Bioenergy EUROPE FULL MEMBER

BIOCHAR EUROPE

HellaBiom

Hellenic Biomass Association

Ελληνική Εταιρεία Ανάπτυξης Βιομάζας

Harnessing Agricultural Biomass: Transforming Crop Residues and Agri-Food By-Products into Sustainable Energy & Biochar

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13TH MAY 2025

HellaBiom - Profile

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The Hellenic Biomass Association (ΕΛΕΑΒΙΟΜ | HellaBiom) is a non-profit organization and one of the prime renewable energy associations in Greece, with activities dating back in the 1990s.

Sectors of Interest:

- ✓ Biomass power generation
- ✓ Combined heat and power (CHP) with biomass
- ✓ District heating
- ✓ Standardized solid biofuels (pellets - briquettes),
- ✓ Biomass valorization technologies (combustion, gasification, pyrolysis)
- ✓ Carbon sequestration and carbon removal technologies (Bioenergy Carbon Capture & Storage - BECCS, Biochar Carbon Removal - BCR)
- ✓ Circular bioeconomy and Biobased products
- ✓ Biomass value chains’ optimization (agricultural, forest, agro-industrial).

International Collaborations:

Full Member: Bioenergy Europe | National Member : Biochar Europe, European Pellet Council | Associate Member: Bio-based Industries Consortium

National Supporting Body: SURE Sustainable Resources Verification Scheme GmbH | Reciprocate Member: FnBB

HellaBiom - Members

Members: **nationwide network** of 100+ members, consisting of **legal entities** (corporations, academic and scientific institutions, clusters, co-operatives) & **individuals** (scientists, engineers, researchers) sharing common interests in sustainable biomass valorization through **bioenergy** and **biobased products**.

HellaBiom - Objectives & Activities

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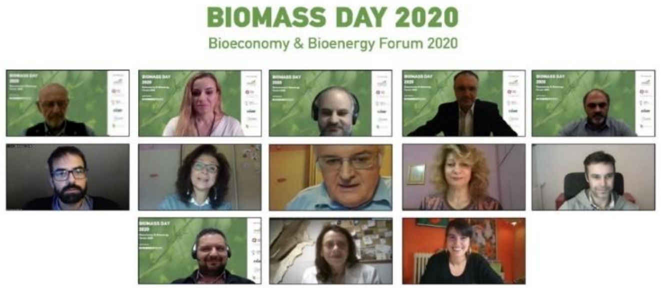
Objectives:

- The **documentation and promotion of scientific research** related to the production, trade, energy use (and all types of industrial exploitation), as well as the agricultural applications of biomass.
- The **dissemination and support** of biomass uses at both national and regional levels.
- The well-intentioned **representation of the interests** of the Greek solid biomass/bioenergy sector, both in Greece, within the European Union, and internationally.

Activities:

- Participation in **working groups** and **consultations** within the framework of **bioenergy policy** development.
- Promotion of **best practices** for the **rational use of biomass**, based on European and international experience.
- The conduct of **market research** and contribution to the preparation of **statistical reports**.
- **Communication activities**: conferences, workshops, webinars, articles, interviews, study visits, etc.

HellaBiom - Events & Webinars



HellaBiom - Communication Campaigns

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The Multilevel Contribution of Biomass
“Much More Than Energy”

Advantages of Sustainable Biomass Valorization:

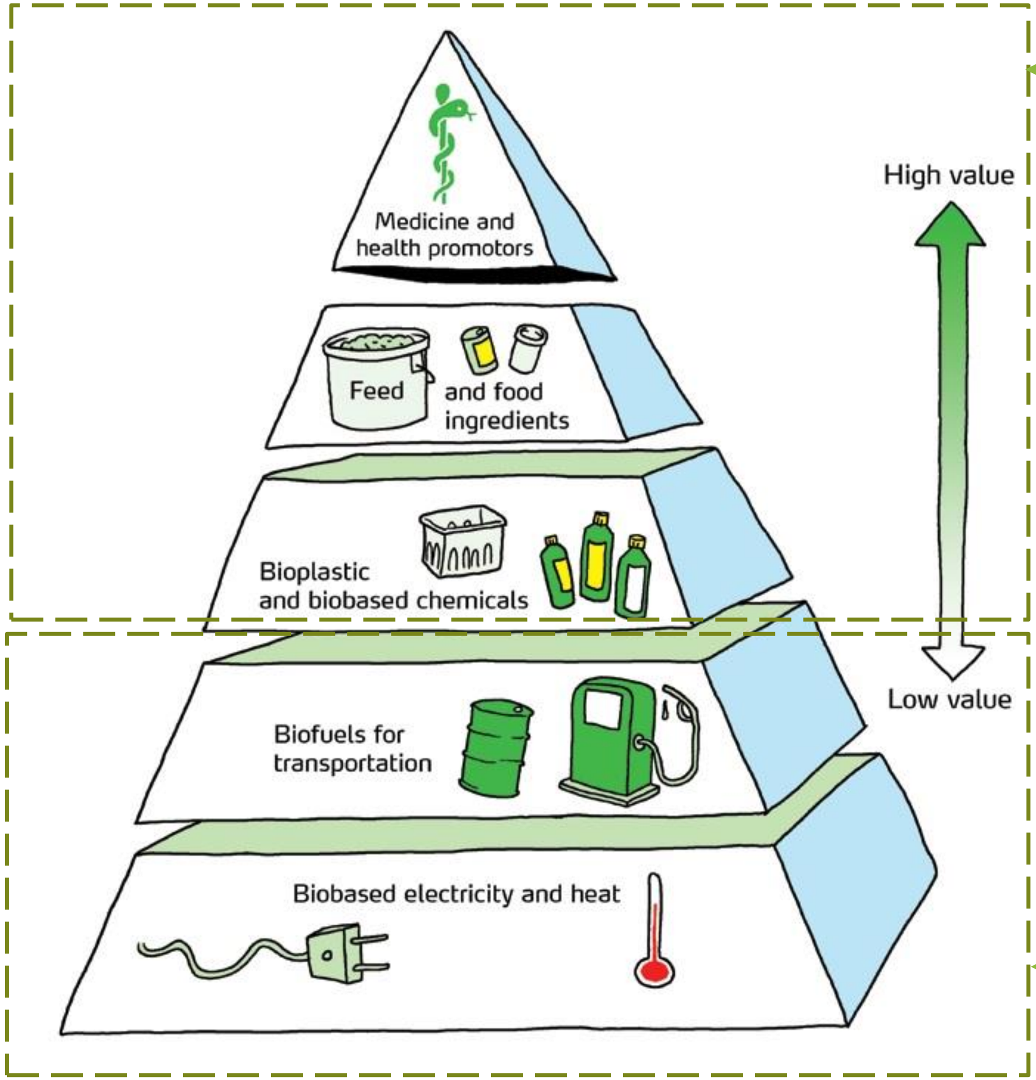
1. **Addressing energy poverty** at national and European level.
2. Activating and **supporting famers** and stimulating the regional and national economy.
3. Creating **thousands of jobs** across the value chain, including the primary sector and industry.
4. Protecting the **environment** and contributing to **sustainable forest management**.
5. **Mitigating the impacts of climate change** and limiting greenhouse gas emissions by avoiding uncontrolled burning and rotting of biomass in forests and rural areas.
6. **Contributing to the circular bioeconomy, climate-neutral agriculture - livestock farming** and the enrichment and remediation of soils through the use of bioenergy and co-produced bioproducts.



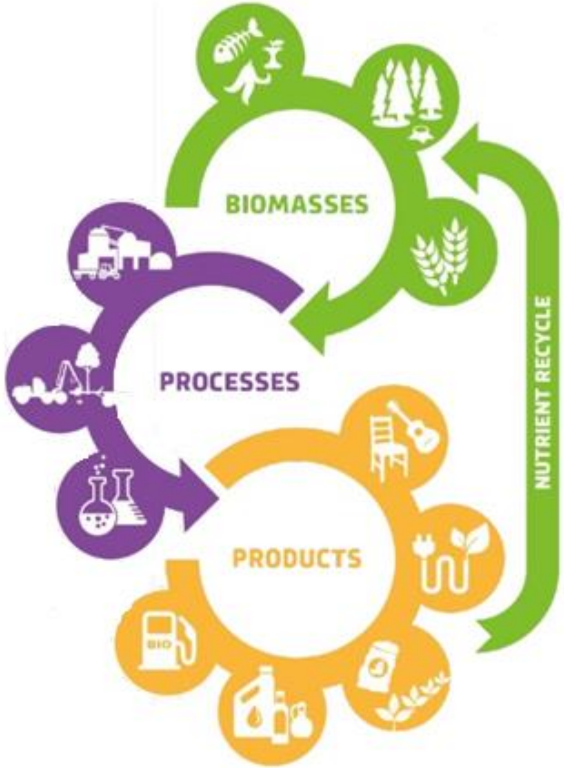


Positioning Biomass in a Modern Bioeconomy ecosystem

The Biomass Value Pyramid



BIOPRODUCTS & BIOMATERIALS

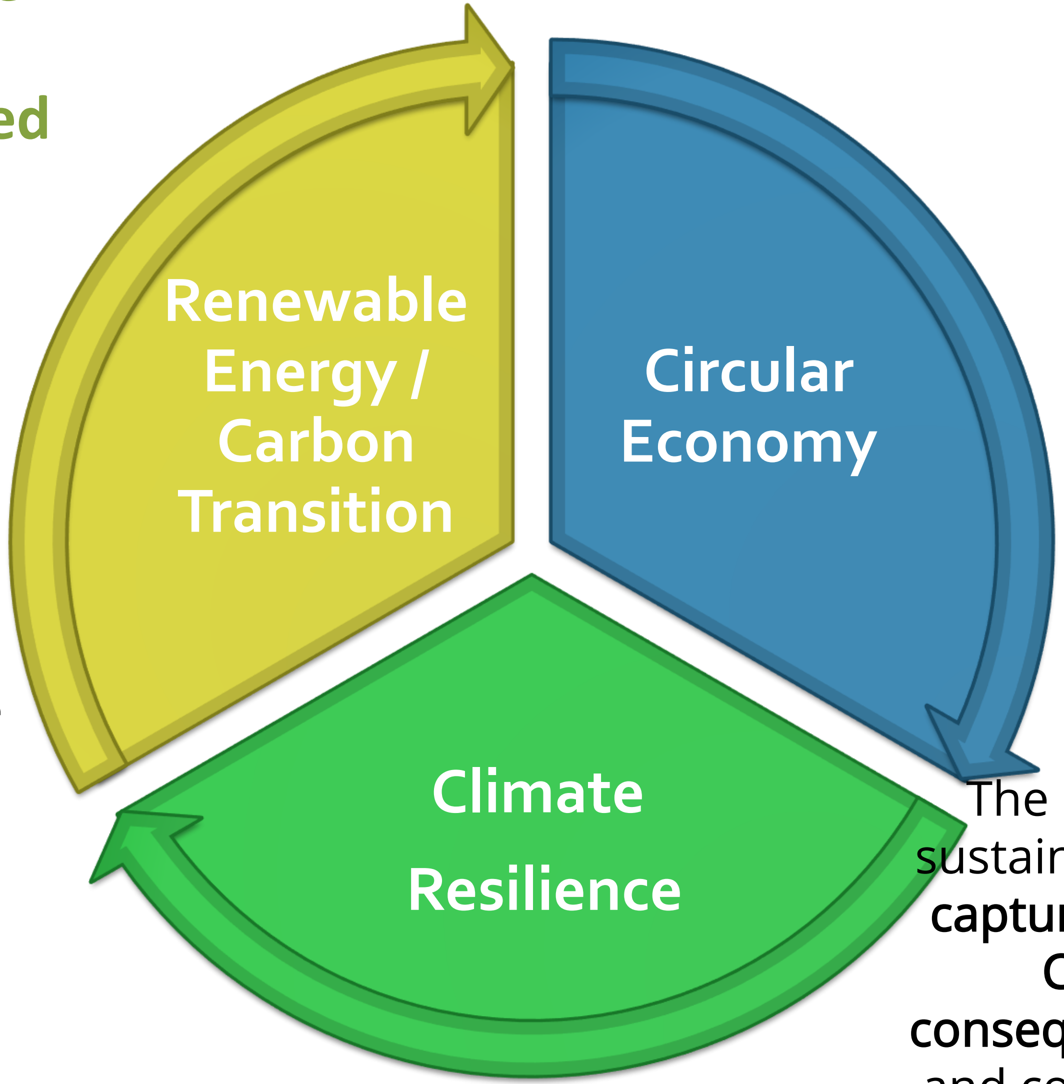


BIOENERGY & BIOFUELS

Source: United Federation of Danish Workers
Publication: "The Fundamentals of Bioeconomy - The Biobased Society"
Design: Opticcircus.dk

The 3 pillars upon which the mission of sustainable Biomass valorization is based

Bioenergy constitutes a **renewable** and **uninterrupted** source which **replaces** conventional energy from **fossil fuels** in **all individual** energy sectors (electrical power generation, heating/cooling, transport).
Likewise, **biobased** products use renewable carbon to **replace fossil carbon** in a number of industries (chemical, packaging pharmaceutical, plastics, etc.)

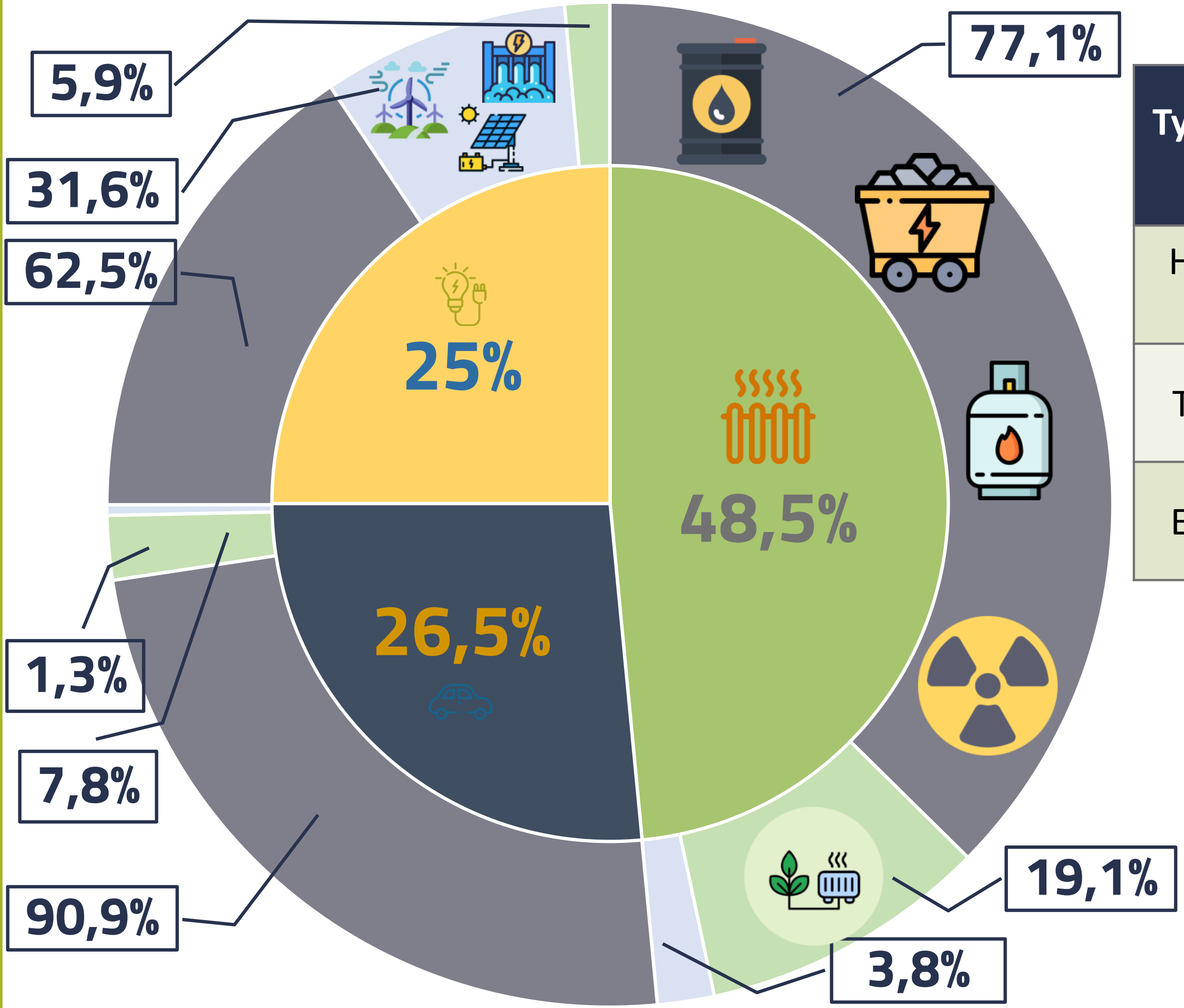


Recycling organic materials and feedstocks in agriculture, livestock farming, forestry, food production, wood processing **preserves natural resources** and **reduces** the **impact on** the **environment**

The products resulting from sustainable biomass valorization **capture** and **permanently store CO2** and **mitigate** the **consequences** of **climate change** and contribute to more **resilient ecosystems** and **biodiversity**

EU Energy System and the role of Bioenergy

Bioenergy EUROPE



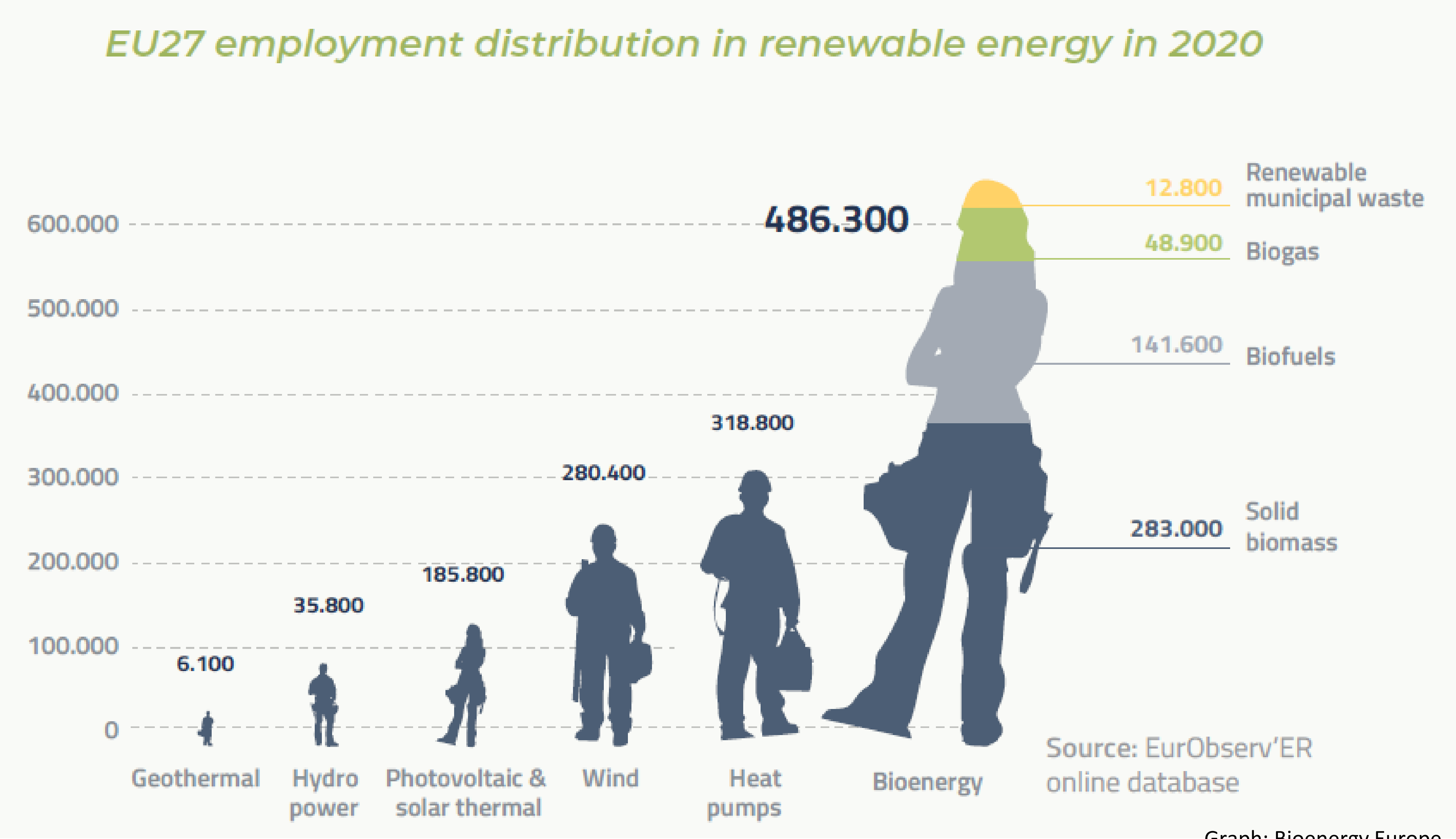
Type of end use	Share of Fossil	Share of RES	Bioenergy share in RES mix
Heating & Cooling	77,1%	22,9%	83,6%
Transport	90,9%	9,1%	85,7%
Electricity	62,5%	37,5%	15,4%

In 2021, Bioenergy = 55,7% of total RES mix!

Bioenergy is key in all final uses!

Source: Eurostat

Bioenergy: Offering more than 1/3 of total jobs in the whole RES spectrum



Graph: Bioenergy Europe

Current and Future Role of Bioenergy

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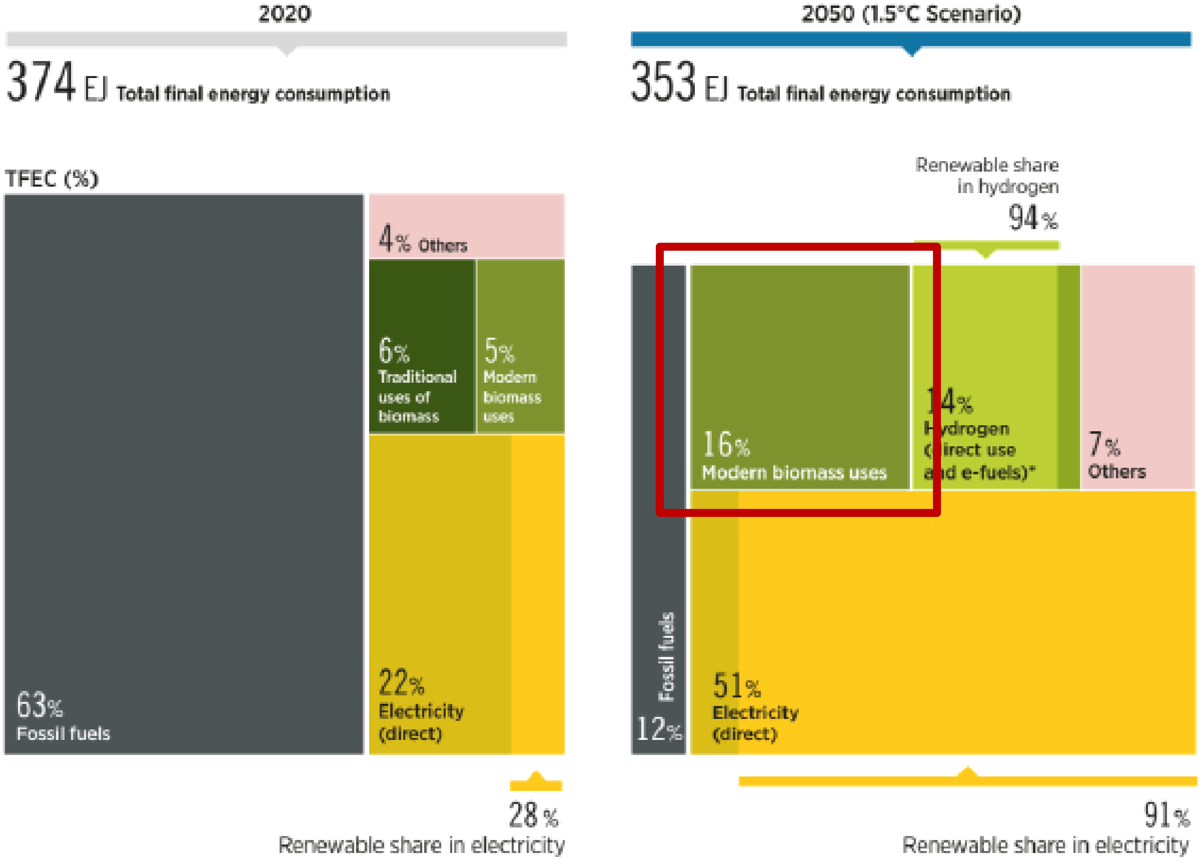
FIGURE 1.2 **Breakdown of total final energy consumption by energy carrier between 2020 and 2050 under the 1.5°C Scenario**



Highlights:

- "Bioenergy plays a key role in the energy transition"
- "Bioenergy would need policy support"
- "countries would have to implement regulations and certificates, and promote partnerships to ensure sustainability of biomass feedstock and the entire supply chain"
- "bioenergy deployment should be based on the local context and coordinated with other sectoral strategies"

Is the EU policy for bioenergy enabling for its future role in the energy system?

Bioenergy EUROPE

Source: IRENA World Energy Transitions Outlook 2023: 1.5°C Pathway

Bioenergy in Greece and EU: A complicated framework

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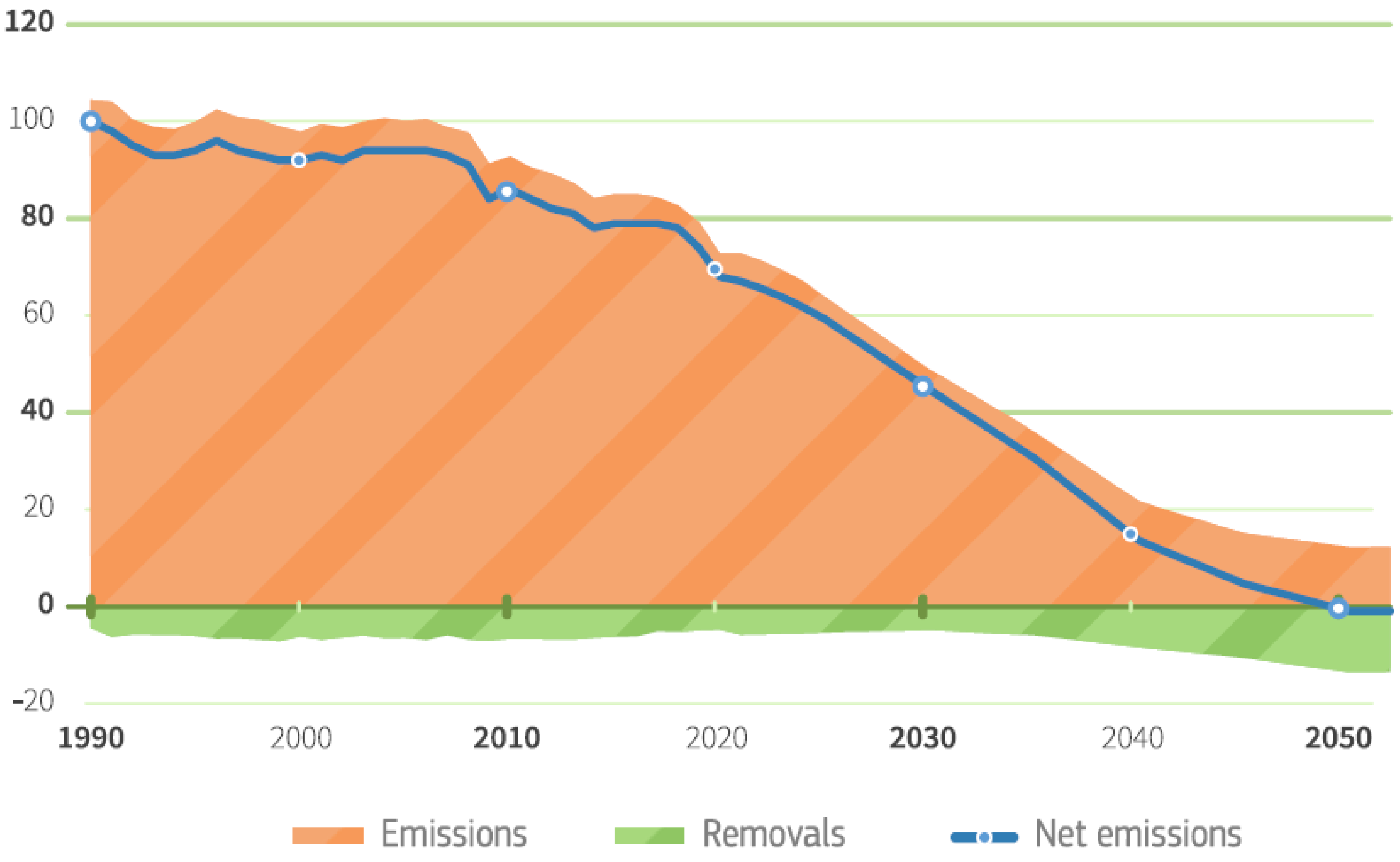
EU POLICY FILES RELEVANT FOR THE SECTOR

KEY EU POLICY FILES	
Renewable Energy Directive – REDII	Energy Efficiency Directive – EED
Renewable Energy Directive – REDIII	Land-Use and Land-Use and – LULUCF
Industrial Emissions Directive – IED	Energy Performance of Buildings - EPBD
Ecodesign & Energy Labelling – ED/EL	EU State Aid – EEAG
Energy Taxation Directive – ETD	General Block Exemption Regulation – GBER
EU Emission Trading System – EU ETS	Medium Combustion Plan Directive – MCP
EU ETS for Buildings – EU ETS II	Social Climate Fund - SCF
EU Taxonomy for Sustainable Finance	EU Deforestation Regulation – EUDR
Sustainable Carbon Cycles Initiative	EU Timber Regulation – EUTR

Bioenergy
EUROPE

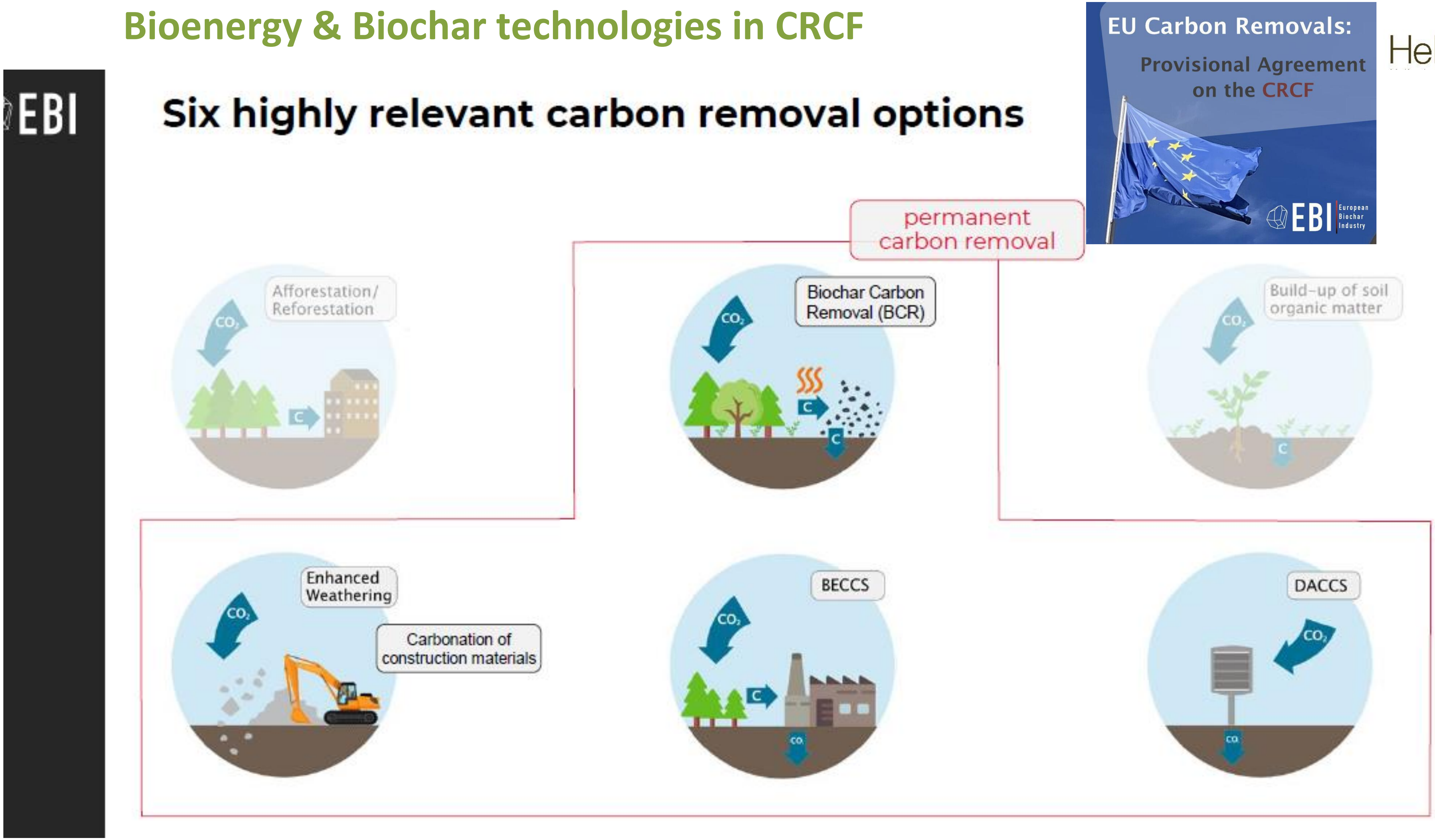
Modern Bioenergy can contribute in CO_2 capture, storage and removal

(technologies BECCS and BCR)



To promote **sustainable solutions** and **innovative carbon capture and storage technologies**, the European Commission has presented a proposal for the first voluntary EU-wide framework for a credible **carbon removal certification**.

Bioenergy & Biochar technologies in CRCF



Πηγή: European Biochar Industry Consortium (EBI)

Assessment of Domestic Biomass Potential

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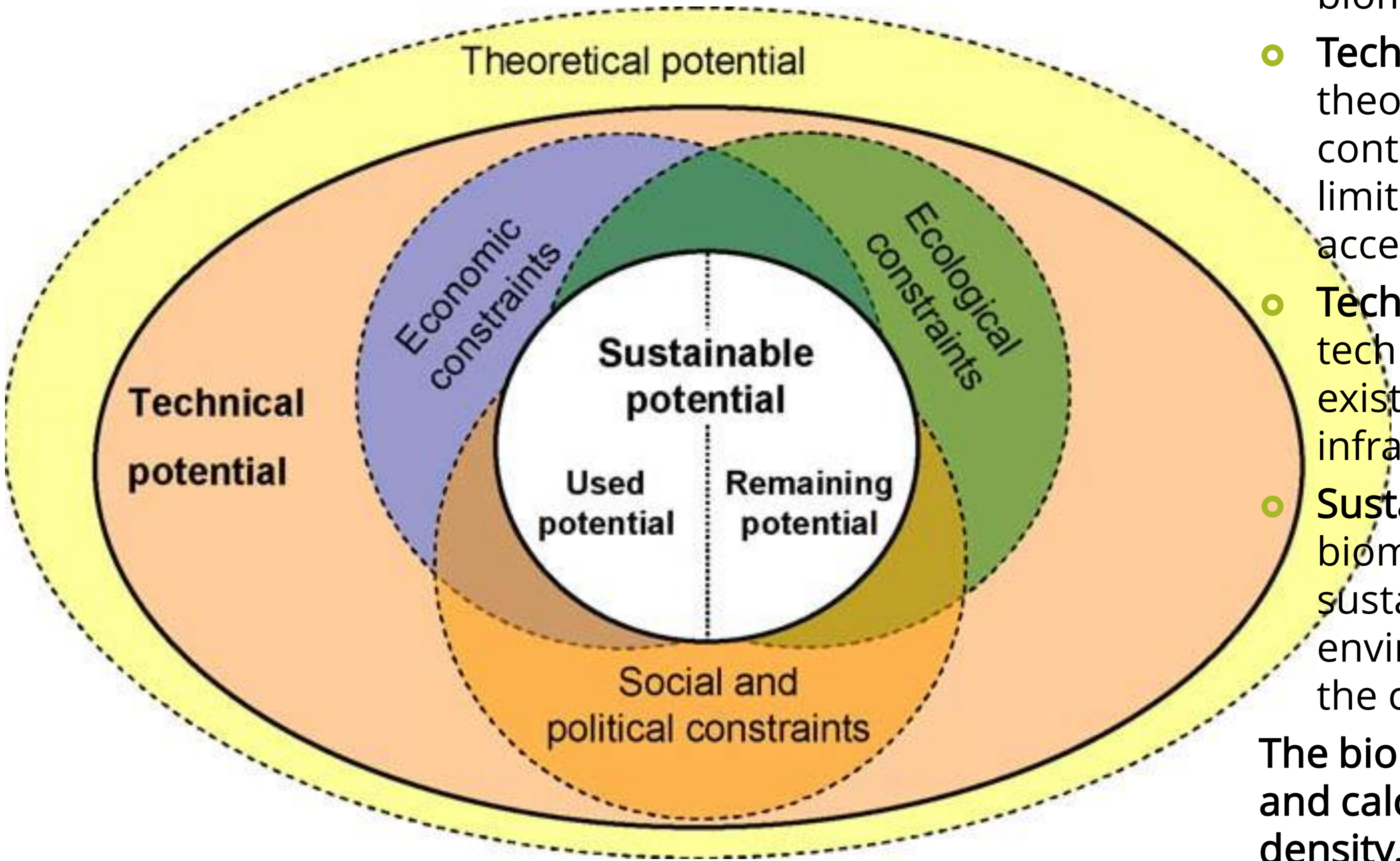
Biomass Potential = An issue of "fractions"



Source: "Bioenergy in Switzerland: Assessing the domestic sustainable biomass potential".
Publication: Article in "Renewable and Sustainable Energy Reviews" October 2010.
Authors: B. Steubing, R. Zah, P. Waeger, C. Ludwig.

- **Theoretical biomass potential:** the maximum amount of biomass that can be produced at a given area.
- **Technically disposable biomass potential**: the fraction of theoretical potential that can be collected by means of contemporary equipment, while taking into account local limitations (e.g. terrain morphology, competitive land uses, access infrastructure, etc.).
- **Technically exploitable biomass potential:** the fraction of technically disposable potential that can be exploited using existing and available technical equipment and supply chain infrastructure.
- **Sustainable biomass potential:** the fraction of the technical biomass potential which remains after taking a sustainability perspective by considering economic, environmental, social and political constraints in addition to the constraints accounted for in the technical potential.

The biomass potential is defined in units of mass or volume and calculated based on contained moisture (%) and bulk density.

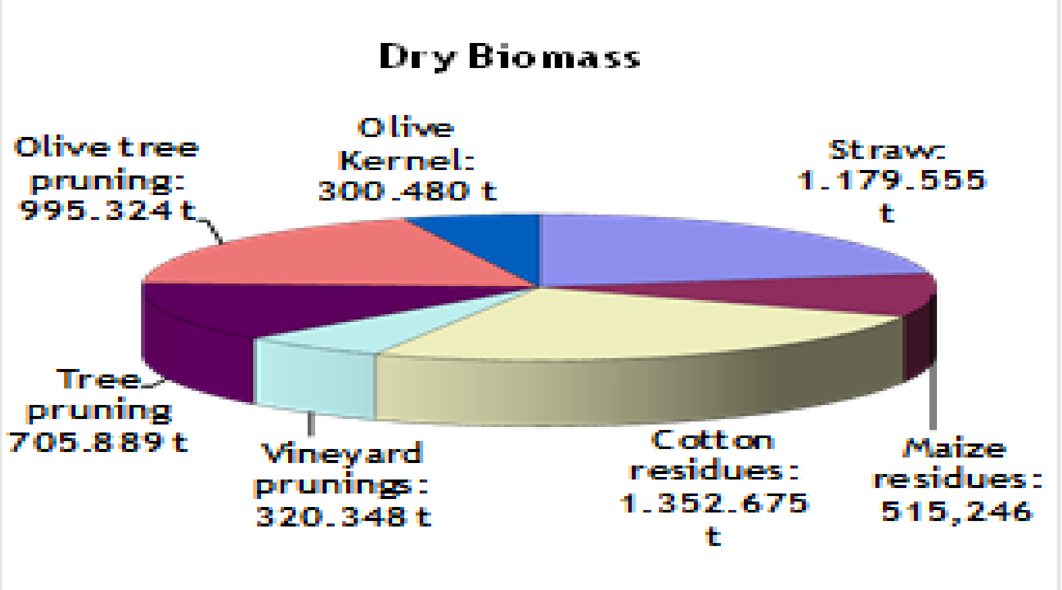
The energy content of biomass is expressed in GWh, MJ, or kcal per ton of material on dry basis.

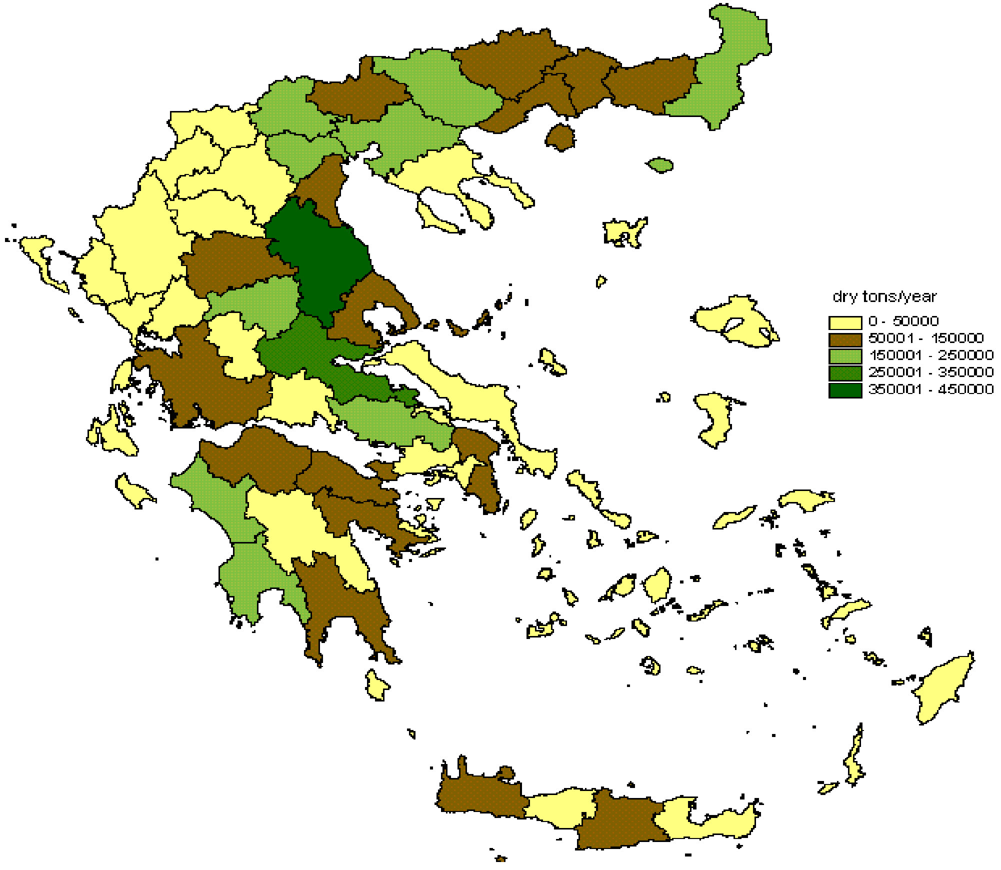
Assessment of Domestic Biomass Potential

Technically disposable biomass potential of agricultural residues in Greece

- Theoretical Potential: ~8.7 Mton dm/year
- Technically Disposable Potential: ~5.5 Mton dm/year
- Energy content: ~99 PJ/year (~ 27.7 TWh)

Distribution of residues per cultivation in tons (d.b.):





Source: CRES, HELLABIOM

Assessment of Domestic Biomass Potential

Technically exploitable biomass potential of agricultural residues in Greece

- Crop residues: ~1.5 Mton dm/year
- Orchard tree pruning: ~1.5 - 2.5 Mton dm/year
- Energy content of total agricultural residues: ~1 billion liters of oil equivalent / year

Source: CERTH, HELLABIOM

Assessment of Domestic Biomass Potential

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Challenges from insufficient agricultural waste management through opening burning or landfilling

- **Hazardous practice** for outbreak of wildfires and degradation of air quality, **with devastating consequences** for human health and life, livestock, natural landscapes, infrastructure and properties.
- **Emission of GHG** to the atmosphere (CH_4 emission due to decay of organic matter or CO_2 emission due to open-air burning).
- **Ecosystem destruction** of useful flora and micro-organisms that grow and live near and in the soil.
- In the case of in situ incorporation into the soil of excessive quantities of residual organic matter, **risk of transition** of **pathogens** and **diseases** to the next crop cycle.
- Ultimately **expensive task**, as it involves employment of personnel and mobilisation of technical equipment for the local concentration of residual biomass material to be destroyed.
- **Loss of export opportunities** for processing companies in the agro-industrial sector (e.g. in the field of standardisation of edible table olives) to companies - customers abroad who demand the satisfaction of specific sustainability criteria of the entire supply chain.

Biomass Valorization for Bioelectricity & Bioheat

For Industrial heat generation there is a consumption of domestic biomass resources (Greece case):

- 190,000 tons of **olive pits** (from olive refineries and kernel oil refineries, etc.)
- 73,000 tons of **residual biomass waste** from agro-industrial sector (cotton gin factories, fruit processing factories, shells from almonds and other nuts, rice husks, industrial pellets, etc.)
- 106,000 tons of **residual woody biomass** from wood-processing industries

Total annual consumption of biomass in recent years amounted to 2,300,000 tons resulting an energy generation of 33,8 PJ.

For power generation:
25 small to medium sized biomass power stations (combustion and gasification technologies) with a nominal installed electrical capacity of 15.5 MWe, ranging from 100 kWe to 5 MWe.

Photo: VIOPAR, Ravago Group

Pellets

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ΕΣΕΚ Ενεργειακή Κοινότητα Καρδίτσας

Karditsa Energy Community: Pellet production plant and Energy Service Company (ESCO) | Fuels: Wood processing residues, coffee residues

Biopower

Viopar 5 MWe biomass plant at Volos
Fuel: Exhausted olive cake, sunflower husk pellets, wood chips

Biopower & Agropellet production

AGRIGAS 500 kWe gasification power plant at Larissa with production of agropellets
Fuel: agricultural residues (straw, cotton, maize)

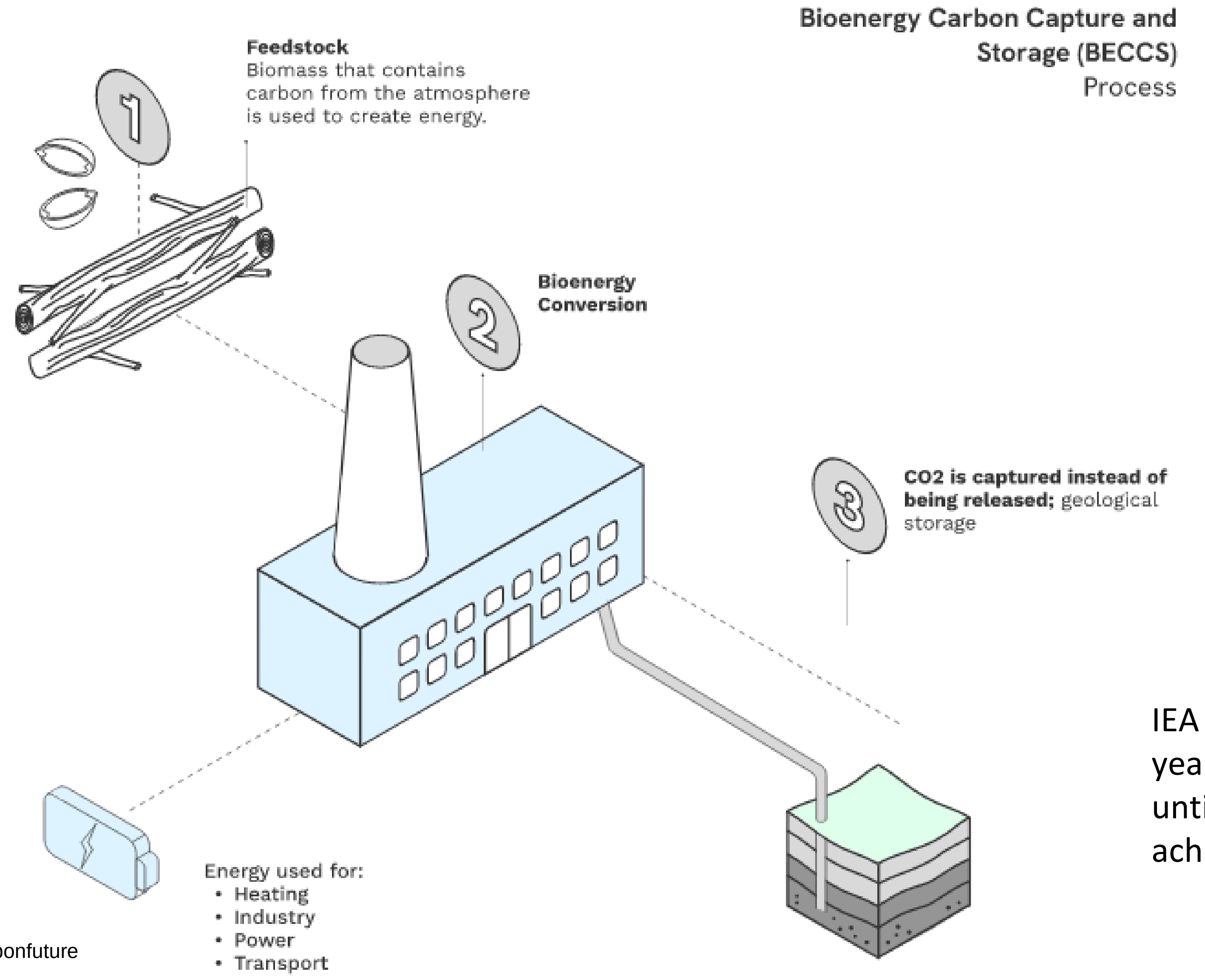
Bioheat / District Heating

DETEPA 30 MWth district heating plant at Amyntaio
Fuel: Biomass (wood chips, agropellets, maize residues), ~~lignite~~

Bioheat / Industry

Heracles / Lafarge – Milaki cement plant
Substitution of fossil fuels by green waste (urban prunings) & agroresidues

Bioenergy Carbon Capture and Storage (BECCS)



Source: Carbonfuture

IEA estimates that ca. **190 Mt CO_2** per year must be captured through BECCS until 2030 in order to get in track towards achieving carbon neutrality by 2050.

Biochar Carbon Removal (BCR)

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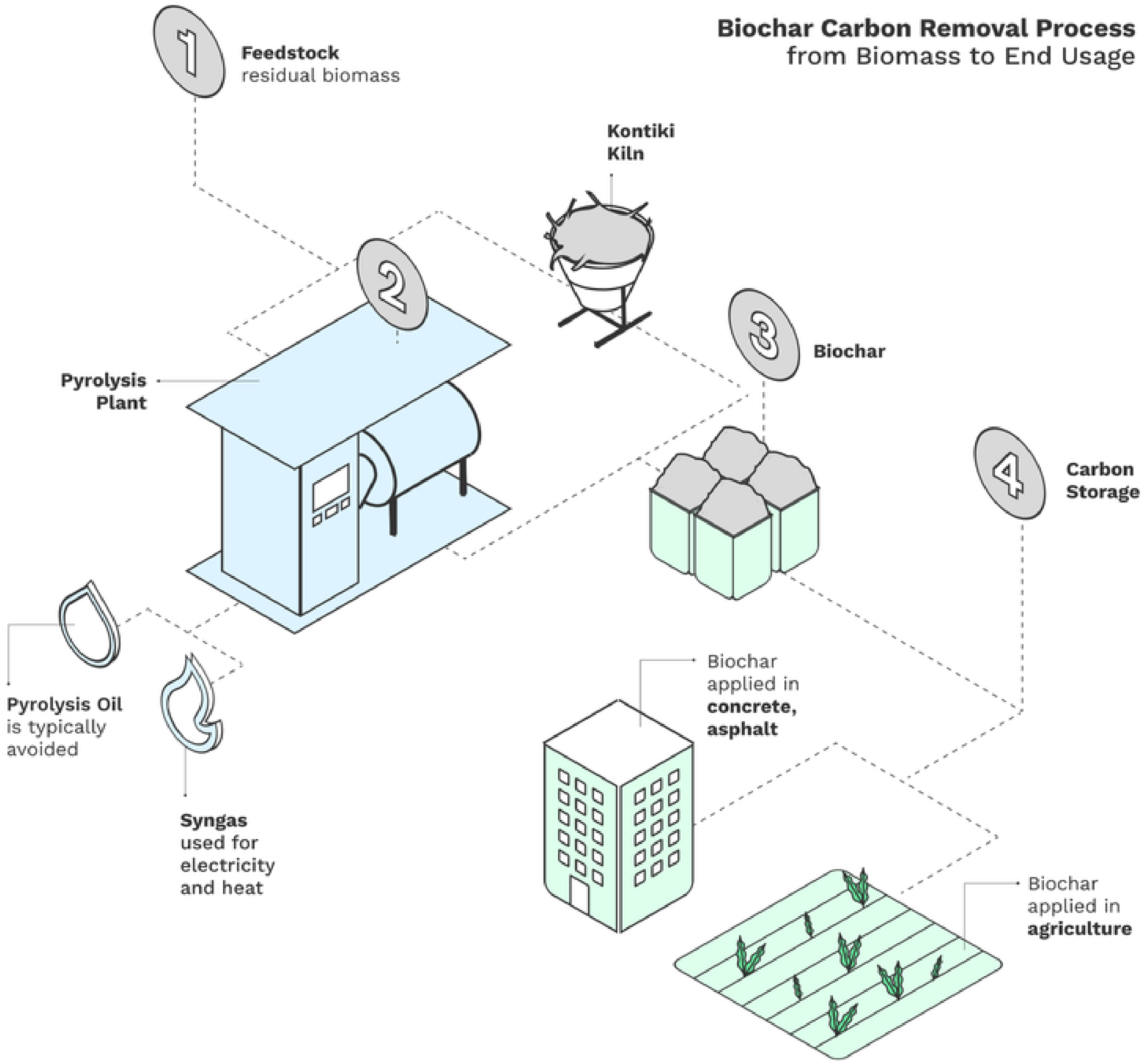
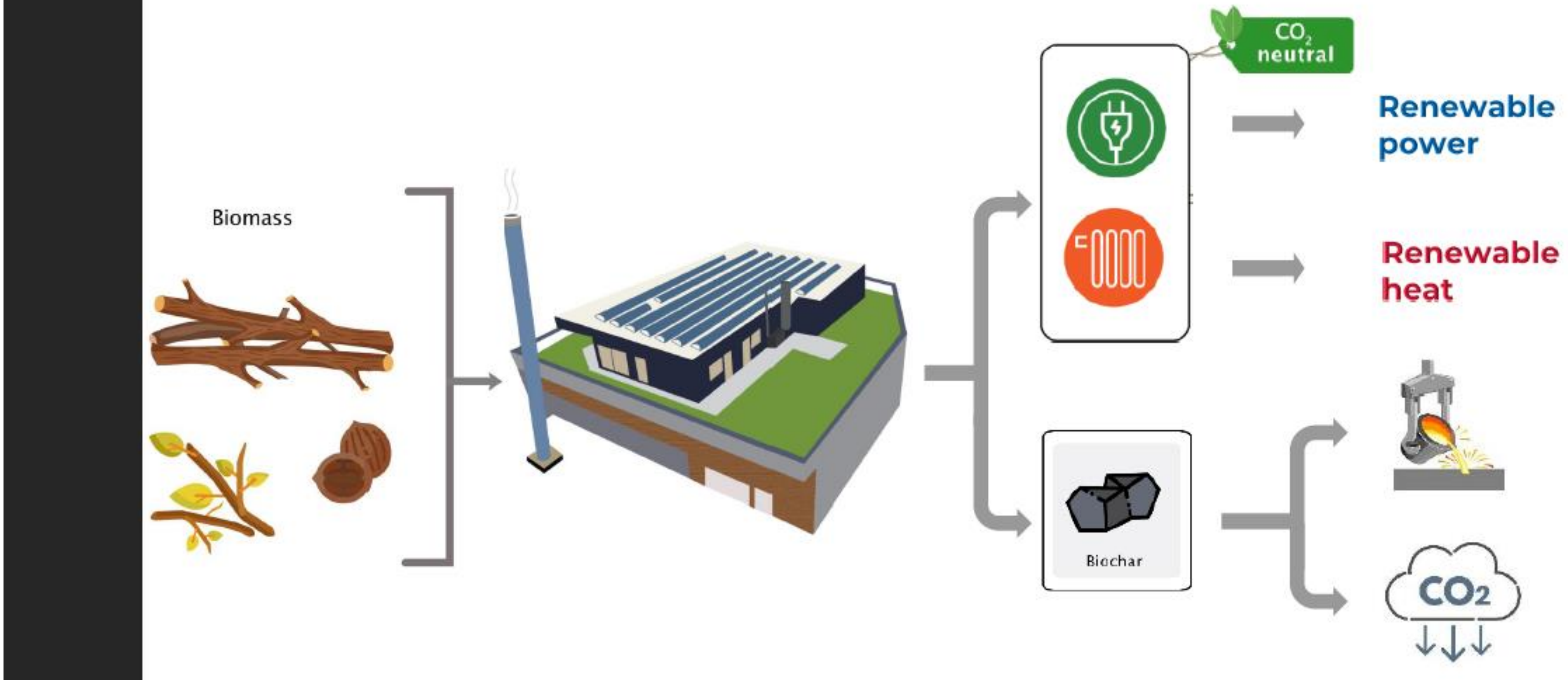


Biochar is derived from the **thermochemical conversion** of organic matter in the absence (or presence of minimal) oxygen. Depending on the specific technology used, the thermochemical process **also co-produces heat, electricity, and bio-oil (pyrolysis oil)**. It is considered an economical option for reducing and diverting organic materials from landfills.

It is estimated that biochar can contribute to the removal of **between 0.5 and 2 gigatonnes of CO2** per year globally (Fuss et al., 2018). In fact, almost all of the CO2 removed from the atmosphere to date has been sequestered using BCR. As of mid-2023, carbon removal from biochar will account for 92% of all ongoing Carbon Dioxide Removal (CDR) deliveries.

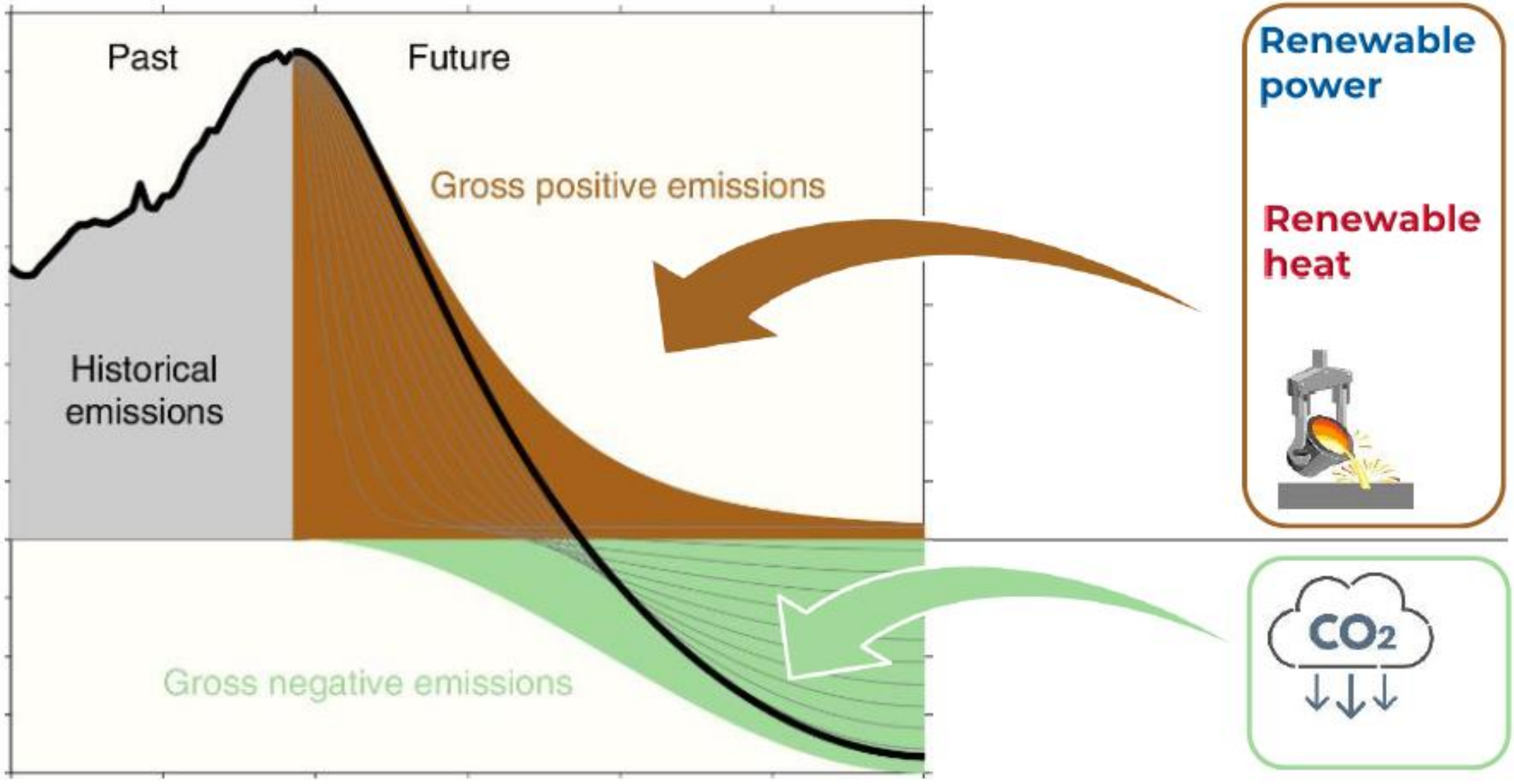
Source: Carbonfuture

Use of biomass for **emission reduction** and **carbon removal**



Source: European Biochar Europe (f. Biochar Industry Consortium - EBI)

Use of biomass for **emission reduction** and **carbon removal**

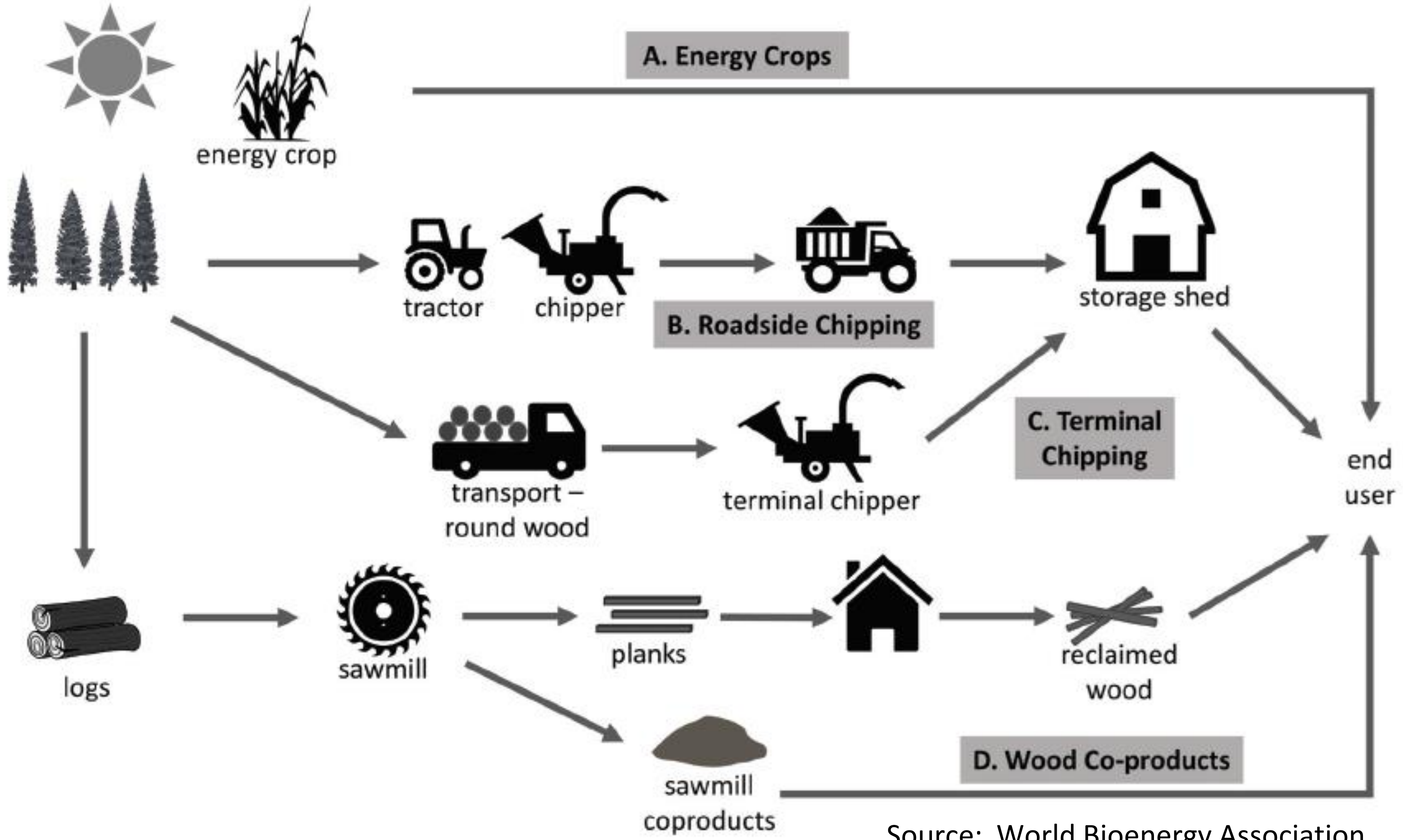


Source: European Biochar Europe (f. Biochar Industry Consortium - EBI)

Biomass therefore offers **proven valorization solutions**... The question is **how do we “bridge the gap”** between **untapped potential** and **end uses** through **environmentally** and **economically sustainable** Bioenergy?

Mobilizing Biomass

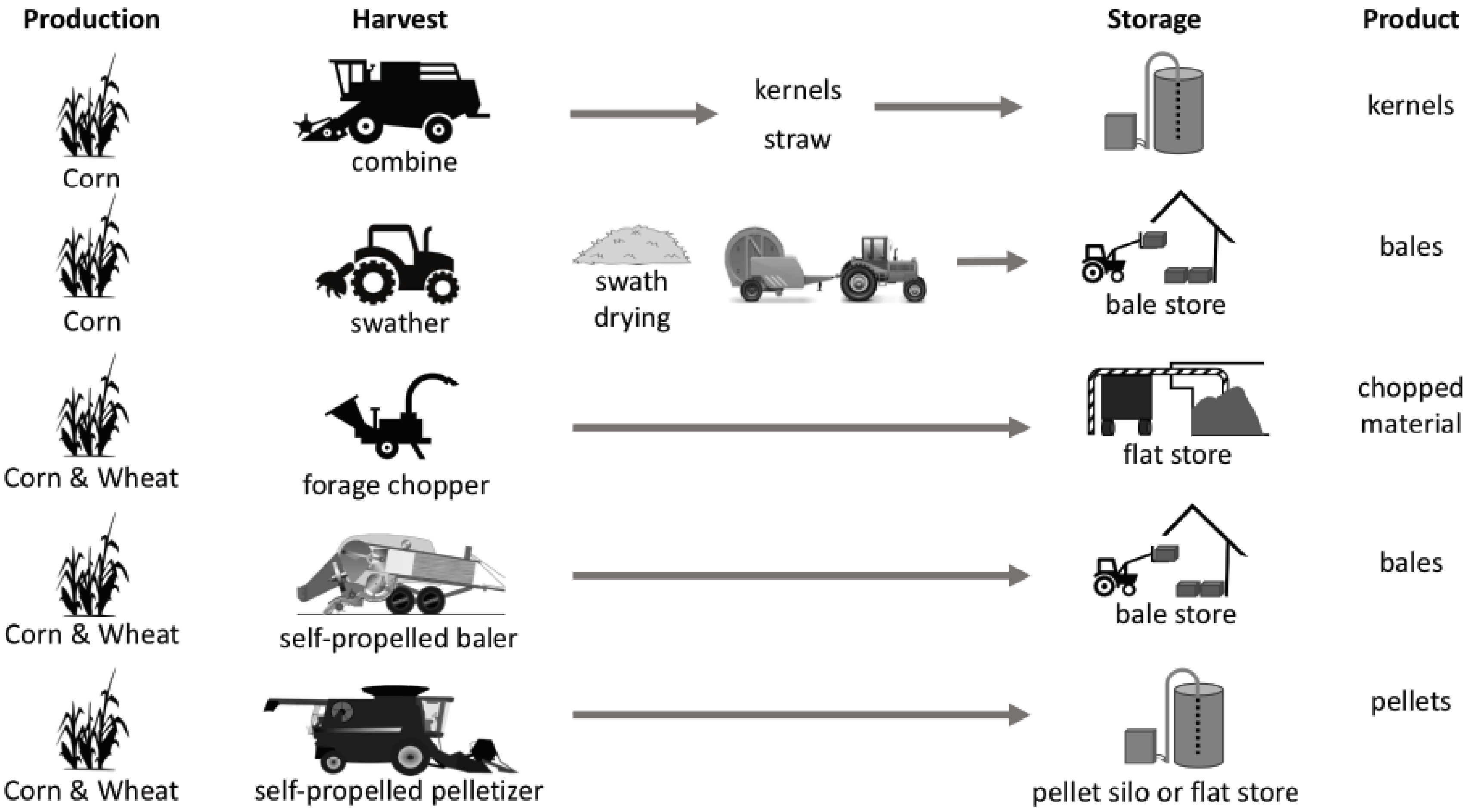
Typical flows of supply chains of woody biomass and energy crops



Source: World Bioenergy Association

Mobilizing Biomass

Typical flows of agribiomass supply chains



Source: World Bioenergy Association

Valorization of biomass waste streams:
A successful example in the agricultural sector

Addressing the environmental problem of residual biomass left over after pruning activities at vineyards

- ☒ **What happens when a vineyard is pruned?** Usually a bulky amount of pruning (branches and twigs) is left over to open-field destruction by burning. Therefore, hazardous fumes are released to the atmosphere.
- ✓ In this example, the **vineyard operator** company undertakes the **baling** and **collection** of the vineyard pruning and its transportation to nearby sorting and post-processing facilities.
- ✓ The purpose is to produce a **secondary product** which would **complement** and **add value** to wine and food tasting and recreational and barbecue activities.
- ✓ This **valorisation model** that could be replicated by vineyard operators who have access to vineyard pruning collection machinery at close proximity to their plantations.

Valorization of biomass waste streams: A successful example in the agricultural sector

Preparation of feedstock for valorisation through the briquetting technology

- ✓ The pruning is being **collected** and **baled** in the vineyard and stored under dry conditions.

- ✓ A **bale chipper**, either mobile or stationary, is then used to reduce the size of the bale for the subsequent downstream processes.

- ✓ After shredding and milling the pruning to a **particle size** of max 15x5x2 mm, they are ready for feeding into the **briquetting press**.

- ✓ Normally there is no need for drying. Sometimes the material will be so dry that it is necessary to add water, to get a **moisture content** of around **10%** .

Source: CAEB Int’l

Valorization of biomass waste streams: A successful example in the agricultural sector

Briquetting operation

- ✓ The milled pre-processed material is being stored into a standard **dosing silo**.
- ✓ This silo feeds one the **briquetting press** for production of briquettes, usually Ø90 mm briquettes in diameter, with or without an Ø20 mm centric hole. The standard capacity ranges between 1100-1500 kg/hour.
- ✓ **Consumer briquettes** are produced in a **continuous string** and conveyed to an automatic saw or a Briquette breaker via a long (min. 30 m), straight cooling line. The long **cooling line** is very important to allow the briquette string to cool down and harden before being handled in the shortening and packaging line.
- ✓ A **puck maker** is inserted close to the press to shorten the briquettes into 15-50 mm long pucks, if the intension is to produce barbeque briquettes.

Source: C.F. Nielsen

Valorization of biomass waste streams:
A successful example in the agricultural sector

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Expanding business opportunities
while informing consumer markets
about bio-circularity

Valorization of biomass waste streams:
A successful example in both the agricultural & forestry sectors

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How about Biochar - an agent of change?

Biochar is a solid product that is obtained by pyrolysis of biomass in the absence of oxygen.

Biochar is a **carbon-rich** and **porous** material which can be used in a wide range of applications, among which as a soil ameliorant for carbon sequestration, soil health retention and soil remediation.

Biochar may be the means to **mitigate global warming** and **climate change** and it is considered as a promising **Carbon Dioxide Removal (CDR)** method - negative emission technology which **offsets greenhouse gas emissions** from practices such as the burning of fossil fuels.

Source: HellaBiom

Biochar is mainly used in agriculture to enhance soil fertility, improve plant growth, and provide crop nutrition. As a result, it **improves** the overall farming **productivity**. It has also gained considerable attention in **livestock farming** as an animal feed.

Therefore, **Biochar** and **Biochar Carbon Removal (BCR)** can provide solutions in **energy transition**, **agriculture** and **soil management**, as well as in the **mitigation of climate change**.

Biochar characteristics:
A biodiversity retention agent

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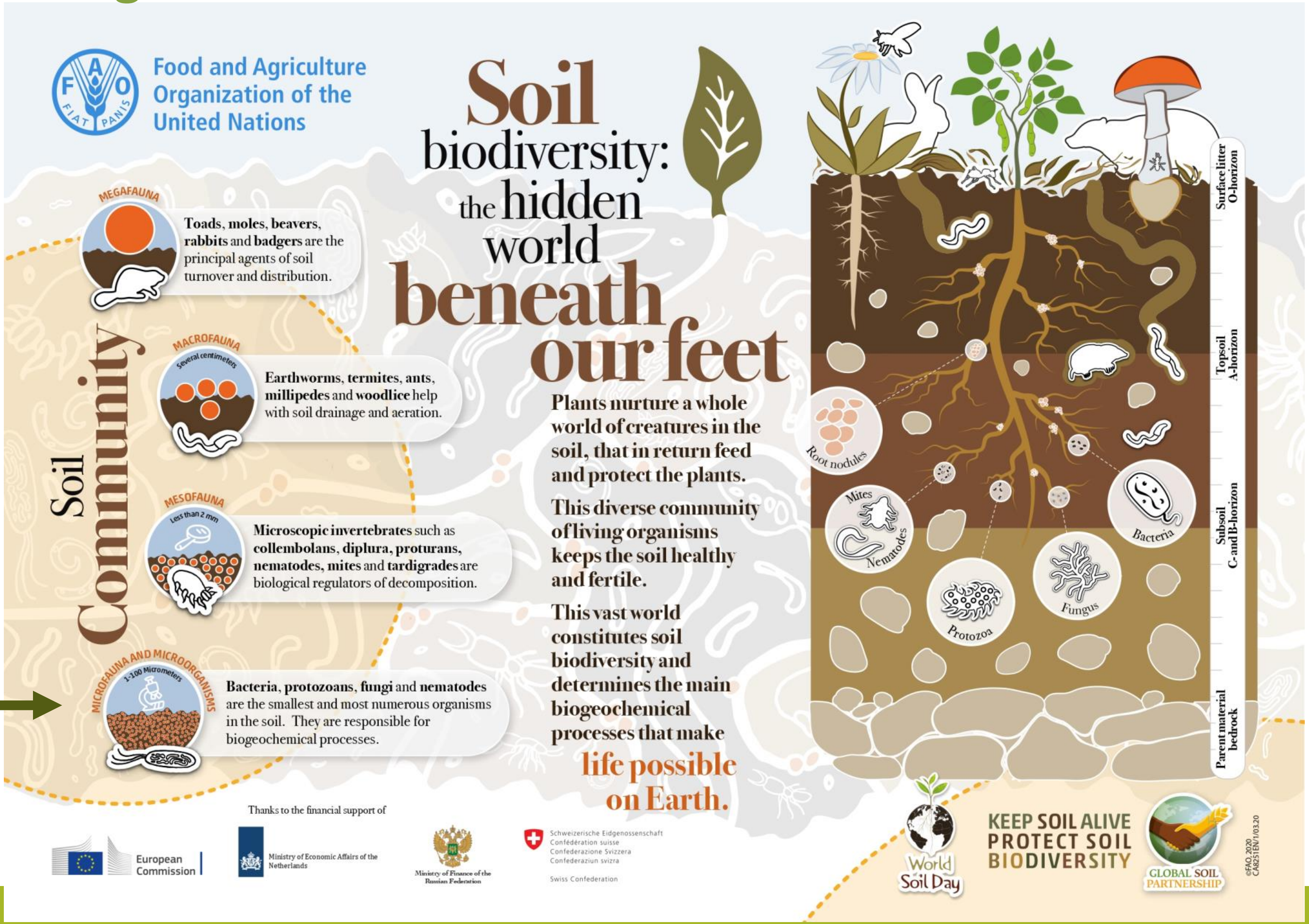
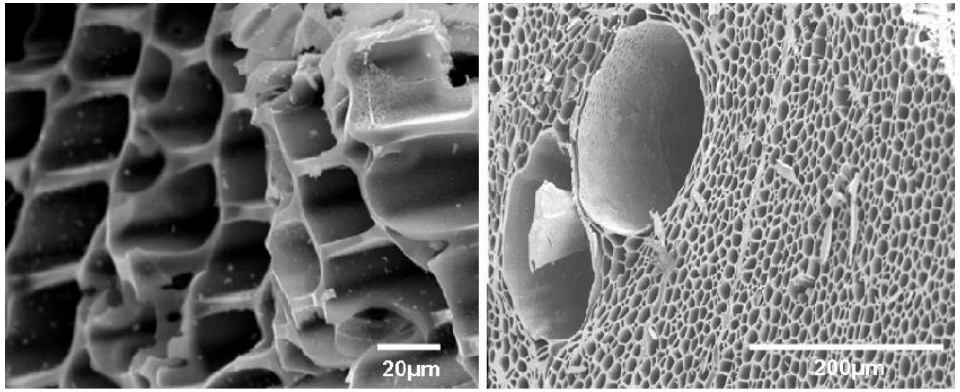
Biochar is not a fertilizer, but rather a **nutrient carrier** and a **habitat** for microorganisms. Primarily, biochar needs to be charged to become biologically active in order to efficiently utilize its soil-enhancing properties and contribute to **biodiversity retention and growth**.



Biochar characteristics: A ‘soil reef’

Like coral reefs that support ocean habitats for marine life, **biochar** supports habitat for soil microbes. It also acts by holding water and nutrients in the rhizosphere—the soil region surrounding plant roots where bacterial activity occurs—and making them available to the plant.

Source: https://GreatSouthernReef,com



Source: Janice E Thies, Cornell University

Biochar characteristics: AC & CEC

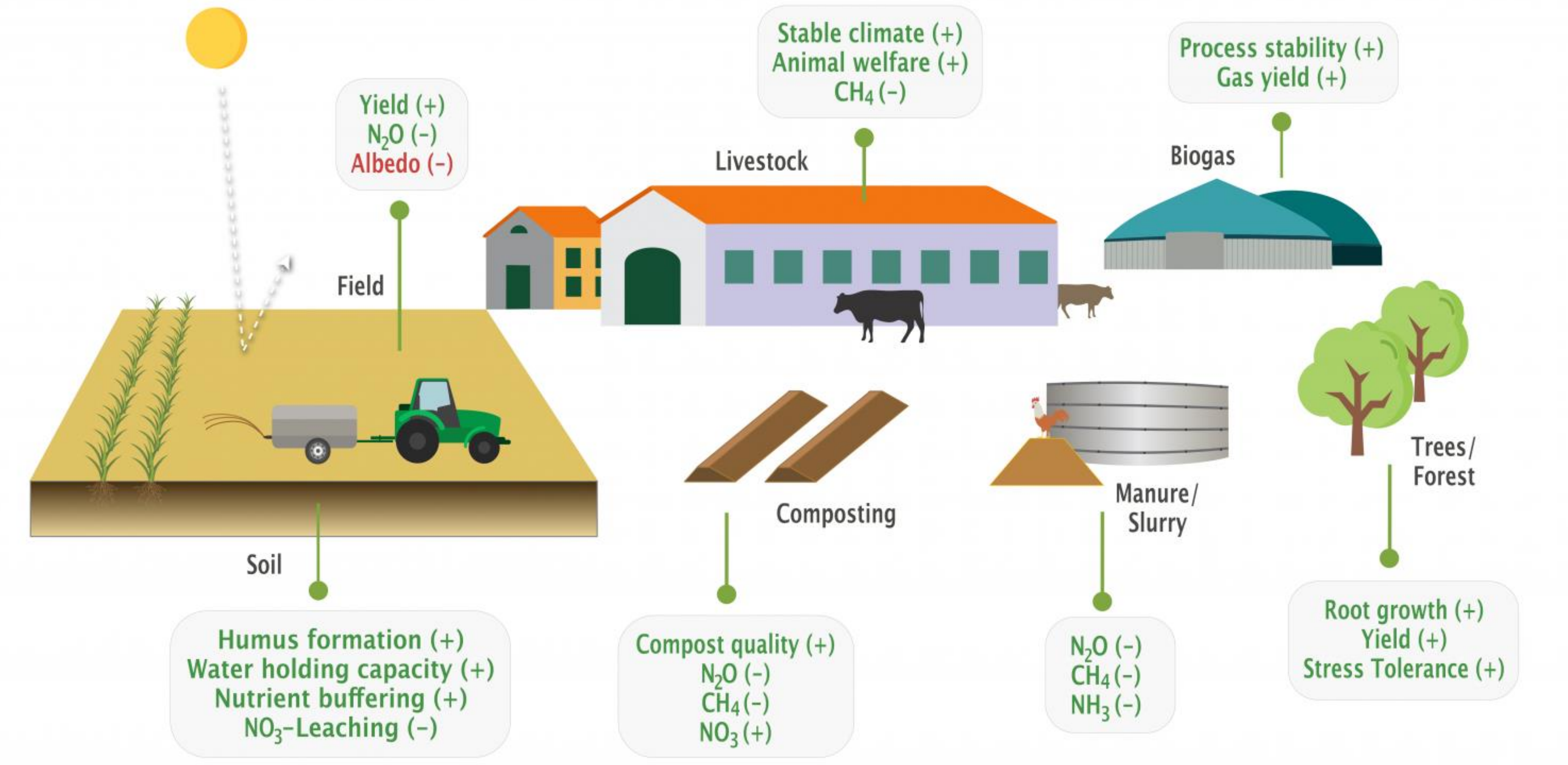
Biochar is extremely porous and has a **huge surface area of 300 m^2 per gram**. Due to its **high porosity**, biochar can incorporate up to five times its own weight in water and dissolved nutrients. This property is called **adsorption capacity (AC)** and depends on the pyrolysed biomass and the pyrolysis temperature. The highest adsorption capacity of biochar is achieved within the temperature range of 450 ° C to 700 ° C.

Regarding the particular nutrient dynamics of biochar, its **high cation exchange capacity (CEC)** is a measure of the ability to bind positively charged ions (cations) on biochar's surface and make them available later, under appropriate conditions, to plants and microorganisms. While CEC depends on the surface of biochar, it is also a chemical value, which increases through oxygen and contact with the soil and reaches its maximum value only after some time. A high CEC **prevents the leaching of mineral nutrients**, such as organic nutrients, and assures high nutrient availability. Furthermore, a high CEC also binds toxic molecules, thereby protecting the soil.

Source: Andreas Tomsen, Hans-Peter Schmidt, Ithaka Journal

Benefits of biochar application in agriculture

Biochar plays an increasingly important role in 7 agricultural systems: **stable**, **manure/slurry**, **biogas plant**, **composting**, **field**, **trees/forest** and **soil**, biochar can improve processes, limit the emission of greenhouse gases and create carbon sinks. Increases (+) and decreases (-) are visualized as positive (green) or negative (red) effects.



Source: European Biochar Industry Consortium (EBI)

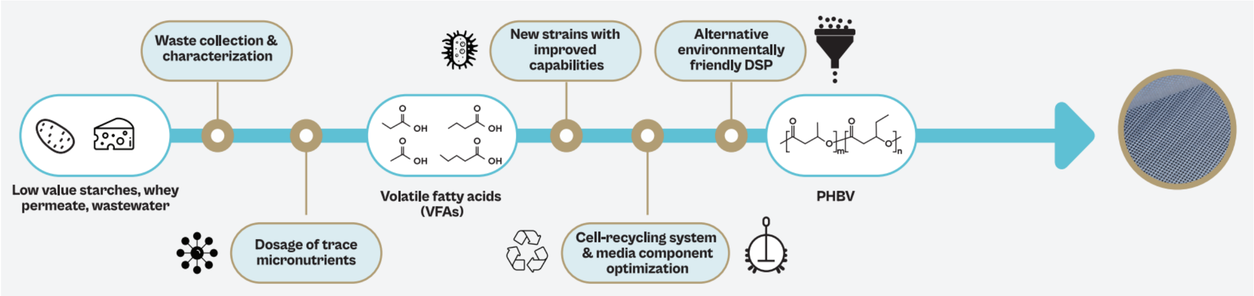
Amplitude and Variety of Biochar Markets within a new Circular Bioeconomy context

Source: Ithaka Institute – Biochar Displacement Strategy

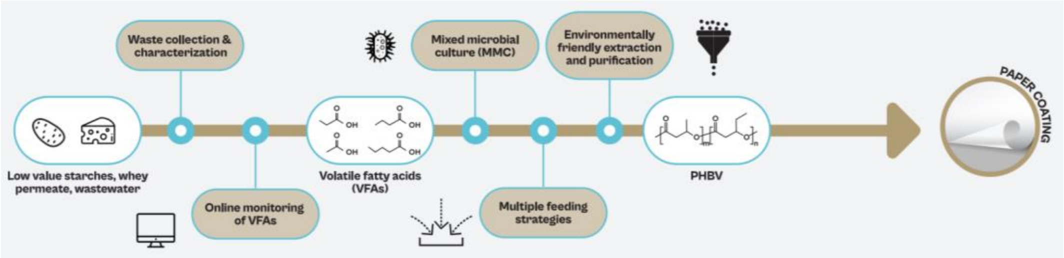
PROMOFER

Three Bio-based Products "Safe & Sustainable by Design" (SSbD)

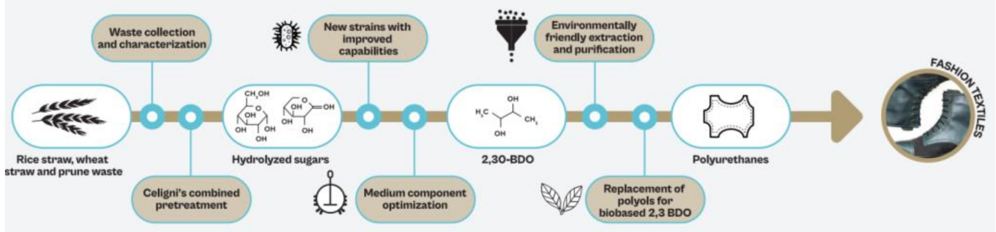
1 PHAs for geo-textiles
(**Agrifarm sector**)



2 PHAs for paper coatings in packaging
(food packaging sector)



3 2,3-BDO for bio PU
(**fashion & textile sector**)



Circular Bio-based Europe Joint Undertaking

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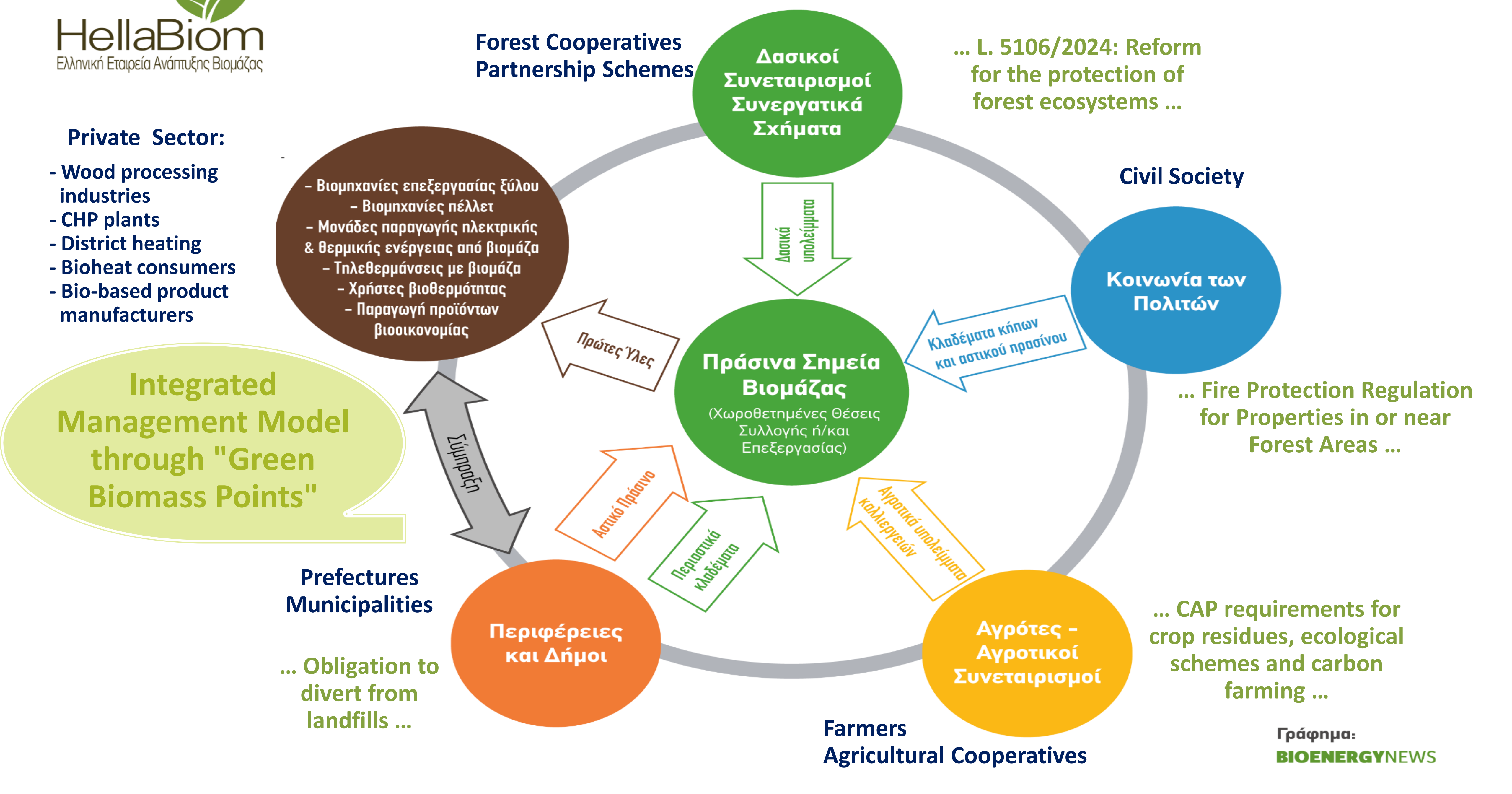
Green Biomass Points/Bio-Hubs



New reform by the Hellenic Ministry of Environment & Energy about the sustainable management of forest ecosystems

The **new reform** of the **Hellenic Ministry of Environment and Energy** (L. 5106 - Government Gazette Nr. 63 A - Part B - Articles 20-32 **"Arrangements to address the multi-layered impacts of climate change in the field of forest management and protection"**), which was voted in the Hellenic Parliament on 1st May 2024, creates a new system for forest management.

- Most of Greek forests have been **unmanaged** for 50, 60, or even 70 years, depending on the area.
- Since **rural abandonment**, especially in southern Greece, forests have been left without care, accumulating fuel materials that, combined with climate change, have led to the **devastating fires** we've experienced in the last decade.
- **Without change** in the way biomass is managed through this new forest management system, **we cannot hope to save our forests**.

Valorization of biomass waste streams - Conclusions

- **Sustainable valorization** of biomass waste streams goes hand in hand with **viable socio-economic models**, contributing to **energy and food security** and **preservation of natural resources**.
- Considering biomass fractions, logistics' costs and end-product / service value is often a **complex and tedious exercise**.
- While determining the **value of the end-use application**, it is equally crucial to place into the equation the **cost of not handling the waste within an approved context**. In other words, not dealing with the problem is not an option; there **shouldn't be such thing as 'zero-cost-solution'**!
- Energy communities, **Farmer cooperatives, ESCos, Public-Private sector schemes** between regional / municipal authorities and private companies could be alternative **organizational vehicles** to **mobilize biomass waste streams**.
- **Biomass valorization**, whether from agricultural residues or from forestry renewable resources, can take place in the form of **project-specific applications** selected across the **whole spectrum of modern bioeconomy**.
- Different **authorities should be aligned** (e.g. Ministries of Environment & Energy, Agriculture, Civil Protection, Finance)

Thank you for your attention!

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