FAO Forestry Department
Wood Energy Programme

UNIFIED BIOENERGY TERMINOLOGY

UBET

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

December 2004

Foreword

FAO has assembled and published historical statistical data in its Forest Products Yearbook and prepared other studies on fuelwood and charcoal. As part of its Wood Energy Programme (WEP) of the Forest Products Division, the Organization is continuously reviewing and improving its Wood Energy Information System (WEIS).

In recent years, as result of this continuous process, WEIS has considerably expanded its scope and its linkages with regional and international bodies producing and/or using information and statistics on energy, bioenergy, forest products, biomass, agricultural residues, etc. In this context and in order to set clarity on the complex issue of wood energy information, WEP developed the *interactive Wood Energy Information System* (i-WEIS), which assembled wood energy data from WEIS, from international databases and other national sources, allowing the combined consultation and comparison of such sources on a given country, item and period of time.

Unfortunately, the communication among the many institutions contributing to, or benefiting from, statistics on biofuels is often limited by the heterogeneity of terms, definitions, aggregation levels, etc., adopted by each institution or simply by the lack of clear definitions. The effect of such heterogeneity is that data comparisons and integration are often impossible, as well as making the processes of "harmonization" more risky.

This paper examines and reviews currently used terminology and definitions for woodfuels and other biofuels used in FAO and other major databases on biomass-based energy sources. It proposes ways to improve the methodology for the definition, classification, compilation and presentation of biofuel data and information using the Unified Bioenergy Terminology (UBET).

FAO efforts towards commonly accepted standards, aimed at improving the dialogue and synergies among energy and forestry operators started 7 years ago. The production and circulation of several drafts of the Unified Wood Energy Terminology (UWET) for discussion took place and inter-agency workshops were held, the last one being in Rome in October 2001. In the process, the target of this initiative widened from pure "Wood Energy" to a wider "Bioenergy" perspective, in consideration of the "family" of biofuels where woodfuels belong. This occurred because of to the common social, economic, cultural contexts and technological aspects involved. Moreover, we believe that understanding the true role of forests and trees as a source of energy, and their sustainable management, requires a comprehensive view of this complex subject, including non-forest woodfuels sources and non-wood biofuels.

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Acknowledgements

This report was prepared in the FAO's Forestry Department by Daniela Thraen, based on the drafts prepared by Miguel A. Trossero, and the contributions of Rudi Drigo, Jim Bourke and Luiz Horta Nogueira. The editorial work was carried out by Tina Etherington, Robert Flood, Marco Perri and María Guardia.

Special thanks are also given to all colleagues who provided contributions and comments which helped improve many of the previous drafts of the report. In particular Kit Prins, Felice Padovani and John Denman (IEA) must be mentioned.

The substantial contribution by the twenty five experts from leading international, regional, and national organizations in Latin-America, Europe, Asia and Africa, who participated in the Expert Consultation on the Unified Wood Energy Terminology – UWET, held in Rome, 3 - 4 October 2001, is gratefully acknowledged.

Summary

This paper examines and reviews currently used terminology and definitions for woodfuels and other biofuels used in FAO, and in other major databases on biomass-based energy sources. It also proposes ways to improve the methodology for the definition, classification, compilation and presentation of biofuel data and information using the Unified Bioenergy Terminology (UBET).

UBET is compared with current terminology and classification systems, notably the FAO system for gathering woodfuel statistics for its FAOSTAT database which is the source of the woodfuel statistics provided in FAO Forest Products Yearbook, the International Energy Agency (IEA), EUROSTAT, and the United Nations Standard International Trade Classification (SITC). The main departure from these systems is that UBET stresses the supply and demand aspects of biofuels, with particular attention to wood-based fuels, as major commodities to satisfy end user requirements.

Biofuels are classified as direct, indirect or recovered biofuels, according to their "journey" from supply to the end user. The inclusion of agrofuels, such as bagasse, straw, stalks, etc. and the use of municipal by-products (sludge, municipal wastes, sludge gas, etc.) represents an innovation in the UWET classification proposal [11]. The document offers basic working definitions and outlines the measurement parameters and units taken into account. Biofuel conversion and accounting factors are provided in order to obtain the energy worth of a mass or volume flow of a particular biofuel.

UWET was prepared jointly and discussed with many institutions, with the common objective of assessing properly the amount of energy produced from biofuels and of facilitating the exchange of bioenergy databases among national and international organizations. Certainly this new terminology and set of definitions are not a panacea for solving the many problems associated with wood energy data, but are intended as a first and essential step towards their improvement.

In the future, more attention will be given to the definition of different types of agrofuels. This is an area that has so far received limited attention - not only regarding the terminology used but also in the development of improved data bases.

1. Introduction

Biofuels[1] can contribute significantly to reaching the political goals of increasing the share of *renewable energy* and reducing CO_2 emissions from anthropogenic sources. A *bioenergy* system is complex; it includes many phases, starting from the production/preparation of raw materials (harvesting, grinding, etc.), through the transportation, and the conversion of raw materials into fuel, transportation of fuel, its distribution to the consumers, to its final utilisation. Such a complex system needs clarity at all levels.

National and international energy statistics seldom include the same level of detailed information on *biofuel* and *woodfuel* consumption as for other conventional energy sources and forest products. Moreover, existing information on *woodfuel* in most forestry data banks, at both national and international levels, is rather limited and very aggregated. It therefore is not suited to the comprehensive analysis of how much *woodfuel* is being used, where and by whom. Moreover, the scarce information available is collected, compiled and presented based on different terminologies, and without clear definitions. The units and conversion factors used make comparison, aggregation and exchange extremely difficult and time consuming. In addition, most existing information on *biofuels* is focused on biomass consumption, without paying due attention to other related aspects such as production and supply sources.

Thus, there has been a growing awareness and interest in improved and more detailed *bioenergy* data in order to gain a proper understanding of *bioenergy* systems and to plan the sustainable production and utilization of *biomass* by households as well as commercial and industrial uses. Up to now, FAO data have been considered a reference for many institutions, but there is an increasing necessity to improve the method by which FAO collects, organizes and presents *wood energy* data.

In response to the need to refine and restructure the way in which *bioenergy* data are presented in FAO statistics, and taking into account other bioenergy database methodologies, this document presents a new framework for *bioenergy* classification and accounting. The basic elements of such an approach include the following:

- creation of a *woodfuel* category which encompasses all kinds of energy material from wood;
- inclusion of new *biofuel* types, including *agrofuels* and *municipal by-products*;
- improved disaggregation on both the supply and demand sides;'
- support for new trading activities on inter-regional and international levels;
- building links to international standardisation activities (i.e. CEN – European Standardisation Committee);
- encouraging the development of consistent *bioenergy balances* and organization of a database as a basis for doing assessments and policy analysis at the international and regional levels (especially assessment on the role of bioenergy use in deforestation and land use changes).

The Unified Bioenergy Terminology (UBET) has been prepared jointly and discussed with many institutions and at the FAO Expert meeting "A Unified Wood Energy Terminology , held in Rome, Italy on 3-4 October 2001. The objective was to assess properly the amount of energy produced from

[1] All terms in italics are defined in chapter 7

biofuels and facilitate the exchange of *bioenergy* databases among national and international organizations.

This paper aims at unifying and organizing currently used terminology and definition of *woodfuels* and other *biofuels* used in forest and energy statistics, *bioenergy balances* and commercial trading operations.

Certainly this new terminology and set of definitions are not a panacea for solving the many problems associated with *bioenergy* statistics and trade aspects. UBET is however intended as a first and essential step towards their improvement. The terminology and definitions should enable the various institutions and organizations to exchange information more easily and to address the different problems of bioenergy utilization more clearly. The ultimate objective of the process is to assist in the identification and development of policy instruments, projects and activities, and investments, in order to assist in encouraging increased private sector interests in wood energy.

2. Need for a Unified Bioenergy Terminology (UBET)

2.1 Statistical database

Data from national administrations are, in most cases, inadequate both in quantity and quality. Energy statistics are frequently restricted to the commercial (and thus more easily measurable) component of the energy picture. In developing countries, there is often a lack of expertise as well as financial and human resources for adequate data collection and estimation, a task rendered more difficult by the decentralised, mostly rural, and largely non-marketed nature of bioenergy use. The variety of sources, the lack of uniform definitions and methodologies, and the use of different units and conversion factors, make comparison between countries and assessment of time trends a difficult task [13]. Even where the figures and values presented or estimated by national and international statistics are well established, the structure of the bioenergy database is affected by the following problems [12]:

- **Coverage:** Different international agencies produce periodic statistical data (i.e. FAOSTAT, UN-ECE, IEA, OLADE, EUROSTAT) on products related to bioenergy but with very heterogeneous approaches and without truly covering bioenergy. Those statistics are based on a few and selected *biofuels* only (e.g. FAO covers charcoal and "Wood Fuel, including wood for charcoal as sub-category of roundwood removals; EUROSTAT covers biomass as renewable energy source with a sub-category called "wood and wood waste that includes, in spite of the definition, also lingo-cellulosic biomass from agro-residues; IEA publishes data on Primary Solid Biomass inclusive of wood and non-wood biomass but keeps estimates of sub components such as wood, black liquor, agricultural residues, etc. The data on *biofuels*, and *woodfuels* in particular, have also to fit into the structure of the energy and forestry statistics which are the main basis for modelling and forecasting work that is undertaken in the technical organizations involved. For instance, data on *black liquor* (the most important form of wood energy in many developed countries) are omitted in FAO statistics. In addition, key *agrofuels* are not considered at all in most of the statistics.
- **Disaggregation:** most existing information on *biofuels* and *woodfuels* is focused on *biomass* consumption and do not pay sufficient attention to other related aspects such as production and supply sources. Regardless of the importance of non-forest supply sources of *wood energy* and the large use of recycled products, the supply side is not disaggregated in the FAOSTAT database. On the other hand, although there is a clear shift of *wood energy* demand from traditional to modern uses, with considerable repercussions for the whole wood energy systems, information on the sectors of utilization is also absent in most databases. Only IEA statistics are consistently disaggregated by sector. Another important but equally neglected aspect concerns the distinction between urban and rural consumption patterns.
- **Definition incompatibility:** the main terminology currently used by the above agencies is not adequate for the proper collection, collation, exchange and presentation of biofuel data yet. The absence of a comprehensive framework and clear sets of definitions limit the possibility of comparison and exchange with other data sources on *bioenergy*.
- **Uncertainty of conversion factors:** *bioenergy* accounting covers primary data from various sources. Energy sources and commodities may be measured by their *mass* or weight or even *volume*, but the essential factor is the *energy content* related to these sources and commodities. The uncertainty of conversion factors limits the possibility of comparison and exchange with other data sources.

Therefore there is a strong need for a unified terminology which will improve data collection and exchange in order to enable assessments and policy analysis at a national and international level. To

develop an adequate database for *bioenergy*, the following aspects need to be taken into consideration:

- **supply sources**: including forestry and agriculture, *biomass* processing industries (wood industry and agro-industry) and end-use products of the society as well as biofuel preparation activities (i.e. charcoal production)
- **demand** (users side): including the main demand sectors (residential, commercial, industrial sectors and heat and power generation) as well as the distinction between urban and rural areas
- **trade**: including import and export of *biofuels.*

The basic idea behind such a terminology is to create a suitable framework for the identification of the amount and type of *bioenergy* flowing from different supply sources to meet end users needs. Thus the fuel or product used to transport energy is the basic parameter to be accounted and properly classified. Whether in commercial or non-commercial terms, these fuels should always be considered goods or commodities that are valuable and capable of meeting demand effectively.

2.2 Bioenergy balances

Bioenergy balances are derived from conventional energy balances, which are commonly used for the representation of data on production, conversion and consumption of all individual fuels in a table or diagram. Bioenergy balances include quantitative summary data on *biomass* used as fuel for energy production.

Bioenergy balances allow the analyses and understanding of all the operation and process units of biofuel cycles from production up to the use of energy generated with them.

Unfortunately, *bioenergy balances* are not commonly used by planners and policy makers. The following figure (Fig.1) gives an overview on *biomass* to *biofuel* flow within a given bioenergy system[2] considering the intermediate activities involved such as preparation, conversion and trading (import and export).

Bioenergy balances also show specific information on the *biomass* production sources which is vitally needed for management purposes in order to examine the production and degradation capacities of different biomass supply sources. They may also help in the assessment of competitions with other uses as well as environmental impacts in order to: a) determine their sustainable use and b) develop sustainable resource management systems.

In addition, they allow the analysis of conversion, trade and utilisation aspects of *biofuels* such as energy efficiencies and conversion losses.

[2] Bioenergy systems include all the steps and/or unit processes and operations involved for the production, preparation, transportation, marketing, trade and conversion of biofuels into energy.

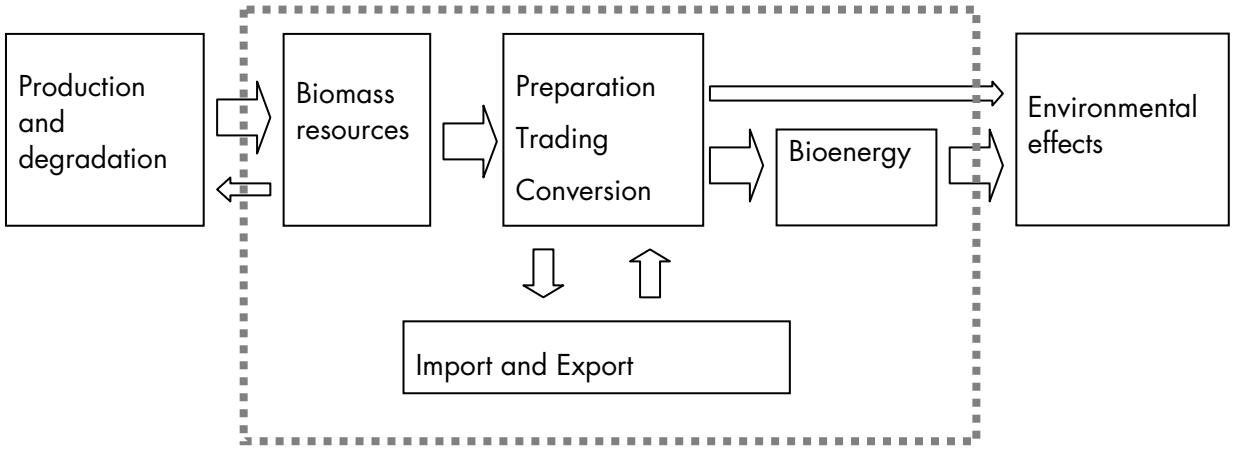


Figure 1: Flow of biofuels from the source

2.3 Trading operations

Most *biofuels* and *woodfuels* in developing countries are traded through informal markets. For the increased, more efficient and cost effective *biofuel* utilisation, more intensive trading activities are necessary at the local as well as international level. These fuels should be considered as an important environmentally friendly source of energy. Compared to other *renewable energy* sources, *biofuels* involve a wide range of *fuels*. These differ in provenance, physical/mechanical properties (e.g. *total moisture*, *particle size* and *particle size distribution*) and chemical composition (e.g. *total carbon, total nitrogen*). In this context the lack of clearly defined *biofuel* properties as well as clear supply conditions are seen as major non-technical impediments to effective trade.

Standardisation of biofuel terminology and the classification of their properties, as well as measurement standardisation, is one of the tools to improve the situation. Having a *biofuel* terminology and specification available, which is well adapted to practical needs, will assist the development of a more effective *biofuel* market. If the properties of the traded product "*biofuel*" are clearly defined and well known (for example for the different types of gasoline or fuel oil), more transparent markets and prices are likely. Based on a unified terminology, market expansion and cost reductions can be expected to follow because of the following effects:

- producers of biofuels get more concrete signals to guide the production of biofuels. They are able to optimise their production processes based on the demanded properties, and to reduce costs;
- energy provision systems and conversion technologies can be better designed, and they can operate more efficiently and environmentally soundly if fuel quality is defined within a narrow range.

With regard to the intended effects there are two relevant areas of standardisation to be taken into consideration:

- **Definition of the relevant biofuel sources and trade forms by a detailed and transparent terminology of the biomass resources (i.e. the different types of forest products and by-products)**: The terminology, definitions and descriptions as well as the *fuel specifications* and classes which are applied in the different countries are characterised by tradition and by characteristics of the national *fuel* market and their need of information. Problems of the comparability of national terms and definitions can arise mainly because of differences in the national systems of nomenclature. These differences can be serious obstacles, hindering trading and comparison of solid biofuels within and across countries. Standardisation in the field of terminology and

definitions as well as *fuel specifications* and classes can make a valuable contribution to facilitating trading and the assessment of the quality and value of *biofuels,* and to increasing their use as an energy source on the international and national level. The development of standards can also provide a vital input to any serious decision making on a host of topics linked in one way or another to *biofuels*.

- **Identification and Classification of the most relevant biofuel properties** to ensure a cheap and trouble-free conversion on a low emission level. Special emphasis is needed on *total moisture*, *total ash*, shape and *particle size* and *density* (see chapter 5).

Within the European Union there is general agreement on the need for European standards in the field of *solid biofuels*. Especially in those EU countries with a high (potential) share of *solid biofuels*, standardisation is regarded as an important issue to promote and increase the use of *biomass* as energy source. As a result of the ongoing discussions that are taking place the Commission of the European Community has mandated the European Committee for Standardisation (CEN) to initiate the development of European standards for solid biofuels [17] [18]. A Technical Committee "Solid Biofuels" was established by CEN in Stockholm at the end of May 2000, and this is to undertake the drafting of more than 20 European standards on terminology, classification, sampling and testing.

Activities on standardisation have to be followed by the development of quality assurance systems. Theoretically, these can be introduced for all processes in the provision chain (i.e. in crop production, harvesting, preparation etc.). A major motivation for quality assurance is to fulfil legal limit requirements (e. g. emission limits), or to meet technical demands for the power plant (e. g. avoiding corrosion). To guarantee these basic conditions, chemical and/or physical parameters may be varied theoretically by crop production processes (e. g. modifying the *total nitrogen* of whole grain crops by Nitrogen fertilisation) as well as by harvesting/preparation (e. g. modifying the *total moisture* of wood by storage). Additionally, at the conversion plant technical means are available for e. g. emission reduction (e. g. primary and secondary measures for NO_x-emission reduction). In practice quality assurance are of most interest for non-woody biofuels used in emission controlled plants.

3. Conceptual approach

The basic idea behind the UBET terminology is to create a suitable framework for the identification of the amount and type of wood energy flowing from different supply sources to meet end user needs. Thus the *fuel* or product used to transport energy is the basic parameter to be accounted and properly classified. Either in commercial or non-commercial terms, these fuels should always be seen as goods or commodities that are valuable and capable of meeting demand effectively.

A conceptual view of *bioenergy* systems, showing how *biofuels* physically flow in order to meet demand is presented in Figure 2.

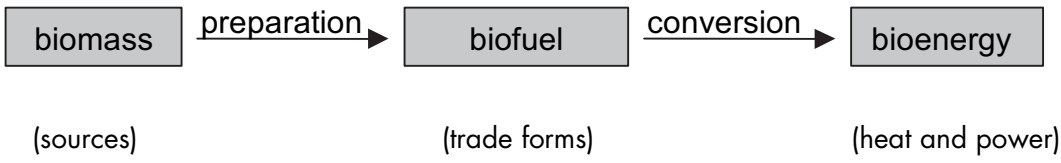


Figure 2: Production chain of bioenergy

To cover the objectives of UBET three different points of view are considered:

- the **sources of biofuels.** This covers the initial location of the input material (*biomass*) in the economic and environmental cycles (like *forest wood, energy forest trees, logging by-products, landscape management by-products, agricultural by-products, agro-industrial by-products,* etc.);
- the **types of biofuels.** This covers the nature/origin of the *biofuel* in the same structure as the *biomass* sources (e.g., *woodfuels, herbaceous fuels*), and the most important trade forms (i.e. *fuelwood, charcoal, producer gas, chipped biofuels, bundled biofuels*);
- the **most relevant biofuel parameters** (e.g., *moisture, total ash*), and terms of sampling, testing, and classification.

Those aspects are covered in more detail in the following chapters. The relevant terms (always written in italics) are indexed in chapter 6 and definitions are given in chapter 7 in alphabetical order. A glossary is provided in chapter 8 with main terms given in English, French and Spanish.

This current version still contains weak points and overlapping areas and these will need clarification in the future. In the light of recent technical developments in the *bioenergy* sector, some terms commonly used in current literature and bibliography have been eliminated. For example, non-commercial energy has been eliminated and the earlier definition of *biofuel*, which used to refer to *biomass* processed to obtain ethanol, esters, etc., has been revised in order to give a more suitable definition. It should be noted that the term *energy plantations* is at present used to refer to both forest and agro-energy plantations; in this new classification, *energy plantations* will refer to forestry energy plantations, while agricultural plantations will simply be called *energy crops*.

In other cases new terms are proposed. For example *agrofuels*, which refers to *biofuels* derived from non-forest activities. It includes energy *agricultural by-products, animal by-products*, and *agro-industrial by-products*. As a general rule, it is proposed that the term *wastes and residues* be replaced by *by-products*.

3.1 Biofuels supply sources

To cover all the different statistical database requirements, a number of aspects need to be addressed. These include trading operations and *biofuel* and *bioenergy balances* for the terminology of *biofuel* sources information on pattern of supply demand and use, environmental resource requirement, and biofuel quality. Therefore different *classification* aspects have to be taken into consideration, including *classification* by production systems, economical sectors and class of material (see table 1).

Table 1: Relevant aspects for classification

classification by		relevant information	needed for		
			statistics	bioenergy balances	trade
production system:	- energy crops - by-products - end use products	- pattern of supply, demand and use - biofuel quality	x	x	x
economical sectors:	- forest fuels - agrofuels - municipal by-products	- pattern of supply - environmental resource requirement	x	x	
material classes :	- woody biomass - herbaceous biomass - fruits and seeds - other / mixtures	- environmental resource requirement - biofuel quality		x	x

In Table 2 those different aspects are brought together and illustrated by some examples. The term "by-products" includes the improperly called solid, liquid and gaseous residues and wastes derived from biomass processing activities. According to the structure in Table 2, Table 3 gives a more detailed overview of the different sources. The main *biofuel* sources used in developing countries are *fuelwood, charcoal, agricultural by-products* and dung.

The main definitions of biofuel supply sources employed in UBET include three types of biofuel: *woodfuels, agrofuels*, and *municipal by-products*.

The biofuel supply sources are put in different biofuel preparation processes. The output of those processes is different types of biofuels (i.e. solid, liquid and gaseous fuels) which are finally converted into heat and power. A detailed scheme for classifying biofuel types is presented in Table 5 (see chapter 4).

Table 2: Classification of Biofuel sources by different characteristics

		woody biomass	herbaceous biomass	biomass from fruits and seeds	others (including mixtures)
		WOODFUELS	**AGROFUELS**		
Energy crop	direct	- energy forest trees - energy plantation trees	- energy grass - energy whole cereal crops	- energy grain	
By-products*	direct	- thinning by-products - logging by-products	crop production by-products:		- animal by-products - horticultural by-products - landscape management by-products
			- straw	- stones, shells, husks	
	indirect	- wood processing industry by-pro-ducts - black liquor	- fibre crop processing by-products	- food processing industry by-products	- biosludge - slaughterhouse by-products
End use materials	recovered	- used wood	- used fibre products	- used products of fruits and seeds	**MUNICIPAL BY-PRODUCTS** - kitchen waste - sewage sludge

*The term "by-products" includes the improperly called solid, liquid and gaseous residues and wastes derived from biomass processing activities.

Table 3: Overview on the most important biofuel supply sources

Material classes	Sources	Examples
woody biomass	forest and plantation wood	energy forest trees
		energy plantation trees
		short rotation trees
		thinning by-products
		logging by-products
		complete tree
		whole tree
		tree section
		slabs
		shrubs
		stumps
		bark
	wood processing industry by-products	edgings
		cross-cut ends
		wood shavings
		grinding dust
		saw dust
		particle/fibre board by-products
		plywood by-products
		cork production by-products
		viscose by-products
		fibre sludge
		black liquor
	used wood	demolition wood
		recovered construction wood
		woody bulk waste
		used paper
herbaceous biomass	energy crops	energy grass
		energy whole cereal crops
	agricultural by-products	straw
	agro-industrial by-products	bagasse
		textile industry by-products
	end use material	used clothes
		used insulation material
biomass from fruits and seeds	energy crops	energy grain
	agricultural by-products	stones
		shells
		husks
	agro-industrial by-products	oil extraction meal
		brewery by-products
		starch processing industry by-products
	end use material	used vegetable oil
others /mixtures	animal by-products	dung
		manure
		poultry waste
	horticultural by-products	bushes
	landscape management by-products	road side green
		protected areas management by-products
	agro-industrial by-products	slaughterhouse by-products
		bio-sludge
	end use material	kitchen waste
		sewage sludge
		bone meal

3.2 Trade in biofuels

Biofuels in general, and woodfuels in particular, are largely traded energy carriers in both formal and informal markets. In most commercialised cases, there are two major types (or forms) of biofuels: primary (unprocessed) *biofuels,* and secondary (processed) *biofuels*.

- **Primary** (unprocessed) *biofuels* are those w*here* the organic material is used essentially in its natural form (as harvested). Such fuels are directly combusted usually to supply cooking, space heating, or electricity production needs, although there are also small- and large-scale industrial applications for steam raising and other processes requiring low-to-medium temperature process heat.
- **Secondary** (processed) *biofuels* in the form of solids (e. g. *charcoal*), liquids (e. g. alcohol, vegetable oil), or gases (e. g. biogas as a mixture of methane and carbon dioxide), can be used for a wider range of applications with higher efficiency rates on average, including transport and high-temperature industrial processes.

The aim of *biofuel* processing is to provide fuels with clearly defined fuel characteristics and ensure a technically simple and environmentally sound conversion into useful energy. Such clearly defined *fuels* can then be used with fewer problems to meet a supply task efficiently and comfortably. To ensure this the conversion processes noted in Figure 3 can be used.

- **Thermo-chemical conversion** summarizes all conversion processes of biomass based on thermal energy. Thus gasification, pyrolysis and *charcoal* production are all relevant. From these various possibilities only *charcoal* production is currently widely used. Gasification for electricity production seems to be a quite promising option which might become available on the market the next few years. Pyrolysis with the aim of providing a liquid *fuel* useable in power units is an option for the future.
- A **physico-chemical conversion** process provides a liquid *fuel* based on physical and chemical processes. The most important process so far is vegetable oil production from oil seed, and the esterification of this oil to fatty acid methyl ester as a substitute for diesel fuel. This technology is used on a large scale within Europe.
- **Bio-chemical conversion** summarizes conversion processes using biological processes. The most important possibilities are alcohol production from *biomass* containing sugar, starch and/or celluloses, and biogas production from organic waste material. Both technologies are state of the art and widely used for energy provision.

These upgraded *biofuels* can be used in specially adapted engines, turbines, boilers, or ovens to provide thermal and/or mechanical energy, which in turn can be converted into electrical energy. Additionally, liquid and (potentially) gaseous *fuels* can be used directly, or after treatment, as transportation *fuels*.

Heat production and electricity generation are the most important uses worldwide for biomass fuel. Direct combustion devices are widely distributed with thermal capacities ranging from a few kW in household stoves up to heating plants with several tens of MW. The conversion efficiencies vary from 8 to 18 % for simple stoves used traditionally in developing countries, up to 90 % and above for modern heating units with high-end technology. Electricity production is based mainly on the conventional steam cycle with efficiencies around 30 % and capacities of several hundreds of kW and above.

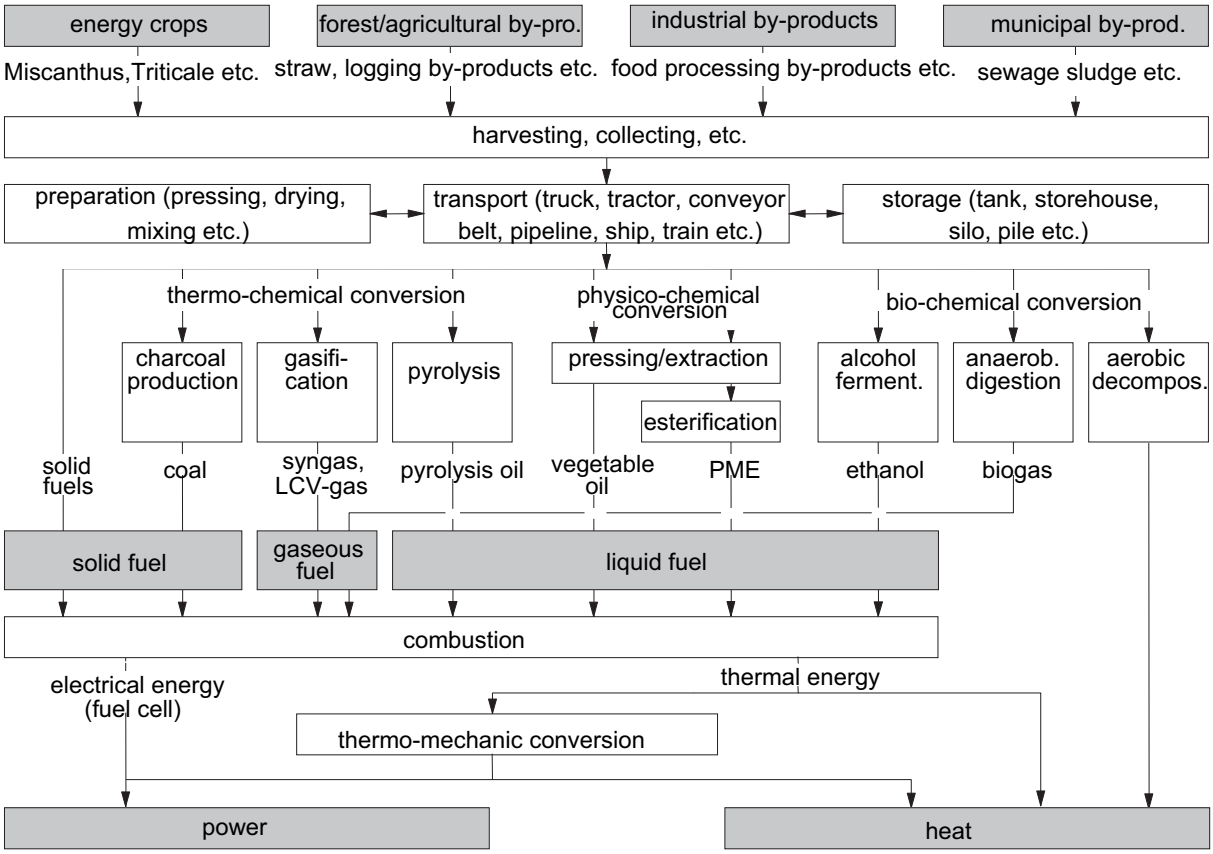


Figure 3: Possibilities to provide heat and/or power as well as fuels from biomass.

Table 4 evaluates the differences among the various conversion routes for *biomass* upgrading concerning feedstock availability. Some conversion technologies are only possible based on specially grown biomass (i. e. energy crops). This provides an important obstacle to wider use since there is considerable effort needed to produce the *biomass,* and there is limited available arable land. Based on availability of different feedstocks, only gasification and pyrolysis seem to be promising options.

Widespread commercial and industrial applications are for example direct combustion of different woody biofuels as well as combustion of wood based charcoal, conversion of food processing industry by-products, municipal by-products, and certain agricultural by-products into biogas by anaerobic digestion for application in combined heat and power plants

Table 4 indicates that some routes are very promising for technology and system technology. This is especially true of the production of *charcoal* or vegetable oil and esterification as well as, with some restrictions, for alcohol production. In some developing countries the charcoal chain is well developed, as is the Biodiesel provision chain (i. e. vegetable oil esterification and use of the *fue*l for transportation purpose) in some industrialised countries (Austria, Germany, France and USA).

The term *System aspects* concerns the possibilities of the integration of these conversion routes into the energy system, the given or expected environmental benefits, the present costs and the possible cost reduction potentials. The table indicates that for some options the costs are quite high, but the cost reduction potentials are also high. The data makes it clear that most of these options can be considered to have *promising* to *very promising* environmental aspect. Therefore *biomass* could make a substantial contribution to meet energy demand in an environmentally sound way. This is especially true for the options of providing energy with modern conversion technologies. Additionally most of the

biomass-based options could be easily integrated into the existing energy system. This would allow an easy transfer from the current energy system based mainly on fossil fuel energy to a more sustainable energy system based on *biomass*.

Table 4: Comparison of biomass conversion routes

	Charcoal prod. & use for heat production.	Syngas production & elect. generation	Pyrolysis oil prod. & use in engines	Vegetable oil prod. & transport. use	Veg. oil esterification & transport use	Alcohol production & transport use	Biogas production & elect. generation
Feedstock							
By-products	++	+++	+++				++
Energy Crops	+++	+++	+++	+++	+++	+++	+
Conversion Technique							
Technology	+++	++	+	+++	+++	+++	++
System Technology	+++	+	+	+++	++	++	++
System Aspects							
System Integration	+	+++	+++	+	+++	+++	++
Environmental Benefits	++	+++	+++	+++	+++	+++	++
Costs	++	+	+	+	+	+	+
Cost Red. Potential	+	+++	+++	+	+	+	++

Evaluation: + less promising; ++ promising; +++ very promising

Source: Smith, K.R.; Kaltschmitt, M.; Thrän, D. 2001 [19]

Use of *biofuel* differs significantly throughout the world. *By-products* concentrated at industrial processing sites (like *bark* and *saw dust* in saw mills) are currently the largest commercially used *biomass* source. For example bagasse, the fibre remaining after juice extraction in sugar cane processing, often provides energy for extracting the juice and processing to pure cane sugar or alcohol at the sugar mill and, in addition, surplus bagasse is used to supply electricity for the local grid.

In developing countries, *biomass* (particularly *fuelwood* and *charcoal*) is used mainly in open combustion devices for cooking and, to a lesser extent, space heating.

4. Bioenergy Terminology

4.1 Terms related to the energy field

Biofuels are already related to both energy statistics and forest statistics. In line with the classification described in Figures 1 to 3, in energy statistics the term *bioenergy* covers all energy derived from *biofuels*. It comprises purpose-grown *energy crops*, managed natural forests, multipurpose plantations and *by-products* (residues and wastes) from both production and processing areas. *Biomass* may be considered as one form of transformed solar-energy. From this point of view *bioenergy* is a *renewable energy* source (see Figure 4). [3]

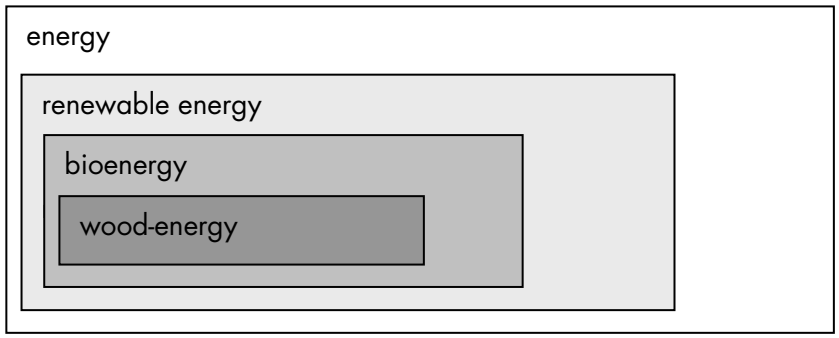


Figure 4: Bioenergy in the energy statistics field

4.2 Terms for biof el classification

Based on the conceptual approach discussed earlier, a detailed scheme for classifying *biofuels* is presented in Table 5. The prime consideration behind the suggested classification is to identify the basic site where *biomass* production takes place; thus it seeks to distinguish whether the *biofuel* was connected to forest, agricultural or municipal activities. The inclusion of a group on the use of *agrofuels* aims at distinguishing classical *biofuels* (generally related to forest exploitation) from those oriented towards annual or pluri-annual plantation.

The groups on the supply side clearly identify the origin of *biofuels*. On the end user side, the variety of *fuels* that can be produced for each group can be observed, thus allowing for data comparison and verification on both supply and demand. The right-hand column of Table 5 lists the different types of primary, secondary and tertiary *fuels* which can be used for heat, electricity and power generation. Secondary and tertiary *fuels* are often derived from raw biomass produced following of relatively complex transformation processes.

The main definitions employed in UBET include three types of *biofuel: woodfuels, agrofuels*, and *municipal by-products* (the term "by-products" includes the improperly called solid, liquid and gaseous residues and wastes derived from biomass processing activities).

[3] An overview on bioenergy production and consumption is given in the bioenergy balance.

Table 5: Biofuel classification scheme

Production side, supply	Common groups	Users side, demand examples
Direct Woodfuels Indirect Woodfuels Recovered Woodfuels Wood-derived fuels	**WOODFUELS**	**Solid**: Fuelwood (wood in the rough, chips, sawdust, pellets), Charcoal **Liquid**: Black liquor, Methanol, Pyrolitic oil **Gases**: Products from gasification and pyrolisis gases of above fuels
Fuel crops Agricultural by-products Animal by-products Agro-industrial by-products	**AGROFUELS**	**Solid**: Straw, Stalks, " usks, Bagasse, Charcoal from the above biofuels **Liquid**: Ethanol, Raw vegetable oil, Oil diester, Methanol, Pyrolitic oil from solid agrofuels **Gases**:Biogas, Producer gas, Pyrolisis gases from agrofuels
Municipal by-products	**MUNICIPAL BY-PRODUCTS**	**Solid**: Municipal solid wastes (MSW) **Liquid**: Sewage sludge, Pyrolitic oil from MSW **Gases**: Landfill gas, Sludge gas

4.2.1. Woodfuels

Woodfuels are included in the sector of forests, woodlands and trees (Figure 5). *Woodfuels* include all types of *biofuels* derived directly and indirectly from trees and shrubs grown on forest and non-forest lands. The definition of **forest** according to FAO Forest Resource Assessment 2005[4] is rather broad and includes land with a minimum tree crown cover of 10%. *Woodfuels* also include biomass derived from silvicultural activities (*thinning*, pruning etc.) and harvesting and *logging* (tops, roots, branches, etc.), as well as industrial by-products derived from primary and secondary forest industries which are used as *fuel*. They also include *woodfuels* derived from forest energy plantations.

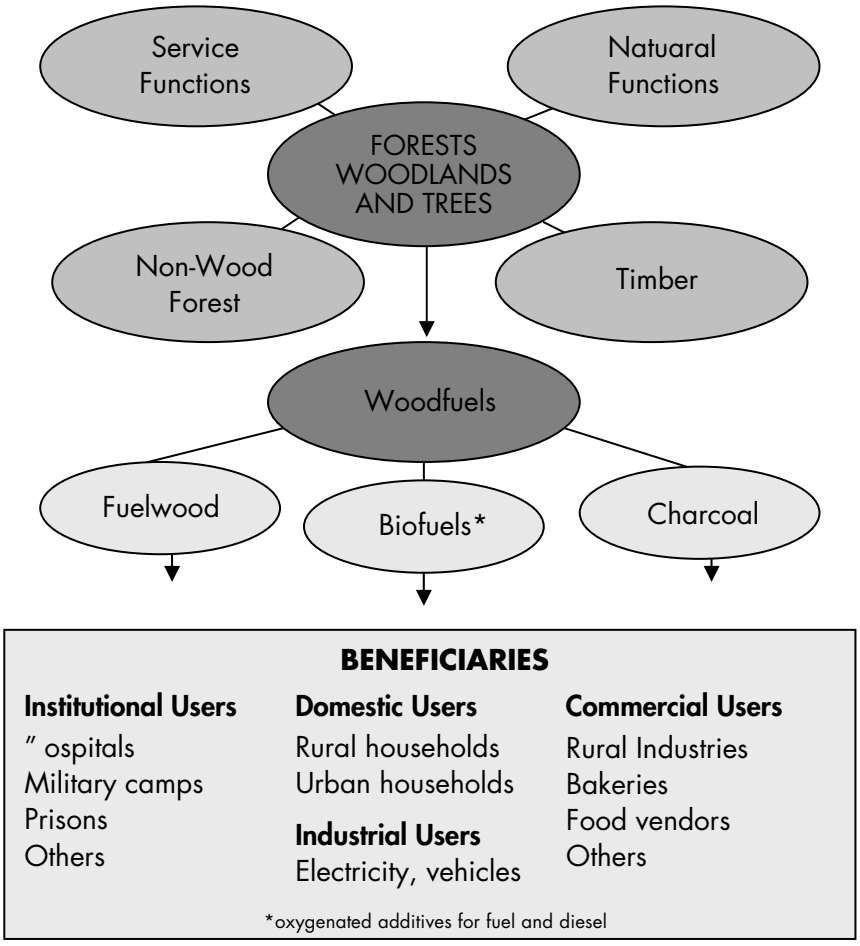


Figure 5: Woodfuels in the forests, woodlands and trees field [FAO, 1995]

Figure 6 presents a conceptual view of *wood energy* systems. The figure introduces the three different supply sources: nature (forests and trees-outside forests), wood industries and society and the main products involved. The user's side is also represented, shared among the main demand sectors. Additional considerations regarding wood energy trade complete the picture. As regards the commodities to be considered in wood energy accounting, *woodfuels* can be divided into four types of products: *fuelwood, charcoal, black liquor* and other. Table 6 summarises the main supply sources for the different types of *woodfuels*.

[4] FAO Forestry web site. Forestry Terminology: URL www.fao.org/forestry/site/25210/en

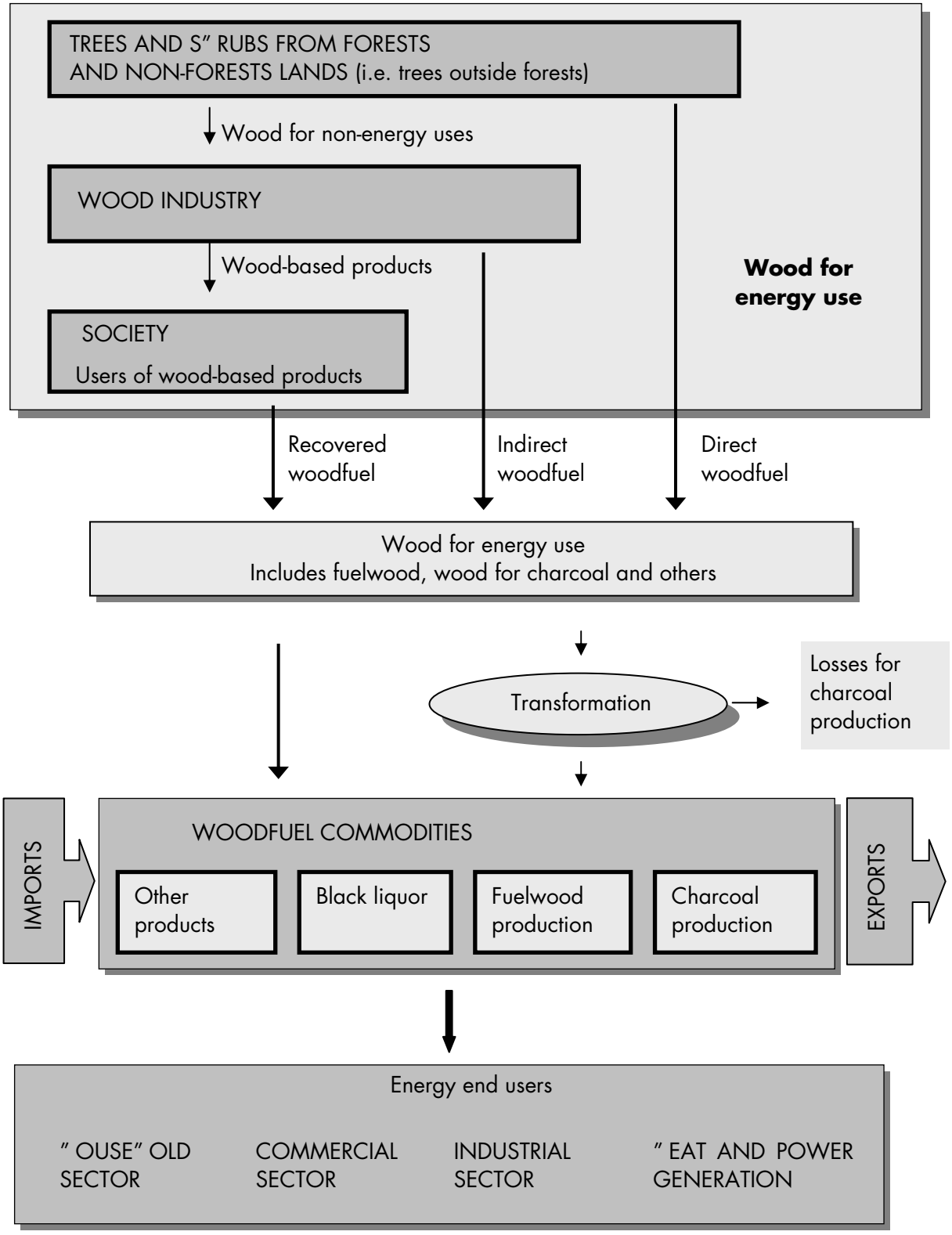


Figure 6. Woodfuel balance scheme, from supply sources to end users

Table 6. Woodfuel types from different supply sources

	Supply side (sources)		
Commodities (wood energy vectors)	**Direct Woodfuels**	**Indirect Woodfuels**	**Recovered Woodfuels**
Fuelwood	**X**	**X**	**X**
Charcoal	**X**	**X**	**X**
Black liquor		**X**	
Other (methanol, ethanol, pyrolitic gas)	**X**	**X**	**X**

4.2.2 Agrofuels

These are *fuels* obtained as a product of agriculture *biomass* and *by-products at farming level, and/or industrial processing of raw material (agroindustries)*. The term covers mainly *biomass* materials derived directly from *fuel crops* (see Tables 5 and 7) and *agricultural, agroindustrial and animal by-products*. In the future more attention will be given to the definition of different types of *agrofuels* which so far have received marginal attention. This will cover both the terminology used but also for the development of improved data bases.

Table 7: Classification of fuel crops

classification		**description/example**
land farms	sugar/starch crops	crops planted basically for the production of ethanol (ethyl alcohol) as a fuel mainly used in transport (on its own or blended with gasoline). Ethanol can be produced by the fermentation of glucose derived from sugar-bearing plants (like sugar-cane) or starchy materials after hydrolysis
	oil crops	oleaginous plants (e.g. sunflower, rape, etc.) planted for direct energy use of vegetable oil extracted, or as raw material for further conversion into a diesel substitute, using transesterification processes
	other energy crops	include plants and specialized crops more recently considered for energy use, such as: elephant grass (*Miscanthus*), cordgrass and galinggale (*Spartina* spp. and *Cyperus longus*), giant reed (*Arundo donax*) and reed canary grass (*Phalaris arundinacea)*
marine farms		algae
fresh water farms		water hyacinths

4.2.3 Municipal by-products

This refers to *biomass by-products* produced by the urban population and comprise two types: solid municipal by-products, and gas/liquid municipal by-products produced in cities and villages.

Solid municipal biofuels: comprises by-products produced by the residential, commercial, industrial, public and tertiary sectors that are collected by local authorities for disposal in a central location, where they are generally incinerated (combusted directly) to produce heat and/or power. Hospital waste is also included in this category.

Gas/liquid municipal biofuels: biofuels derived principally from the anaerobic fermentation (biogas) of solid and liquid municipal wastes which may be land-fill gas or sewage sludge gas.

For easy reference, Table 8 provides brief definitions of the main terms adopted. Table 9 provides some examples for the biofuel classification proposed.

Table 8: Proposed Definition of Biofuel Classifications

1st level	2nd level	Brief definition
Woodfuels	Direct Woodfuels	Wood from forests, shrubs and other trees used as fuel
	Indirect Woodfuels	Mainly solid biofuels produced from wood processing activities
	Recovered Woodfuels	Wood used directly or indirectly as fuel, derived from socio-economic activities outside the forest sector
	Wood-based fuels	Mainly liquid and gaseous biofuels produced from woody biomass
Agrofuels	Fuel crops	Growing plants for the production of biofuels
	Agricultural by-products	Mainly by-products from crop harvesting and other kinds of by-products from agricultural activities left in the field
	Animal by-products	Primarily excreta from cattle, horses, pigs and poultry
	Agro-industrial by-products	Several kinds of biomass materials produced chiefly in food and fibre processing industries, such as bagasse and rice husks
Municipal by-products		Several kinds solid and liquid municipal biomass materials produced in urban societies

Table 9: Examples for proposed biofuel classification

Example	classification for statistics
whole tree chips	direct, primary, solid, woodfuel
black liquor	indirect, primary, liquid, wood-based fuel
charcoal briquette	direct (or indirect or recovered) secondary, solid, wood-based fuel
demolition wood	recovered, primary, solid, woodfuel
plant methyl ester (PME)	secondary, liquid agrofuel from fuel crops
ethanol from bagasse	secondary, liquid agrofuel from agricultural by-product
biogas from MSW digestion	secondary gaseous municipal by-product fuel

5. Parameters, Units and Conversion factors

To identify the *biofuel* quality certain properties must be described adequately. Energy sources and commodities may be measured by their *mass* or weight or even *volume*, but the essential factor is the *energy content* related to theses sources and commodities. That must be evaluated in terms of energy parameters, using standard units. This standardisation in the recording and presentation of original units is a primary task of the energy and forestry statisticians before quantities can be analyzed or compared. It is recommended that for international reporting, and as far as possible in national accounting procedures, energy and forestry statistics should use the International System of Units (officially abbreviated to SI).[5] Additionally, when statistically recording charcoal consumption, charcoal productivity has to be taken into consideration.

5.1 Properties of biofuels

The most relevant biofuel properties in practice are *moisture, energy content, mass, volume* and *density* as well as shape and *particle size* and *total ash*. Data for the main *biofuels* is given in Table 9.

The importance of other *biofuel* properties (i.e. content of different elements, *ash fusibility*) depends on the type of *solid biofuel*, the specific conditions at the combustion plant, the emission control etc. For most of the currently used *woodfuels* those properties have no significant relevance for the use of biofuels and should only be taken into consideration in particular circumstances.

5.1.1 Moisture

The *moisture* of *solid biofuels* varies widely, since the *moisture* of *woodfuels* depends on the time of harvesting, the location, type and duration of the storage and the *fuel* preparation. It varies from less than 10% (*wood processing industry by-products*) up to 50% (forest *wood chips*). The *moisture* is relevant not only for the *calorific value* but for the storage conditions, the combustion temperature and also the amount of exhaust gas.

Two methods (*dry basis* and *wet basis*) are commonly used to specify the *total moisture.* It is important to distinguish between them, especially when *total moisture* is high.

$$Moisture_{drybasis} = 100x\left(\frac{WetWeight - DryWeight}{DryWeight}\right) \quad (1)$$

$$Moisture_{wetbasis} = 100x\left(\frac{WetWeight - DryWeight}{WetWeight}\right) \quad (2)$$

[5] See the International Bureau of Measures at http://www.bipm.fr/en/home/

In the above expressions, **wet weight** refers to the burned condition and **dry weight** refers to wood after a standardized drying process. It is important to state the basis on which *total moisture* is measured. Most *biofuel moisture* is measured on a *dry basis*.

Table 10: Energy content and concentrations of some elements in untreated biomass compared with coal

Type of biomass	Moisture % dry basis	Net calorific value MJ/kg	Total ash % dry basis	Volatile compounds
Sprucewood (with bark)	20-55	18.8	0.6	82.9
Beech-wood (with bark)	20-55	18.4	0.5	84.0
Poplar wood (Short rotation)	20-55	18.5	1.8	81.2
Willow wood (Short rotation)	20-55	18.4	2.0	80.3
Bark (softwood)		19.2	3.8	77.2
Rye straw		17.4	4.8	76.4
Wheat straw	15	17.2	5.7	77.0
Triticale straw	15	17.1	5.9	75.2
Barley straw	15	17.5	4.8	77.3
Rape straw	15	17.1	6.2	75.8
Corn straw	15	17.7	6.7	76.8
Sunflower straw	15	15.8	12.2	72.7
″ emp straw	15	17.0	4.8	81.4
Rice straw	15	12.0	4.4	
″ usk		14.0	19.0	
Groundnut shells	3-10	16.7	4-14	
Coffee husks	13	16.7	8-10	
Cotton husks	5-10	16.7	3	
Coconut husks	5-10	16.7	6	
Oil palm husks	55	8.0	5	
Rye whole crop		17.7	4.2	79.1
Wheat whole crop		17.1	4.1	77.6
Triticale whole crop		17.0	4.4	78.2
Miscanthus		17.6	3.9	77.6
Rye grain		17.1	2.0	80.9
Wheat grain		17.0	2.7	80.0
Triticale grain		16.9	2.1	81.0
Rape grain		26.5	4.6	85.2
Olives (pressed)	15-18	16.7	3	
Corncobs	15	13.4	15-20	
Sugar cane stalk (bagasse)	40-50	8.0	4.0	80
″ ay from various sources		17.4	5.7	75.4
Road side green		14.1	23.1	61.7
″ ard coal		29.7	8.3	34.7
Lignite	50	20.6	5.1	52.1

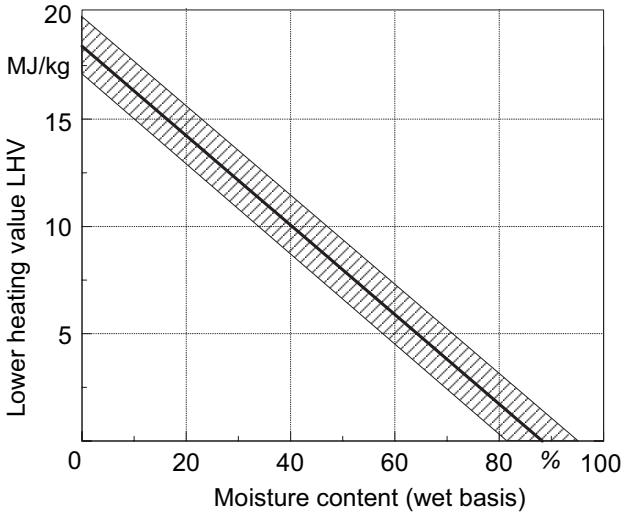
Source: Smith, K.R.; Kaltschmitt, M.; Thrän, D. 2001 [19].

5.1.2 Energy content

In most practical applications the *energy content* of *biofuel* is best described by the *net calorific value*. This is greatly influenced by the *total moisture* of the *biomass* as well as *total hydrogen* of the *fuel*. The actual *net calorific value* of *biomass* containing a known percentage of water can be calculated from the *net calorific value* of the absolute dry *biomass*, which is available from the literature. In equation 3 $H_{u\,(w)}$ describes the *net calorific value* (in MJ/kg) of the *biomass* at a specific *total moisture*, $H_{u\,(wf)}$ the *net calorific value* of the fully dry *biomass*, and *w* the *total moisture* (in %). The constant '2.44' results from the evaporation energy of water.

$$H_{u\,(w)} = \left[H_{u\,(wf)} (100 - w) - 2.44\, w \right] / 100 \qquad (3)$$

Figure 7 shows that the *net calorific value* of wood decreases from approximately 18.5 MJ/kg with increasing *total moisture*. The *net calorific value* is zero at *total moisture* of approximately 88%. Normally the *total moisture* of air-dried wood is between 12 and 20% yielding a *calorific value* of 13 to 16 MJ/kg. Freshly harvested wood is characterized by a *total moisture* of about 50% or more. A low *net calorific value* is the result.



Source: Smith, K.R.; Kaltschmitt, M.; Thrän, D. 2001 [19].

Figure 7: Net calorific value of wood depending on the total moisture.

5.1.3 Mass, Volume and Density

Two basic relationships for bioenergy evaluation are introduced as follows, bearing in mind that both the **calorific value** and **density** depend mainly on the **moisture** of the woodfuel.

$$\text{Energy} = \text{Mass} \times \text{"eating value} \quad (4)$$

$$\text{Mass} = \text{Volume} \times \text{Density} \quad (5)$$

The main parameters of interest are:

Mass: some *woodfuels*, such as *charcoal* and *black liquor*, are measured in units of *mass*. The principal units of mass used to measure energy commodities are the kilogram and the metric ton. The metric ton (1 000 kg) is the most widely adopted.

Volume: units of *volume* are typical units for round wood and *fuelwood* measurement. The basic SI units of volume are the litre and the kilolitre, which is equivalent to the cubic metre. Although the stere or stacked volume, usually considered as equal to 0.65 solid cubic metres, has been widely used in the past when measuring *woodfuel volume,* the main units currently used are **solid volume** units, usually cubic metres (CUM). *Wood chips* and *pellets* are generally measured in **bulk volume** units, usually in cubic metres (CUM). Table 11 contains typical conversion factors of *mass, solid volume* and *bulk volume* for *fuelwood*.

Table 11: Conversion factors for fuelwood accounting

	mass (metric ton)	**solid volume (CUM)**	**bulk volume (CUM)**
mass (metric ton)	1.0	1.3 – 2.5	4.9
solid volume (CUM)	0.4 – 0.75	1.0	2.4
bulk volume (CUM)	0.2	0.6	1.0

Density: the *density* of wood, (i.e. the weight per unit of volume) varies widely between different wood species and types. The usual species used for *fuelwood* are around 650 and 750 kg/CUM. It is important to observe the influence of the *total moisture* on the wood *density*. The more water per unit weight, the less *fuelwood*. Therefore, it is imperative that the *total moisture* be accurately specified when *fuelwood* is measured by weight. There are two different types of *density* relevant for the use of *solid biofuels*:

particle density describes the *density* of the material itself and is relevant for the combustion process (i.e. evaporation rate, energy density etc.), some feeding aspects (i.e. for pneumatic equipment), and storage. The *particle density* of the usual species used for *fuelwood* are around 650 and 750 kg/CUM. The *particle density* can only be varied by producing *compressed biofuels* and is used to describe the quality of those products (i.e. high particle density is an indicator for a high pellet quality).

bulk density is defined as ratio of dry material to *bulk volume* and is relevant for the *volume* needed for transportation and storage. It is very important for trading and supply. The *bulk density* varies widely. Typical *bulk densities of biofuels are* given in Table 12.

Table 12: Typical bulk density of biofuels

woody biofuels		bulk density (kg/m³)	herbaceous biomass		bulk density (kg/m³)
log wood (stacked)	beech	460	round bales	straw	85
	spruce	310		hay	100
wood chips	softwood	195	block bales	straw, Miscanthus	140
	hardwood	260		hay	160
bark	softwood	205		whole plants	190
	hardwood	320	chopped biofuels	straw, Miscanthus	70
saw dust		170		whole plants	150
shavings		90			
wood pellets		600	straw pellets		500

5.1.4 Total ash and ash melting temperature

The *total ash* of *solid biofuels* depends on the type of *biomass* and the *impurities*. It is relevant for the *calorific value* and determines if the *biofuel* is fit for use in particular combustion plants. The *total ash* is always measured on a *dry basis*, which refers to the solid residue remaining after complete combustion. While the *total ash* of *fuelwood* is generally around 1%, some species of *agrofuels* can register a much higher *total ash*. This affects the energy value of the *biofuels* since the substances that form the *ashes* generally have no energy value. Thus dry *woodfuels* with a 4% *total ash* will have 3% less energy than *biomass* with a 1% *total ash*.

For certain *biofuels* the *ash melting temperature* is a relevant driving force for combustion processes, since a high process temperature initiates ash melting and slag expansion, resulting in plant breakdown and high maintenance. Low ash melting temperatures are characteristic for most of the *herbaceous biomass* and *energy grain*, while *woody biomass* is normally not affected by ash melting problems.

5.1.5 Shape and particle size

Particle shape, *particle size* and *particle size distribution* of *solid biofuels* are relevant for transportation, and handling at the conversion plant. In practice the shape and size varies widely i.e. between *milled biofuels* (i.e. *wood flour*), *compressed biofuels* (i.e. straw pellets), *cut biofuels* (i.e. chips) and *baled biofuels* (i.e. straw bales). Those different forms need specific equipment for production, transportation, storage, feeding and combustion. A wide *particle size* range can lead to trouble in fully-automated feeding systems by bridging, obstruction or adhesion processes.

5.2 Charcoal prod ctivity

When statistically recording the conversion from *fuelwood* (or *woodfuels*) to *charcoal*, three principal aspects must be dealt with: wood *density*, *moisture* of the wood, and the means of *charcoal* production. The yield of *charcoal* from *fuelwood* using different types of kilns is given in Table 13 (FAO, Woodfuel Survey, 1983). FAO, in its statistics (FAOSTAT), uses a conversion factor of 165 kg of *charcoal* produced from one cubic metre of *fuelwood*.

Table 13:. Fuelwood requirement for charcoal production (CUM/ton of charcoal)

Kiln type	Fuelwood moisture (%, dry basis)					
	15	20	40	60	80	100
Earth kiln	10	13	16	21	24	27
Portable steel kiln	6	7	9	13	15	16
Brick kiln	6	6	7	10	11	12
Retort	4.5	4.5	5	7	8	9

5.3 Conversion factors

The main factors to be used for *bioenergy* accounting, covering the various types of *biofuel* and considering the usual information available from primary data sources, are shown in Table 14. It presents the values for *density* (necessary when only the *biofuel volume* is given) and the *calorific value* for typical *moisture*. It should be noted that the objective is to obtain the energy worth of a *mass* or *volume* flow of some *biofuel*, so expressions (1) and (2), already presented above, must be used. " owever, taking into account the substantial variations in *calorific value* and *volume* with *moisture*, it is advisable to express the values of *biofuels* in a *dry* and *ash-free basis*, especially for accounting in energy balances.

Table 14: Basic parameters in accounting biofuels

Biofuel	Primary Data	Density (Tons/cum)	Net calorific value (MJ/kg)	Moisture (%, dry basis)
Direct Woodfuels	Volume	0.725	13.8	30
Charcoal	Mass, volume		30.8	5
Indirect Woodfuels	Mass, volume	0.725	13.8	
Recovered Woodfuels	Mass, volume	0.725		
Wood-derived fuels	Mass	-		
Black liquor	Mass			
Methanol	Mass		20.9	0
Non-forest Biofuels	Mass	-		
Ethanol	Mass		27.6	0
Agricultural by-products	Mass		(see Table 9)	
Animal by-products	Mass	-	13.6	
Agro-industrial by-products	Mass	-		
Bagasse	Mass	-	8.4	40
Municipal wastes	Mass	-	19.7	-

* for black liquor accounting as woodfuel, it can be assumed that from one ton of chemical cellulosic pulp production, an amount of liquor equal to 2.27 CUM of woodfuel, in energy terms, results.
Source: FAO, 1997 [10].

6. Index of Terms

(Alphabetical order)

7. Definitions of main Terms

agricultural *by-products*, agricultural residues

biomass by-products originating from production, harvesting, and processing in farm areas.

NOTE See also animal by-products and crop production by-products

agrofuels

biofuels obtained as a product of energy crops and/or agricultural by-products

NOTE See also agricultural by-products, agro-industrial by-products and animal by-products

agro-industrial by-products

Several kinds of biomass materials produced chiefly in food and fibre processing industries

EXAMPLES sugarcane bagasse, rice/paddy husks and hulls, coconut shells, husks, fibre, and pith, olive pressing

animal by-products , animal residues

agricultural by-products originating from livestock keeping. It includes among others solid excreta of animals.

ash

residue obtained by combustion of a *fuel*

NOTE 1 See also total ash and ash fusibility.
NOTE 2 Depending on the combustion efficiency the ash may contain combustibles.
NOTE 3 Adopted to ISO 1213-2:1992 [15]

ash fusibility ; ash melting behaviour

characteristic physical state of the *ash* obtained by heating under specific conditions. Ash fusibility is determined under either oxidizing or reducing conditions.

baled biofuel, bale

solid biofuels which has been compressed and bound to keep its shape and *density*

EXAMPLE Straw bales, bales of energy grass, bales of treetops and branches

bark

organic cellular tissue which is formed by taller plants (trees, bushes) on the outside of the growth zone (cambium) as a shell for the wooden body

basic density

ratio of the mass on *dry basis* and the *solid volume* on *green basis*

bioenergy

energy from *biofuels*

bioenergy balance

quantitative summary data on biomass energy production and consumption represented in an energy balance table and diagram. A bioenergy balance represents an overview of production and consumption of primary and secondary biofuels for a specific area, country or region. All values must have the same units and the same prefix to indicate its magnitude (tera, peta, giga, etc.).

NOTE Energy balances should cover all the primary and secondary energy sources, showing clearly the non-energy use of such sources. In the cases where *biofuels* are utilized for industrial processes, such as in the pig-iron industry, their use should be clearly indicated and consideration given to all the previous processes involved.

biofuel

fuel produced directly or indirectly from *biomass*

biofuel blend

biofuel resulting from intentionally mixing of different *biofuels*

EXAMPLE Straw or *energy grass* with wood, dried *biosludge* with *bark*.

biofuel briquette

densified biofuel made with or without *pressing aids* in the form of cubiform or cylindrical units, produced by compressing pulverised biomass. The raw material for briquettes can be *woody biomass, herbaceous biomass, fruit biomass* and *biomass blends,* and *biomass mixtures*. Biofuel briquettes are usually manufactured in a piston press. The *total moisture* of the biofuel briquette is usually less than 15 % of mass.

biofuel mixture

biofuel resulting from natural or unintentional mixing of different *biofuels* and/or different types of *biomass*

biofuel pellet

densified biofuel made from *pulverised biomass* with or without *pressing aids* usually with a cylindrical form, random length typically 5 to 30 mm, and broken ends. The raw material for biofuel pellets can be *woody biomass, herbaceous biomass, fruit biomass,* or *biomass blends* and *mixtures*. They are usually manufactured in a die. The *total moisture* of biofuel pellets is usually less than 10 % of mass.

biomass

material of biological origin excluding material embedded in geological formations and transformed to fossil

NOTE See also herbaceous biomass, fruit biomass, and woody biomass.

biomass *by-products*, biomass residues

biomass originating from well defined side-streams from agricultural, forestry and related industrial operations

NOTE Adopted to the proposal within the Draft CEN Report Solid Recovered Fuels [18]

biosludge

sludge formed in the aeration basin during biological waste water treatment or biological treatment process and separated by sedimentation. The sludge can be dewatered and further processed into *solid biofuel.*

black liquor

alkaline spent liquor obtained from digesters in the production of sulphate or soda pulp during the process of paper production, in which the energy content is mainly originating from the content of lignin removed from the wood in the pulping process

producer gas

solid biofuel gasified/manufactured in a gasifier.

bulk density

mass of a portion of a solid fuel divided by the volume of the container which is filled by that portion under specific conditions

NOTE Adopted to ISO 1213-2:1992 [15].

bulk volume, loose volume

volume of a material including space between the particles

bundled biofuel, bundle

solid biofuels which has been bound together and where there is a lengthwise orientation of the material

EXAMPLE Bundles of *energy forest trees* and *logging by-products*, small trees, or branches and tops.

calorific value, heating value (Q)

energy amount per unit mass or volume released on complete combustion

NOTE See also gross calorific value, energy density, net calorific value, and net calorific value as received

cereal crops

annual crops grown with the main purpose to use the seed for food production. Some cereal crops can be used as a *solid biofuel*.

EXAMPLES barley, wheat, rye, oat

char

solid partially or non-agglomerated carbonaceous material produced by pyrolysis of solid biofuels

NOTE Adopted to ISO 1213-2:1992 [15].

charcoal

solid residue derived from carbonization distillation, pyrolysis and torrefaction of *fuelwood*

chopped straw

straw which has been cut into small pieces

chunkwood

wood cut with sharp cutting devices in which most of the material has a typical particle length, substantially longer and more coarse than wood chips

NOTE Chunkwood has a typical length of 50 to 150 mm.

complete tree

harvested tree, including limbs and root system

NOTE See also *whole tree*.

cork by-products, cork residues

biomass by-products from cork production

crop production by-products , crop production residues

agricultural by-products originating from crop production, harvesting, and processing in farm areas. It includes among others wood, straw, stalks, and husks.

cross-cut ends

short pieces of *woody biomass* which occur when the ends of logs or sawn timber are cross cut off, with or without *bark*

cut biofuel

solid biofuels cut into pieces

NOTE See also chunkwood, firewood, chopped straw, and smallwood.

cutter chips

wood chips made as a by-product of the wood processing industry, with or without *bark*

demolition wood

used wood arising from demolition of buildings or civil engineering installation

NOTE Adopted to prEN 13965-1:2000 [17]

densified biofuel, compressed biofuel

solid biofuel made by mechanically compressing *biomass* to increase its *density* and to mould the *fuel* into a specific size and shape such as cubes, pressed logs, *biofuel pellets* or *biofuel briquettes*

NOTE See also biofuel briquette and biofuel pellets.

density

ratio of mass to *volume*. It must always be stated whether the density refers to the density of individual particles or to the bulk density of the material and whether the mass of water in the material is included.

NOTE See also basic density, bulk density and particle density.

dry ash free basis

condition in which the *solid biofuel* is free from *moisture* and *inorganic matter*

dry basis

condition in which the *solid biofuel* is free from *moisture*

NOTE Adopted to ISO 1213-2:1992 [15].

dry matter

material after removal of moisture under specific conditions

dry matter content

portion of *dry matter* in the total material on mass basis

edgings

parts of *woody biomass* which occur when trimming sawn timber and which show a remainder of the original rounded surface of the tree, with or without *bark*

energy crops, fuel crops

woody or herbaceous crops grown specifically for their *fuel* value

NOTE See also energy forest trees, energy grass, energy plantation trees.

energy density

ratio of net energy content and *bulk volume*

NOTE The energy density is calculated using the *net calorific value* determined and the *bulk density*.

energy forest trees

woody biomass grown specifically for its *fuel* value in medium to long rotation forestry

energy grass; fuel grass

herbaceous *energy crop*

EXAMPLE Sugarcane, Miscanthus, Reed canary grass.

energy plantation trees

woody biomass grown as *short rotation trees* specifically for its *fuel* value

extraneous ash

total ash from contaminants entering the material at harvest, logging, treatment, transport, storage etc.

fibre board *by-products*, fibre board residues

by-products from fibre board production. Fibre board is a panel product manufactured from low grade wood, wood residues, or similar lignocellulosic materials with primary bonding deriving from the arrangements of fibres and their natural adhesive properties.

fibre sludge

sludge formed in the sedimentation basin as a part of the waste water treatment process in a pulp and paper mill. The main component is pieces of wood fibres. The sludge can be dewatered and further processed into a solid biofuel.

firewood

cut and split oven-ready *fuelwood* used in household wood burning appliances like stoves, fireplaces and central heating systems. Firewood usually has a uniform length, typically in the range 150 mm to 500 mm.

fixed carbon

remainder after the percentage of *total moisture*, *total ash,* and *volatile matter* are subtracted from 100

NOTE Adopted to ISO 1213-2:1992 [15].

food processing industry by-products , food processing industry residues

biomass by-products originating from the food processing industry. It includes among others bone meal, press cake from juice production.

foreign material; impurities

material other than claimed, which has contaminated the *biofuel*

forest chips

forest wood in the form of wood chips

forest fuels

woodfuel produced where the raw material has not previously had another use. Forest fuel is produced directly from forest wood by a mechanical process.

forest wood

woody biomass from forests and/or tree plantations

NOTE See also complete tree, energy forest trees, energy plantation trees, logging by-products, thinning by-products, tree section, and whole tree.

fruit biomass

part of a plant which holds seeds

EXAMPLE Nuts, olives

fuel

energy carrier intended for energy conversion

fuel classification

division of *fuels* into defined fuel classes. The aim of classification can be to describe the *fuel* and/or to physically separate certain particle types.

fuel dust

pulverised biofuel with a typical particle size of 1 to 5 mm

EXAMPLE Saw dust, straw dust

fuel powder; fuel flour

pulverised biofuel with a typical *particle size* less than 1 mm

EXAMPLE Wood powder, wood flour, straw powder

fuel specification

description of *fuel* properties

fuelwood

woodfuel where the original composition of the wood is preserved

green basis

condition based on fresh material at specific *total moisture*

green chips

wood chips made of fresh *logging* and *thinning by-products,* including branches and tops

grinding dust

dust-like wood residue formed in grinding timber and wood boards

gross calorific value (q_{gr})

absolute value of the specific energy of combustion, in joules, for unit mass of a solid fuel burned in oxygen in calorimetric bomb under the conditions specified. The result of combustion are assumed to consist of gaseous, oxygen, nitrogen, carbon dioxide and sulphur dioxide, of liquid water (in equilibrium with its vapour) saturated with carbon dioxide under conditions of the bomb reaction, and of solid ash, all at the reference temperature and at constant volume. Old term is higher heating value.

NOTE Adopted to ISO1928:1995 [14]

gross density

ratio of the mass of a wooden body and its volume, including all cavities (pores and vessels), based on specific *total moisture*

herbaceous biomass

biomass from plants that has a non-woody stem and which dies back at the end of the growing season

NOTE 1 See also *energy grass.*
NOTE 2 Adopted to BioTech's Life Science Dictionary [2].

herbaceous fuels

all types of *biofuels* originating from *herbaceous biomass*

hog fuel

fuelwood in the form of pieces of varying size and shape, produced by crushing with blunt tools such as rollers, hammers, or flails

horticultural *by-products*, horticultural residues

biomass by-products originating from production, harvesting, and processing in horticulture including greenhouses

inorganic matter

non-combustible fraction of *dry matter*

landscape management *by-products* , landscape management residues

by-products of *woody, herbaceous* and *fruit biomass* originating from landscape, park, and cemetery management. It includes among others grass, hay, branches from landscape trees, road side green, and/or wood from shrubs.

log wood

cut *fuelwood* in which most of the material has a length of 500 mm and above

logging by-products, logging residues

woody biomass by-products which are created during harvest of merchantable timber

NOTE Logging by-products include tree tops with branches and they can be salvaged fresh or after seasoning.

mass-reduction

reduction of the mass of a *sample* or *sub-sample*

mechanical strength , mechanical durability

ability of *densified biofuel* units (e.g. briquettes, pellets) to remain intact during loading, unloading, feeding, and transport

moisture

water in a *fuel*

NOTE See also total moisture and moisture analysis sample.

natural ash

total ash of uncontaminated *fuel*

net calorific value (q_{net})

under such conditions that all the water of the reaction products remains as water vapour (at 0.1 MPa), the other products being as for the *gross calorific value*, all at the reference temperature. The net calorific value can be determined at constant pressure or at constant volume. Old term is lower heating value. Net calorific value as received ($q_{net,ar}$) is calculated by the net calorific value from dry matter ($q_{net,d}$) and the *total moisture* as received.

NOTE Adopted to ISO 1928:1995 [14].

organic matter

combustible fraction of *dry matter*

oven dry wood

wood free of *moisture,* produced by drying to constant weight under specific conditions

over size particles

portion of particles exceeding a specific limit value

particle board by-products, particle board residues

by-products from particle board production, which is a panel product produced by densifying small particles of wood or similar lignocellulosic materials while simultaneously bonding with an adhesive

particle density

density of a single particle

particle size

size of the *fuel* particle as determined. Different methods of determination may give different results.

NOTE See also particle size distribution, fine particles and over size particles.

particle size distribution

proportions of various *particle sizes* in a solid *fuel*

NOTE Adopted to ISO 1213-2:1992 [15].

plywood by-products, plywood residues

woody biomass by-products formed in plywood industry

pressing aid

additive to the raw material used for enhancing the production of *densified fuels*

proximate analysis

analysis of a *solid biofuel* reported in terms of *total moisture, volatile matter, ash content* and *fixed carbon* measured at specified conditions

NOTE Adopted to ISO 1213-2:1992 [15].

pulverised biofuel

solid biofuel in the form of dust and powder, produced by milling or grinding

NOTE See also fuel dust and fuel powder.

renewable energy

consists of energy produced and/or derived from sources infinitely renovated (hydro, solar, wind) or generated by combustible renewables (sustainably produced biomass); usually expressed in energy units and, in the case of fuels, based on net calorific values.

recovered construction wood

used wood arising from construction of buildings or from civil engineering works

NOTE Adopted to prEN 13965-1:2000 [17].

sample

quantity of material, representative of a larger quantity for which the quality is to be determined

sawdust

fine particles created when sawing wood

NOTE Most of the material has a typical particle length of 1 to 5 mm.

short rotation trees

woody biomass grown as a raw material and/or for its *fuel* value in short rotation forestry

shredded biofuel

solid biofuels which has been mechanical treated into smaller pieces by blunt tools

EXAMPLE Shredded straw, shredded bark, *hog fuel*.

slabs

parts of *woody biomass* created when cuts are made into the edges of logs and whereby one side shows the original rounded surface of the tree, either completely or partially, with or without *bark*

smallwood

fuelwood cut with sharp cutting devices and in which most of the material has a particle length typically 50 to 500 mm

EXAMPLE Chunkwood, firewood.

solid biofuel

solid *fuels* produced directly or indirectly from *biomass*

solid volume

volume of individual particles

NOTE Typically determined by a fluid displaced by a specific amount of material.

stacked volume

volume of stacked wood including the space between the wood pieces

stemwood

part of tree stem with the branches removed

stemwood chips

wood chips made of *stemwood*, with or without *bark*

stump

part of the tree stem below the felling cut. In total-tree utilisation the root system is included in the stump.

thinning by-products, thinning residues

woody biomass by-products originating from thinning operations

total ash

mass of inorganic residue remaining after combustion of a *fuel* under specified conditions, typically expressed as a percentage of the mass of *dry matter* in *fuel*

NOTE See also extraneous ash and natural ash.

total carbon (C)

sum of carbon in *organic* and *inorganic matter* as a portion of the *fuel*

NOTE Adopted to ISO 1213-2:1992 [15].

total hydrogen (H)

sum of hydrogen in *organic* and *inorganic matter* and in the *moisture* as a portion of the *fuel*

NOTE Adopted to ISO 1213-2:1992 [15].

total moisture M_T

moisture in *fuel* removable under specific conditions

NOTE 1 Indicate reference (*dry matter / dry basis,* or total mass */ wet basis*) to avoid confusion.
NOTE 2 Old term is moisture content.
NOTE 3 Adopted to ISO1928:1995 [14].

tree section

part of a tree (with branches) which has been cut into suitable length but not processed. Tree sections can be processed to pulpwood and forest fuel.

used wood

wood substances or objects which have performed their intended purpose

NOTE 1 See also recovered construction wood and demolition wood.
NOTE 2 Proposal within the Draft CEN Report Solid Recovered Fuels [18].

viscose by-products, viscose residues

by-products from viscose production and processing in which cellulose of wood pulp is treated with high concentrations of sodium hydroxide and carbon disulfide and then dissolved in sodium hydroxide forming a thick solution called viscose

volatile matter

mass loss, corrected for *moisture*, when a *fuel* is heated out of contact with air under specific conditions

NOTE Adopted to ISO 1213-2:1992 [15].

volume

amount of space that is enclosed within an object

NOTE 1 It must always be stated whether the volume refers to the *solid volume* of individual particles, the *bulk volume,* or the *stacked volume* of the material and whether the mass of *moisture* in the material is included.
NOTE 2 See also bulk volume, solid volume, and stacked volume.

wet basis

condition in which the *solid biofuel* contains *moisture*

whole tree

felled, undelimbed tree, excluding root system

whole-tree chips

wood chips made of whole trees

EXAMPLE *Wood chips* containing stems with bark, branches, needles/leaves.

wood chips

chipped *woody biomass* in the form of pieces with a defined *particle size* produced by mechanical treatment with sharp tools such as knives. Wood chips have a subrectangular shape with a typical length 5 to 50 mm and a low thickness compared to other dimensions.

NOTE See also cutter chips, forest chips, green chips, stemwood chips, and whole-tree chips.

wood energy, forest energy

energy derived from *woodfuels* corresponding to *the net calorific value* of the *fuel*

wood energy systems

All the (steps and/or) unit processes and operations involved for the production, preparation, transportation, marketing, trade and conversion of woodfuels into energy

woodfuels, wood based fuels, wood-derived biofuels

all types of *biofuels* originating directly or indirectly from *woody biomass*

NOTE See also fuelwood, forest fuels, and black liquor.

wood processing industry by-products , wood processing industry residues

woody biomass by-products originating from the wood processing as well as the pulp and paper industry

NOTE See also bark, cork by-products, cross-cut ends, edgings, fibre board by-products, grinding dust, particle board by-products, plywood by-products, saw dust, slabs, and wood shavings

wood shavings; cutter shavings

shavings from *woody biomass* created when planing wood

woody biomass

biomass from trees, bushes and shrubs

NOTE See also forest wood, wood processing industry by-products, fibre board by-products, particle board by-products, plywood by-products, and used wood.

8. GLOSSARY – GLOSSAIRE - GLOSARIO

Bioenergy Terminology – Preliminary version /
Terminologie bioénergétique – Version préliminaire
Terminología bioenergética – Versión preliminar

English	Español	Français
	A	
Agricultural by-products	Subproductos agrícolas	Sous-produits agricoles / dérives agricole
Agrofuels	Agrocombustibles	Agro- carburants
Agro-industrial by-products	Subproductos agroindustriales	Sous-produits agro-industriels
Amount unburned	Cantidad no quemada	Quantité non-brulée
Animal by-products	Subproductos de origen animal	Sous-produits animaux / dérivés animaux
Ash content	Contenido de ceniza	Taux de cendre
Ash fusion temperature	Temperatura de fusión de ceniza	Température de fusion des cendres
Ash melting behaviour	Comportamiento de la ceniza en la fusión	Comportement de cendre
	B	
Bagasse	Bagazo	Bagasse
Bark	Corteza , Cáscara	Écorce
Base fuel model	Modelo de combustible	Modèle de combustible
Bioenergy / biomass energy	Bioenergía / energía derivada de biomasas	Bioénergie / Energie de biomasse
Bioenergy balance	Balance bioenergético	Bilan de la bioénergie
Bioenergy Sources	Fuentes de bioenergía	Sources de bioénergie
Biofuel(s) / Biofuel	Biocombustible(s) biocombustible(1); biocarburante	Biocombustible(s) / Biocarburant(s)
Biosludge	Biolodos	
Black liquor	Licor negro	Liqueur noire
Brick kiln	Horno de ladrillo (para la producción de carbón vegetal)	Four en brique (pour la production du charbon de bois)
Briquettes	Briquetas	Briquettes
Brushwood	Madera de arbustos, Matorral, Leña de matorral	Sous-bois - broussailles
Bundled Biofuel	Biocombustible empacado, enfardado, Biocombustible en fascículos	Fagots
Bush	Matorral	Buisson

English	Español	Français

C

Calorific value / Heating value	Poder calorífico	Pouvoir calorifique
Carbonisation	Carbonización	Carbonisation
Charcoal	Carbón Vegetal	Charbon de bois
Charcoal briquettes	Briquetas de carbón vegetal	Briquettes de charbon de bois
Charcoal maker	Carbonero	Charbonnier
Charcoal productivity	Productividad de carbonización	Productivité de Charbon
Charcoaling	Fabricación de carbón vegetal, Carbonización	Fabrication du charbon de bois
Chipped Biofuel	Biocombustible en astillas	Biocombustibles sous forme de copeaux
Chips	Astillas	Copeaux
Chopped Biofuel	Biocombustible picado	Biocombustibles fragmenté
Combustion period	Período de combustión	Durée de combustion
Compressed Biofuel	Biocombustible comprimido, densificado	Biocombustible compacté
Coniferous (C)	Coníferas	Conifères

D

Dead fuelwood	Leña muerta	Bois mort Combustibles morts
Dendrothermal unit	Central dendrotérmica	Centrale électrique à bois
Direct Forest Fuels	Combustibles forestales directos	Combustibles ligneux directs
Direct Woodfuels	Combustibles de madera directos	Combustibles ligneux direct
Disbranched	Desramado / podado	
Dry basis	Base seca	
Dry matter content	Contenido de materia seca	Matière sèche
Dry weight	Peso en seco	Poids sec

E

Earth cover kiln / pit kilm	Horno parva para carbonización	Meule à charbon de bois couverte de terre
Earth mound	Horno parva	Meule en terre (pour la production du charbon de bois)
Energy carrier	Vector energético, Portador energético	Support énergétique
Energy crops	Cultivos energéticos, Cultivos para la producción de biocombustibles	Cultures énergétiques
Energy grass	Planta herbácea energética	Herbe destinée à une utilisation énergétique
Energy plantation	Plantación energética	Plantation (dendroenergetique) de bois de feu
Energy source	Fuente energética Fuente de energía	Source d'énergie
Energy-efficient wood stove	Cocina económica a leña / Fogón a leña	Poêle à bois amélioré

English	Español	Français
	F	
Alternatively / Combustibility / Inflammability	Combustibilidad	Combustibilité
Firewood	Leña	Bois de feu
Fixed carbon	Carbono fijo	Carbone fixé
Forest	Monte / Bosque	Foret
Forest-based energy	Energía forestal, Dendroenergía	Energie d'origine ligneuse
Forestry energy plantations	Plantaciones (energéticos o para producir energía).	Plantations de bois d'énergie
Fuel crops	Cultivos para la producción de biocombustibles	Cultures a usage combustible / Culture de combustibles
Fuel type classification	Clasificación de los combustibles	Classification de combustibles
Fuelwood	Leña	Bois de feu / bois de chauffe
	G H I	
Gas / Liquid municipal biofuels		Biocarburants municipaux gazeux / liquides
Glowing combustion	Incandescencia	Combustion de braises / Braises
Green whole tree chips GWTC	Astillas del árbol entero en verde	Copeaux verts provenant d'arbre entier
″ erbaceous energy crops	Cultivos energéticos herbáceos	Bioénergie des herbes
″ erbaceous fuels	Agrocombustibles, Combustibles herbáceos	Agro-énergie
″ igher heating value	Poder calorífico superior	Pouvoir calorifique supérieur
″ og fuel	Combustible en astillas, Combustible desmenuzado	Déchets de bois écrasé
Indirect woodfuels	Combustibles de madera indirectos	Combustibles ligneux indirects
Inorganic matter	Materia inorgánica	Matière inorganique
	J K L M N	
Joinery	Ebanistería	Menuiserie / Ebénisterie
Land-fill gas	Gas de rellenos sanitarios, Gases de escombreras	
Log wood		
Lower heating value	Poder calorífico inferior	Pouvoir calorifique inférieur
Lump charcoal	Carbon vegetal a granel	
Mass	Masa	Masse
Milled biofuel	Biocombustible molido	
Moisture	″ umedad	″ umidité
Moisture content	Contenido de humedad	Taux d'humidité
Municipal solid wastes	Residuos sólidos de origen municipal	Déchets solides municipaux
Net calorific value	Poder calorífico neto	Pouvoir calorifique net
Non-commercial energy	Energía no comercial	Énergie non commerciale
Non-coniferous	Otras especies, no coníferas	Non-conifère / autres espèces

English	Español	Français
	O P Q R	
Oven dry wood	Madera secada en horno	Bois sec à l'étuve
Pallets	Bandeja de carga, tarima	Paillasse / Palettes
Pellets	Pellet	Boulette
Pig-iron	Arrabio	Fonte
Powder	Polvo	Poussière
Producer gas		
Pruning	Podas	Élagage
Pyrolysis gases	Gases de pirolisis (pirólisis)	Gaz de pyrolyse
Pyrolysis oil	Aceite de pirolisis	" uile de pyrolyse
Recovered woodfuels	Combustibles de madera recuperados	Combustibles ligneux récupérés
Renewable energy	Energía renovable	Énergie renouvelable
Roundwood	Madera en rollo, Rollizo	Bois d'œuvre
	S T	
Sawdust	Aserrín	Sciure
Sewage sludge	Fango de aguas residuales	Vidanges
Sewage sludge gas	Gases de fangos / Lodos residuales	
Shavings	Virutas	Copeaux
Short Rotation Forestry(SFR)	Bosques de corta rotación / Silvicultura de corta rotación	Foresterie à courte rotation
Shredded biofuel	Biocombustible desmenuzado	Biomasse broyé
Shrubs	Arbustos	Arbustes
Slabs	Costeros / costaneros	Plaques
Sludge	Fango	Vase
Sludge gas	Gas procedente de fangos de aguas residuales	
Solid biofuels	Biocombustibles sólidos	Biocombustibles solides
Solid municipal biofuels		Biocarburants municipaux solide
Solid recovered fuels	Combustibles sólidos recuperados	
Stacked volume	Volumen estéreo / Volumen apilado	Volume chargé (stère)
Stalks	Tallos	Tiges
Straw	Paja	Paille
Stumps	Tocones	Souches
Thermochemical converted Biofuel	Biocombustible termoquimicamente transformado	Biomass transformé par thermochimie
Thinning	Aclareos / Raleos	Élagage
Three stones cookfire	Fogon tres piedras	Foyer à trois pierres ; foyer traditionnel
Torrefaction	Torrefación de la madera	Torréfaction
Twig	Rama delgada, gajo	Branche

English	Español	Français
	U V W	
UWET Unified Wood Energy Terminology	TUD Terminología Unificada sobre Dendroenergía	Terminologie Unifiée sur le bois énergie / Terminologie Unifié Dendro-énergitique
Wet basis	Base húmeda	Base humide
Wet weight	Peso en húmedo	Poids frais
Whole tree	Árbol entero	Arbre entier
Whole wood	Madera entera	Bois entier
Whole-tree chips (WTC)	Astillas del árbol entero	Copeaux d'arbre entier
Wood based fuels / woodfuels	Dendrocombustibles / Combustibles forestales / Madera para calefacción / Combustibles de madera	Énergie de biomass / Bois énergie / combustible ligneux
Wood energy = Forest energy	Dendroenergía = Energía forestal	Bois énergie / energie ligneux / énergie forestier
Wood energy system	Sistema dendroenergético	
Woodfuel type	Tipo de combustible de madera	Type de combustible
Wood harvesting	Extracción de madera Recolección de madera	Collecte du bois
Wood pellets	Pellets de madera	Copeaux de bois
Wood shavings	Virutas de madera	Copeaux de bois
Wood Stove	Cocina a leña / fogón a leña	
Wood-based energy	Dendroenergía	Dendroénergie
Wood-derived fuels	Combustibles derivados de la madera Dendrocombustibles / Combustibles forestales / Madera para calefacción / Combustibles de madera	Combustibles dérivés du bois
Wood-derived solid fuels	Combustibles solidos derivados de la madera	Combustibles solides dérivés du bois
Wood-derived solid biofuels	Biocombustibles sólidos forestales	Combustibles solides dérivés du bois
Woodfuel	Dendrocombustibles / Combustibles forestales / combustibles derivados de la madera. Combustibles de madera	Combustible ligneux
Wood-fuelled	Alimentado a leña	Fonctionnant au bois

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