Glossary of Key Terms

2005 Billion-Ton Study **(BTS)** – *Biomass as a Feedstock for Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion Ton Annual Supply* is the first of the billion-ton reports; a national-level, strategic assessment of the potential biophysical availability of biomass. It identified more than 1 billion tons of biomass resources in the United States from agricultural land and forestland.

2011 ***U.S. Billion-Ton Update*** **(BT2)** – *U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry* is the second of the billion-ton reports. It expanded and updated analyses of the *2005 Billion-Ton Study* to provide a more comprehensive assessment of U.S. biomass resources and evaluated the potential economic availability of biomass feedstocks under a range of offered prices and yield scenarios between 2012 and 2030.

2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy **(BT16)** – The third of the billion-ton reports, providing the most recent estimates before the present report of potential biomass that could be available for biorefining. Volume 1 focuses on biomass potentially available at specified prices, and Volume 2 on changes in environmental sustainability indicators associated with select production scenarios in Volume 1.

advanced supply system – Feedstock supply system with advanced preprocessing to transform raw biomass into a tradeable commodity. In this analysis, advanced systems feature preprocessing depots to convert biomass bales or wood chips into pellets, which can then be blended and accepted by any biorefinery.

agricultural land – Cropland and pastureland as specified by the USDA National Agricultural Statistics Service.

agricultural residues – Unharvested portion of crops.

AgSTAR – A collaborative program sponsored by the EPA and USDA to promote biogas recovery systems to reduce methane emissions from livestock waste.

algal biofuels – Utilization of primarily microalgae to produce high quantities of biomass per unit land area. The lipids in the microalgae can be used to produce biodiesel.

animal fats – Tallow, choice white grease, and poultry fat.

bio-based product – As defined by the Farm Security and Rural Investment Act of 2002, a product determined by the U.S. Secretary of Agriculture to be a commercial or industrial product (other than food or feed) that is composed, in whole or in significant part, of biological products, renewable domestic agricultural materials (including plant, animal, and marine materials), or forestry materials.

biodiesel – Fuel derived from vegetable oils or animal fats. It is produced when a vegetable oil or animal fat is chemically reacted with an alcohol, typically methanol. It is mixed with petroleum-based diesel.

bioenergy – A form of renewable energy that is derived from biomass.

bioenergy equivalent – Conversion estimate for the quantity of raw biomass to an energy product, assuming a particular heating content and thermal conversion efficiency.

Bioenergy Knowledge Discovery Framework (Bioenergy KDF) – Online collection of bioenergy-related research, datasets, applications, and maps for bioenergy researchers, policymakers, and industry, including the billion-ton report interactive data and visualizations.

biofuel – Fuel made from biomass resources or their processing and conversion derivatives. Biofuels include ethanol, biodiesel, and methanol.

biogas – Gas generated from the decomposition of organic material, which is composed of approximately 50% methane and 50% carbon dioxide.

biomass – Any organic matter that is available on a renewable or recurring basis, including agricultural crops and trees, wood and wood residues, plants, algae, grasses, animal manure, municipal residues, and other residue materials.

Biomass Assessment Tool (BAT) – A resource assessment and partial techno-economic modeling system comprising numerous modules that combine multiscale spatiotemporal modeling, biophysical modeling, and resource demand and availability using the best available climate, water, land, and infrastructure data, along with environmental constraints, biomass growth parameterization, and more.

biomass resource analysis – The quantification of a supply of biomass that can be used to generate biofuel or biopower under specified conditions (e.g., availability of land, water, and fertilizer; spatial resolution and extent; time frame).

biopower – The use of biomass feedstock to produce electric power or heat through direct combustion of the feedstock, gasification and then combustion of the resultant gas, or other thermal conversion processes. Power is generated with engines, turbines, fuel cells, or other equipment.

biorefinery – A facility that processes and converts biomass into value-added products (e.g., renewable fuels, power, chemical products, intermediates). The biorefinery concept is analogous to a petroleum refinery, which produces a slate of multiple fuels, intermediates, and products from a petroleum feedstock.

Bioregional Inventory Originated Simulation Under Management (BioSum) – Provides simulation-based analytical tools that leverage data from FIA—the nation's forest census—to predict and statistically summarize the consequences of forest management strategies over multimillion-acre forested landscapes. Management strategies can be multiobjective, vary among

owner groups, evolve over time, and be contingent on targeted sets of specific site and vegetation attributes.

black liquor – Solution of lignin residue and the pulping chemicals used to extract lignin during the manufacture of paper.

British thermal unit (Btu) – A unit of energy equal to approximately 1,055 joules. It is the amount of energy required to heat 1 pound (0.454 kg) of water from 39°F to 40°F.

construction and demolition (C&D) materials – Wood waste generated during the construction of new buildings and structures, the repair and remodeling of existing buildings and structures, and the demolition of existing buildings and structures.

chip-n-saw – Similar to fuelwood trees, but these trees are converted to two products by one machine: the outside of the log is chipped, and the rest is sawn into lumber. Chip-n-saw trees are the smallest or lowest-quality conifer sawtimber trees. Logs harvested as chip-n-saw must produce lumber or timbers, but a significant proportion of the volume is chipped for pulp production.

Class 1 timber – Timber greater than 11-inch DBH.

Class 2 timber – Timber 5–11-inch DBH.

Class 3 timber – Timber less than 5-inch DBH.

Component Ratio Method – A method introduced in 2009 used to estimate non-merchantable volumes from merchantable trees by the USFS using species-specific volume and biomass estimation equations.

Composite Resistance Score – Composed of four subscores (0–3) to get a score of 0–12 (with lower scores being better) of crown base height, crown bulk density, predicted volumetric tree mortality under a 6–8-foot flame length surface fire, and proportion of fire-resistant species comprising the stand basal area.

Conservation Reserve Program (CRP) – A land conservation program administered by the Farm Service Agency that pays a yearly rental payment in exchange for farmers removing environmentally sensitive land from agricultural production and planting species that will improve environmental quality.

conventional supply system – Feedstock supply system using traditional agricultural and forestry systems to deliver biomass bales or wood chips to the refinery. In this analysis, conventional systems have little to no active quality control, and biorefineries can only accept one feedstock type.

conventionally sourced wood – Wood that has commercial uses other than fuel (e.g., pulpwood) but is used for energy because of market conditions. This would probably only include smaller-diameter pulpwood-sized trees.

coppice – To regrow from a (tree) stump after harvest.

cotton gin trash – Residue available at a processing site, including seeds, leaves, and other material.

cotton residue – Cotton stalks available for collection after cotton harvest.

crop residues – The portion of a crop remaining after the primary product is harvested.

cropland – Similar to the 2012 USDA Census of Agriculture definition of "total cropland," this land category includes planted and harvested acres of corn, wheat, grain sorghum, barley, soybeans, rice, cotton, barley, and hay.

cropland pasture, or cropland used for pasture or grazing – Defined in the 2012 USDA Census of Agriculture Appendix B as "land used only for pasture or grazing that could have been used for crops without additional improvement. Also included are acres of crops hogged or grazed but not harvested prior to grazing."

current bioenergy, agriculture – The portion of current U.S. bioenergy derived from agricultural lands (e.g., corn to ethanol, soybeans to biodiesel).

current bioenergy, forestry – The portion of current U.S. bioenergy derived from timberlands (e.g., timber processing wastes to power, forest residues to pellets).

current bioenergy, waste – The portion of current U.S. bioenergy derived from wastes (e.g., landfill gas).

delivered cost – An estimate of all costs—including production, harvest, storage, handling, preprocessing, and transportation—to deliver biomass feedstocks to the reactor throat.

dried distillers grains – A byproduct of the corn ethanol industry typically used as a protein-rich animal feed. For local markets, distillers grains are sold in wet form. For longer distances, they are dried to about 10% moisture to reduce weight.

dry ton – Material weight without moisture

ethanol – Also known as ethyl alcohol or grain alcohol, this volatile, flammable, and colorless liquid with the chemical formula C_2H_6O is produced by the fermentation of sugars.

feedstock – A product used as the basis for manufacture of another product.

fiber products – Products derived from fibers of herbaceous and woody plant materials. Examples include pulp, composition board products, and wood chips for export.

Forest Inventory and Analysis (FIA) – A congressionally mandated program that delivers current, consistent, and credible information about the status of forests and forest resources within the United States by continually collecting and analyzing data about these forests and the values they provide.

Forest Resource Outlook Model (FOROM) – A global recursive dynamic partial equilibrium model of the forest sector that recognizes RPA assessment regions as separate producing, consuming, and trading market regions within a complete global market.

Forest Sustainable and Economic Analysis Model (ForSEAM) – A linear program that solves for county-level woody biomass availability from timberland. It accounts for county-level timber stand age class distribution, growth and yield, stumpage prices, and harvest costs. The model includes sustainability constraints according to stand type, slope, and proximity to roads.

Forest Vegetation Simulator (FVS) – A distant independent, individual tree growth and yield model designed to project forest stands through time under management, with the capacity to simulate the effects of very detailed silvicultural prescriptions on future stand conditions and outputs of harvested wood.

forestland – Defined by the USDA as land at least 10% stocked by forest trees of any size, including land that formerly had such tree cover and that will be naturally or artificially regenerated. Includes timberland.

Fuel Reduction Cost Simulator (FRCS) – A forest harvesting costing model utilized in this report to estimate the cost of harvesting small-diameter trees for biomass. **fuelwood –** Wood harvested for energy production for industrial or domestic applications and that is often sourced from small-diameter roundwood, branches, or residues and from wood of any size sourced from lower-value or lower-quality species.

Global MacroAlgae Cultivation MODeling System (G-MACMODS) – Integrates a tested regional ocean model (with an integrated biogeochemical model) with a fine-scale hydrodynamic model, capable of resolving turbulent fluxes at sub-meter resolution, and a macroalgal growth model that includes the influence of hydrodynamics in the uptake of nutrients.

glycerin – Also known as glycerol, a nontoxic, colorless, and odorless liquid used in a wide variety of applications (e.g., food, pharmaceuticals, cosmetics). Glycerin is a byproduct of soap and biodiesel production, with the latter being most common today.

greenhouse gas (GHG) – Natural or anthropogenic gas that can absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and the clouds. Water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3) are the primary GHGs in the Earth's atmosphere.

growing stock – A classification of timber inventory that includes live trees of commercial species meeting specified standards of quality or vigor. Cull trees are excluded. When associated with volume, growing stock includes only trees 5.0-inch DBH and larger.

hardwood species – A category of tree species (angiosperm) that have broad leaves and true flowers with the seed being enclosed.

harvest index – For conventional crops, the ratio of residue to grain.

high scenario (agriculture)– Mature market (simulated as 18 years after 2023), 3% per year dedicated biomass yield improvements, conventional crop yields improve 1.5 times the USDA trend, harvest technology improves from 50% to 90% efficiency. See scenario specifications in Table 1.2.

higher heating value (HHV) – The amount of heat released from a material that is heated from 25°C to vaporization and returned to 25°C. This includes the latent heat of vaporization of water.

idle land – A land class defined as cropland used for cover crops or soil improvement, but not harvested, pastured, or grazed.

industrial wood – All commercial roundwood products except fuelwood.

intermediate crops – Any crop that is planted and harvested between two main crops.

irrigated pasture – Any pastureland that falls under the "irrigated land" land class defined by the USDA.

land use change (LUC) – Any change in land use, defined by the Intergovernmental Panel on Climate Change as "the total of arrangements, activities and inputs applied to a parcel of land."

logging residues – The unused portions of growing-stock and non-growing-stock trees cut or killed by logging and left in the woods.

low scenario (agriculture) – Mature market (simulated as 18 years after 2023), no dedicated biomass crop yield improvements, conventional crop yield improvements assume the USDA baseline, no harvest technology improvements. See scenario specifications in Table 1.2.

management-intensive grazing – Management of grazing land that can increase the carrying capacity, whereby animal nutrient demand through the grazing season is balanced with forage supply based on animal requirements (adapted from *Management-Intensive Grazing* by Jim Gerrish, 2004).

marginal lands – Use of this term varies with context. Resource analysis in this report does not target marginal land per se, but rather simulates optimal allocation based on inputs such as yield, which is a component of defining marginal lands. Can be generally defined as lands that are less than optimal from a production perspective (see Csikós, Nándor, and Gergely Tóth. 2023. "Concepts of agricultural marginal lands and their utilisation: A review." *Agricultural Systems* 204: 103560. doi.org/10.1016/j.agsy.2022.103560).

mature-market scenario – Simulated future market scenarios as specified in Table 1.2.

medium scenario (agriculture) – Mature market (simulated as 18 years after 2023), 1% per year dedicated biomass yield improvements, conventional crop yield improvements assume USDA baseline, harvest technology improves from 50% to 90% efficiency. See scenario specifications in Table 1.2.

mill residues – Bark and woody materials that are generated in primary wood using mills when roundwood products are converted to other products. Examples are slabs, edgings, trimmings, sawdust, shavings, veneer cores and clippings, and pulp screenings. Includes bark residues and wood residues (both coarse and fine materials) but excludes logging residues. May include both primary and secondary mills.

municipal solid waste (MSW) – Wastes (garbage) collected from municipalities consisting mainly of yard trimmings and paper products.

near-term scenario (agriculture) – 7 years after 2023, only crop residues. See scenario specifications in Table 1.2.

non-forestland – Land that has never supported forests and lands formerly forested where use of timber management is precluded by development for other uses. Non-forestland includes areas used for crops, improved pasture, residential areas, city parks, improved roads of any width and adjoining clearings, powerline clearings of any width, and 1- to 4.5-acre areas of water classified by the U.S. Census Bureau as land. If intermingled in forest areas, unimproved roads and non-forest strips must be more than 120 feet wide, and clearings, must be more than 1 acre in area to qualify as non-forestland.

oilseed crops – Crops primarily produced for lipid production (e.g., pennycress).

other forestland – Forestland other than timberland and reserved forestland. It includes available forestland that is incapable of annually producing 20 cubic feet per acre of industrial wood under natural conditions because of adverse site conditions such as sterile soils, dry climate, poor drainage, high elevation, steepness, or rockiness.

other removals and residues – Unutilized wood volume from cut or otherwise killed growing stock, silvicultural operations such as precommercial thinnings, or timberland clearing for other uses (i.e., cropland, pastureland, roads, urban settlement). It does not include volume removed from inventory through reclassification of timberland to productive reserved forestland.

other solid waste – Mixed MSW other than paper or plastic waste.

other wet waste – Wet wastes (e.g., sludge and manures) other than FOG.

pastureland – Land that is primarily used for livestock production.

perennial – A plant that lives for more than 1 year.

permanent pastureland, or rangeland, other than cropland and woodland pastured – Defined in the 2012 USDA Census of Agriculture Appendix B as a land category that "encompasses grazable land that does not qualify as woodland pasture or cropland pasture. It may be irrigated or dry land. In some areas, it can be a high quality pasture that could not be cropped without improvements. In other areas, it is barely able to be grazed and is only marginally better than wasteland."

plastic waste – Any discarded plastic (organic, or synthetic, material derived from polymers, resins, or cellulose) generated by any industrial process, or by consumers (source: United Nations Environmental Programme)**.**

Policy Analysis System Model (POLYSYS) – A linear program partial equilibrium model that simulates the U.S. agriculture sector. With national inputs on projected demands for food, feed, fiber, and exports, and county-level inputs on starting cropland acres, pastureland acres, potential

crop yields, and crop production budgets, the model solves for the most profitable allocation of land from the landowners' perspective.

primary agricultural resources – Resources included within this category include energy crops (annual energy crops, coppice and non-coppice woody crops, and perennial grasses), crop residues (barley straw, corn stover, oat straw, sorghum stubble, and wheat straw), and conventional crops (barley, corn, cotton, hay, oats, rice, sorghum, soybeans, and wheat).

primary wood-using mill – A mill that converts roundwood products into other wood products. Common examples are sawmills that convert saw logs into lumber and pulp mills that convert pulpwood.

pulpwood – Trees that are harvested specifically for pulp production (e.g., for paper).

purpose-grown energy crops – In the context of this report, any crop produced for the primary purpose of energy (fuels or power) and coproducts: switchgrass, miscanthus, biomass sorghum, energy case, willow, poplar, pine, microalgae, or macroalgae.

renewable identification numbers (RINs)-gallon – The back-calculated volume of fuel that generated the document RINs.

renewable fuel – Liquid fuels (e.g., ethanol or biodiesel as a replacement for gasoline, jet fuel, kerosene, or diesel) or other fuels (e.g., pellets as a substitute for fossil-based power production). Note that the generation of renewable fuels can also produce valuable biomass-based products or chemicals.

Renewable Fuel Standard (RFS) – Established by the Energy Policy Act of 2005, it required 7.5 billion gallons of renewable-based fuel (which was primarily ethanol) to be blended into gasoline by 2012. This original RFS (sometimes referred to as RFS1) was expanded upon (RFS2) by the Energy Independence and Security Act of 2007 to include diesel in addition to gasoline, as well as to increase the volume of renewable fuel to be blended into fossil-based fuel to 9 billion and ultimately 36 billion gallons by 2022. RFS2 established life cycle GHG requirements (less than fossil fuels they replace) for renewable fuels.

renewable portfolio standard – A standard or regulation that requires electricity utilities and other retail electricity suppliers to obtain a certain percent of their electricity from certified renewable sources.

resource class (resource analysis class) – One of the resource analysis classes as presented in this report (i.e., currently used for energy and byproducts): forestland/timberland resources; agricultural land resources; and microalgae, macroalgae, and CO_2.

resource subclass (resource analysis subclass) – One of the groupings of biomass resources within the resource analysis classes (e.g., subclasses of agricultural residues, woody energy crops, herbaceous energy crops, and agricultural processing wastes within the agricultural land resources analysis class).

Resources Planning Act (RPA) – The Forest and Rangeland Renewable Resources Planning Act of 1974 requires periodic assessments and reports the status and trends of the nation's renewable resources on all forest and rangelands.

Revised Universal Soil Loss Equation (RUSLE2) – A computer program that estimates erosion and sediment delivery for conservation planning in crop production.

roundwood products – Logs and other round timber generated from harvesting trees for industrial or consumer use.

sawtimber – Trees of a larger size and higher quality from commercial species, with at least one 12-foot saw log or two noncontiguous saw logs, each at least 8 feet long.

shadow price – An estimated monetary value for biomass that is not typically bought or sold in a marketplace.

small-diameter trees – In the context of this report, a tree less than 11" DBH.

softwood species – Conifers and gymnosperms, meaning they are evergreen trees that do not shed their leaves.

Soil Conditioning Index – An index indicating the impact of crop management activities on soil organic matter.

starch – A carbohydrate consisting of many glucose units. It is the most common carbohydrate in the human diet.

stumpage value – The sale value of the products that can be obtained from a stand of trees. This is the value of the wood products at a processing or end use facility minus transport and harvest costs and a profit for the harvester (i.e., price for the right to harvest).

Subregional Timber Supply (SRTS) – An empirical bioeconomic model of timber supply based on detailed FIA data. From these data, we can extract forest inventory, removals, and biological factors for custom subregions that are important to a model client. The flexibility of regional scope makes SRTS applicable to analyzing a variety of problems, from broader policy and sustainability questions to analysis of a small timber basin. The maximum regional extent of the model is the Southern U.S. region.

sustainability – An aspirational concept denoting the capacity to meet current needs while maintaining options for future generations to meet their needs.

thinnings (other forestland treatment thinnings) – The practice of reducing the number of plants in an area or the quantity of vegetative or reproductive structures on individual plants. Thinnings can come from operations to reduce fuel load (i.e., removal of small trees to reduce fire danger) and from composite integrated operations on forestland (activities to harvest merchantable commercial wood and low-quality wood for bioenergy applications simultaneously). Thinnings can also come from pre-commercial operations and from other forestland to improve forest health.

Timber Product Output (TPO) – System that acts as an interface to a standard set of consistently coded TPO data for each state and county in the country, developed in support of the 1997 RPA Assessment. This set of national TPO data consists of 11 data variables that describe for each county the roundwood products harvested, logging residues left behind, timber otherwise removed, and wood and bark residues generated by its primary wood-using mills.

timberland – Forestland that is producing or capable of producing crops of industrial wood, and that is not withdrawn from timber utilization by statute or administrative regulation. Areas qualifying as timberland are capable of producing more than 20 cubic feet per acre per year of industrial wood in natural stands. Currently inaccessible and inoperable areas are included.

urban wood wastes – Wastes coming from MSW and C&D debris. In the MSW portion, there is a wood component in containers, packaging, and discarded durable goods (e.g., furniture) and yard and tree trimmings.

waste grease – Used cooking oil and trap grease.

wet ton – No moisture removed from the material.

yield – The volume of feedstock on a designated land unit at a specific point in time.

Terrestrial Energy Crop Species Modeled

biomass sorghum – *Sorghum bicolor* (L.) Moench

camelina – *Camelina sativa*

carinata – *Brassica carinata*

energy cane – *Saccharum* spp.

eucalyptus – *Eucalyptus* spp.

miscanthus – *Miscanthus* × *giganteus*

pennycress – *Thlapsi arvense* L.

pine – *Pinus* spp., typically *Pinus taeda* or *Pinus echinata*

poplar – *Populus* spp.

switchgrass – *Panicum virgatum*

willow – *Salix* spp.

Classes, Subclasses, and Resources in the 2023 Billion-Ton Report

Table 1. Analysis classes, subclasses, and resources.

Class	Subclass	Chapter	Resource
Currently Used for Energy	Agricultural	2	Current - Agricultural
	Forestry/Wood	2	Current - Forestry/Wood
	Municipal solid waste/other wastes	2	Current - MSW/Other Wastes
Wastes	Fats, oils, and greases	3	FOG, animal fats
	Fats, oils, and greases	3	FOG, brown grease
	Fats, oils, and greases	3	FOG, yellow grease
	Gaseous resources	3	Landfill gas
	Other solid waste	3	Rubber and leather
	Other solid waste	3	Textiles
	Other solid waste	3	Urban wood, clean
	Other solid waste	3	Yard waste
	Other wet waste	3	Food waste, nonresidential
	Other wet waste	3	Food waste, residential
	Other wet waste	3	Manure, beef
	Other wet waste	3	Manure, dairy
	Other wet waste	3	Manure, swine
	Other wet waste	3	Sludge
	Paper	3	Paper and paperboard
	Plastic	3	Plastics
Forestland	Forest processing waste	4	Hardwood processing residues
	Forest processing waste	4	Softwood processing residues
	Logging residues	4	Hardwood lowland logging residues
	Logging residues	4	Hardwood upland logging residues
	Logging residues	4	Mixed wood logging residues
	Logging residues	4	Softwood natural logging residues
	Logging residues	4	Softwood planted logging residues
	Other forest waste	4	Forest waste human generated
	Small-diameter trees	4	Hardwood lowland small-diameter trees
	Small-diameter trees	4	Hardwood upland small-diameter trees

Class	Subclass	Chapter	Resource
	Small-diameter trees	4	Mixed wood small-diameter trees
	Small-diameter trees	4	Softwood natural small-diameter trees
	Small-diameter trees	4	Softwood planted small-diameter trees
Agriculture	Agricultural processing waste	5	Pruning residues, citrus
	Agricultural processing waste	5	Pruning residues, non-citrus
	Agricultural processing waste	5	Pruning residues, tree nuts
	Agricultural residues	5	Barley straw
	Agricultural residues	5	Corn stover
	Agricultural residues	5	Cotton field residues
	Agricultural residues	5	Oats straw
	Agricultural residues	5	Rice straw
	Agricultural residues	5	Sorghum stubble
	Agricultural residues	5	Wheat straw
Agriculture	Energy crops, herbaceous	5	Biomass sorghum
	Energy crops, herbaceous	5	Energy cane
	Energy crops, herbaceous	5	Miscanthus
	Energy crops, herbaceous	5	Switchgrass
	Energy crops, woody	5	Eucalyptus
	Energy crops, woody	5	Pine
	Energy crops, woody	5	Poplar
	Energy crops, woody	5	Willow
	Intermediate oilseeds	5	Camelina
	Intermediate oilseeds	5	Carinata
	Intermediate oilseeds	5	Pennycress
Microalgae	Microalgae	7	Microalgae
Macroalgae	Macroalgae	7	Macroalgae
Carbon Dioxide	Carbon Dioxide	7	Carbon dioxide, total point-source emissions
Carbon Dioxide	Carbon Dioxide	7	Carbon dioxide, high-purity point-source emissions