

## APPENDIX B

# Glossary

### A

- **agricultural residue:** Plant parts, primarily stalks and leaves, not removed from fields with the primary food or fiber product. Examples include corn stover (stalks, leaves, husks, and cobs), wheat straw, and rice straw.
- **algae:** Simple photosynthetic plants containing chlorophyll, often fast growing and able to live in freshwater, seawater, or damp soils. May be unicellular and microscopic or very large, as in the giant kelps.
- **anaerobic:** Living or active in an airless environment.
- **anaerobic digestion:** Degradation of organic matter by microbes in the absence of oxygen to produce methane and CO<sub>2</sub>.

### B

- **benzene:** Aromatic component of gasoline that is a known cancer-causing agent.
- **biodiesel:** Biodegradable transportation fuel used in diesel engines. Biodiesel is produced through transesterification of organically derived oils and fats. It may be used either as a replacement for or component of diesel fuel.
- **bioenergy:** Renewable energy produced from biomass.
- **biofuels:** Fuels for transportation made from biomass or its derivatives after processing. The major biofuels include ethanol and biodiesel.
- **biogas:** Gaseous mixture of CO<sub>2</sub> and methane produced by anaerobic digestion of organic matter.

- **biomass:** Any plant-derived organic matter. Biomass available for energy on a sustainable basis includes herbaceous and woody energy crops, agricultural food and feed crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, and other waste materials, including some municipal wastes.
- **biopower:** Use of biomass to produce electricity and heat.
- **bioproducts:** Commercial or industrial products (other than food or feed) that are composed in whole or significant part of biomass.

### C

- **carbohydrate:** Organic compounds made up of carbon, hydrogen, and oxygen and having approximately the formula (CH<sub>2</sub>O)<sub>n</sub>; includes cellulose, starches, and sugars.
- **carbon dioxide:** (CO<sub>2</sub>) Naturally occurring gas, and also a by-product of burning fossil fuels and biomass, as well as land use changes and other industrial processes. It is the principal anthropogenic GHG that affects the earth's radiative balance.
- **carbon monoxide:** (CO) Colorless, odorless, poisonous gas produced by incomplete combustion.
- **catalyst:** Substance that increases the rate of a chemical reaction without being consumed or produced by the reaction. Enzymes are catalysts for many biochemical reactions.
- **cellulase:** Family of enzymes that break down cellulose into glucose molecules.

- **cellulose:** Carbohydrate that is the principal constituent of wood and other biomass and forms the structural framework of the wood cells.
- **chips:** Small fragments of wood chopped or broken by mechanical equipment. Total tree chips include wood, bark, and foliage. Pulp chips or clean chips are free of bark and foliage.
- **cofiring:** Use of a mixture of two fuels within the same combustion chamber.
- **cogeneration:** Technology of producing electric energy and another form of useful energy (usually thermal) for industrial, commercial, or domestic heating or cooling purposes through sequential use of the energy source. Also called combined heat and power (CHP).
- **combustion:** Chemical reaction between a fuel and oxygen that produces heat (and usually light).
- **coproducts:** Resulting substances and materials that accompany production of a fuel product such as ethanol.
- **corn stover:** Refuse of a corn crop after the grain is harvested.
- **criteria pollutants:** Pollutants regulated under the federal NAAQS, which were established under the Clean Air Act. Criteria pollutants include CO, lead, nitrogen dioxide, PM (PM2.5, PM10), ground-level ozone, and SO<sub>2</sub>.

## D .....

- **digester:** Biochemical reactor in which anaerobic bacteria are used to decompose biomass or organic wastes into methane and CO<sub>2</sub>.

## E .....

- **E10:** Mixture of 10 percent ethanol and 90 percent gasoline based on volume.
- **E85:** Mixture of 85 percent ethanol and 15 percent gasoline based on volume.
- **effluent:** Liquid or gas discharged after processing activities, usually containing residues from such use. Also discharge from a chemical reactor.
- **energy crop:** Crop grown specifically for its fuel value. These include food crops such as corn and sugar cane, and nonfood crops such as poplar trees and switchgrass.

- **enzyme:** Protein or protein-based molecule that speeds up chemical reactions in living things. Enzymes act as catalysts for a single reaction, converting a specific set of reactants into specific products.
- **ester:** Compound formed from the reaction between an acid and an alcohol.
- **ethanol:** (CH<sub>3</sub>CH<sub>2</sub>OH) A colorless, flammable liquid produced by fermentation of sugars. Ethanol is used as a fuel oxygenate. Ethanol is the alcohol found in alcoholic beverages, but is denatured for fuel use.
- **eutrophic conditions:** In surface waters, conditions such as significant algae growth and subsequent oxygen depletion, which can be caused by excessive nutrients from fertilizers, pesticides, and herbicides. Some aquatic species cannot survive eutrophic conditions.

## F .....

- **feedstock:** Any material used as a fuel directly or converted to another form of fuel or energy product.
- **fermentation:** Biochemical reaction that breaks down complex organic molecules (such as carbohydrates) into simpler materials (such as ethanol, CO<sub>2</sub>, and water). Bacteria or yeasts can ferment sugars to ethanol.
- **fluidized bed:** Gasifier or combustor design in which feedstock particles are kept in suspension by a bed of solids kept in motion by a rising column of gas. The fluidized bed produces approximately isothermal conditions with high heat transfer between the particles and gases.
- **forestry residues:** Includes tops, limbs, and other woody material not removed in forest harvesting operations in commercial hardwood and softwood stands, as well as woody material resulting from forest management such as precommercial thinnings and removal of dead and dying trees.
- **fossil fuel:** Carbon or hydrocarbon fuel formed in the ground over millions of years from the remains of dead plants and animals. Oil, natural gas, and coal are fossil fuels.

## G .....

- **gasification:** Any chemical or heat process used to convert a feedstock to a gaseous fuel.
- **greenhouse gas:** Gas—such as water vapor, CO<sub>2</sub>, tropospheric ozone, methane, and low-level ozone—that contributes to the greenhouse effect.

## H

- **hemicellulose:** Hemicellulose consists of short, highly branched chains of sugars. In contrast to cellulose, which is a polymer of only glucose, a hemicellulose is a polymer of five different sugars.
- **herbaceous plants:** Non-woody species of vegetation, usually of low lignin content, such as grasses.
- **herbaceous energy crops:** Perennial non-woody crops that are harvested annually, though they may take two to three years to reach full productivity. Examples include switchgrass (*Panicum virgatum*), reed canary grass (*Phalaris arundinacea*), miscanthus (*Miscanthus x giganteus*), and giant reed (*Arundo donax*).
- **hydrolysis:** Conversion, by reaction with water, of a complex substance into two or more smaller units, such as conversion of cellulose into glucose sugar units.

## I

## K

## L

- **landfill gas:** Biogas produced from natural degradation of organic material in landfills. By volume, LFG is about 50 percent methane and 50 percent CO<sub>2</sub> and water vapor.
- **life-cycle analysis:** Assessment of the impacts from all stages of a product's development, from extraction of fuel for power to production, marketing, use, and disposal.
- **lignin:** Structural constituent of wood and other native plant material that encrusts the cell walls and cements the cells together.
- **lignocellulose:** Plant materials made up primarily of lignin, cellulose, and hemicellulose.

## M

- **methane:** (CH<sub>4</sub>) The major component of natural gas. It can be formed by anaerobic digestion of biomass or gasification of coal or biomass.
- **methanol (wood alcohol):** (CH<sub>3</sub>OH) Alcohol formed by catalytically combining carbon monoxide with hydrogen in a 1:2 ratio under high temperature and pressure.

- **microorganism:** Any microscopic organism such as yeast, bacteria, fungi, etc.
- **municipal solid waste:** Any organic matter, including sewage, industrial, and commercial wastes, from municipal waste collection systems. Municipal waste does not include agricultural and wood wastes or residues.

## N

- **net energy balance:** Total amount of energy used over the full life cycle of a fuel, from feedstock production to end use.
- **nitrogen oxides:** (NO<sub>x</sub>) Product of photochemical reactions of nitric oxide in ambient air, and the major component of photochemical smog.
- **nonrenewable resource:** One that cannot be replaced as it is used. Although fossil fuels, such as coal and oil, are in fact fossilized biomass resources, they form at such a slow rate that, in practice, they are nonrenewable.

## O

- **opportunity fuels:** Biomass feedstocks derived from waste materials that would otherwise go unused or would be disposed of. Bioenergy production provides an opportunity to productively use these materials.
- **oxygenate:** Compound that contains oxygen in its molecular structure. Ethanol and biodiesel act as oxygenates when they are blended with conventional fuels. Oxygenated fuel improves combustion efficiency and reduces tailpipe emissions of CO.

## P

- **particulates:** Fine liquid or solid particle, such as dust, smoke, mist, fumes, or smog, found in air or emissions.
- **petroleum:** Any substance composed of a complex blend of hydrocarbons derived from crude oil, including motor fuel, jet oil, lubricants, petroleum solvents, and used oil.
- **pyrolysis:** Breaking apart of complex molecules by heating in the absence of oxygen, producing solid, liquid, and gaseous fuels.

## R

- **renewable energy resource:** Energy resources that can be replaced as they are used, including solar, wind, geothermal, hydro, and biomass. MSW is also considered a renewable energy resource.
- **residues, biomass:** By-products from processing all forms of biomass that have significant energy potential. For example, making solid wood products and pulp from logs produces bark, shavings, sawdust, and spent pulping liquors. Because these residues are already collected at the point of processing, they can be convenient and relatively inexpensive sources of biomass for energy.

## S

- **silviculture:** Science and practice of growing trees for human use.
- **stover:** Dried stalks and leaves of a crop remaining after the grain has been harvested.
- **syngas:** Synthesis gas produced by the gasification process using biomass feedstock. Syngas can be burned in a boiler or engine to produce electricity or heat, and can be used to produce a liquid for biofuels production.

## T

- **tar:** Liquid product of thermal processing of carbonaceous materials.
- **thermochemical conversion:** Use of heat to change substances chemically to produce energy products.
- **transesterification:** Chemical process that reacts an alcohol with triglycerides contained in vegetable oils and animal fats to produce biodiesel and glycerin.

## U

## V

- **volatile:** Solid or liquid material that easily vaporizes.

## W

## X

- **xylose:** ( $C_5H_{10}O_5$ ) Five-carbon sugar that is a product of hydrolysis of xylan found in the hemicellulose fraction of biomass.

## Z

- **zero net contribution:** Refers to a process that results in contribution of no additional carbon emissions to the atmosphere. For example, combustion of biomass feedstocks returns the same amount of  $CO_2$  to the atmosphere that was absorbed during growth of the biomass, resulting in no additional  $CO_2$  released into the air.

Source: Adapted from National Renewable Energy Laboratory (NREL) Glossary of Biomass Terms, [www.nrel.gov/biomass/glossary.html](http://www.nrel.gov/biomass/glossary.html)