

Building a SEED Park: Part IV – Biomass

Biomass is defined as the product of photosynthesis in plants or the products produced by consuming plants, i.e. animals, microorganisms and fungi. Biomass is organic and composed principally of carbon, hydrogen, and oxygen with lesser quantities of nitrogen, sulfur, calcium, phosphorous, potassium, iron and trace elements. We are organic; our food is organic; trees, flowers, grass, corn, milk and even paper are all organic. Organic materials are biomass.

The elements of biomass, especially the carbon, hydrogen, and nitrogen are of great value. Approximately 238 million tons of municipal solid waste, 70% of which is biomass, is generated annually in landfills in the US. Additionally, agricultural, forest industry residues, and energy crops could produce another 512 million dry tons of biomass annually. Some of this biomass is now returned to croplands as fertilizer, other quantities are burned for energy, buried in landfills or discharged into streams and rivers as runoff from the agricultural and forest-based industries. Ground water and surface waters are both degraded by decomposition products of biomass.

In the wonderful design of nature, what we and all animals use for food is what plants produce. Through a process called photosynthesis, plants use the energy of the sun to convert carbon dioxide, water and fertilizer into plant materials including sugars, proteins, oils, vitamins, and other products while releasing oxygen into the atmosphere. We, and all animals, inhale oxygen and exhale carbon dioxide. The waste products, urine and manure, excreted by animals are the fertilizers required by plants for growth. In this wonderful relationship, animals, and humans, need plants and plants need animals and us.

The liquid waste for animals is high in ammonia, NH_3 . Bacteria convert the ammonia into nitrate and we commonly use ammonium nitrate ($\text{NH}_3\text{-NO}_3$) and other forms of ammonia including urea and anhydrous ammonia to fertilize plants. Compost is organic fertilizer produced from biomass. Waste materials such as leaves, grass, wood shavings, manures, scrap food, etc. are converted by bacteria and fungi into compost. Applied to plants as fertilizer, compost has value. Compost piles typically operate at about 170°F and can be a source of heat extracted to heat greenhouses or other industrial purposes.



A delegation from the San Luis Valley visited Pinetop, AZ to examine a wastewater treatment facility combining sludge and municipal solid waste into compost.



Mark Heberer, of the Pinetop-Lakeside Sanitation District, explains operation of the equipment at the composting facility in Pinetop, AZ.

Some municipalities use earthworms, or vermiculture, to digest organics and produce high-value compost commonly called worm castings, or vermicompost. The worm castings typically have a higher value than do the worms. However, worms have value as protein, as an ingredient in fish feed, as bait for sport fishing, or as live food items for the pet trade.

Municipal solid waste (MSW), more commonly known as garbage and trash, typically contains about 60% organic material, or biomass. Municipal waste water treatment plants also produce biomass in

the form of sewage sludge, sometimes referred to as biosolids. To this author's knowledge, only two locations in the US (Pinetop, AZ and Pigeon Forge, TN) combine MSW and sludge to produce compost. Other municipalities truck all MSW and sludge to landfills.

A SEED Park could derive both compost and energy from biomass, including MSW, sewage sludge, agricultural residues and forest industry residues. These residues could be converted into compost or burned as fuel; however, those choices would provide the lowest economic and environmental return. As biomass is fermented it is broken down by microorganisms producing methane gas and carbon dioxide. Methane gas can be converted to methanol, a liquid form of energy similar to ethanol, gasification of biomass uses heat and a restricted amount of oxygen to produce carbon monoxide (CO), hydrogen and other gases. These gases can be converted into a series of synthetic fuels, or other high-value organic compounds. Both methane and the products of biomass gasification can be used to produce hydrogen for energy and convert the carbon into other reusable products.