



## BIOENERGY

**Chapter 1.** Photosynthesis. Description. The Carbon cycle.

**Chapter 2.** Biomass. Definition, biomass composition, biomass as a carbon dioxide storage, types of biomass . Biorefinery, types of biorefineries.

**Chapter 3.** Biofuels. Introduction. Definition, classification. World markets, production, basic technologies for biofuel production. Relative production efficiency. Energy balance. Biofuels from the environmental point of view.

**Chapter 4.** Definition and composition of bioethanol, prime materials, production technologies, industry processes, applications.

**Chapter 5.** Biodiesel. Definition, the transesterification process. Prime materials. Industrial production. Uses and applications.

**Chapter 6.** Definition and composition of Biogas. Sources, process of biodegradation, production technologies, applications.

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**Chapter 2. Biomass. Definition, biomass composition, biomass as a Carbon dioxide storage, types of biomass . Biorefinery, types of biorefineries.**

### 1. BIOMASS. DEFINITION

#### **BIOMASS, DEFINITION 1:**

Biomass is biological material from living or recently living organisms

#### **BIOMASS, DEFINITION 2:**

Available organic matter: plant or animal matter, Forest residues (dead trees, branches and tree stumps), yard clippings, wood chips and municipal solid waste.

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## Chapter 2. Biomass. Definition, biomass composition, biomass as a Carbon dioxide storage, types of biomass . Biorefinery, types of biorefineries.

### 1. BIOMASS. DEFINITION

As in the case of most renewable energies, energy obtained from BIOMASS has its origin on the sun.

**Summarising:** BIOMASS, is sun energy that plants have converted into organic matter through photosynthesis (stored chemical energy) and the way to recover this energy would be through direct combustion or conversion into other biofuels.

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### 2. BIOMASS composition

BIOMASS from plant origin is formed by components with a variety of different chemical structures:

#### a) Main Components (bataz besteko composition)

- Hydrocarbons (75%): cellulose, starch, quitine and hemicellulose
- Lignine (20%)

#### b) Minor Components (5%)

- Proteins
- Oils
- Vitamines
- Pigments
- Fragances

BIOMASS has a complex composition, alike petroleum, and it can be used to obtain a wide variety of products other than energy.

- To be able to obtain these products out of BIOMASS it is necessary to separate into the different main compound groups.

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### 2. BIOMASS composition

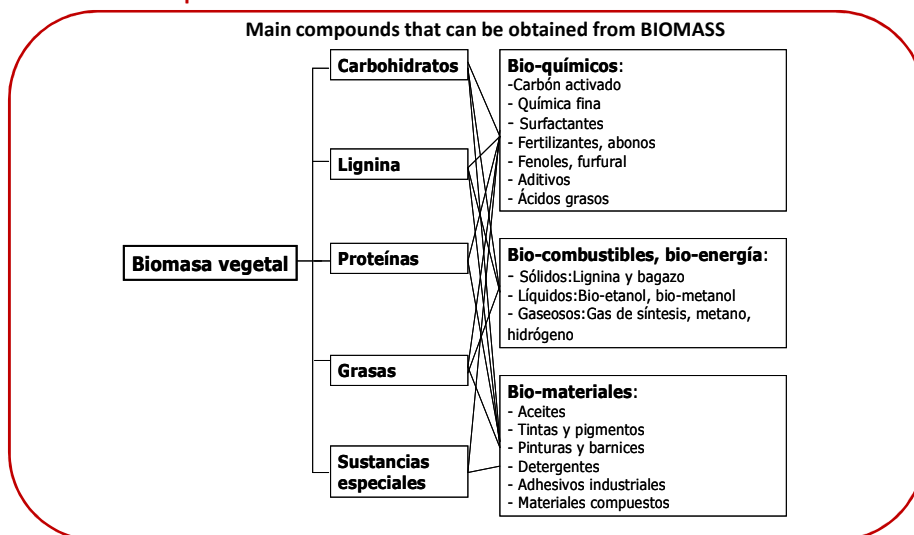


Figura 2. Main Biomass Components and main productus obtained from them.

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### 3. BIOMASS AS CARBON DIOXIDE STORAGE

#### Main differences between Fossil fuels and BIOMASS

BIOMASS berriztagarria dela: eraketa and hazkuntza denborak erabilera denborarekin bat datoz.

BIOMASS	Renewal time for the cycle
Algae	1 month
Farming plantations	3 months to 1 year
Grass	1 year
Shrubs	5 years
Trees	80 years
Fossil fuels (petroleum, gas, coal)	280 milion years

Tabla 1. Cycle renewal time for different types of BIOMASS.

In the case of Fossil fuels, the renewal times are so long that it is not possible to replace them in a renewable way.

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### 3. BIOMASS AS CARBON DIOXIDE STORAGE

- If the use of BIOMASS were made in a proper way, there would not be any carbon imbalance during its life cycle.

- In order to develop plants and BIOMASS products from atmospheric CO<sub>2</sub>, the amount taken and the amount released by use and decomposition should be the same. **If the cycle is balanced, the amount CO<sub>2</sub> consumed and emitted should compensate each other.**

**The source of BIOMASS can be land or sea.**

Use of SEA BIOMASS, even if it has great potential, at present it is not a viable alternative to LAND BIOMASS. Because of this, the rest of this chapter we will talk about land biomass.

### PROPOSAL

**Discuss ways to make use of sea BIOMASS.**

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### 4. BIOMASS CLASSIFICATION



Main Biomass Types

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### 4. BIOMASS CLASSIFICATION

**First classification** depends on the source of the BIOMASS: vegetable or animal

Vegetable biomass would be primary.

- In order to obtain animal **BIOMASS**, it is **necessary to consume vegetable biomass**
- Some industries use Vegetable BIOMASS, while it will be possible to obtain subproducts out of animal biomass.
- It is possible to obtain organic waste that can be reused in our everyday life.

**Second classification** is for vegetable biomass and it is regarding its origin: forest BIOMASS or agricultural BIOMASS.

**Third classification** is also about vegetable BIOMASS: primary, secondary and tertiary, depending on their origin and use in the production chain.

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### 4. BIOMASS CLASSIFICATION

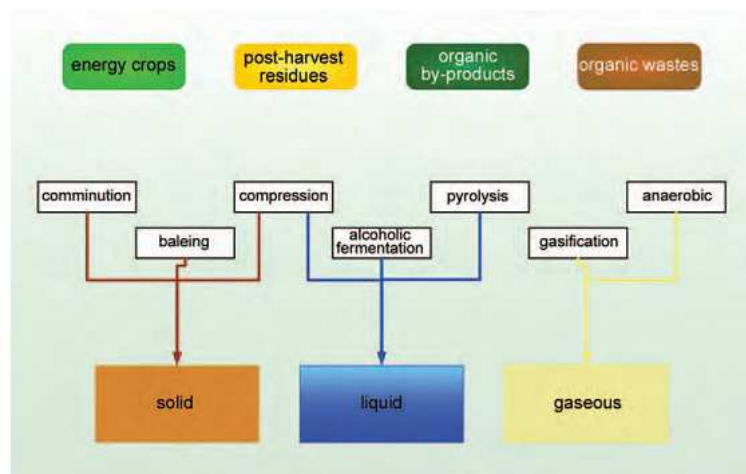


Figura 3. BIOMASS types and applications

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## Chapter 2. Biomass. Definition, biomass composition, biomass as a Carbon dioxide storage, types of biomass . Biorefinery, types of biorefineries.

### 4. BIOMASS CLASSIFICATION

**Primary BIOMASS** : obtained straight from forest farming (timber farming) or energy crops.

**Secondary BIOMASS** : Residues produced while processing primary BIOMASS

**Tertiary BIOMASS** : Residues produced during everyday human activity.

If we look at efficiency and rentability, not all biomass sources are considered equal.

Just primary and some secondary BIOMASS (i.e. wood and paper industry residues) sources are considered to have high potential.

Tertiary sources do not show much potential right now.

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### 4. BIOMASS CLASSIFICATION

#### 4.1 FOREST BIOMASS

Wood is a lignocellulosic material of fibrous nature that has three different kinds of biopolymers: **cellulose, hemicellulose and lignine.**

Historically, the main use FOREST BIOMASS has been as a primary matter for the paper and timber industry.

**The other main use for FOREST BIOMASS** has been as a source for bioenergy, by direct combustion.

**PRIMARY FOREST BIOMASS** : from timber farming for specific use timber, from conventional wood collecting and forest management (dead trees, branches and tree stumps ).

**SECONDARY FOREST BIOMASS** : residues formed during the industrial processing (first and second tranformation industry) and waste from paper and Pulp production processes.

**TERTIARY FOREST BIOMASS**: Residues and waste from the construction and transportation industry (pallets, boxes, containers) and cellulosic waste.

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#### 4. BIOMASS CLASSIFICATION

##### 4.1 FOREST BIOMASS

###### TYPES OF FOREST BIOMASS

- **Timber farming for specific use.**

Devoted to Paper industry and timber industry. These would be wood plantations of fast growth and short rotation trees.

- **residues from forest and landscape management and natural wood collecting.**

Wood obtained from trees that have been removed because of plagues or illnesses or from forest management.

In timber industry, only a specific part of the wood is used and the rest will become a residue.

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Wood harvester machinery

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Residues from landscape management

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**4. BIOMASS CLASSIFICATION**

**4.1 FOREST BIOMASS**

• Residues formed during wood processing

First transformation will take place in the Timber industry, while second transformation will take place in furniture making, packaging- and auxiliary building material confection industry. Residues formed in this processes will be heterogeneous: woodchips, shavings, etc.

• Residues from Pulp and Paper industries

In this kind of industries, wood is treated chemical and mechanically forming a black liquor rich in fibers, lignine and other chemical products. In most cases, this liquor is burned to satisfy part of the energetic needs the factory might have.

• Wood and cellulose derived municipal solid waste.

This group is formed by some waste generated because of human activity: old furniture, building residues, discarded paper and cardboard..

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Industrial Wood and its by-products

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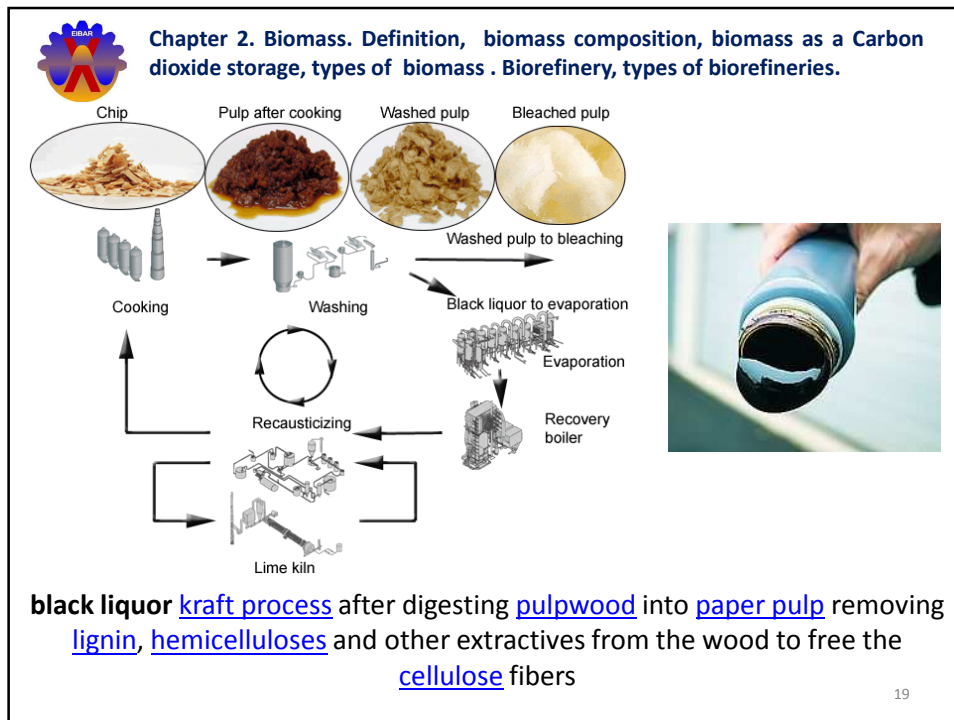
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Dark Bark, by-product of wood processing

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#### 4. BIOMASS CLASSIFICATION

##### 4.2 AGRICULTURAL BIOMASS

- They compound a variety of materials that give a wide array of products: starch, sugars, cellulose, lignocellulosic materials, oils, protein, etc.
- They show a much more heterogeneous composition than FOREST BIOMASS
  - They will need different process technologies.
  - They will have a higher potential to obtain more diverse products.

**PRIMARY AGRICULTURAL BIOMASS:** Crops that specifically grown not to be used for food, are specifically janaritarako ez diren laborantzak, residues that occur in the harvesting and management of food crops, grass.

**SECONDARY AGRICULTURAL BIOMASS:** Residues and by-products that come from processing of biomass, that include manure from animal husbandry and residues from the industrial processing.

**TERTIARY AGRICULTURAL BIOMASS :** [Organic waste](#) (including domestic biowaste, sewage sludge and residues .

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**4. BIOMASS CLASSIFICATION**

**4.2 AGRICULTURAL BIOMASS**

**PRIMARY AGRICULTURAL BIOMASS**

• **Crops specifically not grown for food**

The main group is formed by **energy crops**. These crops are cultivated principally for the generation of energy.

These crops are classified depending on the primary source or the plant's main value:

**1. Starch crops**

There are two kinds: cereal (corn, wheat, oats, sorghum, barley) and potatoes. They comprise the biggest cultivated area in the world. Corn is nowadays the main primary source for bioethanol production. Other uses for starch are: biomaterials and/or fermentation substrates.

**2. Sugar crops**

Sugar cane and sugar beet. In Brazil (one of the main bioethanol producers in the world) use mainly sugar cane for bioethanol production.

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**4. BIOMASS CLASSIFICATION**

**4.2 AGRICULTURAL BIOMASS**

**PRIMARY AGRICULTURAL BIOMASS**

**3. Oleaginous crops**

Crops that produce oily seeds: soya, rapeseed, oil-flax, sunflower. Their main use will be towards the biodiesel industry.

**4. Fibrous crops**

There are crops of plants of fibrous nature that traditionally have been used for fabric production. The main crops are flax (linen) and hemp.

**5. Other crops**

Other crops that do not fit in any of the previous categories that are cultivated, such as thistle and alfalfa.

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Energy Crops

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#### 4. BIOMASS CLASSIFICATION

##### 4.2 AGRICULTURAL BIOMASS

###### PRIMARY AGRICULTURAL BIOMASS

- **Post-harvest residues from food crops**

*They are residues produced after the food part has been removed or the ones created during trimming and pruning.*

- **Wood residues** (from trimming of olive trees, fruit trees or vines)

- **Grassy residues** (cereal straw and corn cane)

In both cases, these materials have mainly a lignocellulosic composition.

**Main uses: animal feedstock and obtention of bioenergy.** Some of it goes back into the land to improve land-regeneration.

- **Grass and yearly plants**

Here we include grass, pastures and yearly plants. They are mainly used for feedstock.

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Straw, a natural residual product

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**4. BIOMASS CLASSIFICATION**

**4.2 AGRICULTURAL BIOMASS**

**SECONDARY AND TERTIARY AGRICULTURAL BIOMASS**

• **Industrial residues from agricultural food production**

Residues and by-products produced during food-processing and packing : oil-industry, Canned-food industries, beer producers, sugar producers, cereals and derived product makers, cheese makers.. The main use will be for compost production, direct agricultural use, animal feedstock or alcohol production.

• **residues from animal husbandry**

Mainly manure that can be used for compost or fertilizer. There are starting to use ifor BIOGAS.

• **Municipal waste**

Organic waste from products that are used by consumers and producers and their residues: domestic biowaste, gardening residues and other materials bound to fermentation. The use is mainly for compost and BIOGAS production.

• **Sewage Sludge**

It is obtained during domestic waste water treatments and it can be used as a source of BIOGAS.

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Organic Municipal Waste

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