TREATMENT AND DISPOSAL OF SOLID WASTE

Garbage arising from human or animal activities, that is abandoned as unwanted and useless is referred as solid waste. Generally, it is generated from industrial, residential and commercial activities in a given area, and may be handled in a variety of ways. However, waste can be categorized based on materials such as paper, plastic, glass, metal and organic waste. Solid waste disposal must be managed systematically to ensure environmental best practices. Solid waste disposal and management is a critical aspect of environmental hygiene and it needs to be incorporated into environmental planning.

Solid waste disposal and management includes planning, administrative, financial, engineering and legal functions. It is typically the job of the generator, subject to local, national and even international authorities.

Introduction:

Solid waste disposal management is usually referred to the process of collecting and treating solid wastes. It provides solutions for recycling items that do not belong to garbage or trash. Solid waste management can be described as how solid waste can be changed and used as a valuable resource.

Improper disposal of municipal solid waste can create unsanitary conditions, and these conditions in turn lead to pollution of the environment. Diseases can be spread by rodents and insects. The tasks of solid waste disposal management are complex technical challenges. They can also pose a wide variety of economic, administrative and social problems that must be changed and solved.

Sources of Solid Wastes

- Solid domestic garbage.
- Solid waste material from various industries.
- Solid agricultural waste.
- Plastics, glass, metals, e-waste, etc.
- Medical waste.
- Construction waste, sewage sludge

Methods of Solid Waste Disposal and Management:

Here are the methods of solid waste disposal and management:

1) Solid Waste Open Burning
2) Sea dumping process
3) Solid wastes sanitary landfills
4) Incineration method
5) Composting process
6) Disposal by Ploughing into the fields
7) Disposal by hog feeding
8) Salvaging procedure
9) Fermentation/biological digestion

1. Solid Waste Open Burning
Solid waste open burning is not the perfect method in the present scenario.

2. Sea Dumping Process
This sea dumping process can be carried out only in coastal cities. This is very costly procedure and not environment friendly.

3. Solid wastes sanitary landfills
Solid wastes sanitary landfills process is simple, clean and effective. In this procedure, layers are compressed with some mechanical equipment and covered with earth, leveled, and compacted. A deep trench of 3 to 5 m is excavated and micro-organisms act on the organic matter and degrade them. In this procedure, refuse depth is generally limited to 2m. Facultative bacteria hydrolyze complex organic matter into simpler water soluble organics.

4. Incineration method
Incineration method is suitable for combustible refuse. High operation costs and construction are involved in this procedure. This method would be suited in crowded cities where sites for land filling are not available. It can be used to reduce the volume of solid wastes for land filling.

5. Composting process
Composting process is similar to sanitary land-filling and it is popular in developing countries. Decomposable organic matter is separated and composted in this procedure. Yields are stable end products and good soil conditioners. They can be used as a base for fertilizers.

Two methods have been used in this process:
a)Open Window Composting
b) Mechanical Composting

6. Disposal by Ploughing into the fields
Disposal by ploughing into the fields are not commonly used. These disposals are not environment friendly in general.

7. Disposal by hog feeding
Disposal by hog feeding is not general procedure in India. Garbage disposal into sewers including BOD and TSS increases by 20-30%. Refuse is ground well in grinders and then fed into sewers.

8. Salvaging procedure
Materials such as metal, paper, glass, rags, certain types of plastic and so on can be salvaged, recycled, and reused.

9. Fermentation/biological digestion
Biodegradable wastes are converted to compost and recycling can be done whenever possible. Hazardous wastes can be disposed using suitable methods.

BIOGAS GENERATION

The United States produces more than 70 million tons of organic waste each year. While source reduction and feeding the hungry are necessary priorities for reducing needless food waste, organic wastes are numerous and extend to non-edible sources, including livestock manure, agriculture wastes, waste water, and inedible food wastes. When these wastes are improperly managed, they pose a significant risk to the environment and public health. Pathogens, chemicals, antibiotics, and nutrients present in wastes can contaminate surface and ground waters through runoff or by leaching into soils. Excess nutrients cause algal blooms, harm wildlife, and infect drinking water. Drinking water with high levels of nitrates is linked to hyperthyroidism and blue-baby syndrome. Municipal water utilities treat drinking water to remove nitrates, but it is costly to do so.

Organic wastes also generate large amounts of methane as they decompose. Methane is a powerful greenhouse gas that traps heat in the atmosphere more efficiently than carbon dioxide. Given equal amounts of methane and carbon dioxide, methane will absorb 86 times more heat in 20 years than carbon dioxide. To reduce greenhouse gas emissions and the risk of pollution to waterways, organic waste can be removed and used to produce biogas, a renewable source of energy. When displacing fossil fuels, biogas creates further emission reductions, sometimes resulting in carbon negative systems. Despite the numerous potential benefits of organic waste utilization, including environmental protection, investment and job creation, the United States currently only has 2,200 operating biogas systems, representing less than 20 percent of the total potential.

What is biogas?

Biogas is produced after organic materials (plant and animal products) are broken down by bacteria in an oxygen-free environment, a process called anaerobic digestion. Biogas systems use anaerobic digestion to recycle these organic materials, turning them into biogas, which contains both energy (gas), and valuable soil products (liquids and solids).

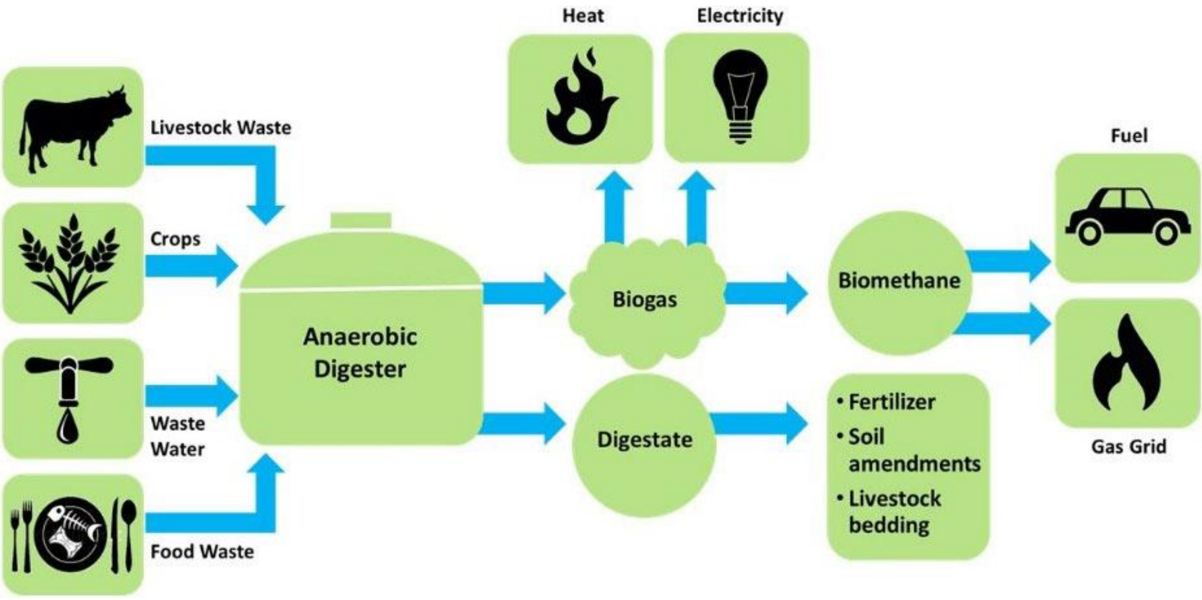

Figure 1: Anaerobic digestion process (Graphic by Sara Tanigawa, EESI).

Anaerobic digestion already occurs in nature, landfills, and some livestock manure management systems, but can be optimized, controlled, and contained using an anaerobic digester. Biogas contains roughly 50-70 percent methane, 30-40 percent carbon dioxide, and trace amounts of other gases. The liquid and solid digested material, called digestate, is frequently used as a soil amendment.

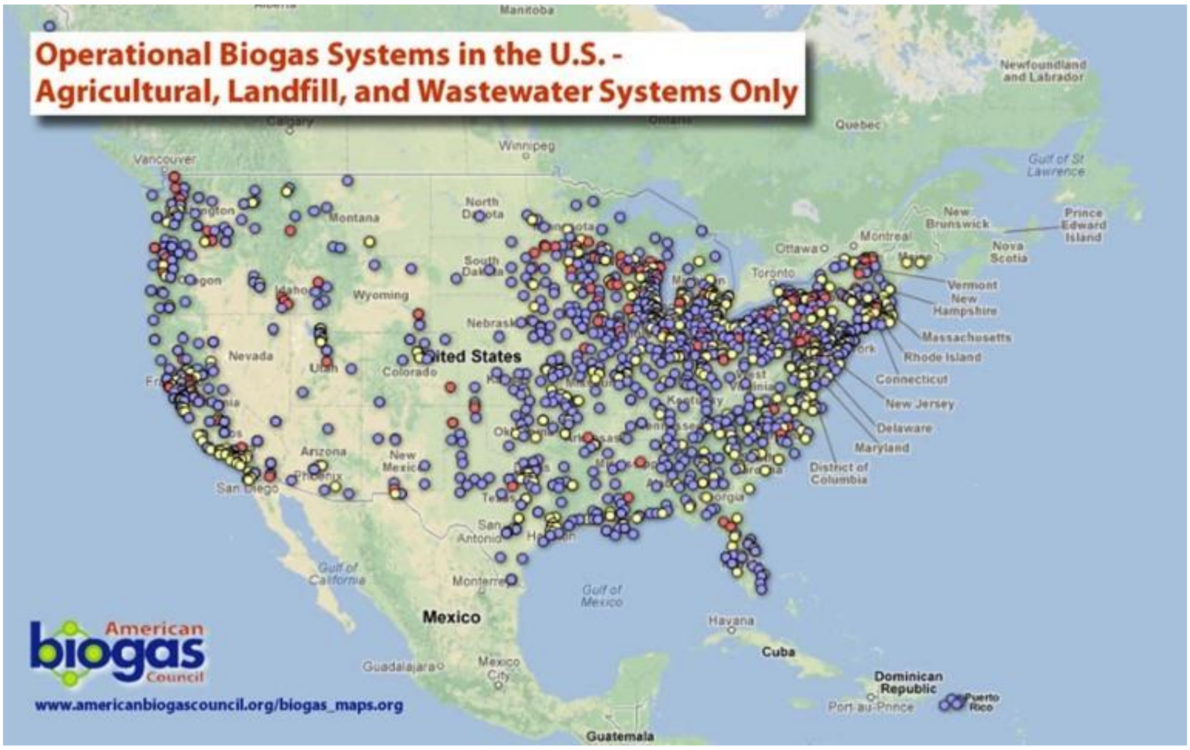

Figure 2: Operational biogas systems in the continental United States (Courtesy: American Biogas Council)

Some organic wastes are more difficult to break down in a digester than others. Food waste, fats, oils, and greases are the easiest organic wastes to break down, while livestock waste tends to be the most difficult. Mixing multiple wastes in the same digester, referred to as co-digestion, can help increase biogas yields. Warmer digesters, typically kept between 30 to 38 degrees Celsius (86-100 Fahrenheit), can also help wastes break down more quickly.

After biogas is captured, it can produce heat and electricity for use in engines, microturbines, and fuel cells. Biogas can also be upgraded into biomethane, also called renewable natural gas or RNG, and injected into natural gas pipelines or used as a vehicle fuel.

The United States currently has 2,200 operating biogas systems across all 50 states, and has the potential to add over 13,500 new systems.

The Benefits of Biogas

Stored biogas can provide a clean, renewable, and reliable source of baseload power in place of coal or natural gas. Baseload power is consistently produced to meet minimum power demands; renewable baseload power can complement more intermittent renewables. Similar to natural gas, biogas can also be used as a source of peak power that can be rapidly ramped up. Using stored biogas limits the amount of methane released into the atmosphere and reduces dependence on fossil fuels. The reduction of methane emissions derived from tapping all the potential biogas in the United States would be equal to the annual emissions of 800,000 to 11 million passenger vehicles. Based on a waste-to-wheels assessment, compressed natural gas derived from biogas reduces greenhouse gas emissions by up to 91 percent relative to petroleum gasoline.

In addition to climate benefits, anaerobic digestion can lower costs associated with waste remediation as well as benefit local economies. Building the 13,500 potential biogas systems in the United States could add over 335,000 temporary construction jobs and 23,000 permanent jobs. Anaerobic digestion also reduces odors, pathogens, and the risk of water pollution from livestock waste. Digestate, the material remaining after the digestion process, can be used or sold as fertilizer, reducing the need for chemical fertilizers. Digestate also can provide additional revenue when sold as livestock bedding or soil amendments.

Biogas Feedstocks

Food Waste

Around 30 percent of the global food supply is lost or wasted each year. In 2010 alone, the United States produced roughly 133 billion pounds (66.5 million tons) of food waste, primarily from the residential and commercial food sectors. To address this waste, EPA's Food Recovery Hierarchy prioritizes source reduction first, then using extra food to address hunger; animal feed or energy production are a lower priority. Food should be sent to landfills as a last resort. Unfortunately, food waste makes up 21 percent of U.S. landfills, with only 5 percent of food waste being recycled into soil improver or fertilizer. Most of this waste is sent to landfills, where it produces methane as it breaks down. While landfills may capture the resultant biogas, landfilling organic wastes provides no opportunity to recycle the nutrients from the source organic material. In 2015, the EPA and USDA set goals to reduce the amount of food waste sent to landfills by 50 percent by 2030. But even if this goal is met, there will be excess food that will need to be recycled. The energy potential is significant. As just one example, with 100 tons of food waste per day, anaerobic digestion can generate enough energy to power 800 to 1,400 homes each year. Fat, oil, and grease collected from the food service industry can also be added to an anaerobic digester to increase biogas production.

Landfill Gas

Landfills are the third largest source of human-related methane emissions in the United States. Landfills contain the same anaerobic bacteria present in a digester that break down organic materials to produce biogas, in this case landfill gas (LFG). Instead of allowing LFG to escape into the atmosphere, it can be collected and used as energy. Currently, LFG projects throughout the United States generate about 17 billion kilowatt-hours of electricity and deliver 98 billion cubic feet of LFG to natural gas pipelines or directly to end-users each year. For reference, the average U.S. home in 2015 used about 10,812 kilowatt-hours of electricity per year.

Livestock Waste

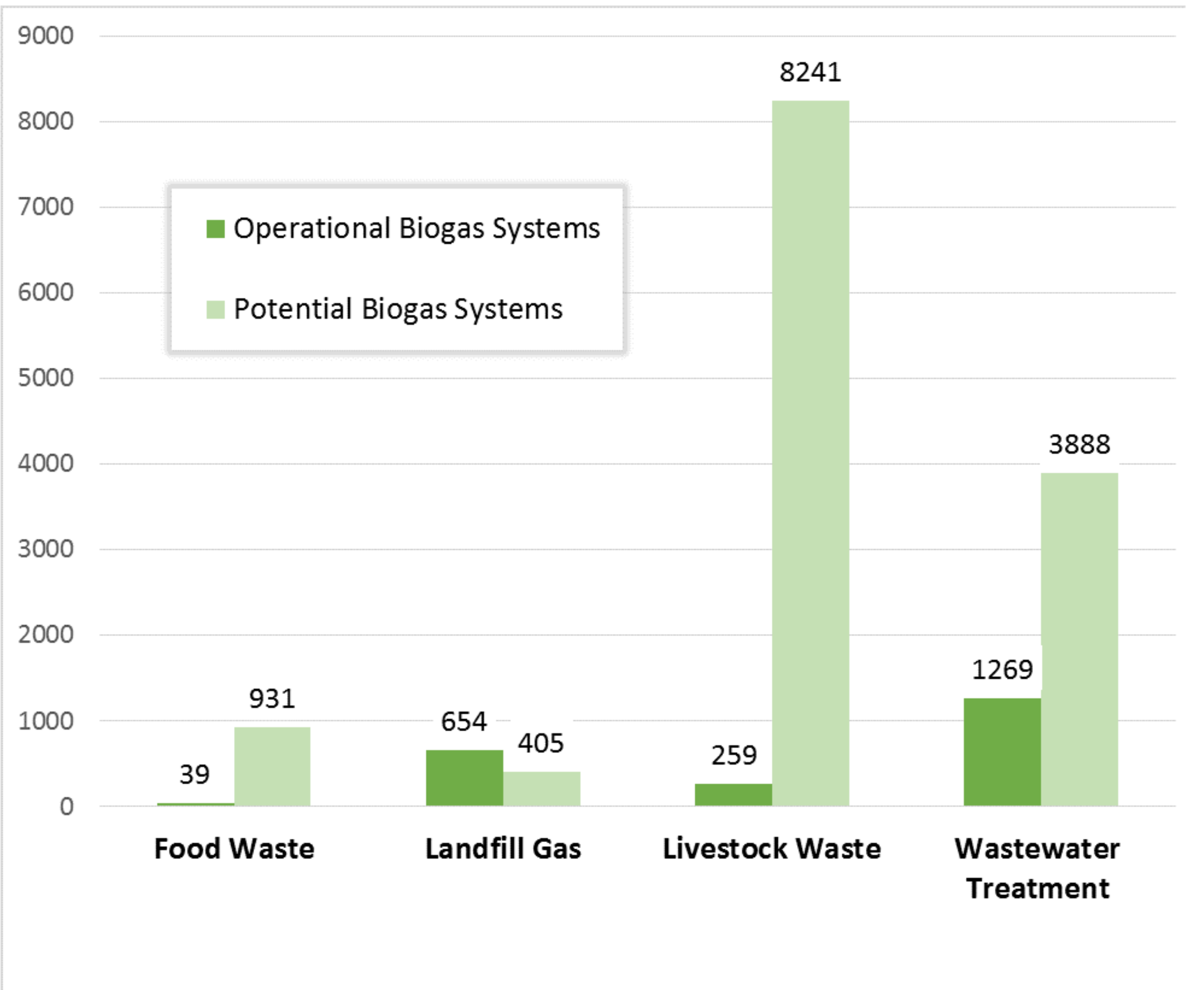

Figure 3: Current number of operational and potential biogas systems in the United States by feedstock. EPA

A 1,000-pound dairy cow produces an average of 80 pounds of manure each day. This manure is often stored in holding tanks before being applied to fields. Not only does the manure produce methane as it decomposes, it may contribute to excess nutrients in waterways. In 2015, livestock manure management contributed about 10 percent of all methane emissions in the United States, yet only 3 percent of livestock waste is recycled by anaerobic digesters. When livestock manure is used to produce biogas, anaerobic digestion can reduce greenhouse gas emissions, reduce odors, and reduce up to 99 percent of manure pathogens. The EPA estimates there is the potential for 8,241 livestock biogas systems, which could together generate over 13 million megawatt-hours of energy each year.

Wastewater Treatment

Many wastewater treatment plants (WWTP) already have on-site anaerobic digesters to treat sewage sludge, the solids separated during the treatment process. However, many WWTP do not have the equipment to use the biogas they produce, and flare it instead. Of the 1,269 wastewater treatment plants using an anaerobic digester, only around 860 use their biogas. If all the facilities that currently use anaerobic digestion—treating over 5 million gallons each day—were to install an energy recovery facility, the United States could reduce annual carbon dioxide emissions by 2.3 million metric tons—equal to the annual emissions from 430,000 passenger vehicles.

Crop Residues

Crop residues can include stalks, straw, and plant trimmings. Some residues are left on the field to retain soil organic content and moisture as well as prevent erosion. However, higher crop yields have increased amounts of residues and removing a portion of these can be sustainable. Sustainable harvest rates vary depending on the crop grown, soil type, and climate factors. Taking into account sustainable harvest rates, the U.S. Department of Energy estimates there are currently around 104 million tons of crop residues available at a price of $60 per dry ton. Crop residues are usually co-digested with other organic waste because their high lignin content makes them difficult to break down.

Biogas End Uses

Raw Biogas and Digestate

With little to no processing, biogas can be burned on-site to heat buildings and power boilers or even the digester itself. Biogas can be used for combined heat and power (CHP) operations, or biogas can simply be turned into electricity using a combustion engine, fuel cell, or gas turbine, with the resulting electricity being used on-site or sold onto the electric grid.

Digestate is the nutrient-rich solid or liquid material remaining after the digestion process; it contains all the recycled nutrients that were present in the original organic material but in a form more readily available for plants and soil building. The composition and nutrient content of the digestate will depend on the feedstock added to the digester. Liquid digestate can be easily spray-applied to farms as fertilizer, reducing the need to purchase synthetic fertilizers. Solid digestate can be used as livestock bedding or composted with minimal processing. Recently, the biogas industry has taken steps to create a digestate certification program, to assure safety and quality control of digestate.

Renewable Natural Gas

Renewable natural gas (RNG), or biomethane, is biogas that has been refined to remove carbon dioxide, water vapor, and other trace gases so that it meets natural gas industry standards. RNG can be injected into the existing natural gas grid (including pipelines) and used interchangeably with conventional natural gas. Natural gas (conventional and renewable) provides 26 percent of U.S. electricity, and 40 percent of natural gas is used to produce electricity. The remainder of natural gas is used for commercial purposes (heating and cooking) and for industrial ones. RNG has the potential to replace up to 10 percent of the natural gas used in the United States.

Compressed Natural Gas and Liquefied Natural Gas

Like conventional natural gas, RNG can be used as a vehicle fuel after it is converted to compressed natural gas (CNG) or liquefied natural gas (LNG). The fuel economy of CNG-powered vehicles is comparable to that of conventional gasoline vehicles and can be used in light- to heavy-duty vehicles. LNG is not as widely used as CNG because it is expensive to both produce and store, though its higher density makes LNG a better fuel for heavy-duty vehicles that travel long distances. To make the most of investments in fueling infrastructure, CNG and LNG are best suited for fleet vehicles that return to a base for refueling. The National Renewable Energy Laboratory estimates RNG could replace five percent of the natural gas used to produce electricity and 56 percent of the natural gas used to produce vehicle fuel.

Federal Policies Supporting the Biogas Industry

The Renewable Fuel Standard

Production of cellulosic biofuel (in gallons) by fuel type

	Ethanol	Renewable CNG	Renewable LNG
2015	2,181,096	81,490,266	58,368,879
2016	3,805,246	116,582,508	71,974,041
2017*	3,536,721	56,916,606	34,224,820

* As of July 2017

The Renewable Fuel Standard (RFS) was created by Congress as part of the 2005 Energy Policy Act. The RFS requires the blending of renewable fuels into the U.S. transportation fuel supply. Currently about 10 percent of the gasoline supply is provided by renewable fuel, primarily ethanol. The RFS sets fuel volumes for a variety of fuel categories: biomass-based diesel, advanced biofuel, cellulosic biofuel, and renewable fuel as a whole. Each category has a required minimum reduction in greenhouse gases.

EPA approved biogas as a qualifying cellulosic feedstock under the RFS in 2014. Cellulosic biofuels must be 60 percent less greenhouse gas-intensive than gasoline. Currently, most of the cellulosic fuel volumes are being met through the use of RNG as a vehicle fuel. Compliance with the RFS is tracked through renewable identification numbers (RINs) that can be traded, and RINs for cellulosic biofuels can earn RNG producers $40/MMBtu (as of September 2017). According to biogas producers, the RFS has become an important driver of investment in the industry.

As part of the approval of biogas, the EPA updated the RFS to allow biogas-derived electricity used as vehicle fuel to qualify for RINs, or “e-RINs.”

However, as of 2017, the EPA has not approved any producer requests to start generating e-RINs, despite biogas production already exceeding current transportation electricity demand.