.1.11 CC will arrange all import permission from Government of Bangladesh (GOB) and related other bodies for machines and equipment to be imported by WTL for the purpose of installing and implementation of the project plant in the schedule premises.

15.1.12 CC will be under obligation to arrange and maintain all regulatory permissions required for establishing the plant from Government of Bangladesh and its related bodies e.g. NBR/BIDA/Bangladesh Bank/Department of Environment etc. but not limited.

15.1.13 CC will arrange required Permission from Bangladesh Petroleum Corporation and relevant other governmental/non-governmental bodies for Sale of the petroleum and other produced products like Low Sulfur Fuel (LSF), Jet Fuel & LPG, Bio-gas and Composed Fertilizers, which will be produced by the way of utilizing WTL Patented Technologies and Conversion Machines.

15.1.14 CC will arrange necessary Power Purchase Agreement (PPA)/ Fuel Purchase Agreement (FPA) from Power Ministry as agreed upon.

15.1.15 CC shall arrange required permission from Bangladesh Bank/ BIDA and other relevant bodies / agencies for bringing foreign currency / fund into Bangladesh for implementation of the projects and to bring out the sale proceeds/profit to abroad.

15.1.16 CC shall arrange required permission and take necessary action to import and receive WTL's Conversion Units and related accessories / materials from USA via Chittagong or Mongla Ports. WTL will provide details tentative time and work schedule accordingly and description of imported materials from USA in separate sheets.

15.1.17 The project being a clean & green one, CC will arrange all types of Tax & Vat exemption for minimum five (5) years for making the project financially viable.

15.2 Responsibilities of WTL

15.2.1 Firstly, WTL will clear and vacate the existing dumping land before building and commissioning the MSW to FGF Process plant at schedule premises.

15.2.2 WTL in USA will arrange all necessary funds required to complete full installation of the Plant in the scheduled premises. WTL will be responsible for fabrication and construction of the plant by their own team or subcontract. CC will not have any objection in this regards. Fabrication and Construction work schedule will be provided to CC for kind information.

15.2.3 WTL will be under the responsibility to conduct all site infrastructure development works at its own capacity/ by its manpower logistics etc.

15.2.4 WTL in USA will supply/ mobilize all necessary and required machines, equipment under the agreement from abroad and local market as Turn-Key basis for the purpose of effecting the terms and conditions under this agreement.

15.2.5 For better understanding and smooth running of the projects, time to time WTL will provide progress report to CC if authorized only by appropriate authority.

15.2.6 WTL will run the facility 24/7 without any interruption. Facility will be under CCTV surveillance and have security force to monitor 24/7 and 365 days for the safety of the project and involved personnel.

15.2.7 For adequate supply of Electricity to run plant 24/7, WTL may use solar panel on the roof and/ generate electricity by using its own fuel. For this WTL will not need written permission from CC, but will inform CC by E-mail and Fax.

15.2.8 WTL will start project within 120 (One Hundred Twenty Days) days of the date of delivery of vacant possession of dumping facility of scheduled project land to the WTL.

15.2.9 WTL will be fully responsible for all funds required for installation, maintenance and operation of the project. However, WTL will pay an amount of net profit of 2.5-5% of the proposed plant per year as royalty/lease price of the scheduled land to the CC. However, payment will start after full recovery of all initial capital expenditure by WTL approximately five years. The royalty/lease price will be adjusted at the rate of 2.5 % after every 10 (Ten) years.

15.2.10 WTL will arrange a visit for the appropriate team to WTL's facilities in the CT, USA if require.

16. Estimated Revenue Earnings of Municipal/City Corporation

City Corporation will get 2.5-5% of profit of the proposed plant as royalty from Waste Technologies LLC. This payment will start after full recovery of all initial investment expenditure of WTL. Since ROI of WTL is approximately 5 years, the estimated revenue earning of Municipal/City Corporation will start from 6th operational year of the process plant.

Based on this, estimated revenue earning for first ten years (starting from 6th year) of Municipal/city corporation will as presented here-

Year of Revenue	From 2.5% of Profit	From 5% of Profit
6th	187,449,084	374,898,168
7th	199,466,990	398,933,980
8th	210,715,969	421,431,937
9th	221,520,975	443,041,951
10th	232,159,898	464,319,796
11th	239,080,962	478,161,924
12th	241,261,128	482,522,255
13th	243,005,260	486,010,520
14th	244,400,566	488,801,132
15th	245,516,811	491,033,622
Total Revenue (10 years)	**2,264,577,643**	**4,529,155,286**

17. Conclusion

17.1 With the trend of rapid urbanization around the globe, tremendous amount of municipal solid waste is generated. Situation is more fragile in Bangladesh. A small piece of land accommodating big amount of population having urbanization trend, made it more complex. In Bangladesh as on now urban area generates approximately 20 thousand tons of MSW per day which is likely to rise up to 47 thousand tons per day by 2025. If situation is not arrested immediately by adopting planned Waste Management System, it might have to face disastrous situation in future.

17.2 The Government of Bangladesh did realize the seriousness of the issue and tried to implement some projects on Waste Management; but again these were not very successful one. On the other hand, Govt. did place the Nation 3Rs Strategy for waste management. They are also trying to achieve Integrated Sustainable Waste Management System having resource management within a Circular Economy. Having all these in view now the Govt. need to select the right institutions and the system to manage the MSW.

17.3 Lots of research and development works were undertaken to find out the right system of managing MSW. With the new inventions of technologies, the system again changed. As of now, five types of energy conversion process are in place to recycle MSW. Now it is Users to decide which conversion process is ecologically viable, technically sound and economically profitable.

17.4 WTL is a USA based solid waste management research & development and equipment manufacturing company. The Founder Chairman of the Company being an Expatriate Bangladeshi wants to contribute in the economic development of his Mother Land at one hand; and keep the country clean and green on the other. Being a Scientist, the Chairman having his own patented

invention on Waste Plastic to Fuel, feels that it can be effectively utilized in Bangladesh. This very system proved to be environmental friendly and economically viable option presently prevailing in the Globe. As a whole, WTL offers the most modern technique of Waste Management to the country. We want to keep our country – Bangladesh clean and safe.

The only Waste Technologies LLC in the world that is able to ensure sustainable and social development by protecting the environment almost 100%.

Waste Technologies

Cleaning Earth, Saving Environment

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Our Organizations

Waste Technologies LLC
SheBa Web Technology LLC
NK Web Technology
Matrimonial & Services
E-Commerce Platform
Moinuddin & Anjuman Foundation,Inc.

Our Web Sites

www.wastetechnologiesllc.com
www.shebawebtech.com
www.nkwebtechnology.com
www.zibonshathi.com / www.jobinbangladesh.com
www.tazabazar.com
www.moinandanjufoundation.com

Waste Technologies Bangladesh LTD
SheBa Waste Technologies LTD
SheBa Publication LLC
SheBa Construction LLC
SheBa Enterprises LLC
Waste Management and Green Environment
Blue Economy and Bio-Diversity
Agro Economy and Agro Waste
Noorzahan Kamaluddin (NK) Foundation
Sofia Alauddin (SA) Foundation