

Biomass Energy Technologies

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*Fostering innovative solutions to Alaska's energy challenges
through applied energy research at the University of Alaska*

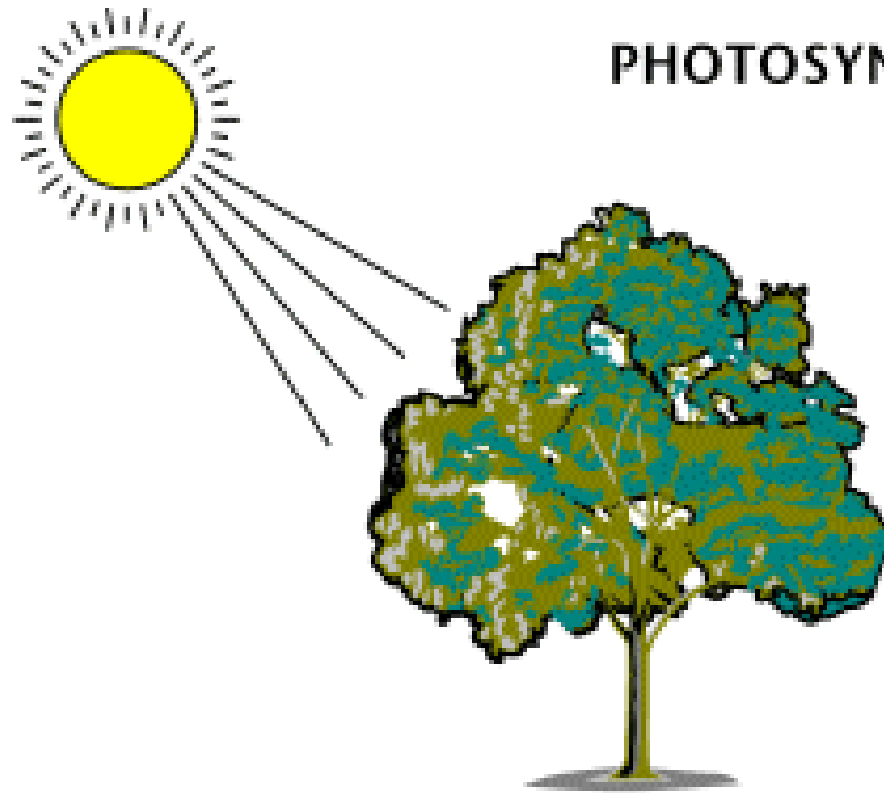
What is biomass?

- ▶ Renewable organic materials, such as wood, agricultural crops or wastes, and municipal wastes, especially when used as a source of fuel or energy. Biomass can be burned directly or processed into biofuels such as ethanol and methane.



What is biomass?

PHOTOSYNTHESIS



In the process of photosynthesis, plants convert radiant energy from the sun into chemical energy in the form of glucose - or sugar.



Biomass in the Lower 48

- ▶ The use of biomass has achieved widespread acceptance as a power source
- ▶ Typical technology is biomass-fired boilers and Rankine steam cycle for power generation
- ▶ EIA data indicate that in 2006, net summer capacity for biomass power generation totaled 9,910 MW (~1% of total U.S. generating capacity)
- ▶ According to EIA, biomass accounts for 4% of total energy used in the U.S.



Biomass use Worldwide

- ▶ Primary energy source for ½ of the world's population
- ▶ Europe is a leader in clean technologies
- ▶ A variety of generation technologies being utilized



2 MW plant in Güssing, Austria



Advantages of Biomass

- ▶ Can supply on demand, base load power
- ▶ Available year-round with storage
- ▶ Carbon neutral
- ▶ Can be processed into a syngas or liquid fuel
- ▶ Can be used for power generation, space heating, and transportation applications



Disadvantages of Biomass

- ▶ Expensive to handle, low energy density
- ▶ Must be utilized near its source
- ▶ Labor intensive
- ▶ Bulky - storage can be a challenge
- ▶ Small scale technologies for power generation still emerging
- ▶ Small scale production of liquid fuels is expensive



Combustion of Biomass

- ▶ Humans have been combusting biomass for heating and cooking for millions of years
- ▶ Robust process, easy to maintain
- ▶ Boilers convert heat to hot water or other medium or generate steam for distribution
- ▶ Thermodynamic limits on efficiency
- ▶ Inefficient systems create more air pollution and require more fuel to operate



Gasification of Biomass

- ▶ Partial combustion to create a gas (CO, H₂, CH₄, CO₂, N₂)
- ▶ Gas has low energy density so must be used near the source
- ▶ Has the potential for higher energy conversion efficiencies than combustion
- ▶ More complex process and requires a uniform biomass fuel



Gasification vs. Direct Combustion

- ▶ Incomplete versus complete combustion to form a syngas
- ▶ Gasification can be more efficient than direct combustion
- ▶ Very little industrial scale gasification being done
- ▶ Main challenges are economic and integration with downstream processing applications, also difficult to achieve optimal performance for varying fuel conditions



Biomass in Interior Alaska

- ▶ Numerous projects throughout the state
- ▶ Tok – AP&T and Nexterra, State Div. of Forestry supplying wood
- ▶ Tanana Garn boiler (washeteria – online since 2007)
- ▶ Galena, Delta Junction, Fort Yukon
- ▶ Superior Pellets



Image from Fairbanks News Miner website



Research Challenge

- ▶ Reduce capital costs
- ▶ Improve efficiency of energy conversion (the smaller the system, the inherently less efficient)
- ▶ Lower emissions
- ▶ Improve integration with existing generation systems

