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Bioeconomy policy governance: results, challanges and opportunities

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ETIFOR valuing nature

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Module organization

- Definitions of bioeconomy and circular economy
- Some data
- The general policy objectives
- Key governance issues:
  - Biomass procurement
  - The general approaches
  - The policy instruments
- Final remarks

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Definitions

Bioeconomy (bio-based e., bio-resources e., nature-based e., bio-technology e.): '*the knowledge-based production and utilization of biological resources, innovative biological processes and principles to sustainably provide goods and services across all economic sectors*' (Global Bioeconomy Summit 2015)

Circular economy is "*one that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles*" (the Ellen MacArthur Foundation)

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EU definitions

Bioeconomy *comprises those* ***parts of the economy that use renewable biological resources*** *from land and sea – such as crops, forests, fish, animals and micro-organisms* ***– to produce food, materials and energy*** (Europe's Bioeconomy Strategy, European Commission, 2012).

It "*includes* ***agriculture, forestry, fisheries, food*** *and* ***pulp and paper production****, as well as* ***parts of chemical, biotechnological and energy industries***" (European Commission 2012b: 5).

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Other similar and connected terms …

- Green economy
- Circular economy
- Circular bio-economy
- Bio-resources economy
- Bio-technology economy
- Knowledge-based bioeconomy
- …

→ **Borders/meanings not always clearly defined!**

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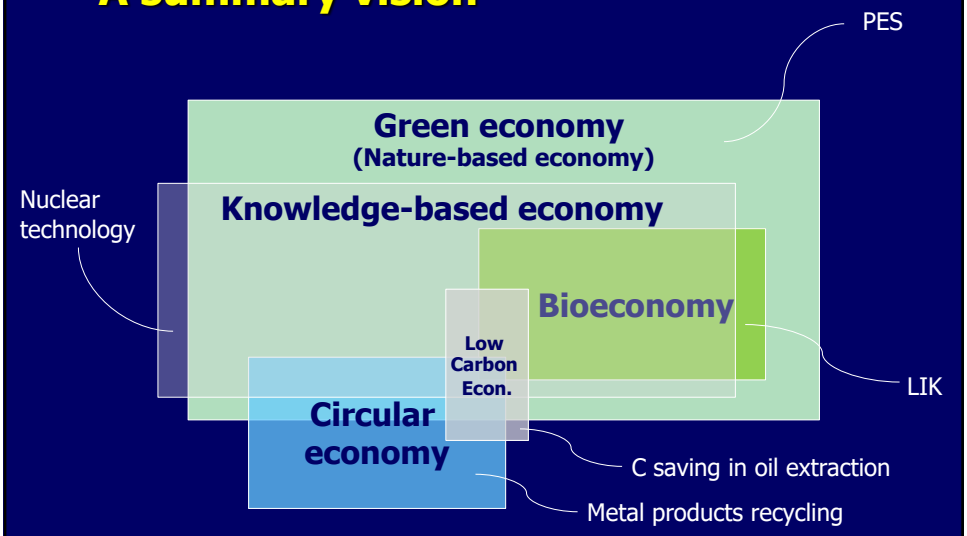
A summary vision



A risk: are we playing with the words?

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Bioeconomy and circular economy: fuzzy concepts

No consensus was found in the literature as to whether they present:

- a **concept** (Cooper 2007, p. 27; Rose 2007, p. 6–7; Thorup Larsen 2007, p. 9; Schmid, Padel & Levidow 2012; Arancibia 2013, p. 79; McCormick & Kautto 2013, p. 2593**),**
- a **paradigm** (Kitchen & Marsden 2011, p. 753; Marsden 2012, p. 258),
- a **master narrative** (Levidow, Birch & Papaionnou 2012, p. 100)
- or a **discourse** (Cooper 2007, p. 37; Birch & Tyfield 2013).

(Staffas, Gustavsson, & McCormick, 2013) (Pülzl, Kleinschmit, & Arts, 2014) taken from material prepared by Carmen Rodrigez and Valentino Govigli

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More concepts related to bioeconomy and circular economy

Bioeconomy:
FFF: food, feed & fibres
Fibres for :

- Material consumption: construction, bio-plastic, bio-textile (MMCF: man-made cellulosic fibres like viscose from dissolving pulp) and other bio-chemicals (for pharmaceutics, cosmetics, painting, other industrial uses)
- Energy (power and bio-fuel)

How much to produce? No concerns (in more recent time: biodiversity protection)

Circular economy (from a linear economy: that based on fossil resources)
No-waste economy. "Cascade approach"

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Cascade approach
(EU Forest Strategy for 2030)

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(…) *wood should be used **as much as possible for long-lived materials and products to substitute their carbon intensive and fossil-based counterparts**, for example in buildings and furniture, whilst acknowledging that not all wood is fit for such purpose.*

(…) ***Bioenergy will continue to have a notable role if biomass is produced sustainably and used efficiently, in line with the cascading principle** and taking into account the Union's carbon sink and biodiversity objectives as well as the overall availability of wood within sustainability boundaries*

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More concepts related to bioeconomy and circular economy

FFF: food, feed & fibres

Fibres for :

- Material consumption: construction, bio-plastic, bio-textile (MMCF: man-made cellulosic fibres like viscose from dissolving pulp) and other bio-chemicals (for pharmaceutics, cosmetics, painting, other industrial uses)
- energy (power and bio-fuel),

How much to produce? No concerns (in more recent time: biodiversity protection)

Circular economy (from a linear economy: that based on fossil resources)

No-waste economy. "Cascade approach"

Circular economy: a concept that can be applied also to non-renewable resources

RRR: recover, recycle, repair

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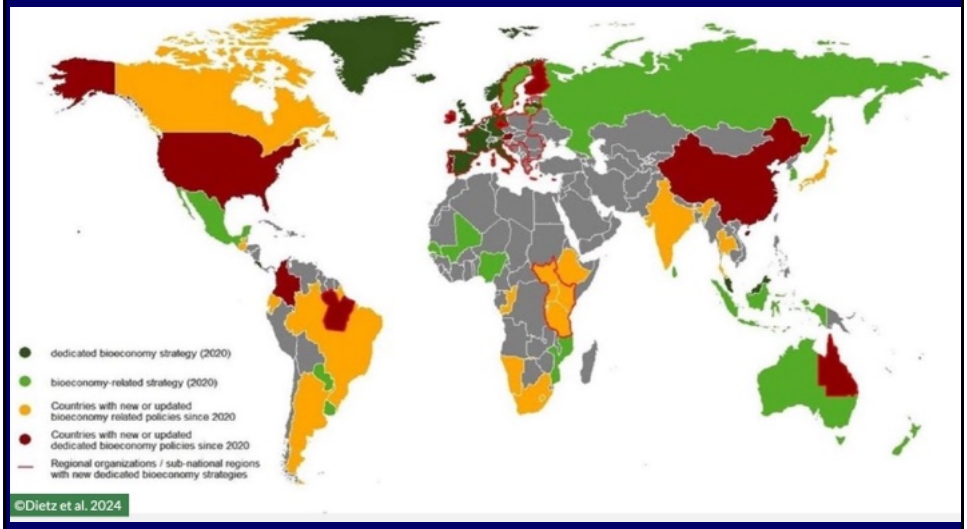
Bioeconomy Policies/Strategies around the World



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From a comparative analysis of the national plans, 5 points about the bio-economy strategies and visions that demand critical attention (Staffas *et al.*, 2013)

- **Sustainability focus** → Sustainability is not heavily emphasized and it is overshadowed by economic growth
- **Scarcity of resources** → Only mentioned in a few of the documents
- **Measures of success** → Few measures are presented in the documents, but the importance of measures is highlighted
- **Consumption patterns** → Not addressed (except for the documents by Finland and Sweden)
- **Stakeholder interaction** → This is acknowledged in the documents as critical, but needs increased efforts.

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Production values and employment

- The estimated value for the EU27 Bioeconomy, which in 2025 stood at **3,174 billion €**, employing over **17 million people**.
- **Four countries** (Germany, France, Italy and Spain), generated a total production value of about 1,760 billion € (**55.4%**), employing about 7.9 million people (**46.5%**).

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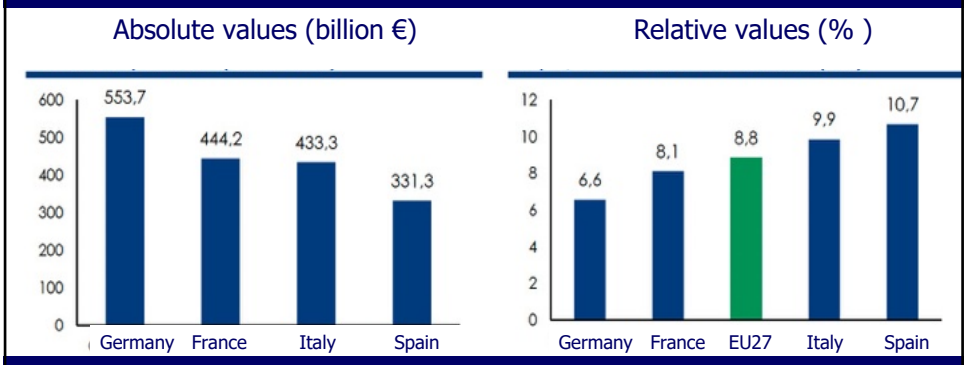
Bioeconomy production values in the main EU countries (2025)



Source: Intesa San Paolo on various sources

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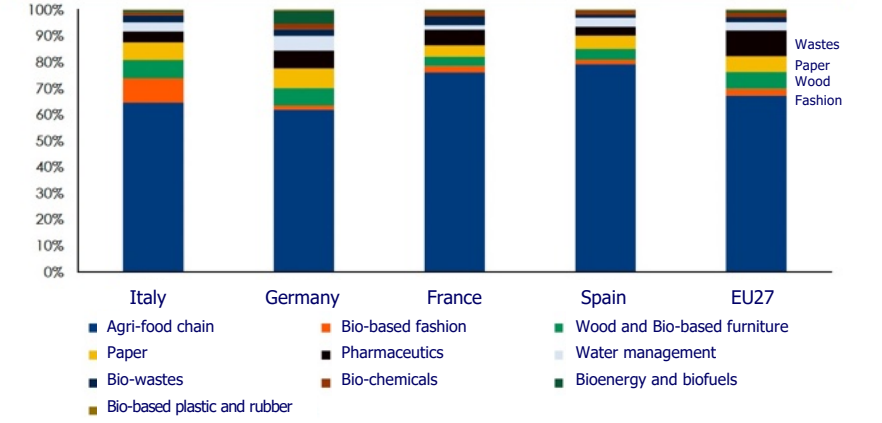
The leading role of the agri-food chain

The value of bieconomy value is significantly influenced by the performance of the agri-food chain: over 60% of the total value in the EU (France and Spain 76% and 79%)



Source: Intesa San Paolo on various sources

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Sectors of specialization among the 4 countries

- **Bio-based fashion**: **Italy** (9.3% of the total Bioeconomy compared to an EU27 average of 2.7%).
- **Bio-based wood and furniture industry: Italy** and **Germany** (7% in Italy, 6.8% in Germany, 6.4% in the EU27).
- **Paper**: **Italy and Germany** (6.6% in Italy, 7.5% in Germany and 6% in the EU27).
- **Bio-based pharmaceutical sector**: **Germany** and **France** (6.7% and 6%), however with lower shares than the EU27 average (9.8%).
- **Plastics, rubber and bioenergy**: **Germany** stands out, with percentages higher than the European average.

Sources: Intesa San Paolo on various sources

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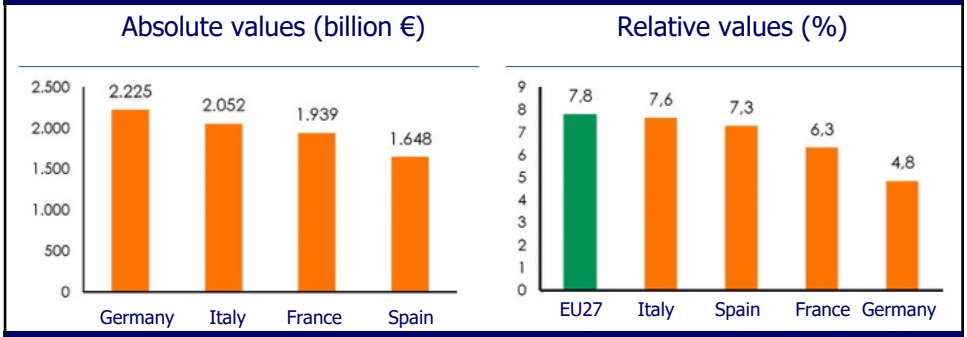
Bioeconomy employment (2025)

EU27: over 17 million people,
7.8% of total employment.



Source: Intesa San Paolo on various sources

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The fundamental problem we face: fossil carbon emission

- The **EU consums** approximately 1 billion tonnes/yr of **biogenic (45%)** and **fossil (54%) carbon** for the functioning of its economy.
- The carbon is used to provide **food (25%), energy (56%)** and **materials (19%)** and only a very small fraction of the carbon used today is from recycled origin.

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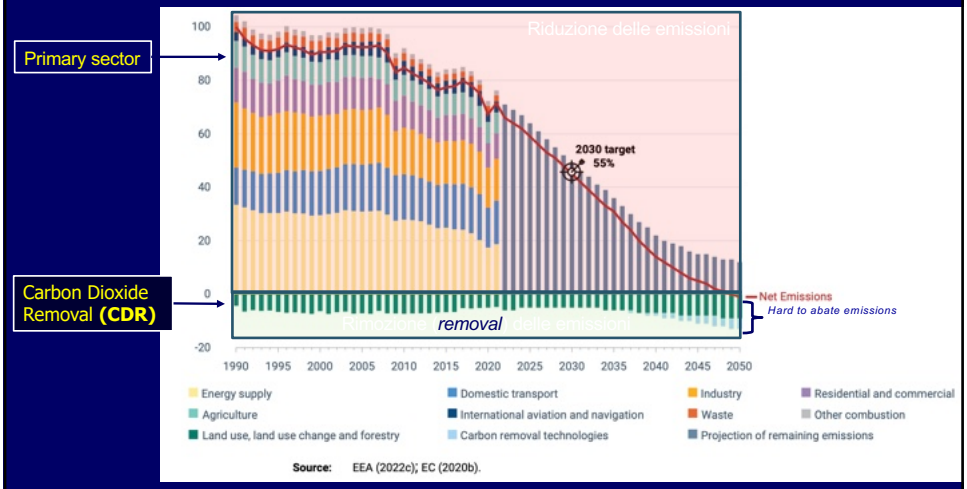
Projections to achieve climate neutrality in the EU



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The most ambitious, simple and well-defined, intersectoral target: the decarbonization of the EU economy ← the New Green Deal

- -55% GHG emission below 1990 levels by 2030 (3 years and 6 months ahead)
- Net zero GHG emissions in 2050

Decarbonization: substitution of
- fossil fuels with renewable energy
- raw materials based on petrol, using biomass
- energy intense materials (e.g., cement, steel) with biomass

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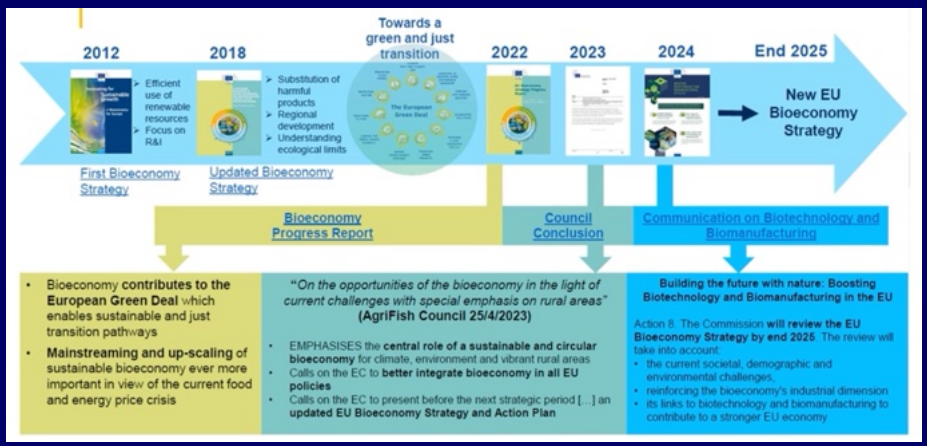
EU bioeconomy strategy



Source: European Commission

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The four pillars of the strategy

EUROPEAN COMMISSION

Brussels, 27.11.2025
COM(2025) 960 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

A Strategic Framework for a Competitive and Sustainable EU Bioeconomy

{SWD(2025) 895 final}

1. Accelerating innovation and investment
- simplifying the regulatory framework;
- speeding up permitting and authorization procedures;
- supporting start-ups and scale-ups;
- developing new financing instruments.

2. Creating new markets for bio-based products
- bioplastics;
- wood- and natural based construction materials;
- bio-based chemicals;
- bio-based textiles.

3. Ensuring a sustainable supply of biomass
- efficient use of biological resources;
- protection of biodiversity;
- promotion of circular economy principles.

4. Strengthening the international dimension
- cooperation with partner countries;
- sustainable trade;
- reinforcing the EU's global leadership in the bioeconomy.

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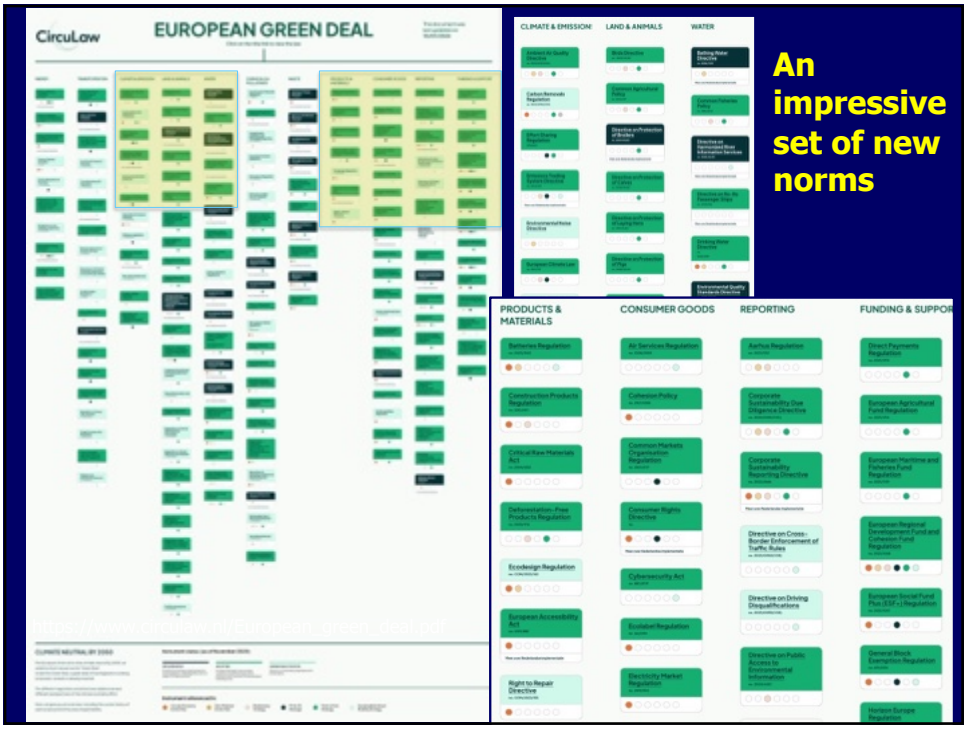

An impressive set of new norms

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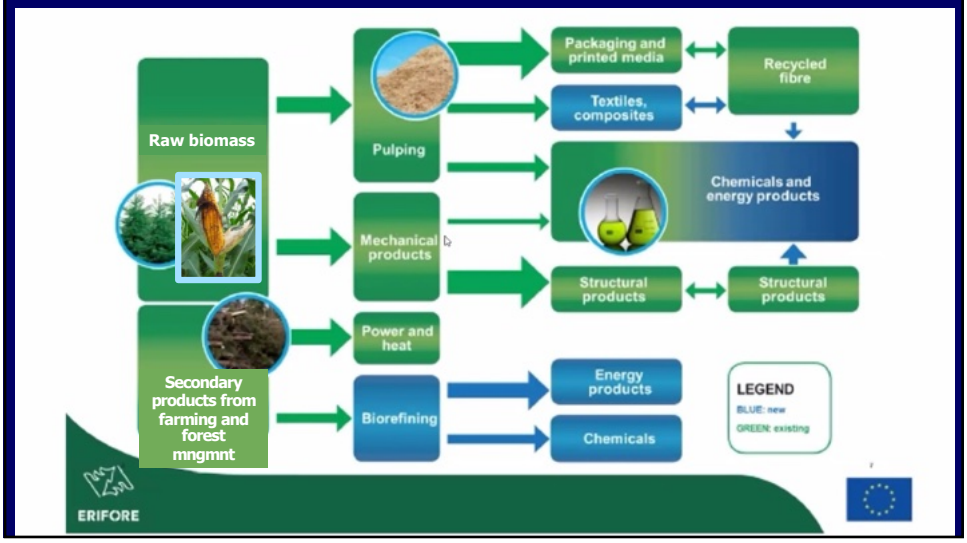
Technological innovations in the foreseen bioeconomy development



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A premise:
I will give you a personal view

One of the representation of the forests

Your informed critical opinion and personal re-interpretation are THE objectives of my presentation, not the learning of MY ideas and opinions

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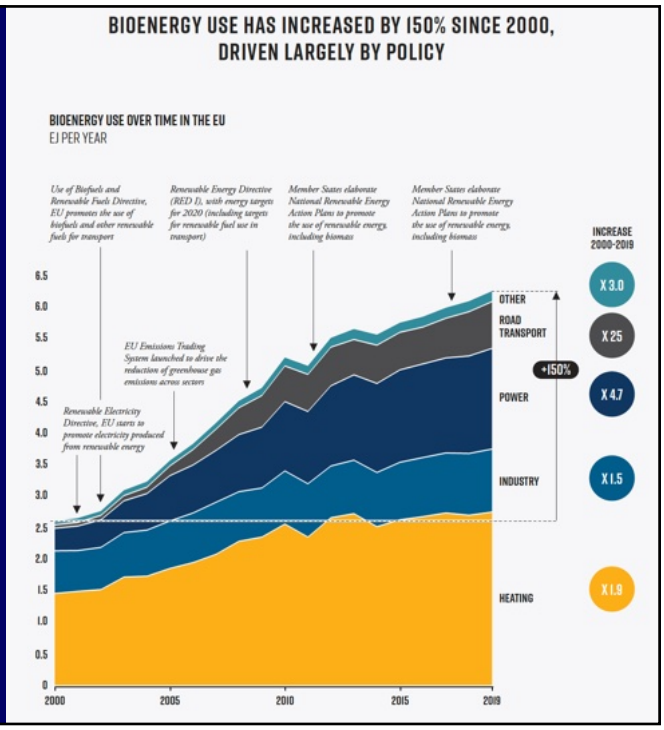
An impressive growth of biomass consumption (and specifically of bioenergy) in the EU in the last years

Material Economics (2022). EU Biomass Use in a Net-Zero Economy. A course correction for EU biomass



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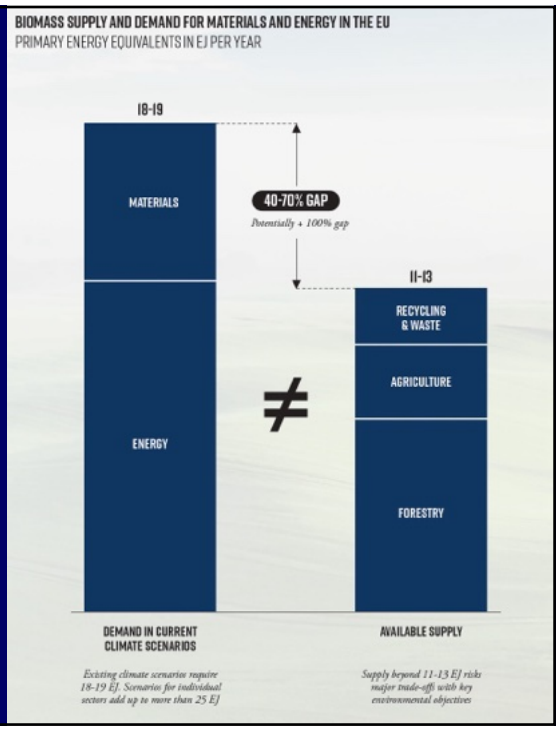
A growing gap between biomass consumption and production in the UE

Source: Material Economics (2022). EU Biomass Use in a Net-Zero Economy.A course correction for EU biomass



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How to deal with a very relevant increase of demand for biomass in the future in Europe?

A. The agricultural sector

B. The forest sector

C. Other sources

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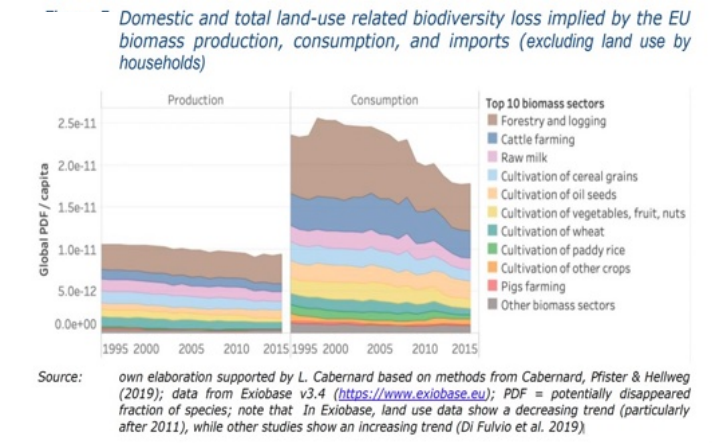
Bioeconomy made in ?



More than 1/3 of biomass inputs for the EU bioeconomy are **sourced and imported from extra-UE areas**

… but the internal expansion potentials are in theory quite large

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A. The agricultural sector

The EU depends heavily on agricultural imports; only China imports more.

nature

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COMMENT | 26 October 2020 | Correction 12 November 2020 | Correction 21 December 2020 | Correction 03 March 2021

Europe's Green Deal offshores environmental damage to other nations

Importing millions of tonnes of crops and meat each year undercuts farming standards in the European Union and destroys tropical forests.

Richard Fuchs, Calum Brown & Mark Rounsevell

EU is buying one-fifth of the crops and three-fifths of meat and dairy products consumed within its borders (118 Mt and 45 Mt, respectively).

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nature sustainability

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Analysis | Open access | Published: 20 September 2024

Biodiversity impacts of recent land-use change driven by increases in agri-food imports

Livia Cabernard, Stephan Pfister & Stefanie Hellweg

Increased food product import
→ Farmland abandonment
→ Biodiversity improvement in Sp, It, … and biodiversity loss in exporting countries of the Global South

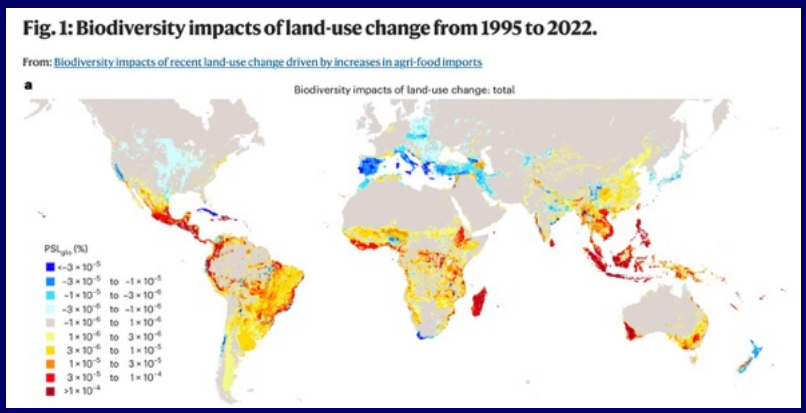
Fig. 1: Biodiversity impacts of land-use change from 1995 to 2022.

From: Biodiversity impacts of recent land-use change driven by increases in agri-food imports

a

Biodiversity impacts of land-use change: total

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A strong emphasis on biorefinery within the bioeconomy framework

- A **key factor** in the transition to a bio-based economy will be the **development of biorefinery systems** (Scarlat *et al.*, 2015)
- Biotechnology and the biorefinery concept are **essential components** of the bioeconomy (McCormick and Kautto, 2013)
- The bioeconomy is integrating traditional agricultural, forest and marine biomass feedstock production systems with a **range of biorefinery options and applications** (SCAR, 2014)
- Biorefineries are increasingly **at the core** of the bioeconomy vision at the EU level and worldwide (World Bioeconomy Summit, 2015)

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2 large biorefinery models

(Europabio, 2011, European Commission, 2012, Ceapraz *et al.*, 2016)

A. **Port-biorefinery → strongly connected to global flows of raw materials**, key-logistic location (inside/nearby harbors, along channels…), high specialization, threshold effects, and economies of scale

B. **Territorial biorefinery → strongly connected to local/surrounding territory** and (in general terms) dependent on a more diverse and more thorough valuation of various biomasses

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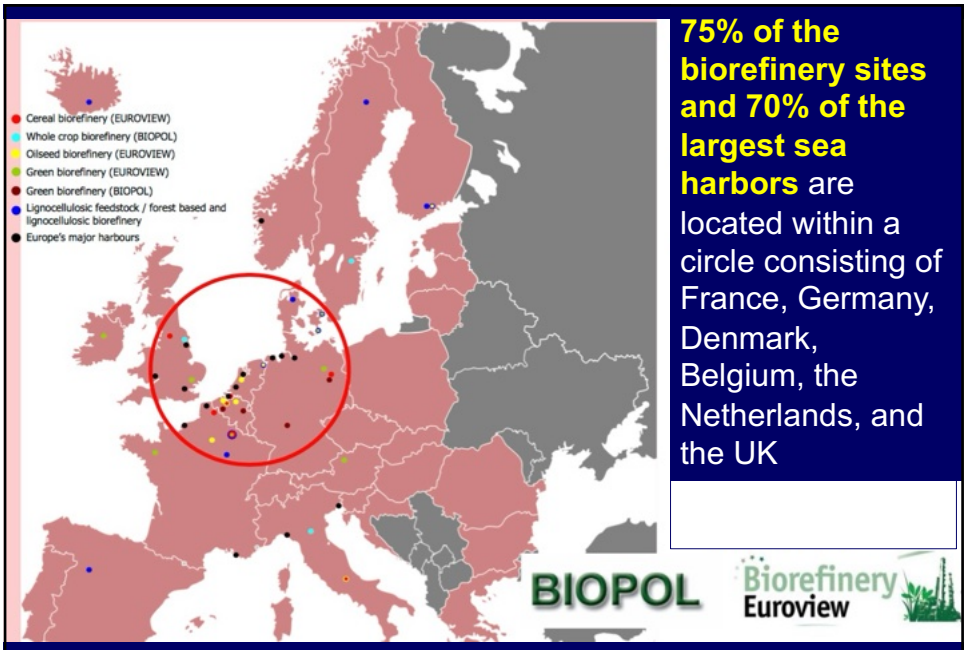

75% of the biorefinery sites and 70% of the largest sea harbors are located within a circle consisting of France, Germany, Denmark, Belgium, the Netherlands, and the UK

Source: Reith and Steinmetz (2009); Fava (2015)

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Embodied deforestation (agriculture and forest commodities)

The 10 largest importers of embodied forest loss.

Country	Forest transition stage	Imports of embodied forest loss (Mha yr^{-1})	Percentage of total imports
China, mainland	4. Post	0.20	14%
India	4. Post	0.10	7%
Russian Federation	4. Post	0.09	6%
The U.S.	4. Post	0.07	5%
Japan	4. Post	0.06	4%
Germany	4. Post	0.05	3%
Italy	4. Post	0.04	3%
United Kingdom	4. Post	0.04	3%
Egypt	Unclassified	0.03	2%
Brazil	3. Late	0.03	2%
All other	Not applicable	0.69	50%

40,000 ha/yr

Source: Pendrill *et al.*, **2019**

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Embodied deforestation (agriculture and forest commodities)
The case of Italy (1/2)

Italian consumption of palm oil, cattle products, soy, wood, coffee, cocoa, and natural rubber (see Regulation 2023/1115 «EUDR» European Union Zero Deforestation Regulation) put approximately **594,000 hectares of forest at risk** between **2005 and 2023**, equivalent to 100 m² per Italian citizen

Source: Masiero and Bausano, **2026**
https://www.etifor.com/it/pubblicazioni/deforestation-made-in-italy/

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Embodied deforestation (agriculture and forest commodities)
The case of Italy (2/2)

Source: Masiero and Bausano, 2026

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B. The role of the forestry sector in the EU circular bioeconomy

- Forestry, manufacture of paper and wood products (included the furniture industry) employed 2.6 million persons in the EU, **19.5% of the total employment in the EU bioeconomy** (13.5 million persons) (Ronzon and M'barek, 2018).
- Wood biomass is the **first renewable energy resource** in Europe
- **80% of the biodiversity** is connected to the presence of forest ecosystems
- **Mitigation potential** of forest and HWP (Harvested Wood Products)

→ Forest = the "green infrastructure" of Europe

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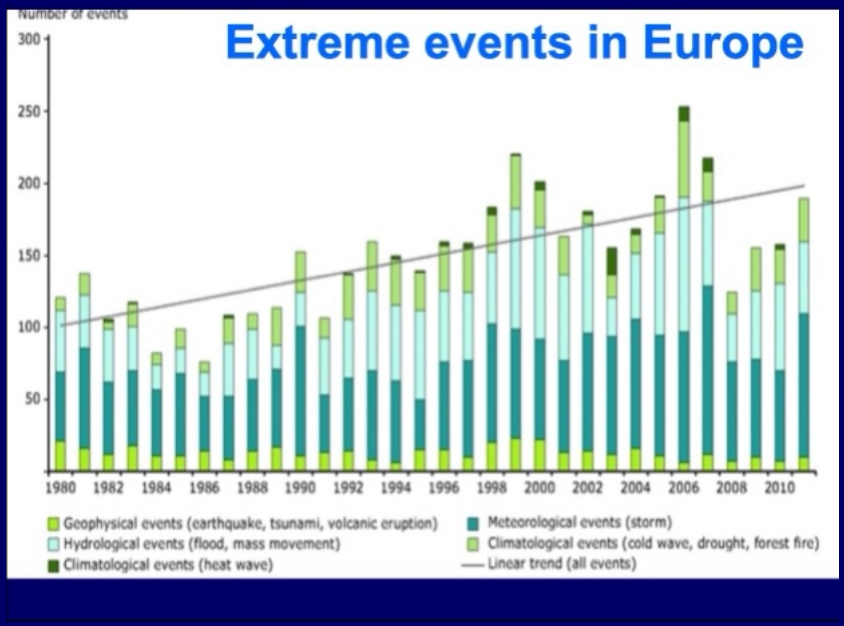

Source: EU Environmental Agency, 2014

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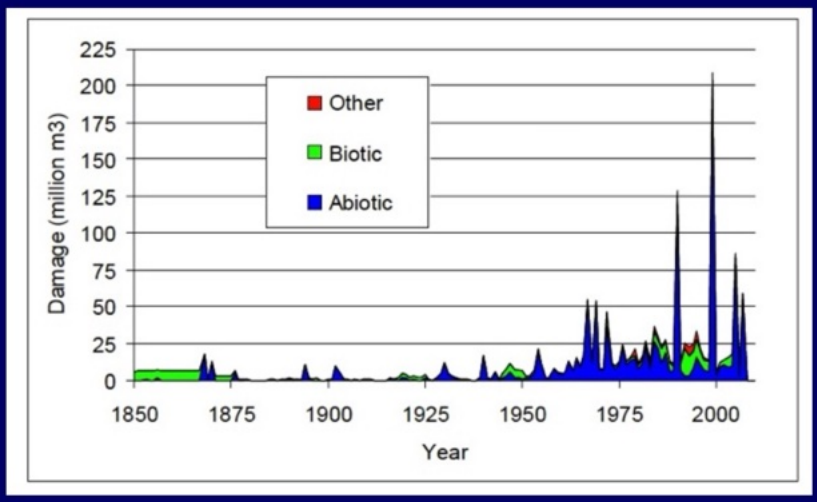
Main large damage event (storms, fires, insect attacks, …) to (ageing) European forests



Schelhaas, 2008

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Gundrum

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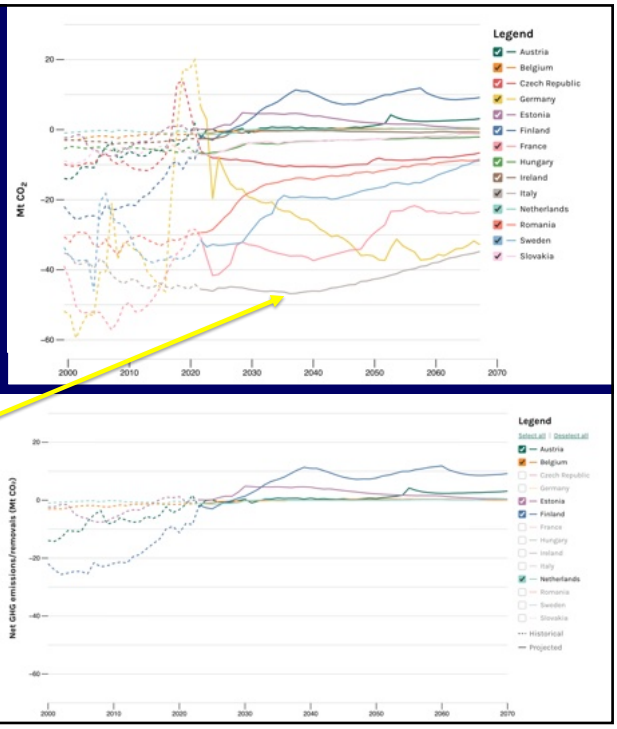
Carbon removal in forests in European countries (2000-2070)



Italy is the country with the highest levels of CO_2 removal (under its baseline conditions)

Source: Forest Navigator project

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C. Other solutions

- Blue biomass?
- Vertical farming?
- Sustainable intensification? Gene-editing techniques?
- …

Probably limited, technologically feasible solutions, but with economic and social feasibility problems in the short-run

An important role paied by recycling, but…

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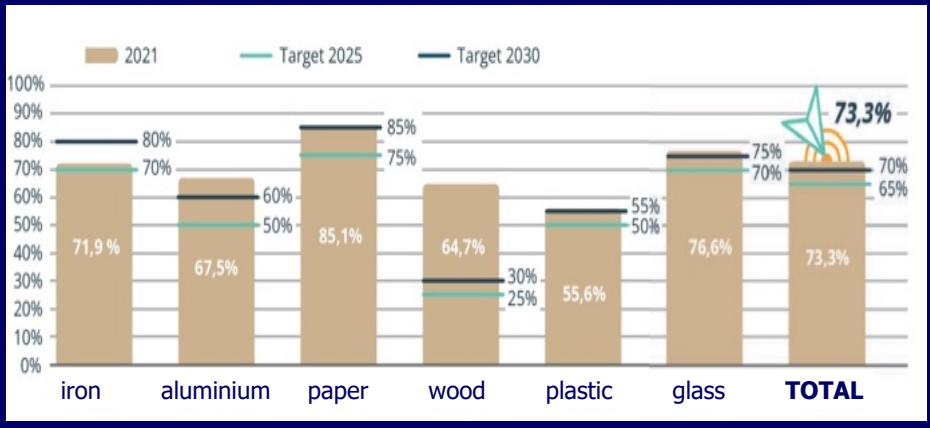
Recycling rate of packaging materials in Italy in 2021 in relation to the EU targets in 2025 and 2030



Fonte: https://www.fondazionesvilupposostenibile.org/wp-content/uploads/dlm_uploads/Sintesi-Il-Riciclo-in-Italia-2022.pdf

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Simplifying the topic, two opposite targets of policy action

The key-idea of **circular bioeconomy** where agriculture, forestry, and fishery, should produce **more goods** becoming the engine of a new growth

Technological approach

Vs.

Social and environmental approach

The increasing political role of the **non-market components** of economy: from an economy based on commodities to an economy based on environmental and social services

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Currently the dominant vision in the EU is the first one, but with an increasing opposition

Examples:

"*EU definition of bioeconomy comprises those parts of the economy that use renewable biological resources from land and sea – such as crops, forests, fish, animals and micro-organisms – **to produce food, materials and energy***" (Europe's Bioeconomy Strategy, European Commission, 2012).

It "*includes **agriculture, forestry, fisheries, food** and **pulp and paper production**, as well as parts of chemical, biotechnological and energy industries*" (European Commission 2012b: 5).

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An example: contrasting positions/coalitions emerged while discussing the EU Forest Strategy for 2030

Bioeconomy and climate-change mitigation *vs* Biodiversity and adaptation to climate-change

Brussels, 23 June 2021

JOINT STATEMENT

Draft new EU Forest Strategy: time to really consider the opinion of EU forest and forest-based sector

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The technological (dominant) approach (modified from Toman, 2012; Pettenella, 2015; Secco *et al.*, 2015)

	Technological approach
Focus on	• Technological innovations • Large scale investments • Value chain perspective • Sectoral development • Vertical integration
Input/output diversification	1 or more inputs Diversification in outputs
Market power	Increasing role of business owning/controlling the (new) technologies
Model regions	Northern EU (UK, Scandinavian countries)

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Technological approach: an example from Finland

- Largest investment in the history of Finnish forest industry
- **100%** of wood raw material used
- **1.3 million tonnes** of pulp/year + bioproducts (e.g. textile fibres, biocomposites, lignin products, fertilisers…) and bioenergy
- **+4.000 jobs** created (including value chain and consumption) → **61.000** jobs expected in 30 years

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The social and environmental approach

(modified from Toman, 2012; Pettenella, 2015; Secco *et al.*, 2015)

	Technological approach	Social approach
Focus on	• Technological innovations • Large scale investments • Value chain perspective • Sectoral development • Vertical integration	• Social innovations • Small scale • Networks • Cross-sectoral development • Horizontal integration (= forests and agriculture as the green infrastructures for rural development)
Input/output diversification	1 or more inputs Diversification in outputs	Diversification in the use of inputs High added value products & services
Market power	Increasing role of business owning/controlling the (new) technologies	Role of networks, groups, associations, public-private partnerships…
Model regions	Northern EU (UK, Scandinavian countries)	Southern EU (Mediterranean region)

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Social and environmental approach: an example from Italy (Borgotaro network)

Imago product:
Boletus mushroom

Enterprises: 62

15 Agro-tourisms/ Farm businesses
12 Hotels/Guest quarters
8 B&B/Inns/Hostels
9 Cheese, sausage and wine growing and producing factories
2 Didactic farms
3 Museums/Private collections
30 Restaurants/Porterhouses
26 Typical products sellers

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Following the social and environmental approach, the real innovative and crucial aspects of the **circular bioeconomy** should be related to **equity, social inclusiveness, tenure security, employment**, i.e. to social and political issues, more than to problems connected to technology development

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3 classes of instruments of policy action

Sticks

Carrots

Sermons

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Instruments of public policy

- **Passive: Command and control (regulative instruments) ("sticks"):**
  - Taxes and fees (Eco-taxation: "who pollutes, pays")
  - Licenses, permits, thresholds, standards, …
- **Active: stimulus to economic incentives (based on voluntary participation) ("carrots"):**
  - Tax deduction, tax exemption
  - Incentives and compensation
  - **Market-based instruments:**
    - Payments for Environmental Services (PES) and PES like schemes
    - Socially responsible procurement policies
    - Tradable permits, deposit-refund systems, offset schemes
    - Standard setting, certification & labeling,
    - Technical support, provision of services (e.g. seedling, irrigation water, infrastructures, … provided at no price or at below costs prices), direct management of some economic activities (e.g.: hospital, school, forests, …)
- **Information ("sermons")**
  - Technical assistance, training & education, R&D

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Two very general (and theorical) assumptions

- The need to protect natural resources much exposed to degradation through an active and intense **regulative policy action** (command and control instruments: regulations, taxes, thresholds and standards, legal requirements, …. at national and international level)
- The need to enhance the use of **voluntary, market-based mechanisms**, also to actively involve civil society in the management of natural resources

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A contradiction connected to the **instruments** of policy action

• we stress the need to enhance the use of **voluntary, market-based mechanisms and social innovations**, linked to the idea to actively involve civil society in the management of forest resources …

•… but we tend to increase the use of **regulative policy tools such as:** Natura 2000, criteria associated to the EU Taxonomy, enhanced conditionality and eco-schemes (3% of set-aside farmland for biodiversity), and more recently…

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Area of policy action	Private initiatives that have previously covered the area of EU policy action	The regulatory initiatives by the EU
Legal origin of the wood products and their CoC and criteria for SFM	CoC standards by FSC, PEFC, Naturaland, Plockhugget, …	EUTR – European Union Timber Regulation, EU Close to Nature standard for Sustainable Forest Management
Sustainable finance	GABV, FEBEA and INAISE networks' activities	Taxonomy
Sustainable use of wood biomass	Better Biomass, ISCC, SBP, … (see https://energy.ec.europa.eu/topics/renewable-energy/bioenergy/voluntary-schemes_en)	REDII and REDIII (draft)
Legal origin of 7 rough natural products and their CoC	GFP, Rainforest Alliance, RTRS, RSB, RSPO, SAN, SBP + already mentioned forest related organizations	EUDR – European Union Deforestation and forest degradation Regulation
Sustainability reporting	GRI, CDP, SASB, ISO 14001 EMS, SASCB, Carbon Trust Standard, Greenhouse Gas Protocol by the WRI and WBCSD,…	CSRD (Corporate Sustainability Reporting Directive) and NFRD (Non-Financial Reporting Directive)
Carbon credits generation	National Schemes and private certification schemes and standards	CRC – Carbon Removal Certification Regulation

CDP: Carbon Disclosure Project, CoC: Chain of Custody, EMS: Environmental Management System, GCP: Global Coffee Platform, GRI: Global Reporting Initiative, ISCC: International Sustainability and Carbon Certification, RSB: Roundtable on Sustainable Biomaterials, RTRS: Round Table on Responsible Soy Association, RSPO: Roundtable on Sustainable Palm Oil, SAN: Sustainable Agriculture Network, SBP: Sustainable Biomass Program, SASB: Sustainability Accounting Standards Board, SASCB: Sustainability Accounting, Standards and Certification Board, WBCSD: World Business Council for Sustainable Development, WRI: World Research Institute.

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Main EU binding targets

Binding targets	Scadenza	Strategia di riferimento principale
Net GHG emission reductions (-55% by 2030; -90% by 2040, 0 by 2050)	2030-50	Green Deal
Improve degraded habitats 30%-60%-90%	2030-50	Nature Restoration Law
At least 42.5% share of renewables in EU final consumption by 2030	2020	Renewable Energy Directive
LULUCF carbon sink ≥310 $MtCO_2eq$	2030	Reg. LULUCF
Restoration with specific projects of 20% land and sea areas	2030	Nature Restoration Law
Reversing the decline of pollinators, 25,000 km	3030	Nature Restoration Law
-20% fertilizers, -50% nutrient loss, -50% antimicrobial	0	Strategia Farm to Fork
≥25% biological framland in the EU	0	Strategia Farm to Fork
-50% food waste	0	Green Deal
Total ban on the import of soybeans, beef, cocoa, coffee, palm oil, wood, rubber drivers of deforestation	2027	EUDR (wood products: EUTR from 2013)
Planting 3 Billion Trees	2030	Forestry Strategy, Biodiversity Strategy
Protected areas 30% (10% of areas with full protection)	2030	Biodiversity Strategy

Impacts by"Readiness 2030" - ReArm Europe Plan with the new instruments SAFE (Security Action for Europe) aand EDIP (European Defence Industry Programme)?

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In this way public administrations **tend to concentrate on bureaucratic control**, while the new options to develop the economy would require a **proactive public administration** open to partnership, negotiation, innovative attitude in sharing responsibilities, advisory services, strong support to R&D, …

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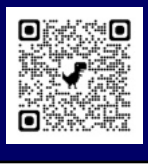
Module organization

- Definitions of bioeconomy and circular economy
- Some data
- The general policy objectives
- Key governance issues:
  - Biomass procurement
  - The targets
  - The policy instruments
- **Final remarks**



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A basic concern about the coherence of the circular bioeconomy policy

The issue of **future biomass availability** to feed the circular bioeconomy (and reach the decarbonization targets) is not much considered:

which trade-off with the increased protection of European nature? With the quality and quantity of biodiversity outside the EU (embodied deforestation and forest degradation)?

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«…not only is there no empirical evidence supporting the existence of a decoupling of economic growth from environmental pressures on anywhere near the scale needed to deal with environmental breakdown, but also, and perhaps more importantly, such decoupling appears unlikely to happen in the future»

Source: Parrique et al., 2019

Is the the idea of a circular bioeconomy based on full substitution of fossil resources with biomass a **concrete and feasible policy** or a **rhetoric commitment**?

Are the 3 R (recover, recycle, repair) enough?

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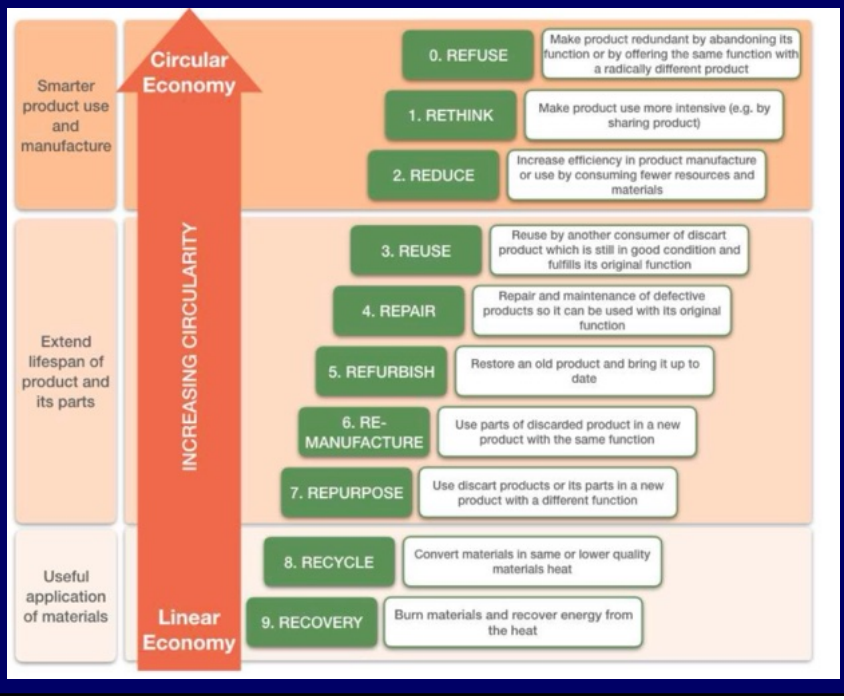

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Opposite views of circular bio-economy

Adaptive strategy ("Old wine in new bottles"): focus on innovation and technological change and the conventional wisdom of externality correction (i.e., "getting prices right" giving the true value to resources, reducing the consumption of natural capital; weak sustainability concept)

Alternative strategy: which consider not only the growth of the economy through its decarbonization, "*but it stresses as well the importance of addressing equity and social inclusion challenges in moving toward a green economy*" (M.Toman, 2012)

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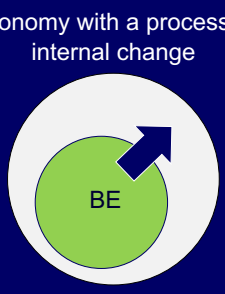
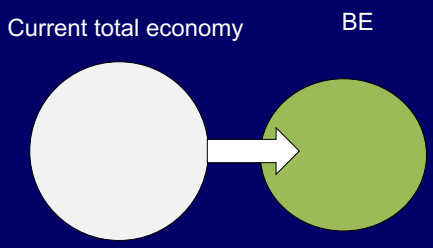
A difference that is not outspoken nor defined (Staffas *et al*., 2013)

- **Bioeconomy (BE)** → a sub-part of the nation's total economy (often in relation to white biotech and life science)



- **Bio-economy (BE) under a growth pattern of material consumption** → an economy where renewable resources instead of fossil ones and mineral constitute feedstocks for both energy, food, feed and materials



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In other words, it is a matter of the direction to be taken…

… but also, of the optimal tools to be used

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