Glossary

ABBREVIATIONS

Table of contents

8 *Glossary*

8.1 *Plant resource supply chains*

The classification of the plant resource supply chains studied and their definitions partially correspond to those developed by the AGRICE research group and, in the case of the definitions, complete them.

Biomaterials

Biomaterials comprise all materials that are biologically synthesized (i.e. by plants or animals). This study focusses exclusively on biomaterials synthesized from bacteria and from agricultural and forest crops, and groups them into two categories of supply chains:

Agrimaterials

Agrimaterials comprise biomaterials that are blends of natural fibres and polymers; they include wood material used as structural building components (dwellings, industrial buildings, etc.). The production of furniture and other non-structural elements (windows, doors, flooring, etc.) is not included in this study.

Biopolymers

Biopolymers are natural polymers from renewable plant, algae or animal sources. These polymers are grouped into three main families: polysaccharides (starch, cellulose, chitosan, pullulan), proteins (collagen, gelatine, casein, etc.) and lignin. They can also be produced by industrial synthesis processes (polymerization) from natural monomers or monomers that are identical to natural monomers. This study covers only biopolymers from the plant resource supply chain.

Energy biofuels

Energy biofuels are solid fuels from plant sources that can be used to produce energy (heat and/or electricity). A distinction is made between energy biofuels produced from agricultural sources and those derived from forest-based sources.

Agricultural biomass

Energy biofuels derived from agricultural biomass comprise all examples of energy recovery from this type of biomass (production of heat, electricity etc.). They are divided into two sub-supply chains:

- fuels from dedicated crops: triticale, barley, hemp, kenaf, Miscanthus, etc., and

- fuels from co-products: cereal straw, oilseed crops, etc.

Forest biomass

Energy biofuels derived from forest biomass comprise all examples of energy recovery from this type of biomass (production of heat, electricity etc.). They are divided into three sub-supply chains:

- fuels from dedicated crops: short or very-short rotation coppice willow, eucalyptus, poplar, etc.,
- fuels from co-products: pellets, sawdust, etc., and
- fuels from slash: billets, chips, etc.

Energy recovery from waste wood is not covered in this study.

Transportation biofuels

Transportation biofuels harness solid, liquid and gaseous materials from plant and animal sources to be used for transportation purposes. Liquid and gaseous forms are obtained by extraction from solid forms (e.g. oils or fats) or by biomass transformation (e.g. thermoconversion). The following two categories of transportation biofuels produced from agricultural or forest biomass, or from their co-products, are covered here:

- oils and their esters, and
- alcohols and their ethers.

The study of transportation biofuels includes the analysis of their corresponding components and additives, but not the use of hydrogen.

Oil esters

Vegetable oils and their esters (VOMEs) are transportation biofuels used in varying proportions in diesel, either as additives (less than 5% of the blend), components (5% or more of the blend), or complete fuels (100%). Vegetable oils are derived from oilseed crops. Their corresponding esters are obtained by esterification of the oils with an alcohol (methanol).

Ether alcohols

Alcohols are transportation biofuels or energy biofuels (fuel cells) used in varying proportions in unleaded gasoline (ethanol, methanol) either as additives (less than 5% of the blend), components (5% or more of the blend), or complete fuels (100%). Their ethers are used in varying proportions in unleaded gasoline (ETBE) and diesel (DME). Ethanol, the alcohol used in these fuels, is obtained by:

- fermentation of starchy crops (wheat, corn, potatoes, etc.),

- ♦ fermentation of sugar-based crops (beets, sugar cane, etc.), and
- ♦ hydrolysis and fermentation of lignocellulose crops (grass, wood, etc.).

ETBE is produced by a reaction between ethanol and isobutene. Methanol is obtained from syngas after a step involving gasification of lignocellulose biomass. Finally, DME is produced by methanol dehydration.

Biomolecules

Biomolecules include all molecules that are biologically synthesized (i.e. by plants or animals). This study focusses exclusively on biomolecules synthesized from agricultural and forest biomass. They are grouped into four categories of supply chains, based on their intended use (surfactants, lubricants, solvents, chemical and other intermediates).

Lubricants and hydraulic fluids

Lubricants include biomolecules that possess lubricating properties, i.e. the capacity to reduce friction and wear, to make a surface smooth and to prevent adherence to it, i.e. to improve the performance of an apparatus. Hydraulic fluids are related to this category. Lubricants and hydraulic fluids are generally obtained from oleochemical raw materials derived, for example, from rapeseed.

Surfactants

Surfactants are amphiphilic biomolecules that possess emulsifying, softening, wetting or detergent characteristics, depending on their structure. The lipophile group can come from oleochemical raw materials derived from rapeseed, sunflower or palm plants. The hydrophilic component can come from co-products of the starch or sugar industries (sugar beets, derivatives of corn or other grain crops).

Solvents

Solvents are biomolecules with properties that enable them to dissolve, suspend or extract other substances without causing chemical changes in either the substances or themselves. Most solvents are derived from vegetable oils or their esters (VOME from rapeseed, sunflower, soy, etc.), or from esters of fermentation-derived organic acids (acetic, citric, lactic, etc.).

Chemical and other intermediates

Chemical intermediates are biomolecules that have no specific final use, but are involved in the production of a number of chemical products that do have a clearly defined final use. “Other” intermediates include biomolecules that are not surfactants, nor are they lubricants, solvents or chemical intermediates. This category includes various products, including binders and additives.

8.2 *Environmental impact categories*

The following environmental impact categories were assessed in the LCA studies identified.

Life cycle analysis (LCA)

Life cycle analysis (LCA) can be used to assess the potential environmental impacts of a system comprising all the activities associated with a product or service, from extraction of raw materials, to disposal of waste. Conducted in accordance with international standards (ISO 14040 to 14043), an LCA sums up the consumption of natural resources and energy, and the production of environmental emissions (air, water, soil) associated with a product or service. The material and energy flows involved are then combined and linked to quantified indicators in various environmental impact categories.

Primary energy

Primary energy is the energy needed to make a product or service available. It represents the summation of the energy required at each phase in the life cycle of the product or service (production, use, etc.). Primary energy comprises renewable and non-renewable energy (the latter being the portion of primary energy obtained from fossil fuel sources: coal, uranium, petroleum, natural gas, etc.). Consumption of primary energy is measured in megajoules (MJ) or gigajoules (GJ).

Greenhouse effect

The greenhouse effect is the result of an increase in the average temperature of the atmosphere brought about by a rise in the average atmospheric concentration of various anthropogenic substances, also known as "greenhouse gases" (CO_2, CH_4, CFC, etc.). The fossil greenhouse effect is determined by subtracting from the "overall" greenhouse effect all greenhouse gas emissions originating from biogenic carbon (i.e. fixed by biomass). The fossil greenhouse effect is thus the product of the combustion of fossil fuels (coal, petroleum, etc.). The indicator chosen to assess the potential impact of a substance on the greenhouse effect is its "greenhouse potential," expressed as kg CO_2 equivalent.

Eutrophication

When nutrients, specifically in the form of nitrogen and phosphate compounds, are added to water, the result is a proliferation of algae. This phenomenon can lead to the death of flora and fauna in the aquatic environment. Eutrophication is expressed as kg phosphate (PO_4) equivalent.

Acidification

The increase in the quantity of acidic substances in the lower atmosphere is responsible for acid rain and the decline of certain forest and freshwater ecosystems. The contribution made by a substance to acidification is generally expressed as kg sulphur dioxide (SO_2) equivalent.

Destruction of the ozone layer

Destruction of the ozone layer is related to the emission of pollutants that deplete stratospheric ozone. These include coolants and other harmful substances such as chlorofluorocarbons (CFCs). The contribution of a substance to the destruction of the ozone layer is generally expressed as kg R11 equivalent.

Photochemical (or photo-oxidizing) pollution

Photochemical pollution is primarily the result of chemical reactions between nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the presence of sunlight; CH_4 and O_3 are also involved in this impact category. Photochemical pollution leads to high levels of ozone and other chemical species that are harmful to humans and plants. The impact of photochemical pollution is generally expressed as kg ethylene (C_2H_4) equivalent.

Ecotoxicity

This impact category comprises two sub-categories:

- impacts on terrestrial ecosystems, including the formation of photochemical oxidants, terrestrial ecotoxicity and acidification, and
- impacts on aquatic ecosystems, including aquatic ecotoxicity and eutrophication.

Terrestrial toxicity

The release of toxic substances into the environment (air, water, soil) affects the health and balance of terrestrial ecosystems. The units used to measure the contribution of a substance to terrestrial toxicity differ from approach to approach (kg equivalent of 1,4-dichlorobenzene or zinc or lead, etc.) because the method of assessment has not yet been standardized.

Aquatic toxicity

The release of toxic substances into the environment (air, water, soil) affects the health and balance of aquatic ecosystems. The units used to assess the contribution of a substance to aquatic toxicity differ from approach to approach (kg equivalent of 1,4-dichlorobenzene or zinc or lead, etc.) because the method of assessment has not yet been standardized.

Human health

The release of toxic substances into the environment affects human health via different pathways (ingestion, inhalation, etc.). The units used to assess the impact of a substance on human health differ from approach to approach (kg equivalent of 1,4-dichlorobenzene or lead, etc.) because the method of assessment has not yet been standardized.

8 *Glossary*

A

ADEME (Agence de l'Environnement et de la Maîtrise de l'Énergie)
French Agency for Environment and Energy Management

AE
Alcohol ethoxylate

AES
Alcohol ethoxylate sulphate

AGRICE (AGRIculture pour la Chimie et l'Énergie)
Agriculture for Chemicals and Energy

Allocation
Many agricultural and industrial production processes are multi-product systems. However, an analysis of a given life cycle generally focusses on only one of these products, and certain environmental loads and the use of certain raw materials must be shared among the product of interest and its co-products. The approach adopted depends on the nature of the products and the systems studied.

Amphiphile
A molecule is said to be an amphiphile if part of it (the head) is hydrophilic and another part (the tail) is hydrophobic.

APG
Alkyl polyglucoside

AS
Alcohol sulphate

B

BD
1,4-butanediol

Biodegradability
The biodegradability of a substance can be defined as its intrinsic capacity to be broken down by microorganisms to increasingly simple structures and finally to CO_2, H_2O and/or CH_4 and new biomass.

Biomass
For purposes of this study, biomass comprises the biodegradable fraction of products, co-products and residues from agriculture, forestry and related industries.

C

Cellulose
A compound produced by glucose polymerization. In plant tissues, cellulose is often associated with hemi-cellulose, lignin and pectin. Cellulose accounts for 90% of cotton fibres, 60% of the wood of conifers, and 30% of straw. It is broken down (cellulolysis) by fungi (trachoderma) and bacteria (cellvibrio) into humus and nitrogenous materials.

CFC
Chlorofluorocarbons. Synthetic gases formed from carbon, hydrogen, chlorine and fluorine. CFCs are primarily used as propellant gases in aerosols, as foaming agents for synthetic materials, and in refrigeration and air-conditioning. The impact of CFCs on the greenhouse effect is thousands of times greater than equal masses of CO_2.

CH_4
Methane

CNO
Coconut oil

CO_2
Carbon dioxide

COV (Composés organiques volatils)
Volatile organic compounds

Cogeneration
Simultaneous production of electric power and heat.

Co-product (or by-product)
In addition to a main product, each step in a production process can also generate one or more secondary products that have commercial value but are unrelated to the function being studied or are used outside the system. The concurrent production of straw and wheat grain is an example of this type of situation.

D

DME
Dimethyl ether

E

EHL
Ethylhexyl laurate

EPS
Expanded polystyrene

Methyl ester
An ester produced by the esterification of an oil with methanol. Also referred to as biodiesel or diester.

ETBE
Ethyl tertiary butyl ether

F

FU
Functional unit

G

GJ
Gigajoule (10**9 J)

GWP
Global warming potential. The GWP factor measures the potential contribution of a specific gas to an increased greenhouse effect; the contribution is measured relative to carbon dioxide.

H

H+
A proton

HDPE
High-density polyethylene

Hydrophilic
Said of a substance that has an affinity for water.

Hydrophobic
Said of a substance that does not exhibit an affinity for water.

I – J - K

Kraft lignin
Co-product resulting from the production of paper by the Kraft process.

L

LAS
Linear alkylbenzene sulphonate

LDPE
Low-density polyethylene

LHV
Lower heating value

Lipophilic
Said of a substance that has an affinity for fats.

M

Mater-bi
A biodegradable plastic produced by the Novamont company and made from a blend of wheat starch or potato starch and synthetic polymers (petrochemicals).

MEHEC
Methyl ethyl hydroxyethyl cellulose

MJ
Megajoule (10**6 J)

MTBE
Methyl tertiary butyl ether

N

NM VOC
Non-methane volatile organic compound. A non-methane VOC is a VOC from which the methane-based compounds have been removed.

N_2O
Nitrous oxide (or dinitrogen oxide)

NOx
Oxides of nitrogen

O

Organosolv lignin
A co-product resulting from the production of paper by the Organosolv process

P

PAH
Polycyclic aromatic hydrocarbon

Pc
Petrochemical

PCL
Polycaprolactone

PE
Polyethylene

PET
Polyethylene terephthalate

PHA
Polyhydroxyalkanoate

PKO
Palm kernel oil

PLA
Polylactic acid

PM 10
Particulate matter that is less than 10 µm in diameter

PO
Palm oil

PO_4
Phosphate

PP
Polypropylene

PS
Polystyrene

PSE (Polystyrène expansé)
Expanded polystyrene

PVA
Polyvinyl alcohol

Q - R

Range of variation
Expression used to refer to the extent of values that can be attributed to the environmental impact of a sub-sector relative to a specific impact category

RME
Rapeseed methyl ester

S

SAS
Secondary alkane sulphonate

SRC
Short rotation coppice

T

Tall oil
Oil from a residue of softwood processing; the residue is generated when Kraft pulp is produced during the papermaking process.

TPS
Thermoplastic starch

U

Uncertainties
Term assigned to the range of values that can be represented by the environmental impact of a sub-sector relative to a specific impact category, as a function of the inventory data and the impact assessment method

V

Variation
Term used to refer to variability in the results for a sector imposed by parameters that exert a strong influence

VOC
Volatile organic compound

VOFA
Vegetable oils and their fatty acid esters

VOME
Vegetable oil methyl ester

W - X - Y - Z

ADEME

2, square La Fayette – BP 406
F-49004 Angers Cedex 1
Tel.: +33 (0) 2 41 20 41 20
Fax: +33 (0) 2 41 20 42 00
www.ademe.fr

Contact:
Hilaire Bewa, hilaire.bewa@ademe.fr (agrimaterials, agricultural biomass, biopolymers, solvents)
Luc Bodineau, luc.bodineau@ademe.fr (forest biomass)
Etienne Poitrat, Etienne.poitrat@ademe.fr (biofuels, lubricants)
Magali Rocher, magali.rocher@ademe.fr (surfactants, chemical and other intermediates)

BG

Technoparc Pays de Gex
Rue Gustave Eiffel
F – 01630 St. Genis-Pouilly
Tel.: +33 (0) 4 50 42 28 68
Fax: +33 (0) 4 50 42 28 76
www.bg-21.com

Contact:
Grégory Houillon, gregory.houillon@bg-21.com

EPFL

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Environnement Naturel et Construit
Laboratoire de gestion des Ecosystèmes
Groupe Analyse de Cycle de Vie
Ecublens
CH – 1015 Lausanne
Tel.: +41 (0) 21 693 57 68
Fax: +41 (0) 21 693 57 60
www.epfl.ch

Contact:
Olivier Jolliet, olivier.jolliet@epfl.ch
Josef Känzig, josef.kaenzig@epfl.ch