

Biofuels

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Biofuels

- Biomass is any energy derived from living matter such as field crops, wood products, water plants, and municipal solid waste that is converted into energy.
- This is not an option for a large scale worldwide use.

Fuel	Description	Energy 1 gal gas=116,090	Advantages	Disadvantages
Wood Products and Byproducts firewood, charcoal, chips, sheets, pellets, or sawdust	combustion of wood and byproducts to create thermal heat energy for cooking, heating, and fueling steam engines	7,600-9,600 Btu/lb	technology advances such as airtight stoves and secondary combustion chambers - This is a readily available source of energy in many developing nations without access to technical resources	smoke containing water vapor, CO ₂ , aerosol particulates, and fine particles (fly ash) - Gathering and harvesting of fuel has serious implications to native sinks
Solid Wastes The waste by-products of one-use consumerism that returns to landfills.	Incinerating trash pile-up to generate steam for energy	Average 4,500 - 4,800 Btu/lb	mitigating trash pile-up by incineration from large volumes of waste into ash for long-term storage will save on increasing space needs	combustion of solid landfill will release air pollutants like heavy metals and carcinogenic chlorine compounds known as dioxins. Encourages the continued waste stream levels.
Ethanol Food crops including corn, sugarcane, wood, sugar beets and rye.	Fermentation and distillation of starches and sugars from food crops into a grain or ethyl alcohol to produce ethanol.	76,330 Btu/gal for E100	technology exists as a replacement for gasoline without a need to adjust car engines.	does not have a net reduction in greenhouse gas emissions -land requirements remove options for food stuffs and forested lands
Methanol Any material made of carbon, wood products	the gasification of organic materials into a synthetic gas synthesized into methyl alcohol	57,250 Btu/gal	-less expensive to produce than ethanol	" "
Biodiesel vegetable oils or animal fats	the transesterification of oils or fats with the assistance of methanol and the removal of gum and sludge to the products	119,550 Btu/gal for B100	technology exists as a replacement for diesel without a need to adjust car engines. -used vegetable oil can be used and will remove the oil from waste stream	" " -the utilization of used oil has supply concern because of the availability in mass quantities and methanol requirements
Biogas sewage, animal manure, organic products and waste	the production of methane gas from the anaerobic digestion of organic wastes	At 60 % methane=9 kWh/therm *natural gas = 11.0 kWh/therm	utilizes already prevalent waste stream to create energy. Byproducts of digestion can be marketable fro compost. -easily adapted to small scale use in developing nations	bio gas is 60% CO ₂ and 40% CH ₄ -raw biogas has trace elements that require purification to remove contaminants to be introduced into the gas grid
Biohydrogen algae, bacteria, archaea	fermentation of hydrogen from organic wastes; producing hydrogen from algae that is deprived of sulfur	51,965 Btu/lb	provides a biologically produced hydrogen source	- at this time it is not economically efficient -end-user technologies such as storage techniques still require development

Advantages and Disadvantages

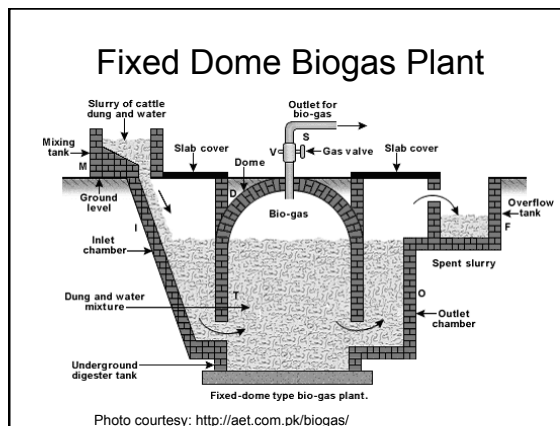
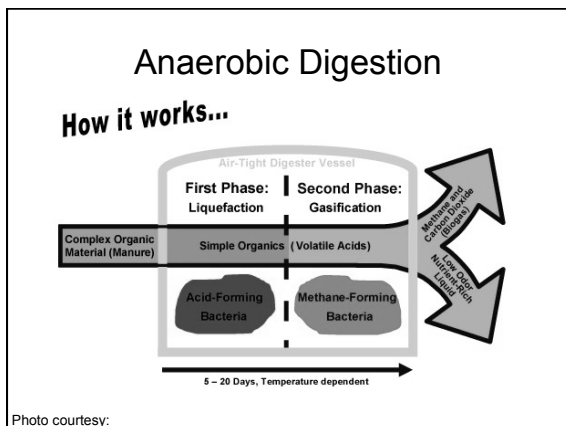
- **Advantages**
 - Biofuel is nontoxic, biodegradable, and free from sulfur.
 - These fuels offer direct energy needs that are available at constant rates for a truly reliable source and replacement to traditional fossil fuels.
 - In some cases they are utilizing the human waste stream for additional energy use
- **Disadvantages**
 - Does not have a net reduction in greenhouse gas emissions when made from major crops due to petroleum used in the conversion of crops to fuel.
 - Putting significant energy into producing fuel from crop production results in getting a small net amount from fuel burning.
 - Ethanol has a 1 unit input for 1.3 unit output.
 - Significant concern comes from the increased agricultural land that is directed away from food crops and the removal of forested lands for increased agriculture land for fuel crops

Biogas and Landfill gas

- Methane produced from decomposition of organic material by bacteria to produce methane and carbon dioxide gases.
- Anaerobic digestion takes place in digesters that hold any organic waste from human sewage to agricultural manures.
- Digesting bacteria convert waste to biogas used for energy needs such as heating, cooking, gas refrigerators, and electricity generation.

What is Used

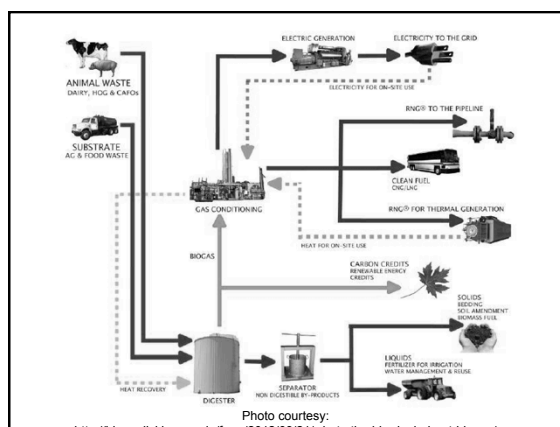
- Municipal organic waste (food waste)
- Biowaste from industry and business activities
 - fat, waste from grocery stores, biosludge from pulp and paper industry, dairy by-products, rejected animal food, fishery by-products etc.
- Raw sewage sludge
 - produced at wastewater treatment plants
- Manure
- Harvest residues



- ### Make up of gas properties
- 45-85 % methane (CH₄)
 - 15-45 % carbon dioxide (CO₂)
 - exact proportions depend on the production conditions and processing techniques.
 - small amounts
 - hydrogen sulphide (H₂S)
 - ammonia (NH₃)
 - nitrogen gas (N₂)

- ### Energy
- Pure methane - 9.81 kWh/Nm³ (9810 Wh/Nm³) (Normal cubic meters).
 - The energy value of biogas varies between 4.5 and 8.5 kWh/Nm³, depending on the relative amounts of methane, carbon dioxide and other gases present.
 - If biogas comprises 60 % methane, the energy content is ~ 6.0 kWh/Nm³.
 - One cow's annual output is equivalent to the energy in approximately 50 gallons of gasoline.

- ### Applications
- Cogeneration gas engines
 - Compressed natural gas to fuel combustion engines and fuel cells
 - Upgraded to biomethane for introduction into local natural gas grid

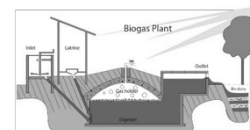


Germany Biogas

- 5,905 plants
- 2,291 MW installed electrical capacity
- 12.8 TWh
- Directly connected to a biomethane CHP and fed to power grid
- Utilizes bio gas from energy crops and manure

Small Scale Examples in India

- 2 million households in India, fifty thousand in Bangladesh, and thousands in Pakistan
- Airtight circular pit of concrete with pipe that is directly connected to fireplace kitchen through control valves.
- Manure and bathroom waste mixed with waste water



Small scale home operation



Landfill Gas

- The gas produced is often more polluted than biogas from an anaerobic digester
- mostly used in gas engines or gas boilers for recovery of heat and/or electricity which can be used on site.
 - Landfill gas becomes explosive when it escapes from the landfill and mixes with oxygen.
 - The methane contained within biogas is 20 times more potent as a greenhouse gas than is carbon dioxide.
 - Volatile organic compounds (VOCs) contained within landfill gas contribute to the formation of photochemical smog.
 - Biogas must be refined and upgraded to use as vehicle fuel while landfill gas cannot due to the high concentration of nitrogen.

Calabasas Landfill

- Los Angeles County, CA
- Disposes 850 tons per day
- Produces 4,500 scfm of landfill gas at 30% methane
- 7 MW net generation of electricity delivered to the distribution system

Advantages

- Technology in place to use readily available gas
- Byproduct of digesters is to produce agricultural compost for a marketable use as well.
- Carbon-neutral
- Available for small operations in developing nations
- Utilization of current waste stream in some cases

Disadvantages

- Agricultural crop use towards energy generation
- Competition for food
- Upgrading requirements to the grid
- Reliance on waste stream and increase animal use
- There are too many variables to determine available energy options
 - Historically (2003) 147 trillion Btu of energy was consumed in the US from landfill gas (0.6% of us natural gas consumption)

Sources

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