

APPENDIX A: GLOSSARY

RENEWABLE FUELS ROADMAP AND SUSTAINABLE BIOMASS FEEDSTOCK SUPPLY FOR NEW YORK

Final Report

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Glossary of Terms

A

Acetaldehyde

Acetaldehyde is the major metabolite of ethanol. Many of the adverse effects of ethanol are attributed to acetaldehyde. Mainly used as an intermediate in the synthesis of other chemicals. It is ubiquitous in the environment and may be formed in the body from the breakdown of ethanol. Acute (short-term) exposure to acetaldehyde results in effects including irritation of the eyes, skin, and respiratory tract. Symptoms of chronic (long-term) ingestion of acetaldehyde resemble those of alcoholism. Acetaldehyde is considered a probable human carcinogen based on animal studies. Acetaldehyde is also released to the environment from the combustion of fuels.

Acid Hydrolysis

The treatment of cellulosic, starch, or hemicellulosic materials using acid solutions (usually mineral acids) to break down the complex sugars (sugar chains) to simple sugars.

Agricultural Residue

Agricultural crop residues are the plant parts, primarily stalks and leaves, not removed from the 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. Algae are a potential biofuels feedstock.

Anaerobic Digester

An enclosed system designed to optimize naturally occurring anaerobic bacteria to accelerate decomposition of the feedstock.

Anaerobic Digestion

Degradation of organic matter by microbes in the absence of oxygen to produce methane and carbon dioxide.

Annual Crop

A crop that completes its life cycle within a one year period.

B

B20

A mixture of 20% biodiesel and 80% conventional diesel.

B100

Pure (100%) biodiesel.

Barren Land (Rock/Sand/Clay)

Barren areas of bedrock, desert pavement, scarps, talus, slides, glacial debris, sand dunes, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.

Baseline Assessment (also Baseline Data)

A baseline assessment is an assessment that is usually undertaken before a biofuel operation is initiated to provide data on the local environmental and social context prior to the initiation of the project. This data on the baseline context would then be compared with the results of future monitoring and/or targets to assess the impacts of the operation and inform ongoing management of impacts.

Benzene

An aromatic component of gasoline: a known cancer-causing agent.

Biobutanol

Alcohol containing four carbon atoms per molecule, produced from the same biomass-based feedstocks as ethanol, but with a modified fermentation and distillation process. Less water-soluble than ethanol, biobutanol has a higher energy density and can be transported by pipeline more easily.

Bioconversion

A general term describing the use of biological systems to transform one compound into another. Examples are digestion of organic wastes or sewage by microorganisms to produce methane and the synthesis of organic compounds from carbon dioxide and water by plants.

Biodiesel

A biodegradable transportation fuel for use in diesel engines. Biodiesel, a fatty acid methyl ester, is produced through the transesterification of organically-derived oils or fats. It may be used either as a replacement for or as a component of diesel fuel. Note that “straight vegetable oil,” “green diesel,” and “renewable diesel” are other replacements for diesel fuel, but are chemically distinct from biodiesel and from each other.

Bioenergy

The production, conversion, and use of biomass to manufacture fuels and substitutes for petrochemical and other energy-intensive products.

Biofuels

Biomass converted to liquid fuels such as ethanol and biodiesel.

Biogas

A gaseous mixture of carbon dioxide and methane produced by the 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 residues, wood residues.

Board Feet

The amount of wood contained in an unfinished board one inch thick, one foot long, and one foot wide.

British Thermal Units (Btus)

The amount of heat energy needed to raise the temperature of one pound of water by one degree Fahrenheit.

Buffer Zones

Buffer zones are small areas or strips of land in permanent vegetation, designed to intercept pollutants and manage other environmental concerns. Buffer zones include the regions near the border of an area that is protected or managed for conservation, transition zones between areas managed for different objectives (including e.g. riparian buffer zones between rivers and production areas), or areas on the edge of protected areas that have land use controls and allow only activities compatible with protection of the core area, such as research, environmental education, recreation, and tourism. Buffers include: riparian buffers, filter strips, grassed waterways, shelterbelts, windbreaks, living snow fences, contour grass strips, cross-wind trap strips, shallow water areas for wildlife, field borders, alley cropping, herbaceous wind barriers, and vegetative barriers.

Bushel (bu)

A bushel is a unit of volume. A standard bushel of corn weighs 56 lbs. Other materials will have other weights/bushel.

C

Carbon Debt

Amount of initial greenhouse gas emissions due to land use change that would need to be repaid before gaining any net greenhouse gas benefits from a new land use practice, such as growing soybean for biodiesel production on land that was formerly pasture.

Carbon Dioxide (CO₂)

A colorless, odorless gas produced by respiration and combustion of carbon-containing fuels. Plants use it as a food in the photosynthesis process.

Carbon Dioxide equivalent (CO₂eq)

A universal standard of measurement against which the impacts of releasing (or avoiding the release of) different greenhouse gases can be evaluated.

Carbon Monoxide (CO)

A colorless, odorless, poisonous gas produced by incomplete combustion.

Carbon Sequestration

The provision of long-term storage of carbon in the terrestrial biosphere, underground, or the oceans so that the buildup of carbon dioxide (the principal greenhouse gas) concentration in the atmosphere will reduce or slow.

Carbon Stock

The absolute quantity of carbon held in a carbon pool(s) or reservoir at a specified time and expressed in tons of Carbon per hectare (t C/ha). It is converted to greenhouse gas emissions by multiplying t C/ha by 44/12 (the ratio of the molecular weight of CO₂ to the molecular weight of carbon) to get t CO₂/ha.

Cellulose

The carbohydrate that is the principal constituent of wood and other biomass and forms the structural framework of the wood cells.

Centroid

The center of an area, region, or polygon.

Co-Firing

The use of a mixture of two fuels within the same combustion chamber.

Combined Heat and Power/Co-Generation

The technology of producing electric energy and another form of useful energy (usually thermal) for industrial, commercial, or domestic heating or cooling purposes through the sequential use of the energy source.

Corn Stover

The refuse of a corn crop after the grain is harvested, including stalks and cobs.

Criteria Pollutants

Six commonly found air pollutants regulated under the Clean Air Act – ozone, PM, CO, NOx, SOx, lead.

Crop Land

Areas used for the production of annual crops, such as corn, soybeans, vegetables, and also perennial woody crops such as orchards and vineyards. This class also includes all land being actively tilled.

Crop Rotation

The practice of alternating the annual crops grown on a specific field in a planned pattern or sequence in successive crop years so that crops of the same species or family are not grown without interruption on the same field.

Perennial cropping systems employ means such as alley cropping, intercropping, and hedgerows to introduce biological diversity in lieu of crop rotation.

D-E

Developed Land

Developed land includes areas with a mixture of constructed materials and vegetation, including low intensity, medium intensity, and high intensity development, with up to 100% impervious surface. This also includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses including large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

Dried Distiller's Grains and Solubles (DDGS)

Byproduct of dry mill ethanol production that can be used to feed livestock.

Downstream

The stage of the fuel's total lifecycle that is associated with fuel consumption, or vehicle operation.

Dry Ton/Oven-Dry Ton

Two-thousand lb of biomass on a moisture-free basis, meaning material without any water content that can be removed by oven drying.

E10

A mixture of 10% ethanol and 90% gasoline based on volume. Sold for use in traditional gasoline vehicles.

E20

A mixture of 20% ethanol and 80% gasoline based on volume.

E85

A mixture of 85% ethanol and 15% gasoline based on volume. Sold for use in FFVs.

Enterprise Budget

A written statement of goals for a crop or livestock production activity. It lists the production goals, product mix, profits and losses, fixed and variable costs, etc.

Equine Land

Land used for horses, including pasture.

Ethanol ($\text{CH}_3\text{CH}_2\text{OH}$)

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.

F

Feedstock

Raw materials that may be treated or converted to create fuels. Biomass feedstocks in New York include forestry products, crop residues, municipal waste streams, manure and food processing waste.

Field to Wheels

Accounting of the energy inputs required to produce biofuel, including land use, pesticide use, etc. (see Upstream)

Fischer-Tropsch Process

Method of producing liquid fuels, usually diesel fuel, from natural gas or synthetic gas from gasified coal or biomass.

Flexible Fuel Vehicle (FFV)

Automobile capable of running on gasoline and high-ethanol blends (such as E85) interchangeably.

Food Security

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

Forest/Forest Land

Areas dominated by trees generally greater than 15 feet tall, and greater than 20% of total vegetation cover.

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 operations such as pre-commercial thinnings and removal of dead and dying trees.

G-H

Gallon Ethanol Equivalent (GEE)

A factor that describes the number of gallons of a fuel that has the equivalent amount of energy as one gallon of ethanol.

Gallon Gasoline Equivalent (GGE)

A factor that describes the number of gallons of a fuel that has the equivalent amount of energy as one gallon of gasoline.

Gasification

Any chemical or heat process used to convert a feedstock to a gaseous fuel.

Gasifier

A device that converts solid feedstocks to gas. Generally refers to thermochemical processes.

Greenhouse Gas (GHG)

A gas, such as water vapor, carbon dioxide, tropospheric ozone, methane, and low level ozone, which contributes to the greenhouse effect.

GREET

Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model – A model developed by Argonne National Laboratory for life cycle environmental analysis.

Green Tons

A term used in the forest products industry for a U.S. ton or metric ton (tonne) of freshly cut timber, bark mulch, i.e., undried biomass material. A dry ton weighs less than a green ton (conversion used in the Roadmap: dry tons are calculated as 60% of green tons).

Gross Domestic Product

The total market values of goods and services produced by workers and capital within a nation's borders during a given period.

Hardwood

One of the botanical groups of dicotyledonous trees that have broad leaves in contrast to the conifers or softwoods. The term has no reference to the actual hardness of the wood. The botanical name for hardwoods is angiosperms. Short-rotation, fast growing hardwood trees are being developed as future energy crops. Examples include: Hybrid poplars (*Populus sp.*), Hybrid willows (*Salix sp.*), Silver maple (*Acer saccharinum*), and Black locust (*Robinia pseudoacacia*).

Hemicellulose

A component of biomass, 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. It contains five-carbon sugars (usually D-xylose and L-arabinose) and six-carbon sugars (D-galactose, D-glucose, and D-mannose), and uronic acid. The sugars are highly substituted with acetic acid. The branched nature of hemicellulose renders it amorphous and relatively easy to hydrolyze to its constituent sugars compared to cellulose. When hydrolyzed, the hemicellulose from hardwoods releases products high in xylose (a five-carbon sugar). The hemicellulose contained in softwoods, by contrast, yields more six-carbon sugars.

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 canarygrass (*Phalaris arundinacea*), Miscanthus (*Miscanthus x giganteus*), and Giant reed (*Arundo donax*).

Herbaceous Plants

Non-woody species of vegetation, usually of low lignin content such as grasses.

Higher Heating Value (HHV)

The maximum potential energy released during complete oxidation of a unit of fuel. Includes the thermal energy recaptured by condensing and cooling all products of combustion. As HHV varies with moisture content, HHV should only be presented in conjunction with moisture content.

Hundredweight (cwt)

A “hundredweight” is equal to 100 lbs.

Hydrolysis

The conversion, by reaction with water, of a complex substance into two or more smaller units, such as the conversion of cellulose into glucose sugar units.

I-L

IMPLAN Modeling System

The IMPLAN modeling system combines the U.S. Bureau of Economic Analysis' Input-Output Benchmarks with other data to construct quantitative models of trade flow relationships between businesses, and between businesses and final consumers.

Input-Output (I-O) Modeling

This is a standard method for estimating regional economic change due to alterations in industrial output, changes in consumer behavior, or some other pertinent alteration in an economy. I-O models are detailed accountings of inter-industrial transactions within an economy.

Landfill Gas

Biogas produced from the natural degradation of organic material in landfills.

Land Use

All the arrangements, activities, and inputs undertaken in a certain land cover type (a set of human actions) or the social and economic purposes for which land is managed (e.g., grazing, timber extraction, conservation).

Life Cycle Analysis (LCA)

A life cycle analysis accounts for each of the emissions events along the entire fuel-cycle chain. Life cycle analysis of biofuel production requires consideration of not only the energy, environmental, and health impacts associated with fuel consumption (i.e., “downstream effects”), but also the impacts that occur during feedstock production, fuel processing, and transportation and distribution of fuel (i.e., “upstream effects”).

Lignin

The major non-carbohydrate, polyphenolic structural constituent of wood and other native plant material that encrusts the cell walls and cements the cells together. It is a highly polymeric substance, with a complex, cross-

linked, highly aromatic structure of molecular weight about 10,000 derived principally from coniferyl alcohol ($C_{10}H_{12}O_3$) by extensive condensation polymerization. Higher heating value (oven dry basis): HHV=9111 BTU/LB (5062 CAL/G, 21178 J/G). Lignin can be a useful fuel but it typically does not ferment.

Lignocellulosic Material

Plant biomass that is composed primarily of cellulose, hemicellulose, and lignin.

Lower Heating Value (LHV)

The net energy released during oxidation of a unit of fuel excluding the heat required for vaporisation of the water in the fuel and the water produced from combustion of the fuel hydrogen. $LHV = HHV - 21.998 (H) - 2.444 (W)$.

M-N-O

Methane (CH₄)

The major component of natural gas. It can be formed by anaerobic digestion of biomass or gasification of coal or biomass.

Methyl Tertiary Butyl Ether (MTBE)

Ether created from methanol that can increase octane and decrease the volatility of gasoline, decreasing evaporation and smog formation.

Metric Ton

A metric ton is equal to 1,000 kilograms.

Mill Residues

Wood and bark residues produced in processing logs into lumber, plywood, and paper.

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.

National Biorefinery Siting Model

A biorefining industry supply chain optimization model developed for the Department of Energy and the Western Governors' Association by UC Davis, Antares, and Dr. Richard Nelson.

Nitrogen Oxides (NO_x)

Compounds formed by the oxidation of nitrogen, including nitrogen dioxide and nitric oxide. These compounds are air pollutants because they undergo photochemical reactions to form smog and ozone; they are also believed to contribute to the depletion of the earth's protective ozone layer.

Nitrous Oxide (N₂O)

A powerful greenhouse gas with a global warming potential 320 times greater than carbon dioxide. Major sources of nitrous oxide include soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

NY-GREET

A model that is based on the national GREET model developed at Argonne National Lab, but uses input assumptions relevant for New York State (such as electricity mix, fuel transportation distances, and agricultural assumptions).

Oil Seed

Crops such as soybeans and canola that are used to produce oilseed meal for animal feed and vegetable oils, which in turn may be used to produce biofuels.

Open Water

All areas of open water, generally with less than 25% cover or vegetation or soil.

P-R

Particulate Matter

Fine liquid or solid particles such as dust, smoke, mist, fumes, or smog, found in air or emissions. It is usually separated into PM₁₀ and PM_{2.5}, which are particles of diameter equal to or less than 10 and 2.5 micrometers (μm), respectively.

Pasture, Hay and Grassland

Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Also areas dominated by grass-like or herbaceous vegetation, generally greater than 80% of total vegetation.

Perennial Crop

A crop that completes its life cycle over two or more years.

Policy Lever

A policy lever is a measure intended to induce a change in behavior in order to accomplish a particular goal.

Pyrolysis

The breaking apart of complex molecules by heating in the absence of oxygen, producing solid, liquid, and gaseous fuels.

Renewable Energy Resource

An energy resource that can be replaced as it is used. Renewable energy resources include solar, wind, geothermal, hydro, and biomass. Municipal solid waste (MSW) is sometimes also considered to be a renewable energy resource.

Renewable Fuel Standard (RFS)

Legislation enacted by Congress as part of the Energy Policy Act of 2005, requiring an increasing level of biofuels be used every year, rising to 7.5 billion gallons by 2012.

Renewable Fuel Standard 2 (RFS2)

Legislation enacted by Congress under the Energy Independence and Security Act of 2007, which built upon the program designed to implement the standards set under the Energy Policy Act of 2005. It requires an increasing level of biofuels to be used each year, rising to 36 billion gallons by 2020. It also creates categories of biofuels that each have specific volumetric targets: cellulosic biofuels, biomass-based diesel, and advanced biofuels.

Residues

Byproducts from processing all forms of biomass and that have significant energy potential. For example, making solid wood products and pulp from logs produces bark, shavings and 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

Roundwood

Wood in its natural state as felled, (if applicable de-branched), and cut to length, with or without bark.

S

Short Rotation Woody Crops

Trees such as poplar and willow that can be used as feedstocks for biofuel. Benefits over traditional row crops include improved soil quality and stability, cover for wildlife, and lower inputs of energy, water, and agrochemicals.

Short Ton

In the United States, a short ton is 2,000 lbs.

Shrub & Scrub

Areas dominated by shrubs; less than 15 feet tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.

Silage

Silage is fermented, high-moisture feed given to animals like cattle and sheep. It is fermented and stored in a silo. Silage is most often made from corn. Silage is made from the entire plant, not just the grain.

Softwood

Generally, one of the botanical groups of trees that in most cases have needle-like or scale-like leaves; the conifers; also the wood produced by such trees. The term has no reference to the actual hardness of the wood. The botanical name for softwoods is gymnosperms.

Soybeans

A common oilseed crop used to make biofuels. Soybeans are most commonly used to make biodiesel.

Starch

A molecule composed of long chains of α -glucose molecules linked together (repeating unit $C_{12}H_{16}O_5$). These linkages occur in chains of α -1,4 linkages with branches formed as a result of α -1,6 linkages (see below). This polysaccharide is widely distributed in the vegetable kingdom and is stored in all grains and tubers. A not-so-obvious consequence of the α -linkages in starch is that this polymer is highly amorphous, making it more readily attacked by human and animal enzyme systems and broken down into glucose. Gross heat of combustion: $Q_v(\text{gross})=7560 \text{ Btu/lb (4200 cal/g, 17570 J/g)}$.

Stover

The stalks, leaves and sometimes cobs of a crop remaining after the grain has been harvested.

Sulfur Dioxide (SO_2)

Sulfur dioxide is a gas produced by burning coal, most notably in power plants. Some industrial processes, such as production of paper and smelting of metals, produce sulfur dioxide. Sulfur dioxide is closely related to sulfuric acid, a strong acid. Sulfur dioxide plays an important role in the production of acid rain.

Sustainable Yield Management

The ability for an area to be managed in such a manner that would ensure a continuous supply of timber through time

Switchgrass

Prairie grass native to the United States and known for its hardiness and rapid growth, often cited as a potentially abundant feedstock for ethanol.

Syngas

Syngas, short for synthesis gas, is a mixture of primarily carbon monoxide (CO) and hydrogen (H_2). It is the product of high temperature gasification of organic material such as biomass. Following clean-up to remove any impurities such as tars, syngas can be converted to liquid biofuels such as synthetic diesel (via Fischer-Tropsch synthesis).

T-U-V-W

Tailpipe Emissions

Emissions that result from engine operations and exit through a vehicle's tailpipe system.

Thermochemical Gasification

A process operated at elevated temperature that converts a solid feedstock into a gaseous fuel, while maximizing the chemical energy content of the product gas.

Timberland

Timberland is defined by the U.S. Forest Service as forest land producing or capable of producing crops of industrial wood (more than 20 cubic feet per acre per year) and not withdrawn from timber utilization (formerly known as commercial forest land). Forestland that it is suitable for sustainable harvest management.

Ton-mile

A measure of output for freight transportation; reflects weight of shipment and the distance it is hauled; a multiplication of tons hauled by the distance traveled.

Upstream

Operations associated with the feedstock and fuel production stages in the total life cycle analysis.

Volatile Organic Compounds (VOCs)

Organic compounds that evaporate readily and contribute to air pollution directly or through chemical or photochemical reactions to produce secondary air pollutants, principally ozone and peroxyacetyl nitrate. VOCs embrace both hydrocarbons and compounds of carbon and hydrogen containing other elements such as oxygen, nitrogen, or chlorine.

Well-To-Pump (WTP)

Well-to-pump energy use and emissions refer to energy use and emissions that take place during feedstock and fuel production, and delivery to the fuel pump.

Well-To-Wheels (W2W)

Well-to-wheel is the specific life cycle assessment of the efficiency of fuels used for road transportation.

Wet Distiller's Grain with Solubles (WDGS)

Distiller's grain, with solubles, that is not dried, thereby saving energy in production. WDGS has a short shelf-life and must be consumed quickly, usually by animals in a feedlot co-located with an ethanol production facility.

Wet Milling Process

Corn Wet Milling separates corn into its four major components: fiber, protein, oil and highly purified corn starch. The corn starch can be further processed into many different sweeteners, ethanol or feedstocks to make chemicals and plastics. Wet milling typically results in more product streams than dry milling.

Woody Wetlands

Woody wetlands are areas where the soil or substrate is periodically saturated with or covered with water. May include woody or herbaceous vegetation. Includes tidal wetlands.