ABEN 499/696 Biofuels

Catalog description

The economics, energetics, limitations and environmental benefits of biofuels production. Biomass harvesting, storage and conversion will be discussed for technologies, including starch/corn ethanol, cellulosic ethanol, biodiesel, biological hydrogen and biogas.

Objectives

At the end of the course, students will be able to:

- Explain the economic, environmental and political importance of biobased fuels
- Explain options and challenges for biomass production, harvest, transportation and storage
- Explain the individual steps involved in producing corn ethanol, cellulosic ethanol, biodiesel, biogas and thermochemical fuel production, including the importance and challenges in those processing steps

Grading

Undergraduate students

Homework/weekly writing assignments*	40%
Group project	40%
Final exam	20%

Graduate students

Homework/weekly writing assignments*	30%
Group project	30%
Individual project	20%
Final exam	20%

*Assignments should be sent via e-mail and typically will be due on Mondays at 4 p.m.

Course materials

Brown, R.C. 2003. Biorenewable Resources: Engineering New Products from Agriculture. Iowa State Press, Ames, Iowa (List Price $89.99)

Various other reading assignments (e.g., technical papers, Department of Energy and USDA reports, etc.) will be provided by instructor and/or placed on Blackboard.

Students with disabilities

Any students with disabilities or other special needs who need special accommodations in this course are invited to share these concerns or requests with the instructor as soon as possible.

Academic integrity

All work in this course must be completed in a manner consistent with NDSU University Senate Policy, Section 335: Code of Academic Responsibility and Conduct. www.ndsu.nodak.edu/policy/335.htm

Biofuels

ABEN 499/696

Department of Agricultural and Biosystems Engineering

NDSU
North Dakota State University

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This course is open to students from a variety of engineering and science disciplines and will benefit from the diversity of student backgrounds. Because students will be enrolled from programs such as biotechnology and crop science, the science and technology aspects will be emphasized over the engineering. A broad course covering biofuels almost demands an interdisciplinary approach because topics from agriculture, chemistry, biochemistry, microbiology and thermodynamics all are relevant.

The intention is to look at the system for biofuels from resource base to production to conversion and utilization. Process energetics will be an important part of the class. We will cover energy requirements for physical, chemical and biological conversion processes and the energy yields from those products. Energy balances and efficiencies will be calculated for liquid, gaseous and solid fuels.

The course will cover the fundamentals of physical (dewatering, densification, separation, etc.), chemical (catalytic conversion of biogas to liquid fuels, biodiesel production, pretreatment of lignocellulosic materials for ethanol production, etc.) or biological (fermentation, biogas production, etc.) conversion processes and the equipment used for those processes. Reactor configurations, such as plug-flow reactors and completely stirred tank reactors, will be discussed for anaerobic digestion systems.

Most problems will focus on topics such as conversion efficiencies of biological resources, amounts of biomass needed to supply a given energy requirement for various processes or the potential energy production of a biomass resource. A final project (written and oral) of the students' choosing will account for 40 percent of the final grade. Engineering students will be encouraged to complete a project more relevant to their specific discipline that would include a stronger design and/or engineering component.

Some questions that will be addressed during the course:

- What is the current and future biomass resource base?
- What factors must be considered when deciding on which harvest, storage and conversion processes to use?
- How efficient are the various conversion technologies?
- What is the net energy balance for different conversion technologies?
- What are the advantages and disadvantages (economics, technology, waste products) of biofuels in general and specific energy technologies?
- What questions remain unanswered and where is research heading

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3 credits
Two lectures (75 minutes) per week

Prerequisites

Junior standing in a science or engineering field or by permission of instructor

Instructor

Scott W. Pryor
104 Agricultural and Biosystems Engineering
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Fax: (701) 231-1008
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Office hours

Mondays and Thursdays noon to 1 p.m. or by appointment. Drop-ins are acceptable at other times but instructor availability cannot always be guaranteed. Students also are welcome to call or send questions via e-mail.

Topic outline

(based on two 75-minute classes per week)

1. Introduction
2. Current energy consumption and resources
3. Chemistry/engineering background
4. Biomass energy markets
5. Biomass resources
    a. Virgin biomass
    b. Waste biomass
    c. Land use
6. Harvesting and storage
7. Biomass potential
8. Current policies, economic factors (Cole Gustafson)
9. Transportation issues (Mark Berwick, Mark Lofgren)
10. Agronomics (Burton Johnson)
11. Farm level impacts (Dwight Aakre)
12. Physical conversion
    a. Drying
    b. Size reduction
    c. Densification
    d. Separation
13. Thermal conversion
    a. Combustion
    b. Pyrolysis/liquefaction
    c. Gasification
14. Corn ethanol
    a. Dry grind
    b. Wet milling
    c. Fermentation
    d. Coproducts
    e. Energy balance
15. Cellulosic ethanol
    a. Process overview
    b. Pretreatment technologies
    c. Hydrolysis
    d. Fermentation
    e. Coproducts
    f. Energy balance
    g. Gasification/fermentation
16. Biodiesel (Dennis Wiesenborn)
    a. Vegetable oil inputs – quantity/quality
    b. Conversion technologies
    c. Coproducts
    d. Properties
    e. Use
17. Biogas
    a. Landfill gas recovery
    b. Anaerobic digestion of animal waste
18. Policy and economics – looking forward (Cole Gustafson)
19. Project presentations