

Energy from Biomass

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EGY 105 – Energy in Our World

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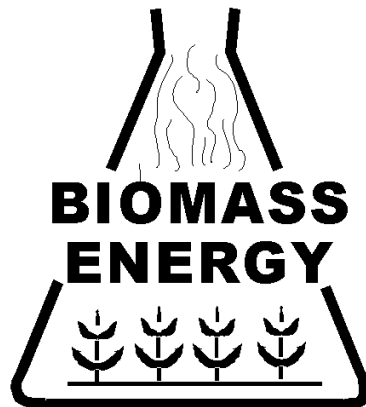
Overview

- All utilize energy fixed by photosynthetic reactions
 - $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$
 - Sugar is an energy-rich molecule
 - Can be converted into starch, lignin, lipids, ethanol
 - Combustion releases energy for heating, electricity, transportation fuel



Attractive as an energy source

- Based on recent (not ancient) photosynthesis
- Combustion does not contribute net addition to atmospheric CO₂
- Supplies will not run out – thus sustainable



Topics to be discussed

- Presentation I: Biomass
 - Forms
 - Utilization
 - Benefits and drawbacks
- Presentation II: Biodiesel
 - What is it?
 - How made
 - Utilization
 - Benefits and drawbacks
- Presentation III: Ethanol
 - What is it?
 - Grain vs cellulosic
 - Utilization
 - Benefits and drawbacks



Biomass energy

- Direct use of organic material
 - Harvested plant material
 - Waste material
 - Pulp manufacturing
 - Municipal waste
 - Animal wastes
- Combustion for heat
 - Dried solids
 - Gasses



Plant derived biomass

- Material derived from woody or herbaceous plants
- Typically requires physical conversion
 - Cutting
 - Drying
 - Compressing
- Chemical conversion is minimal
- Used for millennia through burning wood
- Current techniques involve compressing herbaceous material

Wood as biomass

- Derived from trees and other long-lived plants



<http://www.calmexfireplaces.com/images/logs-without-flame.jpg>

Wood as biomass

- Processing involves timbering, drying, cutting into logs, and perhaps chipping
 - Thus, often easier to transport and use than herbaceous plant matter



<http://thetyee.cachefly.net/Opinion/2009/07/15/loggingtruck.jpg>



http://www.lanl.gov/orgs/pa/newsbulletin/images/Firewood_Giveaway.jpg

Wood as biomass

- Not all trees are equal
 - Growth rate
 - Wood density
 - Additional compounds in wood



Each species has unique geographic distribution



Baobob Tree in Hawaii



Spruce Trees in Maine

Some areas (tundra, grasslands, desert) not forested



Once cut, trees take a long time to regrow. But can be cultivated.



<http://pubs.usgs.gov/sir/2007/5011/images/coverphoto.jpg>



<https://theecologist.org/2013/feb/15/>

Tree species often used for biomass



Eucalyptus



Willow



Poplar

Herbaceous plants as biomass

- Based mainly on stems and leaves
- Derived from grasses and herbs



Herbaceous plants as biomass

- Processing involves cutting, drying, and perhaps pelletizing
 - Not as convenient to transport as wood



<http://www.abe.msstate.edu/Biomass/images/gasifierpics/Chips&Pellets.jpg>

Herbaceous plants as biomass

- Look for rapid growth and high density foliage



<http://www.ncagr.gov/Research/images/switchgrass.jpg>

Herbaceous plants as biomass



<http://www.oh.nrcs.usda.gov/>



<http://www.sbp.de/de/html/>

- Grow best in grasslands
 - Need ecosystem disturbance to grow in otherwise forested areas
 - Need irrigation to grow in deserts, scrublands
 - Amenable to cultivation in greenhouses

Herbaceous species used in biomass

Miscanthus



<http://www.michelleworld.com/images/plants/Miscanthus%20sinensis%20%27Giganteus%27.jpg>

Switchgrass



[http://nybiofuels.info/generalInformation/biomass/PublishingImages/switchgrass%20\(Small\).JPG](http://nybiofuels.info/generalInformation/biomass/PublishingImages/switchgrass%20(Small).JPG)

Additional considerations



- Ability to accumulate biomass amenable to breeding
- Biomass cultivation viewed as beneficial use of severely disturbed lands

Other forms of biomass

- Waste from pulp manufacturing
 - High in cellulose
 - Used to make electricity through steam production



Other forms of biomass

- Municipal waste
 - Contains paper, wood, food waste, other organics
 - Incineration yields energy
 - Landfill waste yields natural gas.



Other forms of biomass

- Agricultural waste
- Methane from farm animals
 - 280 L / cow / day (http://www.riverdeep.net/current/2002/03/032502t_cowpower.jhtml)

