

Bioenergy & Sustainability		BIOEN
		Course Glossary

BIOEN

Course Glossary

Terms used within the Bioenergy Curriculum

Definitions without a citation are taken from the BIOEN curriculum documents.

This material is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under Agreement No. 2007-51130-03909. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.

Aquifer

A geological formation containing or conducting ground water, especially one that supplies the water for wells, springs. (Dictionary.com Unabridged. Retrieved March 4, 2011, from Dictionary.com website: <http://dictionary.reference.com/browse/Aquifer>)

Bagasse

The fibrous material left after sugarcane or sweet sorghum has been crushed and the juice extracted. It can be used directly as a feedstock for cellulosic biofuel production.

Biochar or Black Carbon

Biochar is a form of charcoal resulting from gasification and pyrolysis. It is used most commonly as a fertilizer or soil amendment.

Biochemical Oxygen Demand (BOD)

The biological activity associated with disposal of the untreated or minimally treated wastewater with a high organic content that creates anaerobic conditions in the soil which causes release of the naturally occurring iron, manganese and arsenic that had been adsorbed onto soil particles to a form that is soluble in groundwater.

Biodiesel

A diesel fuel substitute that can be made from a variety of oils, fats, and greases. It is made by reacting vegetable oil, animal fat or microalgae oils with an alcohol and a catalyst to separate the glycerin from the oil or fat. The resulting product, biodiesel, is thinner than the original oil or fat and thus works better in a diesel engine. ("Introduction to Biodiesel" (n.d.). Accessed July 12, 2011 <http://create.extension.org/node/3427>)

Bioeconomy

A bioeconomy is an economy where the basic building blocks for industry and the raw materials for energy are derived from plant/crop-based (i.e. renewable) sources. (Bioeconomy Institute (n.d.). "Glossary of Biorenewables Terms." Accessed July 12, 2011 <http://www.biorenew.iastate.edu/resources/glossary-of-biorenewables-terms.html>)

Bioenergy

The renewable energy derived from recently living biological material, or biomass.

Bioenergy Crops

Crops grown specifically for bioenergy production including starch-based crops (corn, wheat, barley), cellulosic crops (switchgrass, *Miscanthus* spp., sorghums and other perennial warm season grasses, and poplars) and oilseed crops (canola, oriental mustard, camelina, pennycress). (*Module 1: Introduction to Bioenergy, Unit 1*)

Algae

Algae include cellular and micro-cellular plants that live in water. They conduct photosynthesis and store various forms of carbon. Algae have the potential to produce energy and other high value bioproducts.

Brassica spp.

Members of the mustard family grown for the high levels of oil produced in their seed. Important Brassica species include canola (rape), oriental mustard and camelina.

Corn

Seed from corn is currently the primary crop used to make ethanol in the U.S. Starch in the seed is converted to ethanol through fermentation and distillation. Stover can also be used for cellulosic ethanol production.

Miscanthus spp.

A tall perennial grass that has been evaluated as a new bioenergy crop. Most of the *Miscanthus* cultivars proposed as a commercial crop are sterile hybrids (*Miscanthus* x *giganteus*). (Questions and Answers about *Miscanthus* (n.d.). Bioenergy Feedstock Information Network, Oak Ridge National Laboratory. Accessed March 11, 2011. <http://bioenergy.ornl.gov/papers/miscanthus/miscanthus.html>)

Poplar

A short rotation, fast growing tree that can be used for pulpwood or to make cellulosic ethanol.

Sweet Sorghum

A potential bioenergy crop being evaluated for the high level of sugar in the sap of the stalk. In the south, this sap is pressed out and used to make molasses. Once the sap is squeezed out, the remainder of the stalk or bagasse can be used as feedstock for cellulosic ethanol production.

Soybeans

An oilseed crop common in the U.S.. Oil from the seed can be used to make biodiesel. The cost of the crop and value for food grade oil make soybean only marginally valuable as a biodiesel feedstock.

Sugarcane

Grown only in the southernmost parts of the U.S., sugar squeezed from the stalks can be used to make ethanol. The remaining part of the plant (bagasse) can be used to make cellulosic feedstock. Research is being done to breed cold tolerance into sugarcane so that it can be grown in a larger area in the U.S.

Switchgrass

Panicum virgatum is a warm season perennial grass native to the tallgrass prairies once found across much of the U.S., and now grown mainly as a forage crop or as ground cover in the Conservation Reserve Program and wildlife habitat programs. Its rapid growth rate and winter hardiness make it an attractive biomass crop for biofuel production. The crop can be fermented into biofuel or burned as an energy source for producing grain ethanol.

(Switchgrass (n.d.) Iowa State University Department of Agronomy. Retrieved March 11, 2011, <http://www.extension.iastate.edu/publications/ag200.pdf>)

Willow

A short rotation woody crop that can be grown on marginal lands. Willow can be used as feedstock for cellulosic ethanol or can be burned to generate electricity in cogeneration plants.

Bioenergy Facility, also Biorefinery

An industrial facility that produces ethanol (feedstock fermented into mash, then distilled which separates the solid and liquids).

Biofuels

Liquid, gas and solid fuels produced from two types of biomass materials – plant sugars and starches (e.g., grains), and lignocellulosic materials (e.g., leaves, stems and stalks). Liquid and gas biofuels are produced through fermentation (bioethanol), gasification (syngas), pyrolysis (syngas and biochar), torrefaction (bio-coal), and transesterification (biodiesel).

Biomass

The majority of biomass for bioenergy feedstocks comes from three sources: forests (wood, wood wastes), agriculture (agricultural crops and wastes), and waste (animal wastes, livestock operation residues, mill residues and industrial wastes). However, non-forest conservation lands, such as grasslands and savannahs, and algaculture (cultivation of algae) are also potential sources of bioenergy feedstocks.

Biopower

Electricity generated from combustion of biomass or in combination with coal, natural gas or other fuel (termed co-firing). Heat and steam, or a combination of both, may also be produced through combustion of biomass, and may be produced in co-generation with electricity. The heat and/or electricity produced from biomass energy systems is usually measured in J/g (Joules of energy per gram of fuel), MJ/g, or GJ/g.

Biotechnology

The use of living organisms or other biological systems in the manufacture of drugs or other products or for environmental management, as in waste recycling: includes the use of bioreactors in manufacturing, microorganisms to degrade oil slicks or organic waste, genetically engineered bacteria to produce human hormones, and monoclonal antibodies to identify antigens.

(Dictionary.com Unabridged. Retrieved March 4, 2011, from Dictionary.com website: <http://dictionary.reference.com/browse/Biotechnology>)

Cap and Trade

A cap and trade system is one in which a central authority (usually a government or international body) sets a limit or "cap" on the amount of a pollutant that can be emitted. Companies or other groups are issued emission permits and are required to hold an equivalent number of allowances (or credits) which represent the right to emit a specific amount. The total amount of allowances and credits cannot exceed the cap, limiting total emissions to that level.

(http://cop.extension.org/wiki/Cap_and_trade. Retrieved March 4, 2011)

Carbon-Neutral

Balancing the amount of carbon released by use of energy (e.g. burning fossil fuels and biomass or decomposition of plant biomass) with an equivalent amount put into and stored in soils, plant and animal tissues, or other material such as the ocean floor.

Carbon Sequestration

Long-term storage of carbon in the terrestrial biosphere, underground, or oceans, so that the buildup of carbon dioxide (a principle greenhouse gas) concentration in the atmosphere reduces or slows.

(http://cop.extension.org/wiki/Carbon_Sequestration, accessed March 1, 2011).

Combined heat and power (CHP) or Cogeneration

The simultaneous production of electricity and heat from a single fuel source. Heat from an industrial process can be used to power an electric generator, used for industrial processes, or space and water heating purposes.

Corporate Average Fuel Economy (CAFE) Atandards

CAFE is the sales weighted average fuel economy, expressed in miles per gallon (mpg), of a manufacturer's fleet of passenger cars or light trucks with a gross vehicle weight rating (GVWR) of 8,500 lbs. or less, manufactured for sale in the United States, for any given model year. Fuel economy is defined as the average mileage traveled by an automobile per gallon of gasoline (or equivalent amount of other fuel) consumed as measured in accordance with the testing and evaluation protocol set forth by the Environmental Protection Agency (EPA).

(CAFE Overview - Frequently Asked Questions (n.d.). National Highway Traffic Safety Administration. Retrieved March 4, 2011, <http://www.nhtsa.gov/cars/rules/cale/overview.htm>)

Dead Zone

An area in a body of water with insufficient oxygen to suport life.

Densification

Any number of densification processes are used to make a fuel easier to transport and handle, and work better as a combustion fuel. Pelletizing, briquetting, and cubing reduce volume. In-woods pyrolysis can convert forest biomass into liquid form.

(Taylor, Eric L. Holley, A. Gordon and Blazier, Mike (2011). "Comparisons of In-Woods Densification Options in the Western Gulf." Accessed July 7, 2011 <http://create.extension.org/node/27089>.)

Disinfection by products (DBPs)

DBPs are formed when disinfectants used in water treatment plants react with bromide and/or natural organic matter (i.e., decaying vegetation) present in the source water.

(Disinfection Byproducts: A Reference Resource (n.d.). U.S. EPA, accessed March 11, 2011 http://www.epa.gov/envirofw/html/icr/gloss_dbp.html).

Dried Distillers Grains (DDGs)

A cereal by-product of the corn grain ethanol distillation process that has been dried to 10-12 percent moisture for storage purposes.

(*Module 1: Introduction to Bioenergy, Unit 2*)

Due Diligence

Such diligence as a reasonable person under the same circumstances would use, of reasonable but not necessarily exhaustive efforts. In the context of business, due diligence is the care that a prudent person might be expected to exercise in the examination and evaluation of risks affecting a business transaction.

(Merriam-Webster's Dictionary of Law (n.d.). Retrieved March 11, 2011, from Dictionary.com website: <http://dictionary.reference.com/browse/due> diligence)

Ecological Impacts

The effects on ecosystems and species within them (including humans).

Ecosystem Services

Provisioning; the goods and products obtained from ecosystems, including food and fiber - both cultivated and wild. Regulating; the benefits derived from ecosystems' control of natural processes such as erosion and natural hazards. Supporting; the services that are necessary for non-humans and maintenance of all other ecosystem services. Cultural; recreational, educational and spiritual benefits

[The Millennium Ecosystem Assessment (2005). Food and Agriculture Organization of the United Nations in *Module 1: Introduction to Bioenergy, Unit 3*]

Environmental Impacts

The effects on geophysical systems such as water and climate.

Evapo-ranspiration

The water lost by a plant through evaporation and transpiration.

Feedstock

Pre-processing biomass (Stems, stalks, leaves or seed from annual, perennial, or woody crops) used for the generation of bioenergy and the creation of other bioproducts.

Feasibility Study

Analysis of the practicality of a proposed plan or method, based on factors like marketplace, competition, available technology, human resources, and financial resources. Feasibility studies use standard methods and reporting formats.

(Dictionary.com's 21st Century Lexicon (n.d.). Retrieved March 11, 2011, from Dictionary.com website: <http://dictionary.reference.com/browse/feasibility> study).

First Generation Biofuels

Alcohols produced through fermentation of sugars derived from wheat, corn, sugar cane, etc.

Fourth Generation Biofuels

Syngas, char and bio-coal derived in bio-chemical and thermo-chemical processes such as pyrolysis, gasification and torrefaction.

Glycerol or Glycerin

The primary co-product of the transesterification process used in biodiesel production.

Greenhouse Gas (GHG)

Gases in the atmosphere that absorb and emit thermal radiation. Primary GHGs are water vapor, carbon dioxide, methane, nitrous oxide, and ozone.

Greenhouse Gas Emissions

Those greenhouse gases emitted solely through human activities, and through secondary processes that are a result of human land use (e.g. land use changes that result in GHG emissions, such as changes in soil respiration). Power plants are the biggest contributor to annual GHG emissions, followed by industrial processes, and transportation fuels. The principal greenhouse gases that enter the atmosphere because of human activities are:

Carbon Dioxide (CO₂) enters the atmosphere through the burning of fossil fuels, solid waste, trees and wood products, from soil disturbance, and also as a result of other chemical reactions such as the manufacture of cement.

Methane (CH₄) is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.

Nitrous Oxide (N₂O) is emitted during agricultural activities (agricultural soil management, animal manure management, application of nitrogenous fertilizer, soil disturbance), as well as during combustion of fossil fuels and solid waste.

Fluorinated Gases (Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride) are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes.

(Greenhouse Gas Emissions, U.S. EPA, accessed March 11, 2011 <http://www.epa.gov/climatechange/emissions/index.html>)

Greenhouse effect

The mechanism by which solar radiation is captured and earth is warmed to an extent necessary for supporting life.

Herbaceous Crops

Those crops whose stem does not produce woody tissue and which generally die back at the end of each growing season. This includes grasses, forbs and herbs. Herbaceous bioenergy crops are Miscanthus spp., switchgrass, corn, sorghum, sugarcane, alfalfa, and soybeans.

(The American Heritage® Science Dictionary (n.d.). Retrieved March 15, 2011, from Dictionary.com website: <http://dictionary.reference.com/browse/herbaceous>.)

Hydrology

The study of the distribution, conservation, use, etc, of the water of the earth and its atmosphere, particularly at the land surface.

(Collins English Dictionary - Complete & Unabridged 10th Edition. Retrieved March 04, 2011, from Dictionary.com website: <http://dictionary.reference.com/browse/hydrology>)

Infiltration

The flow of a fluid into a substance through pores of small openings. It connotes flow into a substance in contradistinction to the word percolation.

(From: Society for Range Management. 1998. Glossary of terms used in range management, fourth edition. Edited by the Glossary Update Task Group, Thomas E. Bedell, Chairman. - <http://cop.extension.org/wiki/Infiltration>. Accessed March 4, 2011.)

Intangible infrastructure

Includes public policy, regulatory structures, quality standards, and marketing institutions.

Integrated Pest Management (IPM)

The use of several different methods of controlling a particular pest or group of pests, rather than relying solely on a single method of control. IPM is a holistic approach to pest management.

(<http://cop.extension.org/wiki/IPM>. Accessed March 4, 2011.)

Living Wage

A wage rate required to meet minimum [community] standards of living.

(Living Wage Calculator, Pennsylvania State University Department of Geography, retrieved March 4, 2011, <http://www.livingwage.geog.psu.edu/>)

MMBTU

One million British Thermal Units (BTUs), a standard unit of measure. The energy of one MMBTU is roughly equivalent to the energy in 7.14 gallons of #2 oil or 293 KW of electricity.

Monoculture

The production of the same plants over a large area, with no other types of plants present. (Urban Integrated Pest Management: Glossary Terms (2011). Accessed July 7, 2011. <http://create.extension.org/node/19039#M.>)

Nitrates, Nitrites

Chemical that are water soluble and highly leachable. They can move with precipitation runoff or infiltration. Nitrates and nitrites are health concerns in drinking water for both humans and livestock.

Particulate Matter

Minute, solid, airborne particles that result from combustion.
(http://cop.extension.org/wiki/Particulate_Matter. Retrieved March 1, 2011).

Perennial bioenergy crops

Perennial bioenergy crops include herbaceous and woody crops grown for their cellulose. Perennial herbaceous crops include grasses like switchgrass and Miscanthus spp. Perennial non-forest woody crops include hybrid poplar and other fast-growing trees. Perennial crops typically have lower input requirements partly due to the fact that they don't have to be planted each year.
(*Module 1: Introduction to Bioenergy, Unit 2*)

Polyculture

Ecologically designed, mixed-crop planting that maximizes biological diversity.
(Spicer, Lynette (2010). "Ohio State University Urban Farming Study: What's the Best Way to Turn a Parking Lot into a Garden?" accessed July 7, 2011. <http://create.extension.org/node/8351.>)

Pyrolysis

The thermal decomposition of biomass at high temperatures (greater than 200° C) in the absence of air. The end products are solids (char), liquids (oxygenated oils), and gases (methane, carbon monoxide, and carbon dioxide). (Ashton, Sarah (2009). "Pyrolysis." Accessed July 7, 2011. <http://create.extension.org/node/26879>.)

Renewable energy

The energy contained in biomass is energy from the sun captured through natural processes of photosynthesis. As long as the quantity of biomass used is equal to or less than the amount that can be regrown or regenerated, it is potentially renewable indefinitely. Energy derived from sources such as sunlight, wind, tides, geothermal, and flowing water is also considered renewable because these sources are constantly being replenished by natural processes. These energy sources can be used indefinitely, unlike non-renewable energy sources such as petroleum, coal, and other fossil fuels.

Renewable Portfolio Standards (RPS)

An RPS requires electric utilities and other retail electric providers to supply a specified minimum amount of customer load with electricity from eligible renewable energy sources.
(US EPA, Renewable Portfolio Standards Fact Sheet. Retrieved 4 March 2011, http://www.epa.gov/chp/state-policy/renewable_fs.html#fn1)

Return On Investment

ROI is a performance measure used to evaluate the efficiency of an investment. To calculate the benefit (return) of an investment is divided by the cost of the investment; the result is expressed as a percentage or a ratio. $ROI = (\text{gain from investment} - \text{cost of investment}) / \text{cost of investment}$.
(Return On Investment – ROI. Investopedia. Retrieved March 4, 2011, <http://www.investopedia.com/terms/r/returnoninvestment.asp>)

Ridge-till

Row crop cultivation for weed control that builds ridges then plants into the ridge the following year.

Second Generation Biofuels

Fuels produced from non-food crops (such as perennial grasses). Cellulosic plant materials, for example, are used to produce cellulosic ethanol.

Sedimentation

The accumulation of matter settling to the bottom of a liquid.
(Dictionary.com Unabridged and Collins English Dictionary - Complete & Unabridged 10th Edition.. Retrieved March 4, 2011, from Dictionary.com website: <http://dictionary.reference.com/browse/sedimentation>)

Slash

Logging slash is any material left on the ground after trees have been cut. (Kiesel, Linda (2011). "What is Logging Slash?" Accessed 7 July 2011. <http://create.extension.org/node/74748>.)

Stomata (pl), Stomate (sing.)

Small pores usually on the underside of leaves for gaseous exchange (of water vapor, oxygen, and carbon dioxide).
(<http://cop.extension.org/wiki/Stomate>. Retrieved March 4, 2011.)

Strip-till

Tilling only part of the field in the row zone for the subsequent crop to be planted.

Sustainability

Sustainability can be described as 1) a set of goals; 2) practices and behavior that support such goals; and 3) a branch of science. The most popular definition of sustainability can be traced to a 1987 UN conference on Environment and Development. It defined sustainable developments as those that "meet present needs without compromising the ability of future generations to meet their needs"(UN Report of the World Commission on Environment and Development: Our Common Future, 1987).

Tax Increment Financing (TIF)

TIF is used by cities and other development authorities to finance certain types of development costs for redevelopment of blighted areas, construction of low- and moderate income housing, provision of employment opportunities, and improvement of the tax base. With TIF, a city "captures" the additional property taxes generated by the development that would have gone to other taxing jurisdictions and uses the "tax increments" to finance the development costs. Development in a TIF district is usually encouraged with infrastructure improvements and incentives.
(Tax Increment Financing (1996). Minnesota Office of the Legislative Auditor. Accessed March 4, 2011 <http://www.auditor.leg.state.mn.us/ped/1996/Tif.htm>. http://cop.extension.org/wiki/Tax_Increment_Financing, Retrieved March 4, 2011.)

Third generation biofuels

Those derived from algae.

Tilth

The workability of soil. (<http://cop.extension.org/wiki/Tilth>. Retrieved March 4, 2011.)

Transpiration

The release of water vapor from plant parts, especially the leaves via stomates.

Trihalomethanes (THMs)

Any of various organic compounds that can occur in chlorinated water as a result of reaction between organic materials in the water and chlorine added as a disinfectant. Trihalomethanes are thought to be carcinogenic.
(The American Heritage® Science Dictionary. Retrieved March 4, 2011, from Dictionary.com website: <http://dictionary.reference.com/browse/trihalomethane>.)

Water Cycle/Hydrologic Cycle

The continuous movement of water on, in and above the surface of the earth

Watershed

The area of land that drains to a common point (lake, river, etc.).

Wet Distillers Grains (WDGs)

A cereal by-product of the corn-grain ethanol distillation process that has not been dried, which means that it has a much shorter storage window than dried distillers grains.

(Module 1: Introduction to Bioenergy, Unit 2)