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Role of HEI in Sustainable Forest Management and Bio-economy

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Contents

- Bioeconomy as a concept
- Sectoral and system view of the economy
- Forest value chains
- Financial aspects of forest bioeconomy
- Research on bioeconomy
- Innovations and examples

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Current state: a fossil-based, wasteful economy

- Use of large amounts of non-renewable resources for production and services
- Non-renewables generate in extremely long cycles
- Their consumption is rather new approx 200 years
- A big difference between capture and release

Algae

Million years

Petroleum

Land biomass

Million years

Coal

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Non-renewable carbon resources

- Non-renewable carbon resources especially problematic
  - Petroleum
  - Coal
  - Natural gas
- Use cases
  - Energy production
  - Production of chemicals and materials
- These materials are not biocompatible

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Renewable resources

- Raw inputs consumed in amounts they are regenerated
  - Sustainable
- Non-biological
  - Sun, wind
- Biological
  - Biomass

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Sectoral approach to economy

- The economy is currently divided into three sectors
  - Primary – mining, harvesting resources
  - Secondary – industrial processing
  - Tertiary – services
- Clean divisions in the model
- Does not reflect reality

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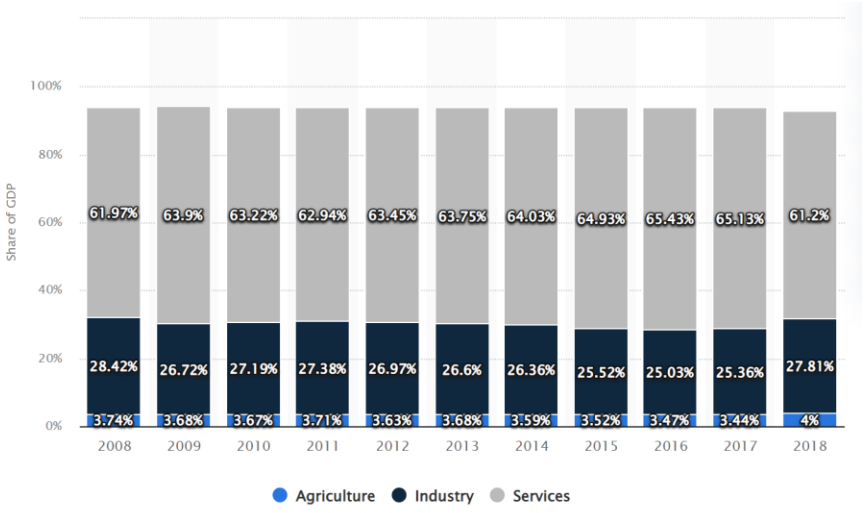
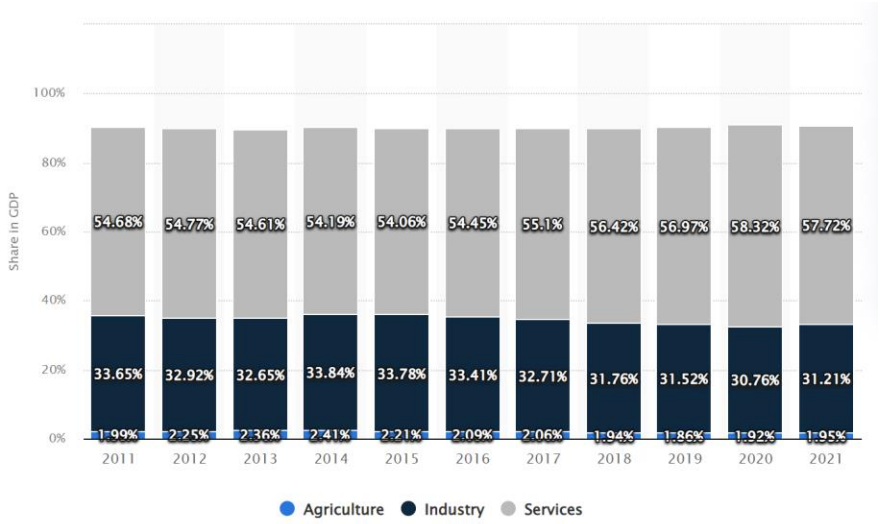
GDP distribution by sector

Global



Czechia



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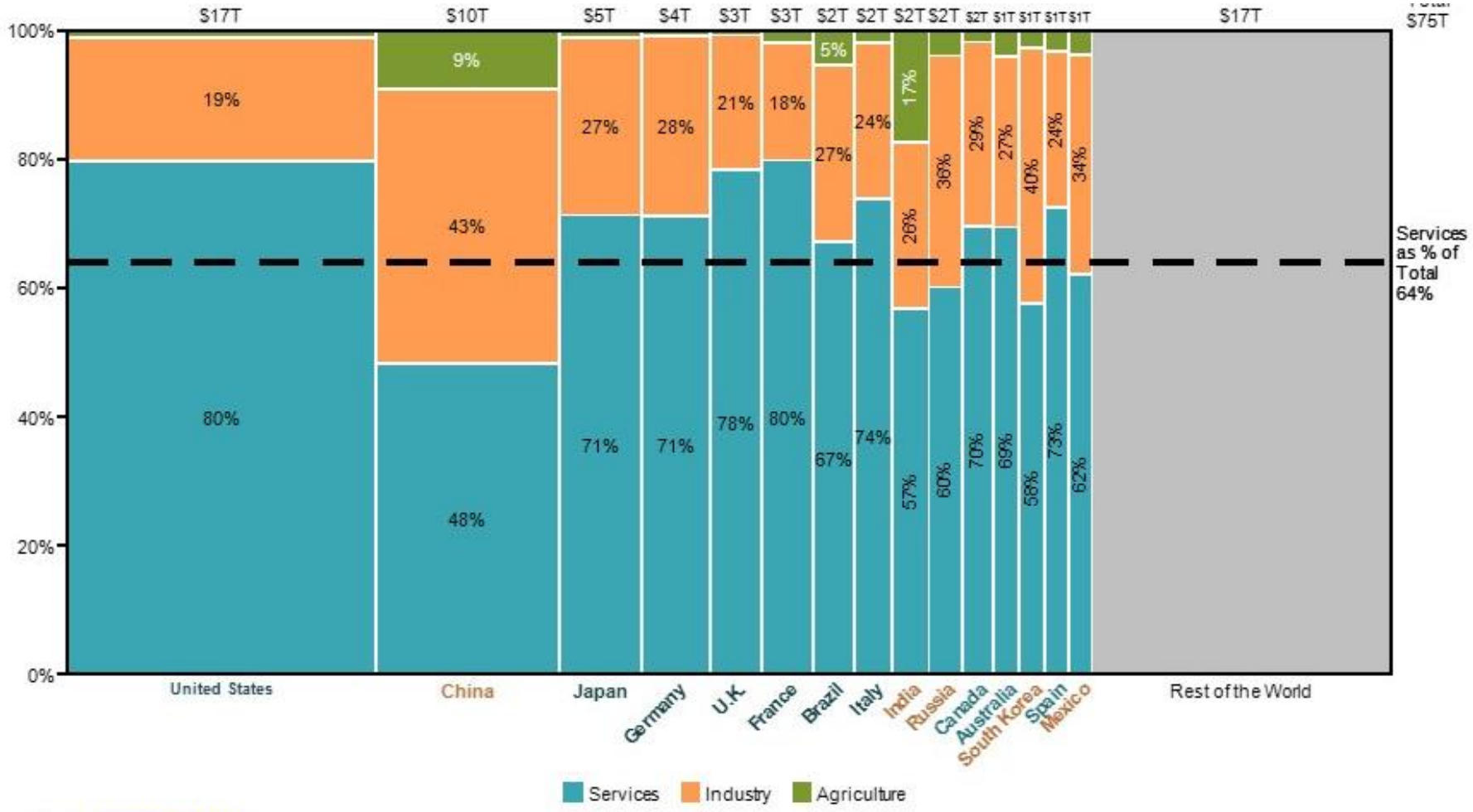
FRAME

GDP by sectors



Source: howmuch.net

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Sectoral approach to economy

- More problems arise when we consider:
  - The complexity of the global economy
  - Public costs vs. private costs of production (externalities)
  - Wealth distribution –
    - Regional development inequalities
    - Inequalities along the supply chain

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Obstacles to overcome

- To function properly, the economy needs to tackle the threats of chaos and isolationism,
- Those would lead to
  - Economic depression
  - Unjust social development

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Obstacles to overcome

- We can overcome these by
  - Adjusting to a networking model (systems approach)
  - Transitioning to environmentally sound and regenerative agricultural models (systems approach, circular bioeconomy)
  - Developing biotechnologies (systems approach, circular bioeconomy)
  - Optimizing along the full cycle (systems approach)

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Solving the problems through bioeconomy

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History of bioeconomy

- Resource limitations (scarcity)
  - 1776/A. Smith
  - T. Malthus, D. Ricardo
- Economic growth and sustainability (Meadows)
- N. Georgescu-Roegen – theory of bioeconomy (1970)
  - *theoretical approach leading to the optimal use of natural resources according to the mathematical-statistical modelling*
- Bioeconomy visions:
  - Biotechnologies/research
  - Biological sources (agriculture, aquaculture, bioenergy, value chains)/research
  - Bio-ecological approach (biodiversity, regional and integrated processes)

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Bioeconomy vs. circular economy and sustainability

- Sustainable development (SDGs, biological sources protection, research)
- Circular economy
- It should be noted that different authors might tackle the issue differently:
  - BE as a part of circular economy
  - BE = circular + „green“ (low-carbon) economy
  - BE as a superstructure of the circular economy (See Nova institute)
  - Circular bioeconomy
- The topics included:
  - *Ecosystem services*
  - *Sustainability*
  - *Resource limitations*
  - *Ensuring resources and food*
  - *Climate change*

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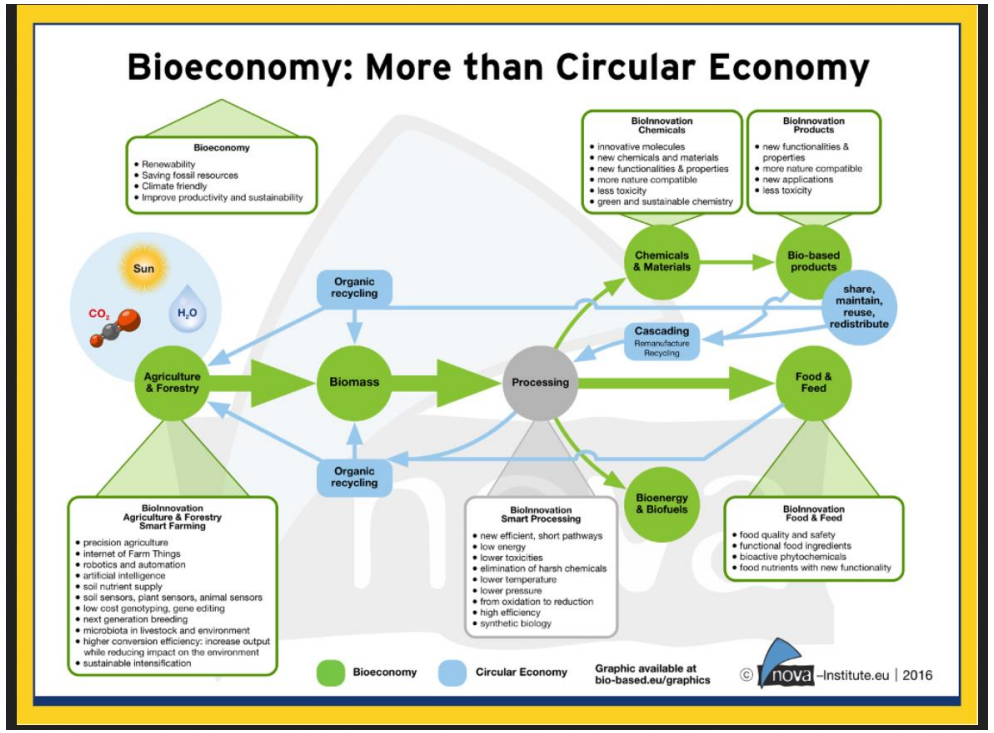
Bioeconomy vs. circular economy and sustainability



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Bioeconomy vs. circular economy and sustainability

- Circular economy
  - Aims to keep the value of products, materials and the resources as long as possible in the economic cycle and to return them to the production cycle at the end of their life while minimizing the waste generation
- Sustainability:
  - Rio de Janeiro (1992)
  - meeting human development goals while also sustaining the ability of natural systems to provide the natural resources and ecosystem services on which the economy and society depend – not to threaten the future generations (SGDs: 2015 (UN), see https://sdgs.un.org/goals)

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Bioeconomy - definition

- *„The 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“ (EC,2012)*
- „The bioeconomy is an economic concept based on the increased use of renewable resources in new value chains, which will enable the deployment of innovative biotechnologies in particular. Due to its multidisciplinarity, the bioeconomy combines the work of several ministries into a single agenda - the Ministry of the Agriculture, which is responsible for the sustainable production of renewable resources, Ministry of Industry and Trade, which is responsible for the use of these resources in the Czech economy for the creation of value, the Ministry of Regional Development, which is responsible, for example, for the cohesion of regions, and the Ministry of the Environment, which is responsible for protecting and improving the environment, its individual components, improving biodiversity, etc.“ *CZU, 2020*

https://op.europa.eu/en/publication-detail/-/publication/1f0d8515-8dc0-4435-ba53-9570e47dbd51

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Bioeconomy – definition

- Bioeconomy concept in the Czech Republic from the perspective o the Ministry of Agriculture (2019-2024):
  - „The bioeconomy can be defined as an economy based on the sustainable use and processing of biomass, leading to an increase in the use of biomass products in various sectors of society, based on innovation and knowledge of economic growth and the creation of jobs in rural areas.“
  - Sustainable management, climate change adaptation, increasing stability and vitality of forest ecosystems, utilization of wood products, rural development + employment
- Hetemäki (2017) states that the bioeconomy is “the use of renewable biomass of forests or forest (biome) for materials, products and services”.

BIOECONOMY CONCEPT IN THE CZECH REPUBLIC FROM THE PERSPECTIVE OF THE MINISTRY OF AGRICULTURE (2019-2024)

https://eagri.cz/public/web/file/658143/Leaflet_Bioeconomy_concept_in_the_Czech_Republic.pdf
Hetemäki, Lauri, 2017. Future of forest industry in bioeconomy. Lecture at the Managerial economics and business strategy in forest industry course, University of Helsinki, 16 February 2017. DOI:10.13140/RG.2.2.25828.78727

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Aims of Bioeconomy concept

The main objective of the Bioeconomy concept is to increase the efficiency of already implemented activities, increase their synergic effect through system management management tools and at the same time to ensure effective investment of public funds into research and related transfer of RDI (research, development, innovation) into practice, to bring the results which can be used for bioeconomy development in mentioned areas. To achieve these objectives, it is necessary to set up effective measures and control mechanisms.

INNOVATION AND RESEARCH

FIELD OF ECOSYSTEMS AND ECOSYSTEM SERVICES

RURAL - SOCIAL AREA

ECONOMIC AREA

FIELD OF FOOD INDUSTRY

Key activity A: Reinsurance of steering and realization of the Bioeconomy concept on the national level

Objective A1: Reinsurance of activity of the expert interdepartmental working group and Steering committee

Objective A2: Evaluation of Bioeconomy concept in the year 2025 and realization of Strategy of bioeconomy in the Czech Republic

Key activity B: Development support of bioeconomy in the Czech Republic with the use of international cooperation

Objective B1: Together with the states of Visegrad Group seek for development of bioeconomy

Objective B2: Active cooperation in international expert working group dealing with bioeconomy

Key activity C: Reinforcement of the technological development and innovations

Objective C1: Cooperation in the European research projects focused on bioeconomy

Objective C2: Transfer of research results and good practice towards stakeholders

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Priorities in bioeconomy.

- ensure food and nutrition security,
- manage natural resources sustainably,
- reduce dependence on non-renewable, unsustainable resources,
- limit and adapt to climate change,
- strengthen European competitiveness and create jobs.
- *The 2018 update of the Bioeconomy Strategy aims to accelerate the deployment of a sustainable European bioeconomy to contribute towards the Sustainable Development Goals (SDGs), and to help fulfilling the goals of the Paris Agreement.*
- *It also responds to new European policy priorities, such as the renewed Industrial Policy Strategy, the Circular Economy Action Plan and the Communication on Accelerating Clean Energy Innovation, all of which highlight the importance of a sustainable, circular bioeconomy to achieve their objectives.*
- *A related action plan formulates 14 concrete measures launched in 2019. They are based on three key priorities:*

1. *Strengthen and scale up the bio-based sectors, unlock investments and markets;*
2. *Deploy local bioeconomies rapidly across the whole of Europe;*
3. *Understand the ecological boundaries of the bioeconomy.*

European Commission, Directorate-General for Research and Innovation, *Innovating for sustainable growth : a bioeconomy for Europe*, Publications Office, 2012, https://data.europa.eu/doi/10.2777/6462, https://knowledge4policy.ec.europa.eu/bioeconomy/bioeconomy-strategy_en

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- Lovrić et al. (2020) - forest-based bioeconomy is divided into four parts: forest systems, forest biomass and raw materials, primary processing (such as pulp, bioenergy, and wood processing) and secondary processing (biorefinery, biopolymers etc.).

- See:
  - Hetemäki, Lauri, 2017. Future of forest industry in bioeconomy. Lecture at the Managerial economics and business strategy in forest industry course, University of Helsinki, 16 February 2017. DOI:10.13140/RG.2.2.25828.78727.
  - Lovrić, N., Lovrić, M., Mavsar, R., 2020. Factors behind development of innovations in European forest-based bioeconomy, Forest Policy and Economics, Volume 111, 102079, ISSN 1389- 9341, DOI: 10.1016/j.forpol.2019.102079.

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Agricultural bioeconomy

- Covers agronomical, ecological, economic, social and ethical aspects
- Should lead to the GHG emissions reduction, lowering dependence on fossil fuels, more reasonable natural resources management and ensuring food security
- Agricultural sustainability in rural areas (see Common Agricultural Policy (CAP) and in connection to the Green Deal /sustainable food system, *Farm to Fork – fertilizers, ecological agriculture, food policies and overal goals until 2030*, biological diversity, carbon neutrality, zero pollution)
- Soil protection, new products and innovatice solutions (fuels)
- Precise agriculture (agriculture 4.0/digital agriculture)
- But: Agriculture is dependent on many factors such as subsidies, pesticides and is facing some important challenges (drought, ageing of workers, increase in costs, differences in financial systems, …)

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Forest bioeconomy (Czech Republic)

- *No bioeconomy strategy for the whole country*
- *Bioeconomy concept in the Czech Republic (MoA):*
  - *Sustainable management, climate change adaptation, increasing stability and vitality of forest ecosystems, utilization of wood products, rural development + employment*
- *Separate national-wide strategies*
  - *Strategic Framework Czech Republic 2030*
  - *Strategy of the Ministry of Environment of the Czech Republic with an outlook until 2030*
  - *Concept of the State Forestry Policy …*
- http://eagri.cz/public/web/mze/poradenstvi-a-vyzkum/vyzkum-a-vyvoj/koncepce-a-strategie/koncepce-biohospodarstvi-v-ceske.html

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Teaching at FFWS CZU/bioeconomy

- Lesnická bioekonomika *(Forest bioeconomy)* for bachelor students (Forestry, taught in Czech)
- Forest Bio-economy for Forestry (Foresty, English study programme, bachelor level)
- Perspectives to Forestry Bio-Economy/English study programme FWLM (master level)
- Bioekonomika v lesnicko-dřevařském sektoru *(Bioeconomy in the forest-wood sector)* (doctoral study programme Economics and Management in Forestry and Wood Procesing Industry)

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Forest bioeconomy team at FFWS CZU

Aim of the team:

- Research in bioeconomy related topics
- Awareness raising
- Integration of forest bioeconomy in education

Vedoucí Týmu pro lesní bioekonomiku

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https://www.fld.czu.cz/cs/r-16459-tym-pro-lesni-bioekonomiku-fld

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Aquaculture

- Biomass aquisition from the water environment for nutrition, feed and technical purposes
- The systems:
  - Open (mollusk)
  - Semi-opened (ponds, cage breeding)
  - Closed (bioalgae in bioreactors)
- IMTA – integrated multitropic aquaculture – integration of fish production, crustacean and mollusk production, sea algae; also waste substances are used in the production processes

	EMPLOYMENT (MILLION JOBS)	TURNOVER (BILLION EUR)	VALUE ADDED (BILLION EUR)
FISHING AND AQUACULTURE	0.2	12	7

European Commission's Knowledge Centre for Bioeconomy, based on based on Ronzon & M'Barek, 2018
https://doi.org/10.3390/su10061745

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The role of ecosystem services in bioeconomy

- The current issue – increasing interest nowadays, including payment schemes for ES
- Czechia (forest functions vs. forest services)
- The term used for the first time by Ehrlich and Ehrlich in 1981
- *„the processes of ecosystems that directly or indirectly support the mankind“*
- Relations between ecosystems, ecosystem services and human welfare evaluated as a comples in MEA (2005) – division of ES into 4 categories: provisioning, supporting (erosion, water retention), cultural, regulating (nutrients, biodiversity)
- ES services division: productive and non-productive
  - Forest functions – market (wood-production function, game management) and
  - non-market (with indirect impact to the market – NWFP, erosion, hydric etc.) and without timber-impact (health-hygienic, cultural-educational)

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Activities on bioeconomy in the Czech Republic

- Platform for Bioeconomy of the Czech Republic
  - https://bioeconomy.czu.cz/en
- Bioeconomy at the University of South Bohemia in České Budějovice
  - http://bei.jcu.cz/
- Circular bioeconomy/INCIEN
  - https://incien.org/
- BIOEAST HUB CZ
  - http://www.bio-hub.cz/index.php/en

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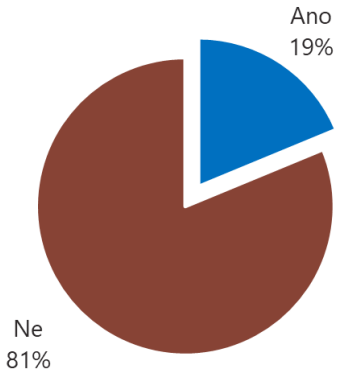
Research on bioeconomy/FFWS CZU

- Empowering the Central and Eastern European Countries to Develop Circular Bioeconomy Strategies and Action Plans (CEE2ACT) led by Geonardo Environmental Technologies
  - Bulgaria, Croatia, Czech Republic, Greece, Hungary, Poland, Romania, Serbia, Slovakia and Slovenia (2022 – 2025)
- Advanced Research Supporting the Forestry and Wood-processing Sector´s Adaptation to Global Change and the 4th Industrial Revolution (2017 – 2022)
  - SP 8: Models of decision support as a preparation to Global Change and Industry 4.0
    - SP8b/WP5 Bioeconomy and forestry

Have you heard about the term „bioeconomy“? NO – 81 %



Q24. Setkali jste se již s pojmem „bioekonomika“?
Všichni respondenti, N=1509 [údaje v %]

Source: survey conducted in autumn 2020 for EVA4.0 project, STEM/MARK agency

See: https://www.fld.czu.cz/en/r-9417-projects-and-partnerships/r-11062-projects

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Research on bioeconomy/FFWS CZU

Q25. Co podle Vás znamená pojem bioekonomika?
Ti, kteří vědí, co znamená bioekonomika, n=283 [údaje v %]

Source: survey conducted in autumn 2020 for EVA4.0 project, STEM/MARK agency

- Perception of bioeconomy among students in the Czech Republic and in the Slovak Republic
  - Conducted in 2020
  - 367 responses (forestry students/all levels)
  - Higher awareness of bioeconomy among students in Slovakia (82%)/FFWS CZU 54 %

Survey conducted in 2020 (printed questionnaires + online survey: LimeSurvey + Survio) based on the methodology by Masiero et al., 2020 – results were not yet published/the paper is under review (Navrátilová et al.)

Masiero, M., Secco, L., Pettenella, D. *et al.* Bioeconomy perception by future stakeholders: Hearing from European forestry students. *Ambio* **49**, 1925–1942 (2020). https://doi.org/10.1007/s13280-020-01376-y

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Research on forest bioeconomy

International Forestry Review Vol.**24**(4), 2022 1

Forest bioeconomy in three European countries: Finland, the Czech Republic and the Slovak Republic

P. PALÁTOVÁ[a,b], R.C. PURWESTRI[b] and L. MARCINEKOVÁ[c]

TABLE 2 *Outputs in Web of Science*

Number of references/term	Forest bioeconomy	Forestry bioeconomy	Forest-based bioeconomy
In total	1 046/804 articles	675/487 articles	185/139 articles
Finland	357 (16,06)	170 (7,65)	95 (4,27)
Czech Republic	29 (10,86)	32 (11,98)	5 (1,87)
Slovak Republic	35 (18,04)	41 (21,13)	21 (10,82)

Source: Web of Science database (retrieved on 1st October, 2022)

TABLE 3 *Outputs in Scopus*

Number of references/term	Forest bioeconomy	Forestry bioeconomy	Forest-based bioeconomy
In total	440/295 articles	377/256 articles	105/80 articles
Finland	130 (5,85)	90 (4,05)	45 (2,02)
Czech Republic	17 (6,36)	13 (4,86)	5 (1,87)
Slovak Republic	12 (6,18)	9 (4,63)	5 (2,58)

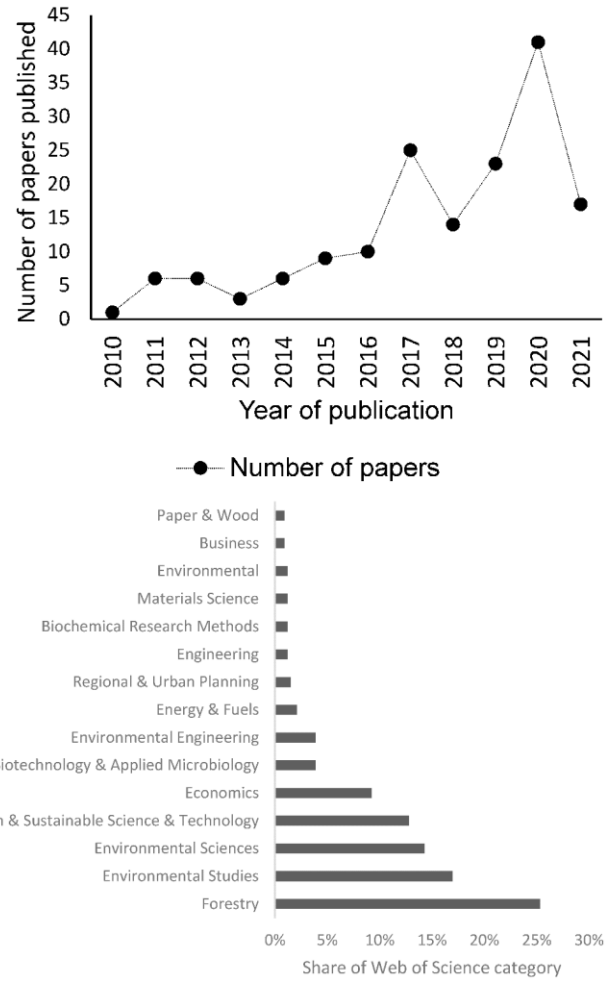
Source: Scopus database (retrieved on 1st October, 2022)

forests MDPI

Review

Innovations in Forest Bioeconomy: A Bibliometric Analysis

Martin Jankovský *, Sandra P. García-Jácome, Jiří Dvořák, Isaac Nyarko and Miroslav Hájek



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Research on forest bioeconomy/FFWS CZU

ELSEVIER

New Biotechnology
Volume 61, 25 March 2021, Pages 1-8

Review article

Current state and future directions of bioeconomy in the Czech Republic

Miroslav Hájek [a], Michaela Holecová [b], Helena Smolová [a], Ladislav Jeřábek [c], Ivo Frébort [b]

International Forestry Review Vol.24(4), 2022 1

Forest bioeconomy in three European countries: Finland, the Czech Republic and the Slovak Republic

P. PALÁTOVÁ[a], R.C. PURWESTRI[b] and L. MARCINEKOVÁ[c]

Open Access Article

Bioeconomy in the National Forest Strategy: A Comparison Study in Germany and the Czech Republic

by Ratna Chrismiari Purwestri, Miroslav Hájek *, Miroslava Šodková, Mathy Sane and Jan Kašpar

forests

MDPI

Review

Innovations in Forest Bioeconomy: A Bibliometric Analysis

Martin Jankovský *, Sandra P. García-Jácome, Jiří Dvořák, Isaac Nyarko and Miroslav Hájek

The role of Bioeconomy in the Czech national forest strategy: a comparison with Sweden
pp. 492-510(19)
Authors: *Purwestri, R.C.; Hájek, M.; Hochmalová, M.; Palátová, P.; Huertas-Bernal, D.C.; García-Jácome, S.P.; Jarský, V.; Kašpar, J.; Riedl, M.; Marušák, R.*

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Innovations in bioeconomy

- Canada (https://www.ccfm.org/climate-conscious/canadas-bioeconomy-transformation-innovation-in-mitigating-climate-change/)
  - Clothes made from rayon (artificial silk) . originally made from pulp
  - Cellulose from trees on mobile screens
  - Aircraft and ship insulation and wood panels made from lignin – products similar to carbon foam
  - Bioplastics used in 3D printers from biomass remaining after resin extraction …
- Finland (*https://finland.fi/business-innovation/forests-support-innovative-bioeconomy/*
  - Microfibrils from cellulose/wood pulp used in paper, hardboard, furniture, cars, …

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Innovation in bioeconomy – mills in Finland (GPE)

- Äänekoski – job creation, independence on fossil fuels, significant investment…
  - „bioproduct mill“ (https://www.metsagroup.com/metsafibre/about-metsafibre/pulp-production/aanekoski-bioproduct-mill/)
  - Visitors´centre (https://www.metsagroup.com/metsa-group/experience-metsa/pro-nemus/)
- Kemi
  - (https://www.metsafibre.com/en/about-us/Production-units/Bioproduct-mill/Pages/default.aspx)

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FRAME

Systems approach to economy

www.frameerasmus.eu

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Systems approach to the economy

- An alternative to the traditional, rigid, and unjust sectoral view
- The economy is viewed as a system with multiple components that affect each other.
- By observing these interactions, and their effects on the system output, we can achieve an optimal state of the system

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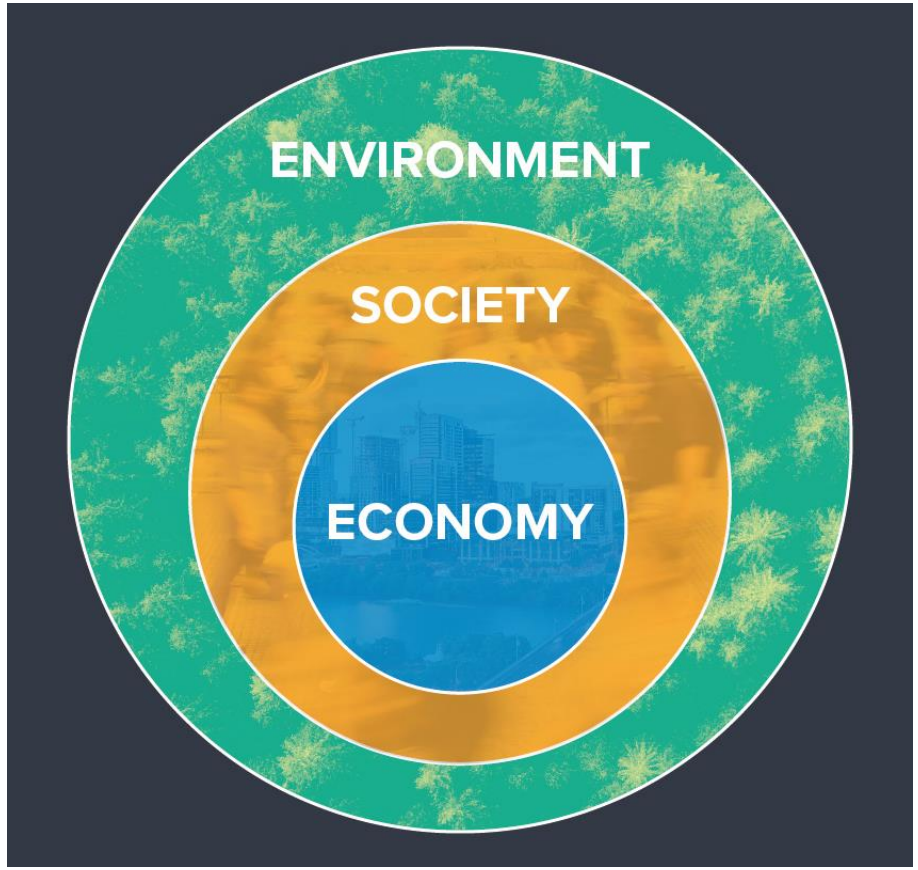
Key characteristics of a system

- Environment
- Boundaries
- Homeostasis
- Throughput
- Feedback loops
- Equifinality



Bioeconomy is then a subsystem.
A cluster, where harvested bioresources are connected to their processing and consumption in value chains, which are not tied to particular sectors

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What is a Forest Value Chain?

- If a **value chain** is "a sequence of business activities performed to deliver a valuable product to a given market"[1]
  - Then
- A **Forest value chain** is the above, when you use forest resources to deliver the product to a market

https://resonateforest.org/wp-content/uploads/2022/09/Shareble-PDF.pdf

1. Porter, M.E. (1985). Competitive advantage: creating and sustaining superior performance. Boston, MA: Free press, p. 557.

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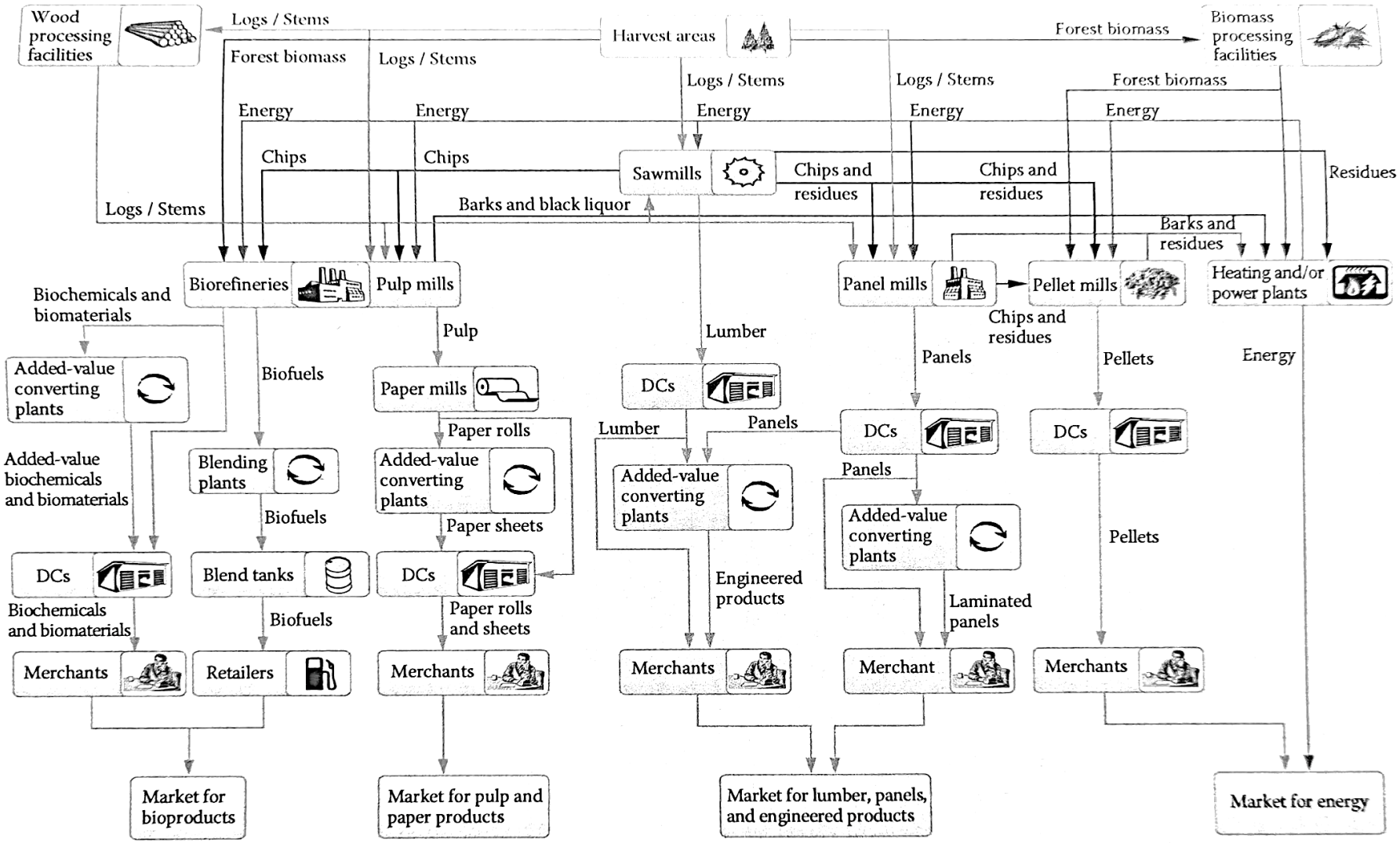
Timber-based Forest value chains



2. D'Amours et al. (2017). Forest value chain optimization and sustainability. Boca Raton, FL: CRC Press, p. 343

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NTFPs and their value chains

Products	HS6 Code	Level of processing	Part of wild harvest	World	From EU28	To EU28	EU28 balance	World-EU28		Top three world traders in value	
				2011	2011	2011		Exp. %	Imp. %	Exporters	Importers
Honey	040900	Raw	Yes	1370	443						
Mosses	060410	Raw	Yes	42	24						
Fresh foliage	060491	Mix	Yes	870	524						
Dry foliage	060499	Mix	Yes	264	122						
Fresh & frozen Agaricus	070951	Raw	No	936	792						
Fresh & frozen truffles	070952	Raw	Yes	1	0						
Fresh & frozen mushrooms	070959	Raw	Yes	565	297						
Preserved Agaricus	071151	Processed	No	72	23						
Preserved mushrooms	071159	Processed	Yes	85	12						
Dried Agaricus	071231	Raw	No	83	30						
Dried Auricularia	071232	Raw	Yes	141	3						
Dried Tremella	071233	Raw	Yes	39	1						
Other dried mushrooms	071239	Raw	Yes	985	51						
Prepared Agaricus	200310	Processed	No	848	411						
Prepared truffles	200320	Processed	Yes	21	17						
Prepared mushrooms	200390	Processed	Yes	164	60						
Almonds	080211	Raw	No	750	26						
Shelled almonds	080212	Processed	No	2422	483						
Hazelnuts	080221	Raw	No	130	18						
Shelled hazelnuts	080222	Processed	No	1281	213						
Walnuts	080231	Raw	No	710	118						
Shelled walnuts	080232	Processed	No	1111	157						
Chestnuts	080240	Mix	Yes	215	110	87	22	51	41	IT, CH, KR	JP, FR, IT
Pistachios	080250	Mix	No	2166	376	925	-549	17	43	-	-
Fresh strawberries	081010	Raw	No	1854	1153	1102	51	62	59	-	-
Fresh raspberries, blackberries, mulberries and loganberries	081020	Raw	No	843	295	318	-23	35	38	-	-
Fresh currants, gooseberries	081030	Raw	No	0	0	0	-	-	-	-	-
Fresh cranberries, bilberries and other fruits of the genus Vaccinium	081040	Raw	Yes	1026	248	351	-103	24	34	CL, US, CN	US, CN, GB
Fresh other fruitsand nuts	081090	Raw	No	2119	513	657	-144	24	31	-	-
Frozen strawberries	081110	Raw	No	784	344	507	-163	44	65	-	-
Frozen raspberries, blackberries, mulberries and loganberries	081120	Raw	No	684	299	499	-200	44	73	-	-
Frozen fruits and nuts	081190	Raw	Yes	1819	742	1067	-324	41	59	-	-
Quebracho tannins	320110	Raw	Yes	61	5	23	-18	8	37	AR, BR, ZA	IN, IT, CH
Wattle tannins	320120	Raw	Yes	94	3	17	-14	3	18		
Other vegetable tannins	320190	Mix	Yes	140	66	41	25	47	29	-	-
Natural Cork	450110	Raw	Yes	106	101	95	6	95	90	-	-
Cork in pieces	450190	Processed	Yes	67	57	50	7	85	74	-	-
Cork squared	450200	Processed	Yes	52	45	30	15	88	58	-	-
Cork Stopper	450310	Processed	Yes	534	507	292	215	95	55	PT, ES, FR	FR, US, ES
Total overview				25448	8687	12398	-3710	34	49		

3. Wolfslehner, B., Prokofieva, I. and Mavsar, R. (editors). 2019. Non-wood forest products in Europe: Seeing the forest around the trees. What Science Can Tell Us 10. European Forest Institute.

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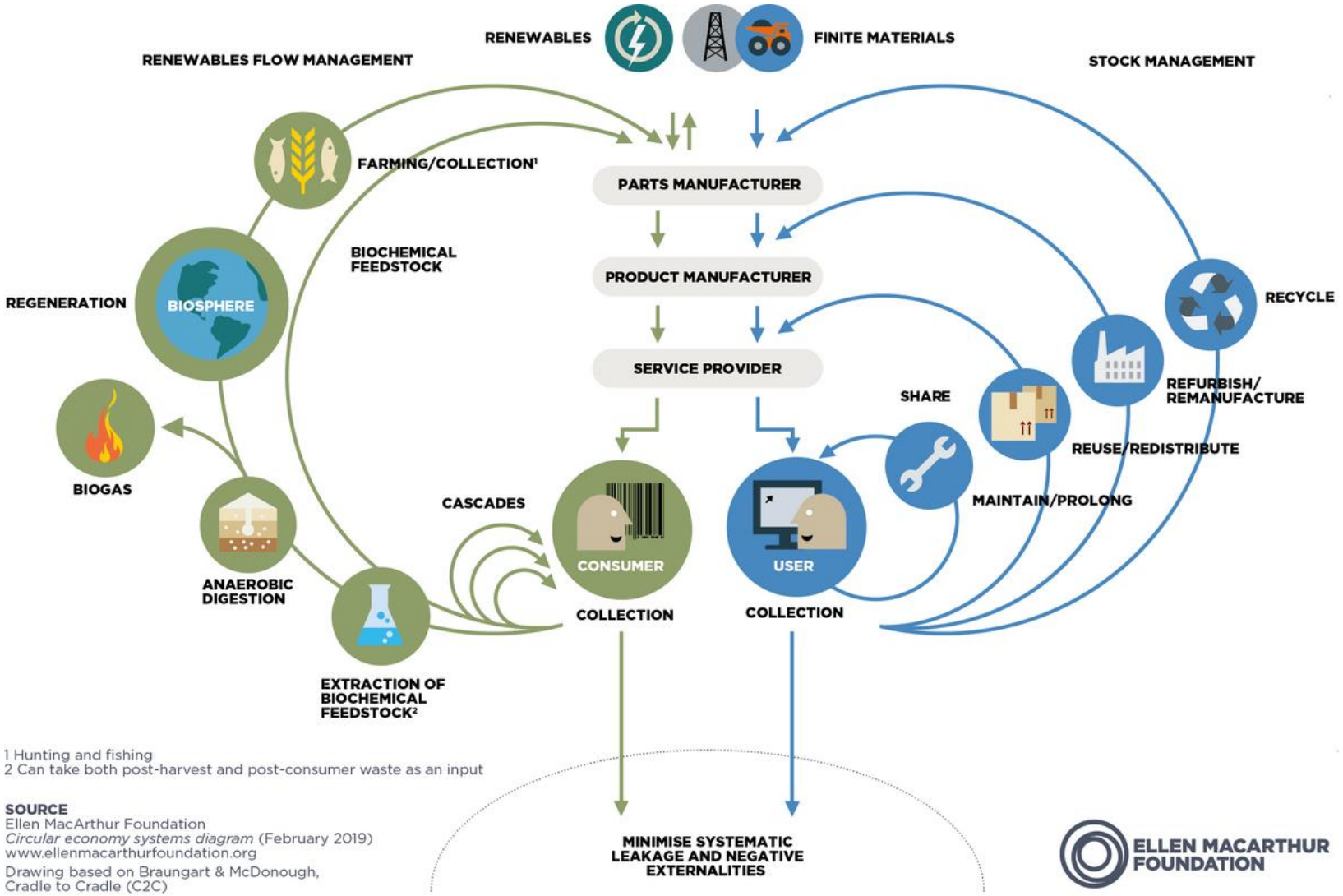
Forest value chains – adding in the circularity



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Forest value chains

- The bioeconomy is fairly complex
- Efficiency of delivering stuff to markets difficult to observe
  - Production processes have too many elements that can interplay
- Need to observe the efficiency and optimize it to minimize negative externalities

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Forest value chains

- Observing and optimizing the processes can be done by changing perspective from traditional analytical methods to systems thinking
- The value chain approach is a demonstration of such a change in perspective
- Value chain approach forces companies to focus on the whole process, rather than the part they control
- By providing information on the whole process, it offers the industry a chance to manage and lower the resistance to change [innovation]

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Forest value chains

So… what the heck are Forest Value Chains?

Forest value chains are a representation of the forest bioeconomy system. They improve our understanding of how products are produced, and services provided, help uncover the inefficiencies in material, energy, and labor use, thus enabling us to achieve the SDGs through innovation.

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How are value chains set up?

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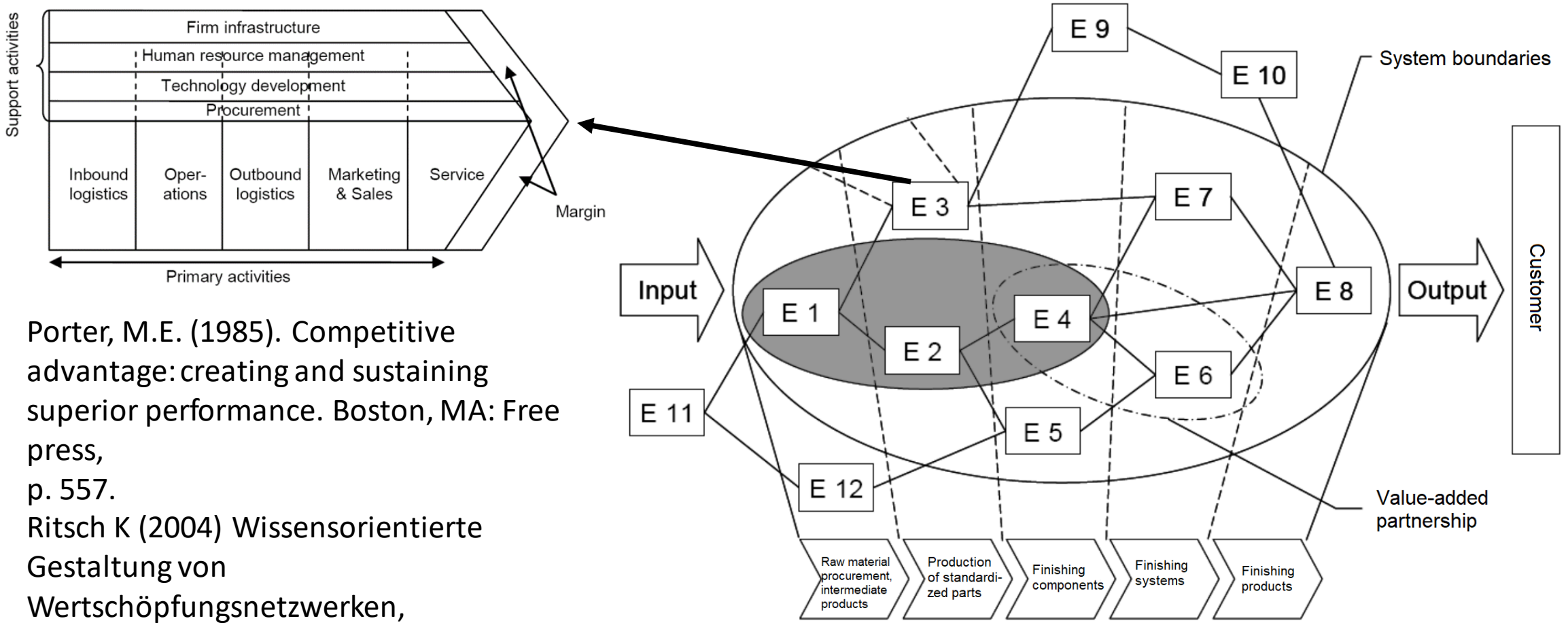
Generic value chain schematic



Porter, M.E. (1985). Competitive advantage: creating and sustaining superior performance. Boston, MA: Free press,
p. 557.
Ritsch K (2004) Wissensorientierte Gestaltung von Wertschöpfungsnetzwerken, Dissertation, Technische Universität Graz

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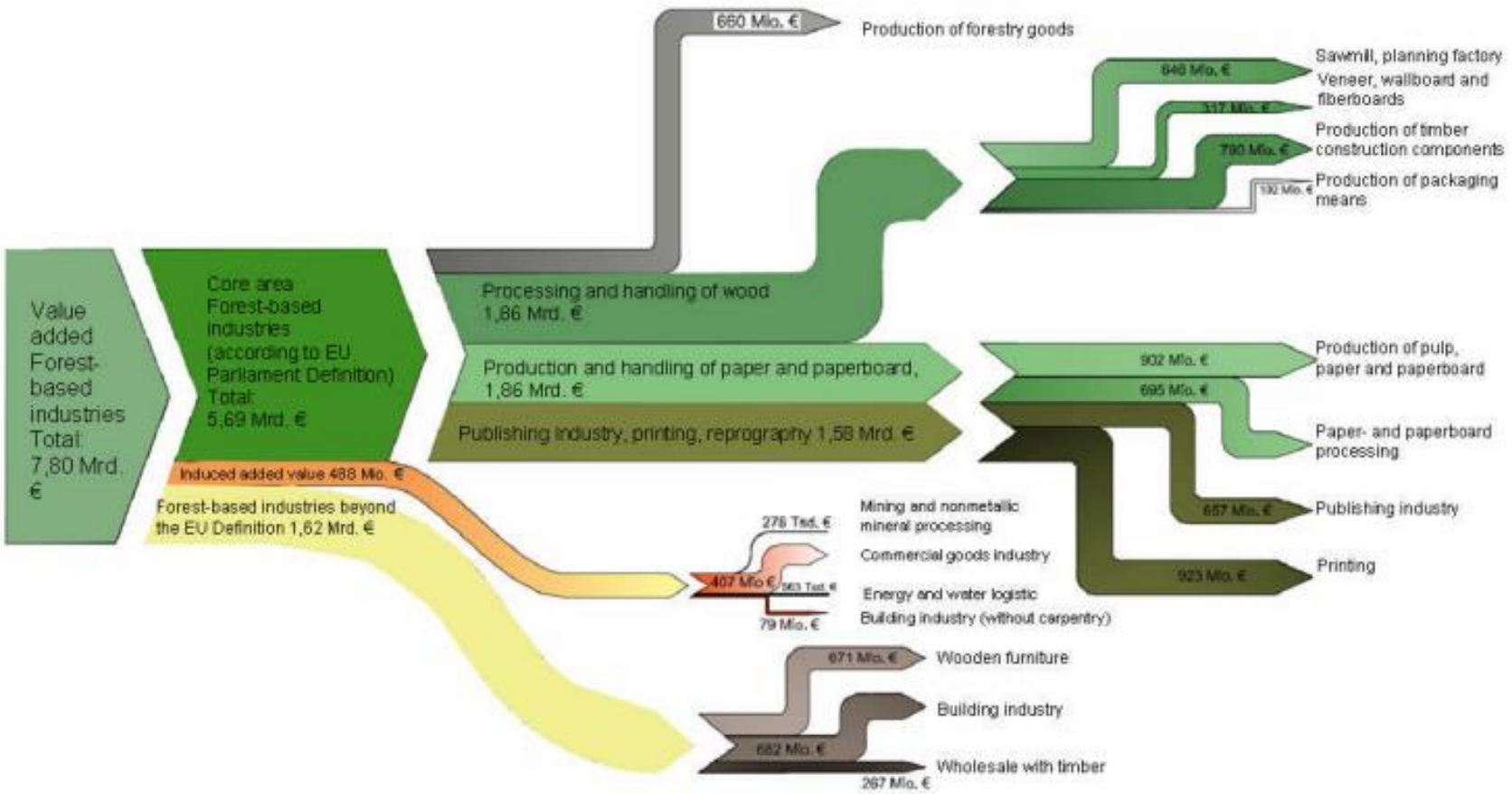
Aggregated forest value chain in Austria



Green streams: account for the EU-statistics for the forest-based sector
Orange stream: induced value added in downstream branches
Yellow/grey streams: furniture, wholesale trade and wood-related construction sector which is accounted for the forest-based sector in Austria but not in the EU-statistics

Teischinger, A. (2009). The forest-based sector value chain – a tentative survey. Lenzinger Berichte 87:1-10.

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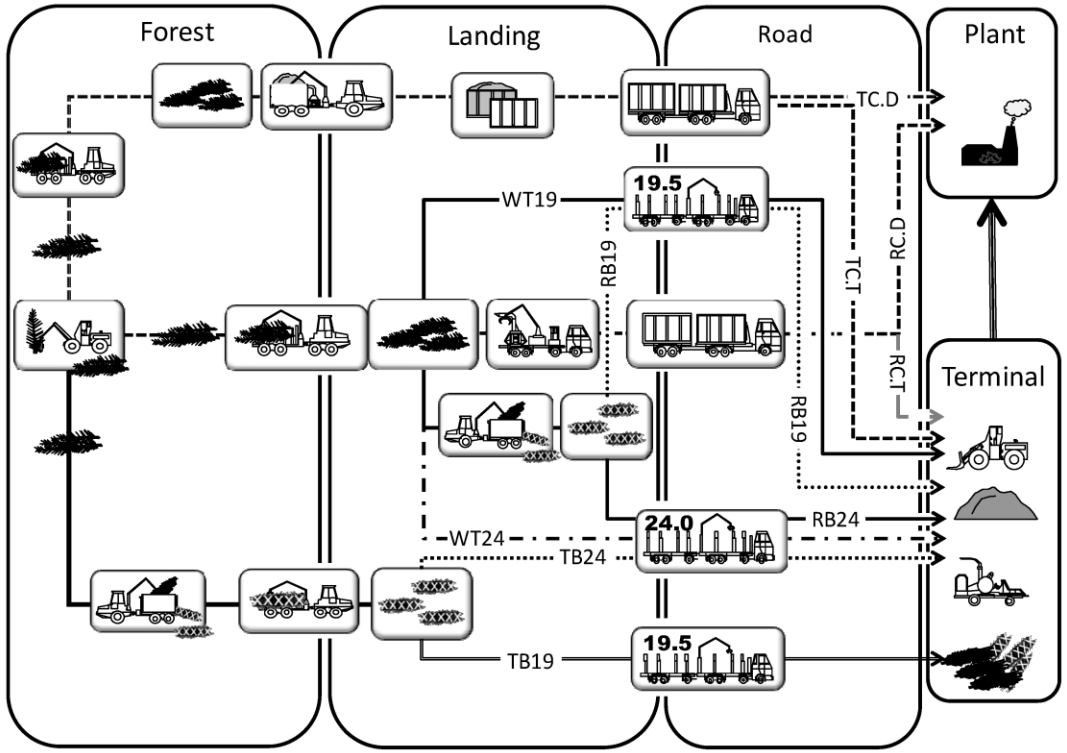
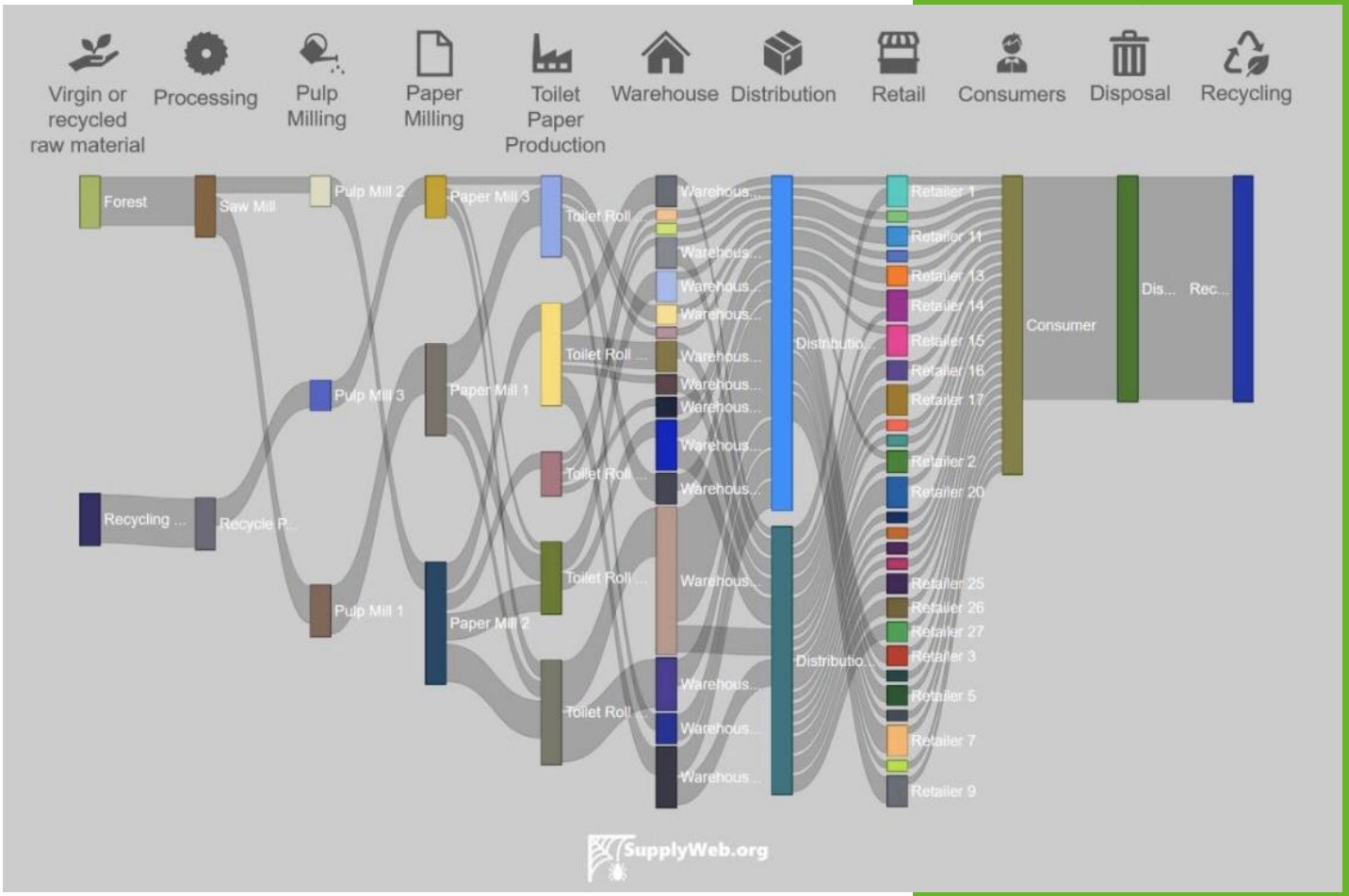
FRAME

Paper supply chain – value added partnerships





Belbo, H., Talbot, B. (2014). Systems analysis of ten supply chains for whole tree chips. Forests 5(9): 2084-2105.;
https://supplychaingamechanger.com/the-toilet-paper-supply-chain/

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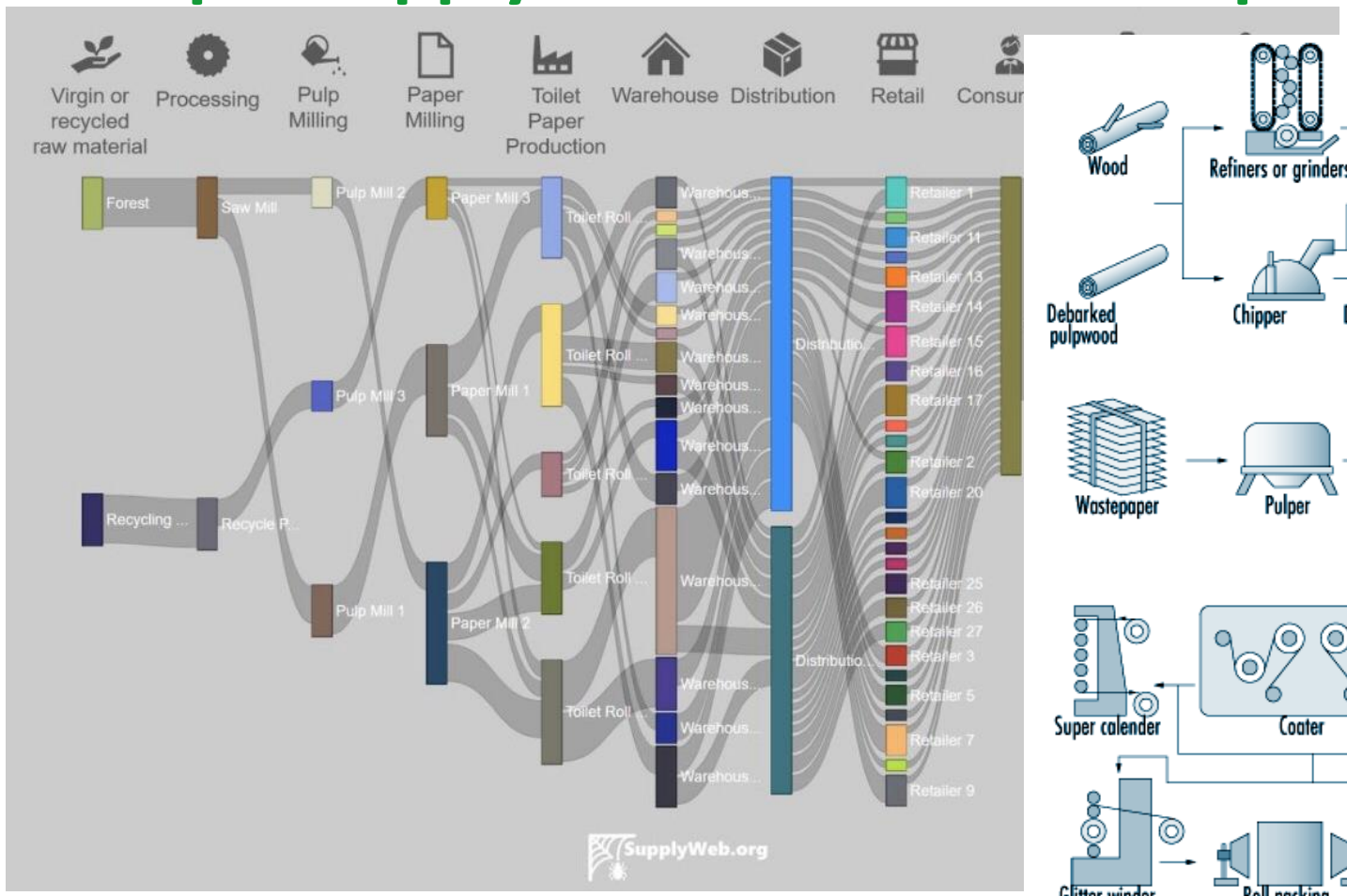
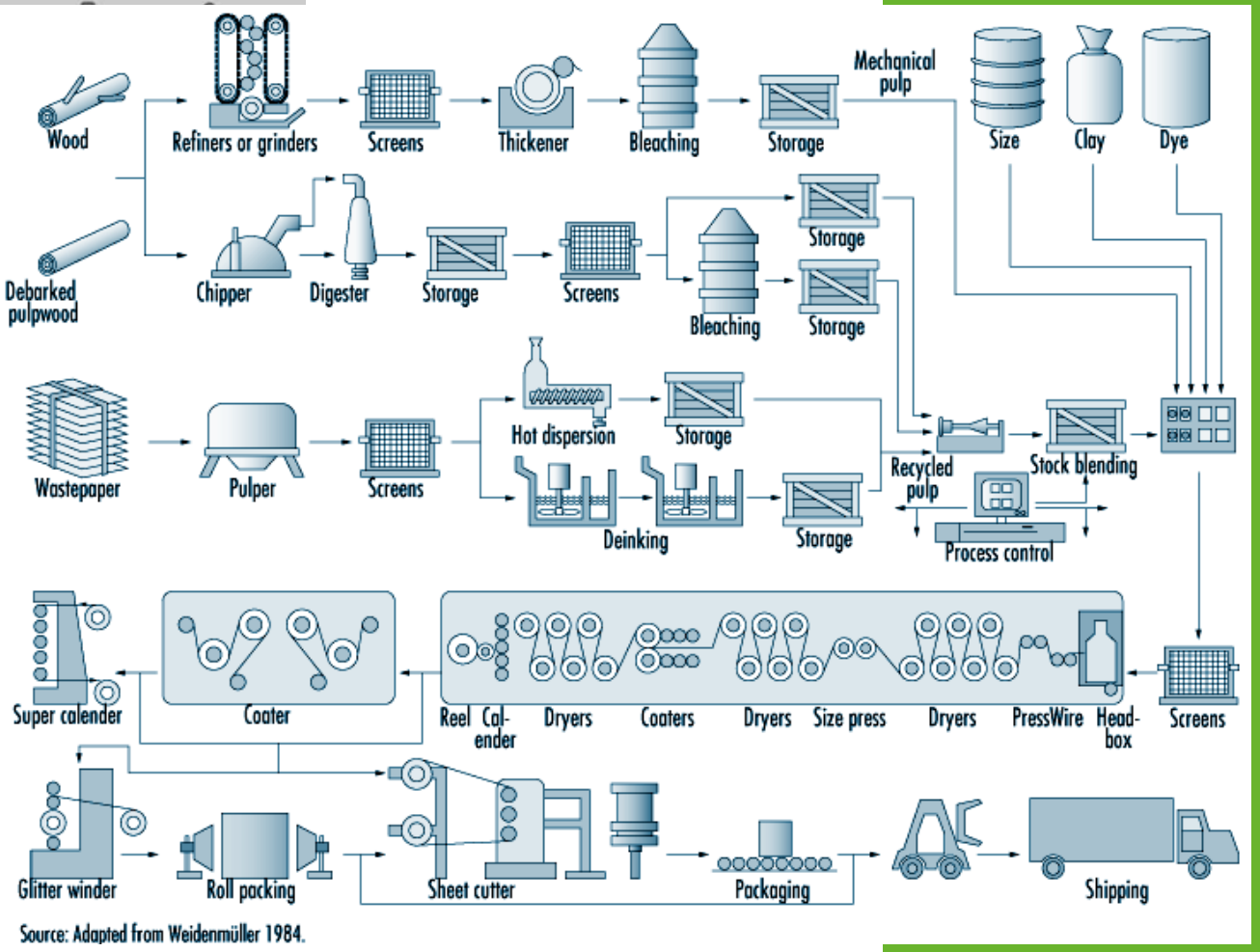
Paper supply chain – value added partnerships





Belbo, H., Talbot, B. (2014). Systems analysis of ten supply chains for whole tree chips. Forests 5(9): 2084-2105.;
https://supplychaingamechanger.com/the-toilet-paper-supply-chain/

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What does value stand for in forest value chains?

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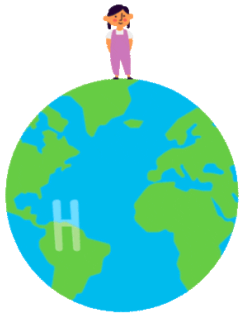
The value in forest value chains

- FVCs vs. SCs
- Value primarily understood in economic terms
- In reality, value, like beauty, is in the eyes of the beholders
  - It means that something is worthy, important, or useful for the user

or / and



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Understanding the value in value chains

- Value means different things to different people (stakeholders)
  - Government
  - Local stakeholders
  - General public
  - Industry
- Even a small improvement in efficiency will result in large overall gains
- The goal is to maximize the value over the whole value chain, rather than maximizing it for its constituent parts via... optimization

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Challenges of forest value chain optimization

- Different meaning of value to different people
- Ownership structure – public forests vs. private industries
- Ecosystem structure
- Planning complexity – need to consider climatic, seasonal, weather, and other factors in initial links of the chain
- In forest value chains: unclear system boundaries

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So… How DO we optimize the timber-based forest value chains?

- Depends on the value chain setup; forest value chains can be:
  - Demand (buyer) driven
  - Supply (producer) driven (there is a key actor within the chain)
- Depends on what we want to achieve
  - Improve quality
  - Improve system efficiency
  - Develop differentiated products
- Depends on the amount and quality of information we have
- Depends on the ability to cluster (create value-added partnerships)

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Timber-based forest value chain optimization

- Need to upscale management practices
  - Focus planning and other activities on the network rather than on single companies
- Equilibrium models – decentralized perspective, yet a more holistic approach to value chain
- Centralize value chain planning – coordinate decisions to reach a common objective
  - Lead agent should not dominate, the actors need to develop goals that foster cooperation

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Planning for timber-based value chains

- Two levels of strategic planning
  - Top level – government and companies develop policies and industry-wide strategies
  - Medium-term strategic planning – company level business models, strategies, capacities
- Tactical planning
  - Resource allocation decisions, optimize performance of the companies
  - Sales, workforce, contractors, harvesting, product flows
- Operational planning
  - Carrying out tactical plans on a short-term basis
  - Order fulfillment, product allocation, distribution, scheduling, harvesting control
- Feedback loops between lower-level and higher-level planning are vital

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Scenarios

- Preparing the actors to a variety of plausible futures
- Myriads of scenarios can be thought of, need to make their number manageable, e.g.:
  - Large-scale changing demand patterns
  - Constraints on resource availability
  - Technological advances
  - Policy changes
  - Climate change impacts
  - Large-scale disturbances

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Collaborative planning

- Especially for complex value chains with multiple actors, planning should be coordinate and collaborative
- Leads to better alignment of logistical streams considering seasonality of works
- Allows for better, more agile logistics and production capacities that absorb market disturbances

Decentralized control

- A certain level of centralization is necessary
- Everybody needs to control if everything is up to snuff
- Shadow prices can be used
- Mathematical programming based on game theory concepts can be used too
  - Deciding on the optimal compromise for value chain actors
  - Providing info on cost/savings sharing among value chain actors
- Much research is needed still

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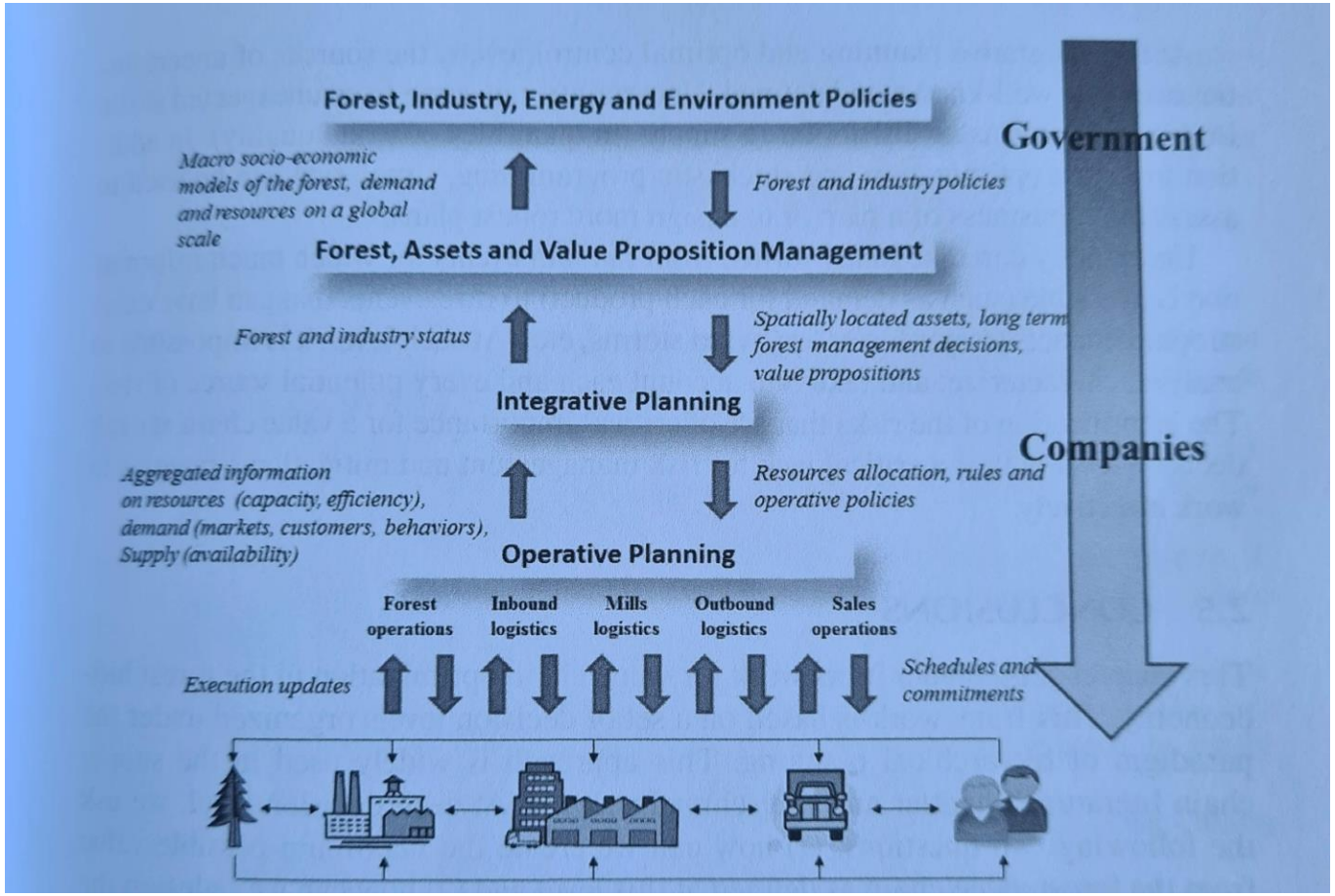
Knowledge and information sharing



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Summary of the section

- Forest value chains are a sequence of business activities performed to deliver a valuable product to a given market using forest-based bioresources
- The challenges for the uptake on the concept are
  - Unclear system boundaries
  - Planning complexity
  - Presence of numerous and diverse stakeholders
  - Sharing the pie instead of eating it all by yourself
- On the other hand, the value chain approach offers
  - Improved efficiency of the whole system
  - Improved quality
  - Improved ability to produce differentiated products
  - Improved information exchange and the ability to tackle large-scale problems

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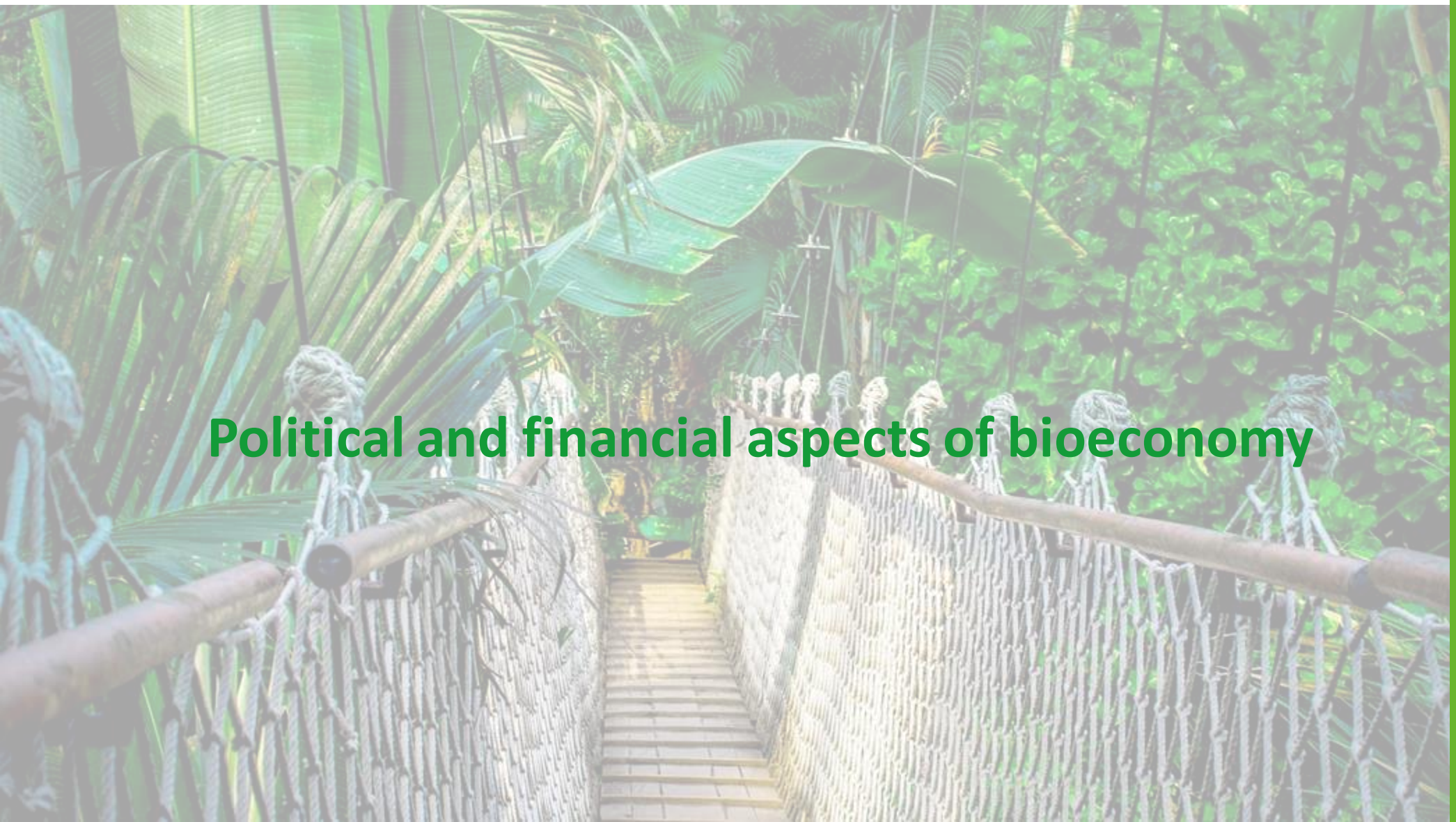

Political and financial aspects of bioeconomy

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Real impact of BE – state of implementation

- How to include BE ideas into policy?
- What step countries should do?
    1. Idea to adopt
    2. Responsibility
    3. Idea – Action
    4. Strategic Documents
    5. Action Plan on different levels

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Real impact of BE – state of implementation

- Different stage of implementation in different countries
- By 30. 4. 2022 a total of 12 EU countries have adopted their own BE policy strategy
  - Finland – 2014
  - Italy – 2019
  - Germany – 2020
  - Czech Republic – X
  - Slovakia - X
- Situation outside Europe

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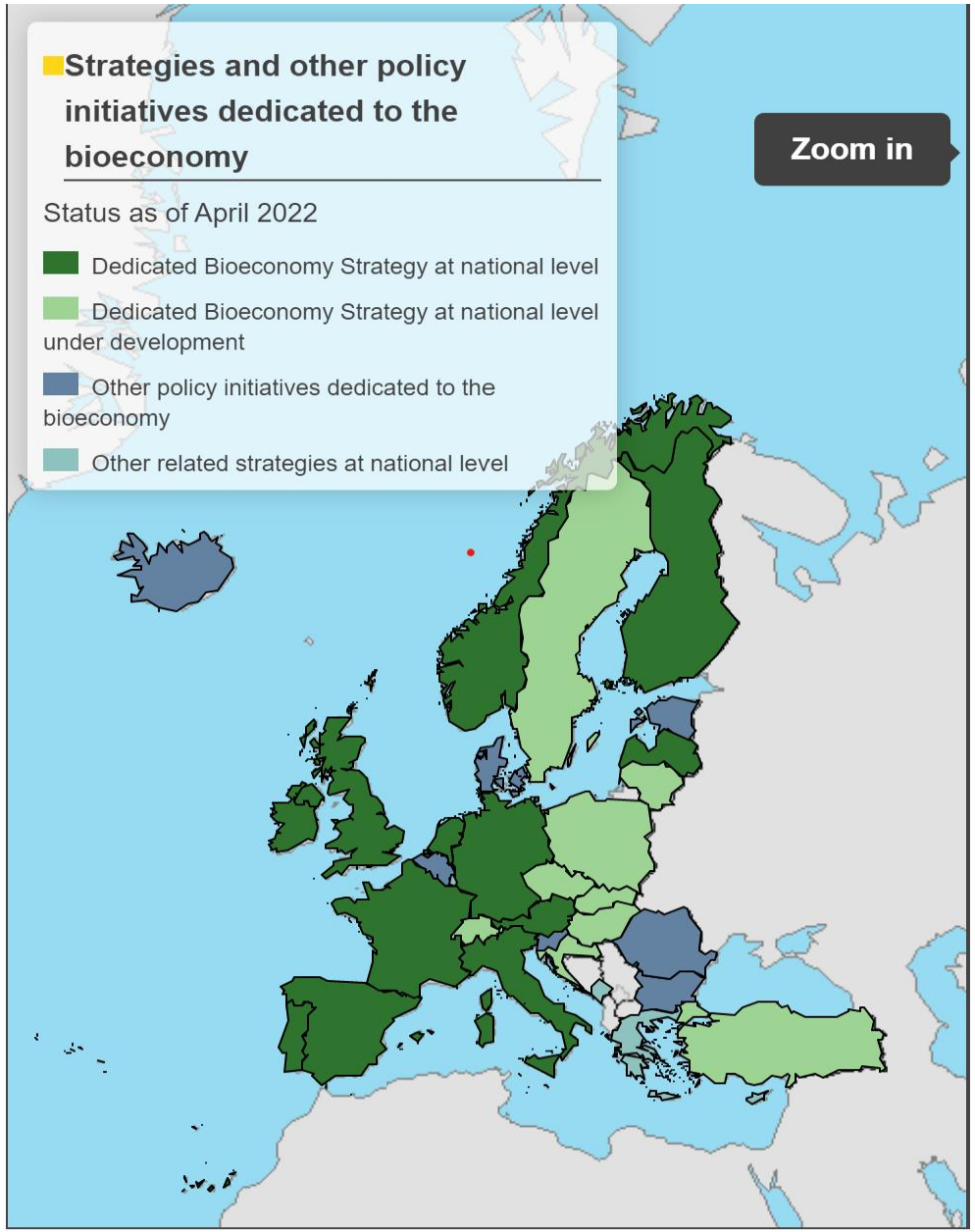

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Real impact of BE – state of implementation

- Example of strategic and other documents of selected states:
  - Italy: BIT II – Bioeconomy in Italy (BIT II, 2019);
  - Finland: Finnish Bioeconomy Strategy for 2022–2035 (MoEAaE, 2022);
  - Germany: National Bioeconomy Strategy (TFG, 2020);

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Real impact of BE – state of implementation

- Example of strategic and other documents of selected states:
  - Czechia:
    - The concept of bioeconomy in Czechia from the perspective of the MoA for 2019–2024 (2019);
    - Strategic framework of the circular economy of Czechia 2040 (DS, 2021);
    - The concept of state forest policy until 2035 (eAgri, 2020);
    - The concept of the MoA to the economic policy of Forests of Czechia (Lesy ČR), State Enterprise (DS, 2015).

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Real impact of BE – state of implementation

- Example of strategic and other documents of selected states:
  - Slovakia:
    - Low-carbon development strategy of the Slovakia until 2030 with an outlook to 2050 (Enviroportál, 2019);
    - Draft of integrated national energy and climate plan for 2021–2030 (ÚVSR, 2019);
    - Bioeconomy case study The wood biomass sustainability criteria in Slovakia (ENfRD, 2020);
    - Strategy for Bioeconomy in Slovakia – The contribution of the Slovak bioeconomy to the strategic plan SPP 2021–2027 report (MoAaRD, 2020).

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EU position

- “The bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services” (EU, 2018)

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EU position

- 2012 – 1st Strategy
- 2018 – 2nd Strategy + Action Plan
- Horizont Projects

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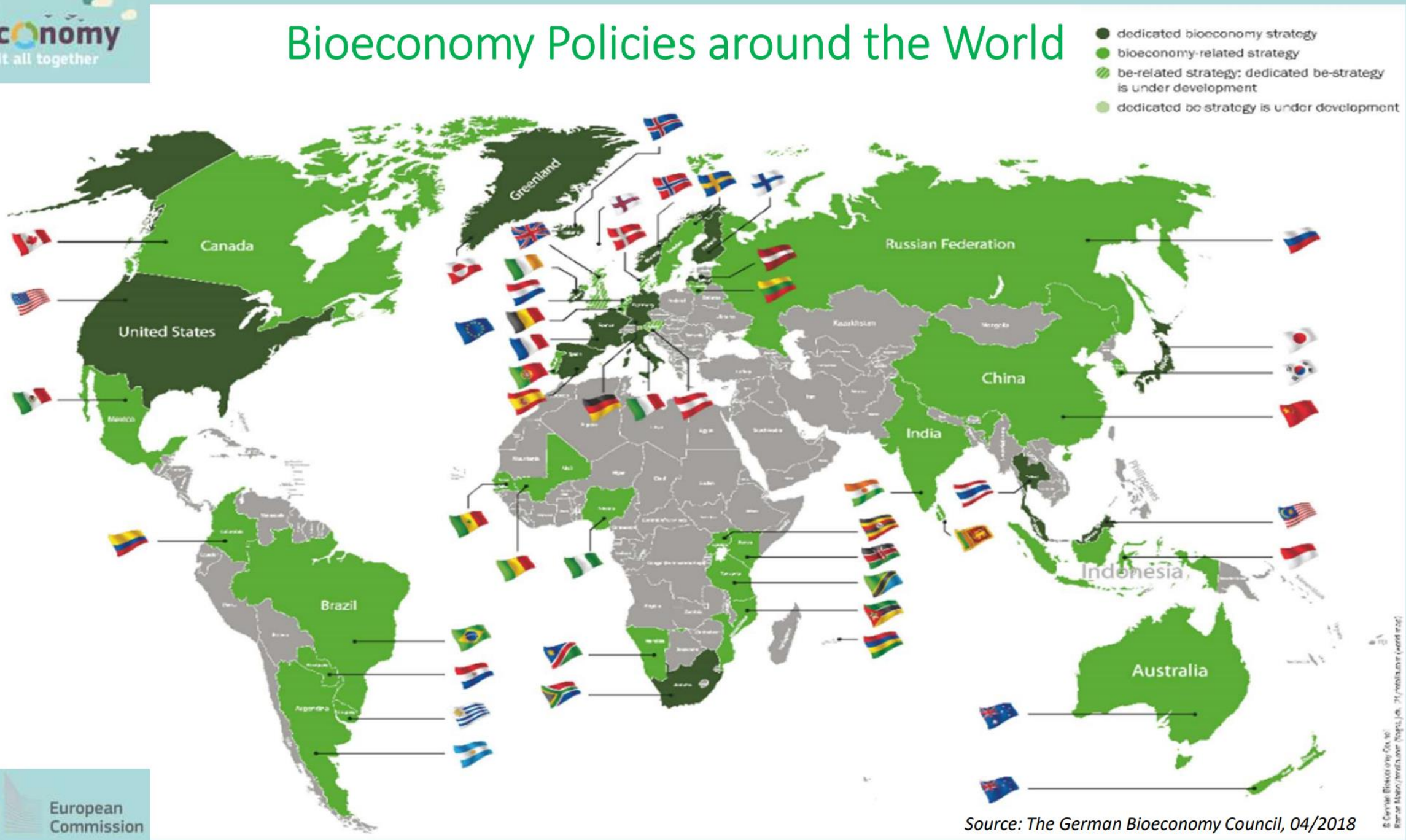
Position outside EU

- USA
- Latin America
- Asia
- Africa
- Australia

Europe's bioeconomy
weaving it all together

Bioeconomy Policies around the World



Source: The German Bioeconomy Council, 04/2018

European Commission

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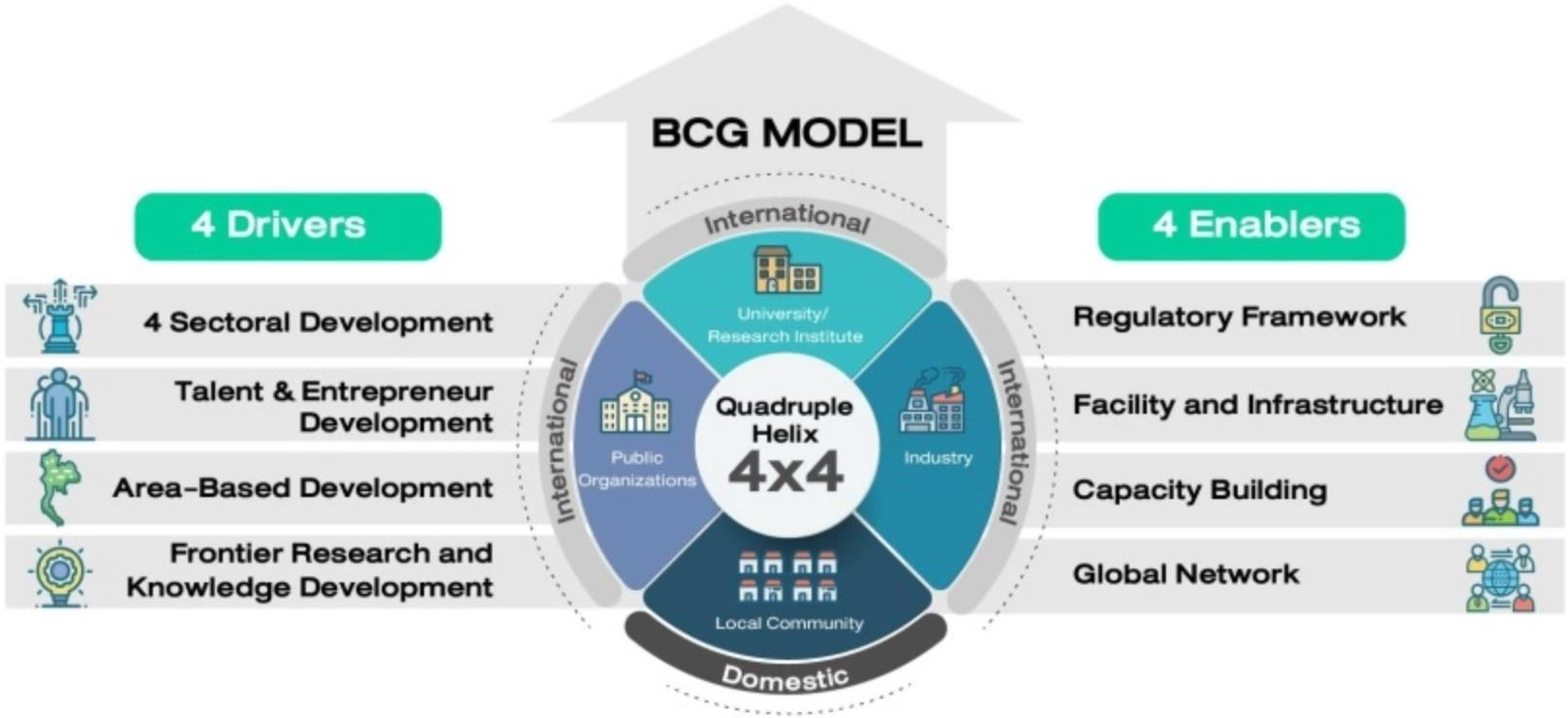

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Regional Bieoconomy

- Different Regional Bioeconomy priorities

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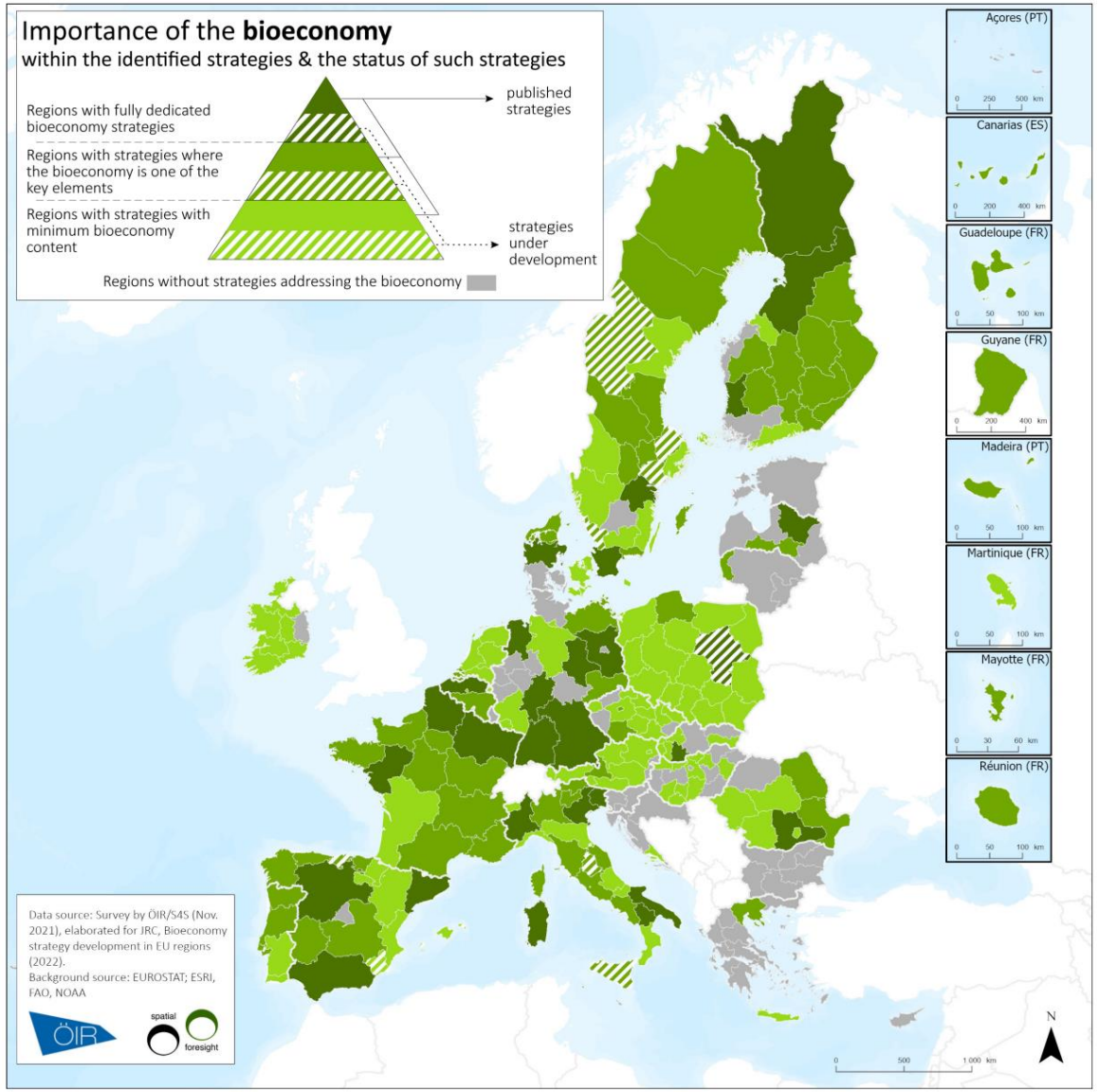
EU regions with bioeconomy strategies



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Map 2 EU regions with fully dedicated bioeconomy strategies (published/under development)

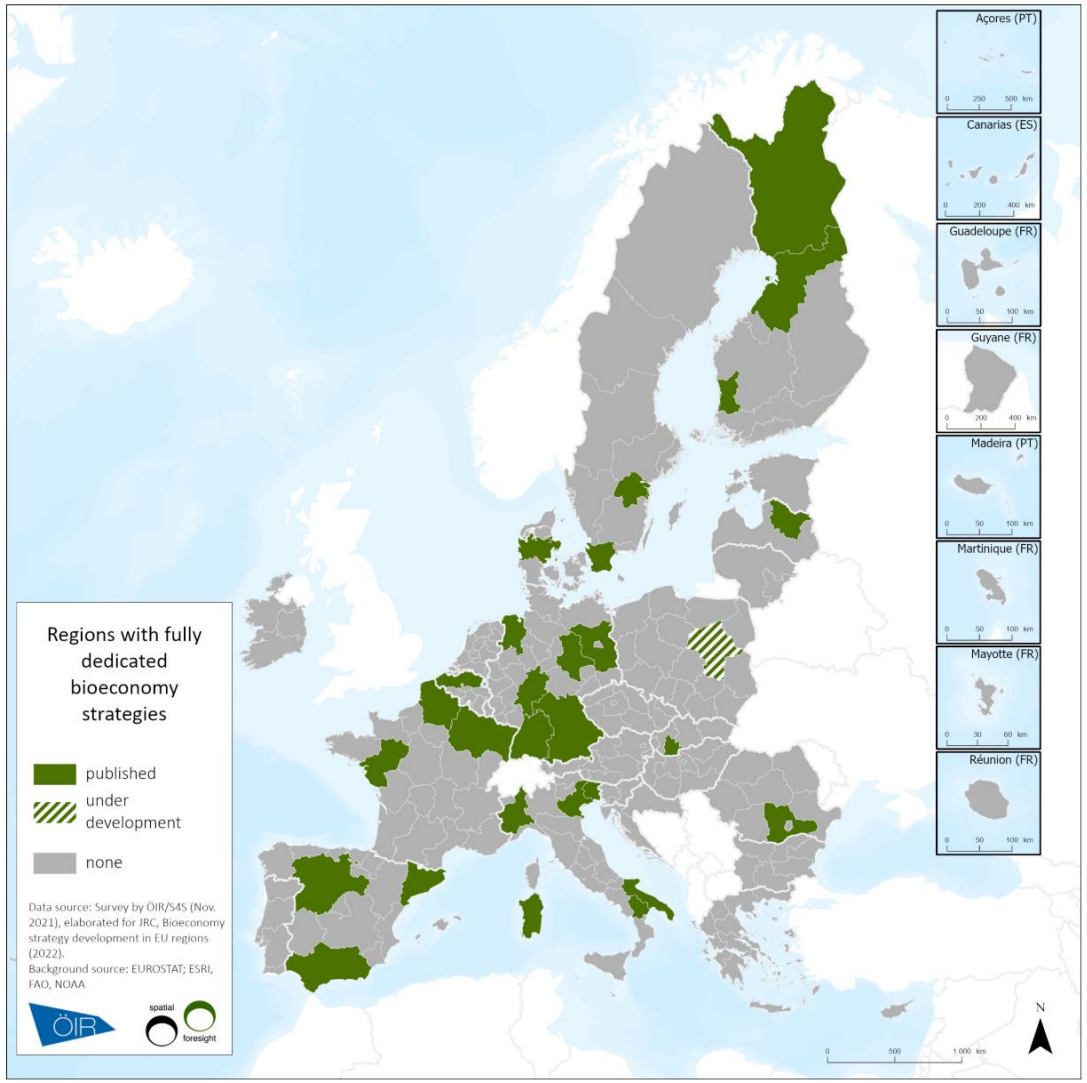

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Figure 4 Bioeconomy covered in sectoral strategies (no. of strategies per sector)

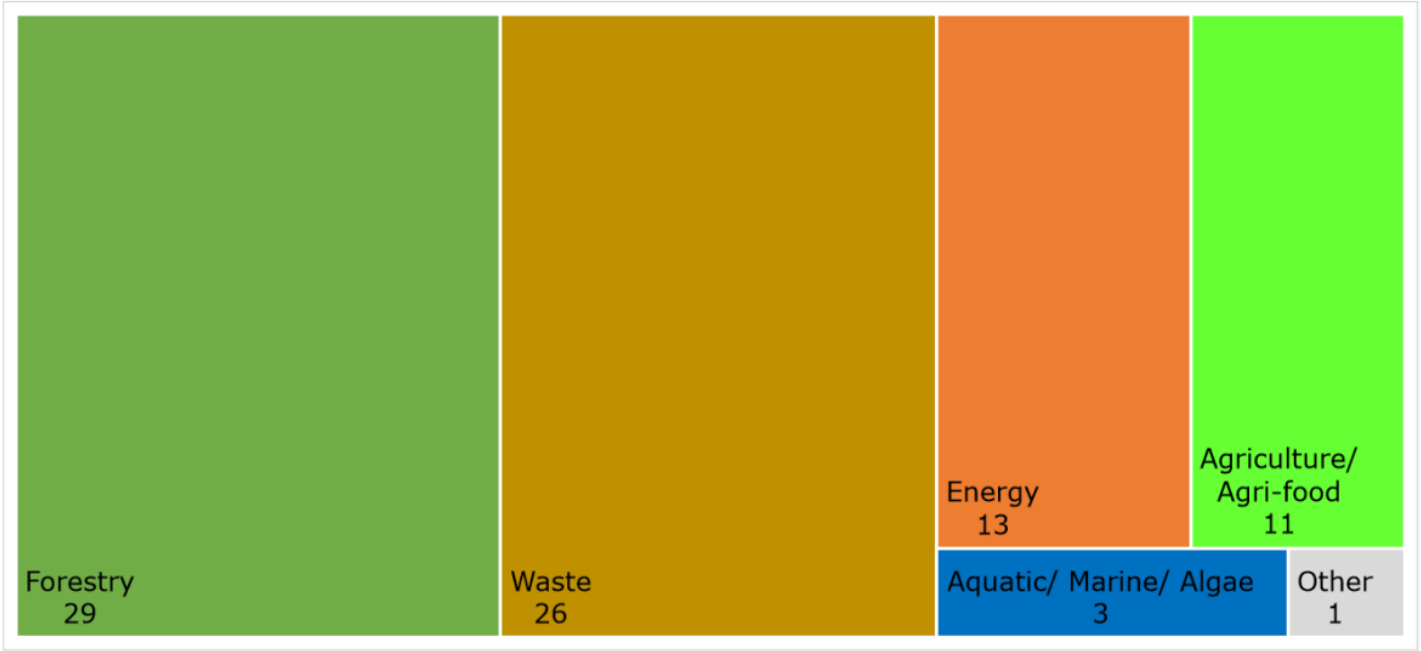

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*Figure 5 Bioeconomy embedded in wider strategies (no. of strategies per theme) (*RRP = Recovery and Resilience Plan)*

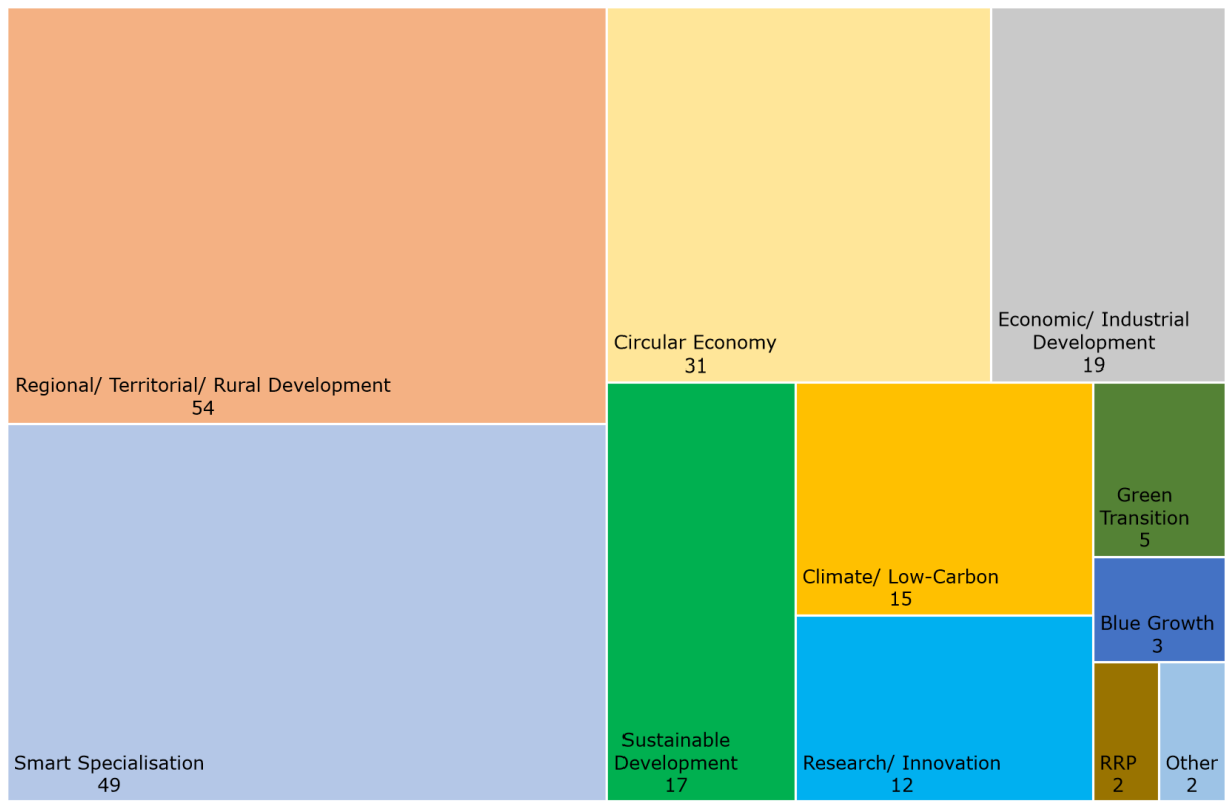

Figure 6 EU Bioeconomy strategy objectives in regional strategies (% of strategies)

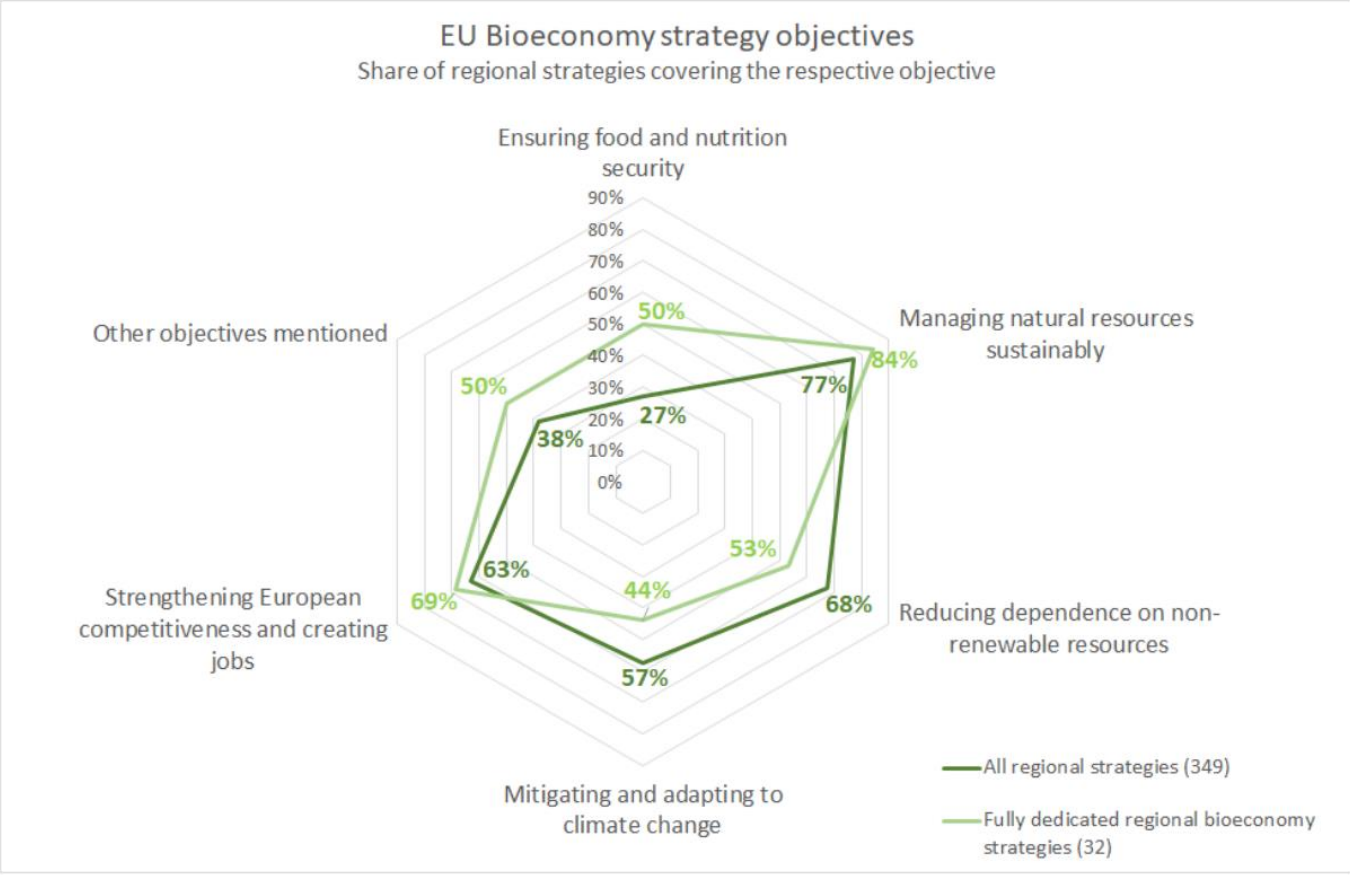

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Table 5 Groups of countries and strategies presented in chapter 5

Section 5.1 Countries with no bioeconomy-relevant regional strategies	Section 5.2 Countries with moderate regional strategic action to deploy bioeconomy	Section 5.3 Countries with intense regional strategic action to deploy bioeconomy	Section 5.4 Other
Bulgaria Cyprus Estonia Luxembourg Malta Slovenia	Austria Belgium Czechia Germany Denmark Greece Croatia Hungary Ireland Lithuania Latvia The Netherlands Portugal Romania Slovakia	Spain Finland France Italy Poland Sweden	Macroregional, cross-border and interregional bioeconomy-relevant strategies

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Identification of driving factors - barriers

- Transportation / logistics costs and management
- Limitations on infrastructure and storage capabilities
- Lack of knowledge on valorization pathways
- Lack of financial resources
- Overregulation or inadequate regulation
- Lack of demand
- Cultural unfitness
- Seasonality of feedstock
- (partial) lack of governmental support

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Identification of driving factors - challenges

- Scaling-up (only prototypes)
- Need of investment
- Finding market demand for bio-based market
- Lack of public / consumer awarness
- Price competitivness
- Lack of adequate technology
- Lack of regulation and policies to promote bio product design

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Identification of driving factors - drivers

- Competitive advantage
- Establishment of collaborations and networks
- Establishment of public policies / govern. support
- Products with potentially lower environmental impacts
- New business models
- Designing our waste
- More efficient resource use
- Technological advancement

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Identification of driving factors - opportunities

- Valorization of bioresources
- Waste recovery
- Turning waste into bioproducts
- Bioenergy production
- Value recovery
- Exploring the local economy
- Lower production costs when using bioresources

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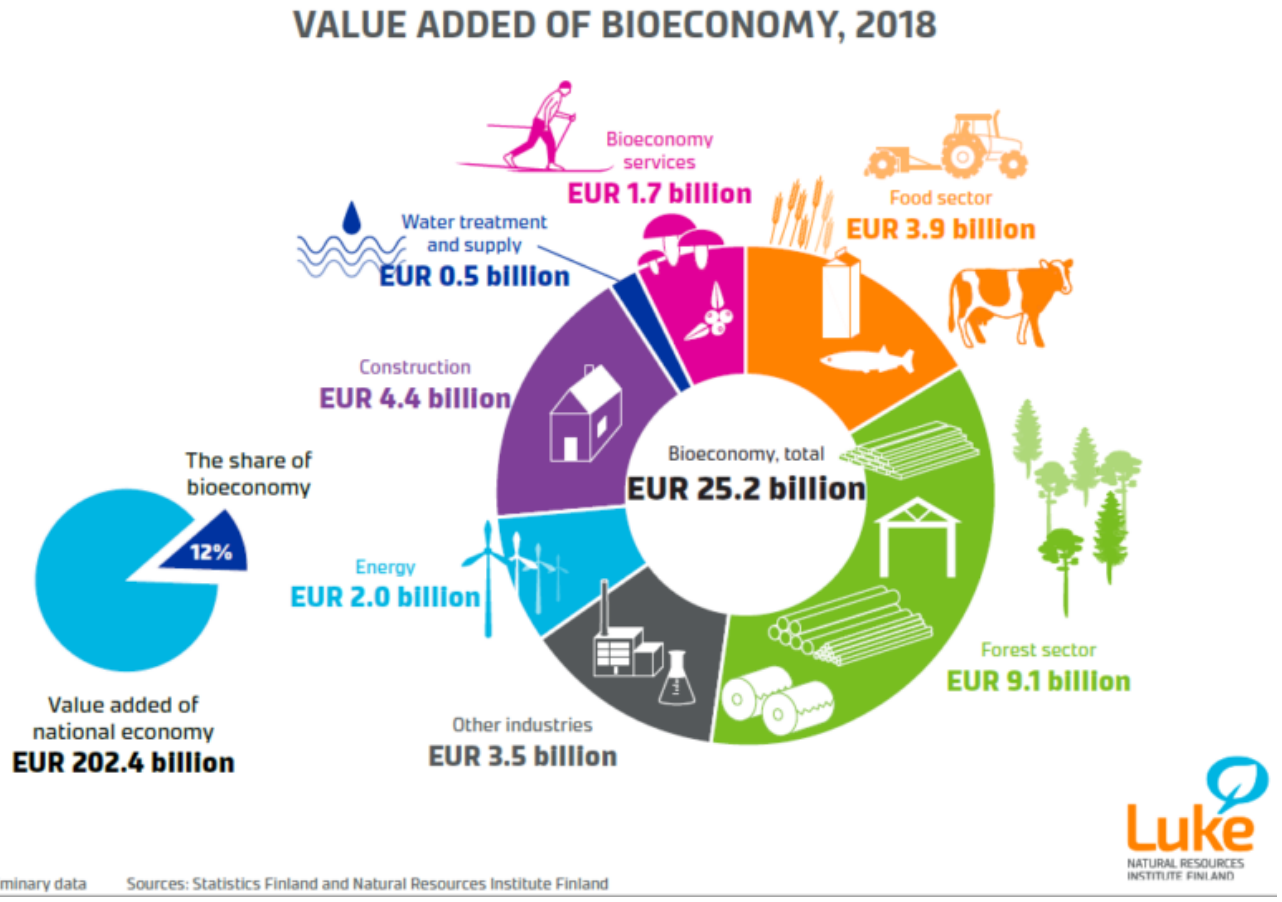
Financial aspects of BE



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Financial aspects of bioeconomy

- The concept of FBE was divided according to the findings into the categories below:
  - Wood (forest biomass) as a forest product
  - Non-productive (ecosystem) forest functions
  - Mitigation of climate change impacts
  - Utilization of forest production waste
  - Research and Education in Forestry
  - New technologies (digitization, ICT, etc.)
  - Sustainable development (closer-to-nature forestry) with an emphasis on biodiversity
  - Economic aspects of forestry
  - Production and wood / wood-based products

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Different perspectives of BE / FBE

FOREST BIOECONOMY					
	Italy	**Finland**	**Czechia**	**Slovakia**	**Germany**
Wood (forest biomass) as a forest product	YES	YES	YES	YES	NO
Non-productive (ecosystem) forest functions	YES	YES	YES	NO	YES
Mitigation of climate change impacts	YES	YES	YES	YES	YES
Utilization of forest production waste	YES	NO	NO	NO	YES
Research and Education in Forestry	YES	NE	YES	NO	NO
New technologies (digitization, ICT, etc.)	NO	YES	YES	NO	YES
Sustainable development (closer-to-nature forestry) with an emphasis on biodiversity	YES	YES	YES	YES	YES
Economic aspects of forestry	YES	YES	YES	NO	NO
Production and wood / wood-based products	YES	YES	YES	NO	NO

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Different perspectives of BE / FBE

- Factual analysis of Czech financial subsidies:
  - 4.3.2 Forest infrastructure
  - 8.3.1 Introduction of preventive measures in forests
  - 8.4.1 Restoration of forest stands after calamities
  - 8.4.2 Elimination of damage caused by floods
  - 8.5.1 Investments in the protection of amelioration/strengthening trees
  - 8.5.2 Non-productive investments in forests
  - 8.5.3 Conversion of substitute tree stands
  - 8.6.1 Machinery and technology for forestry
  - 8.6.2 Technical equipment of wood processing plants.

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Different perspectives of BE / FBE

Categories – supported areas	Concurrence with Italy	Concurrence with Finland	Concurrence with Czechia	Concurrence with Slovakia	Concurrence with Germany
Reconstruction + renewal of forest roads	YES	×	×	×	×
Construction of new forest roads	YES	×	×	×	×
Flood protection measures	YES	YES	YES	YES	×
Restoration, reconstruction, and transformation of vegetation	YES	YES	YES	×	YES
Construction of fences (in order to protect amelioration/strengthening trees)	YES	YES	YES	YES	×
Support of recreational forest functions	YES	YES	YES	×	YES
Acquisition of machinery and technology for forestry	×	YES	YES	×	YES
Acquisition of machinery and technology for the timber industry	YES	YES	YES	×	×

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FRAME

Different perspectives of BE / FBE

Categories – supported areas	Italy	Finland	Czechia	Slovakia	Germany
Reconstruction + renewal of forest roads	31 763 723 EUR	×	×	×	×
Construction of new forest roads	1 301 821 EUR	×	×	×	×
Flood protection measures	2 427 903 EUR	2 427 903 EUR	2 427 903 EUR	2 427 903 EUR	×
Restoration, reconstruction, and transformation of vegetation	18 362 535 EUR	18 362 535 EUR	18 362 535 EUR	×	18 362 535 EUR
Construction of fences (in order to protect amelioration/strengthening trees)	2 732 788 EUR	2 732 788 EUR	2 732 788 EUR	2 732 788 EUR	×
Support of recreational forest functions	6 171 980 EUR	6 171 980 EUR	6 171 980 EUR	×	6 171 980 EUR
Acquisition of machinery and technology for forestry	×	28 344 775 EUR	28 344 775 EUR	×	28 344 775 EUR
Acquisition of machinery and technology for the timber industry	4 943 332 EUR	4 943 332 EUR	4 943 332 EUR	×	×
TOTAL	**67 704 083 EUR**	**62 983 314 EUR**	**62 983 314 EUR**	**5 160 691 EUR**	**52 879 291 EUR**

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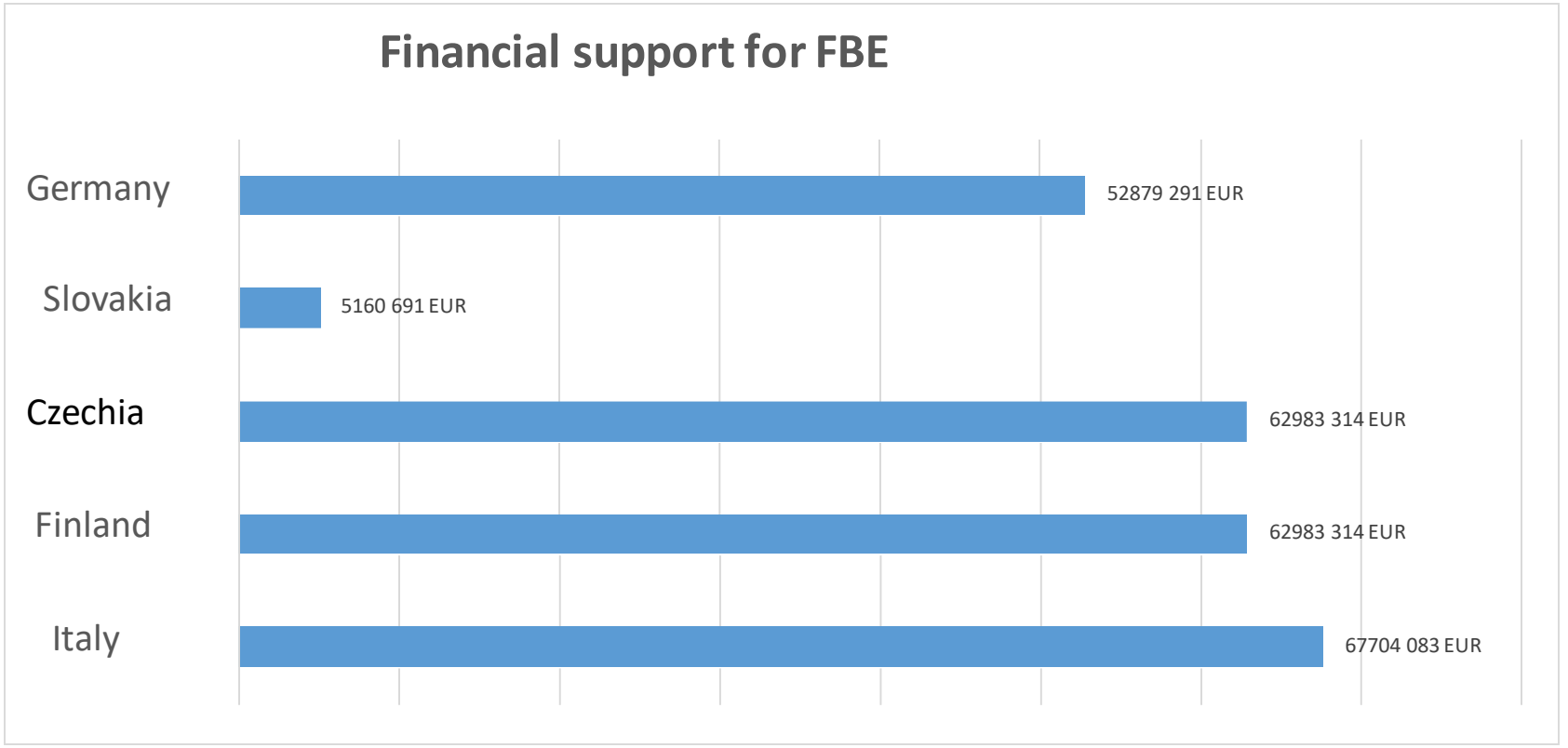
Different perspectives of BE / FBE



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Bioeconomy examples

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Bioeconomy transition challenges

- Transitioning to increased use of bioresources will not be easy
- Challenges will have to be met
  - Scales – Aligning the scales of bioresource production and consumption – biomass is spatially dispersed
  - Logistical problems – biomass has awkward mass/size/density ratio
  - Quality assessment – Non-existent standardization of quality assessment for new biomass uses
  - Regulations are strict towards innovative biomass uses and lax to fossil resources
  - And several others

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Forest bioeconomy – future state

- Technical innovation
  - Industry digitization
  - Biorafining
  - Increased harvesting efficiency
  - Increased logistical systems efficiency
  - Development of partial biorefining
  - Bioresources commoditization
  - Use of residues
- Social innovation
  - Creation of new regulátory frameworks
  - Valuation of negative/positive externalities tied to resource consumption
  - Changes to consumer patterns
  - Changes of institutional behaviours

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How to overcome challenges?

- Lessons learned from oil tycoons
- Minimize inefficient logistical flows – how?
- By pre-refining bioresources in local BioHubs
- By comoditization of new biorefinery and other products

BioHub

- Concentrates biomass:
  - From nearby locations
  - Of various origins
  - Of various quality grades
- Storage
- Scaling
- Grading
- Mixing
- Pre-refining
  - Drying,
  - Chipping,
  - Torrefaction,
  - Extraction

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Biomass products commoditization

- Biomass scale does not match the scale of processing
- Key is to transport refined products (not raw materials)

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What commodities are?

A commodity

- Is simple to store
- Is simple to transport
- Is fungible
- Is standardized
- Has standardized trading systems
- Has functioning markets
- Is highly marketable
- Is sustainable

A non-commodity

- Is difficult to store
- Is difficult to transport
- Has no standards
- Its trade is based on mutual trust of the partners
- Has high transaction costs
- Is inefficient
- Is not secure

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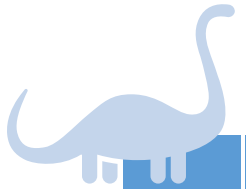
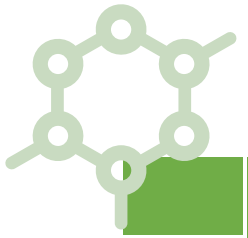
Chemically processed biomass



Traditional biomass uses

- Paper
- Cardboard
- Pulp
- Black licquor
- Packaging



Innovative biomass products

- Biopolymers
- Emulgators
- Pharmaceuticals
- Liquid biofuels
- Gaseous biofuels
- Lubricants
- Feed
- Impregnators
- Composites

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References	Material	Application	Type of information
Brownlie [6]	Hemicelluloses	Food encapsulation	Market
Burt [7]	Extractives	Essential oils in food	Application
CBI [8]	Extractives	Essential oils in cosmetics	Market
Chun et al. [11]	Hemicelluloses	Concrete additives	Application
Crawford et al. [12]	Hemicelluloses	Cattle feed	Application
Curling et al. [13]	Hemicelluloses	Hydro gel	Application
Doherty et al. [16]	Lignin	Various	Application
Dornburg et al. [19]	Various	Platform chemicals	Market
Edlund et al. [22]	Hemicelluloses	Barrier films	Application
Feldman et al. [25]	Lignin	Concrete additives	Application
Gargulak & Lebo [27]	Lignin	Various	Application & Market
Gröndahl et al. [29]	Hemicelluloses	Barrier films	Application
Hansen & Plackett [30]	Hemicelluloses	Films and coatings	Application
Hansen & Plackett [31]	Hemicelluloses	Food packaging	Application
Hartman et al. [33]	Hemicelluloses	Barrier films	Application
Kelkar et al.[38]	Extractives & Resins	Essential Oils	Application & Market
Lora [39]	Lignin	Various	Application
Mabee & Saddler [40]	Celluloses & Hemicell.	Ethanol	Application
Mansouri & Salvadó [41]	Lignin	Adhesives	Application
Meszaros [46]	Hydroxy acids	Complexing agents	Market
Moure et al. [48]	Hemicelluloses	Food additives and dietary supplements	Application
Muller et al. [49]	Lignin	Bio plastics	Application
PACKAKTUELL [56]	Conventional	Food packaging	Market
Petersen et al. [57]	Hemicelluloses	Food packaging	Application
Pye [58]	Lignin	Various	Application
Schüler [64]	Conventional	Food packaging	Market
Sena-Martins et al. [72]	Lignin	various	Application
Shrinivas & Kudli [74]	Extractives	Essential oils as fragrance	Market
Sloan [76]	Conventional	Carbon fibres	Market
Stern et al. [85]	Extractives	Food additives and dietary supplements	Market
Stern, T. [80]	Hemicelluloses	Food additives and dietary supplements	Market
Stern et al., [84]	Lignin	Adhesives	Market
Stern et al., [83]	Hemicelluloses	Food packaging	Market
Stern et al., [82]	Hemicelluloses	Food additives and dietary supplements	Market
Stern & Schwarzbauer [81]	Lignin	Concrete additives	Market
Steward [86]	Conventional	Carbon fibres	Market

What we can make from forest-based bioresources

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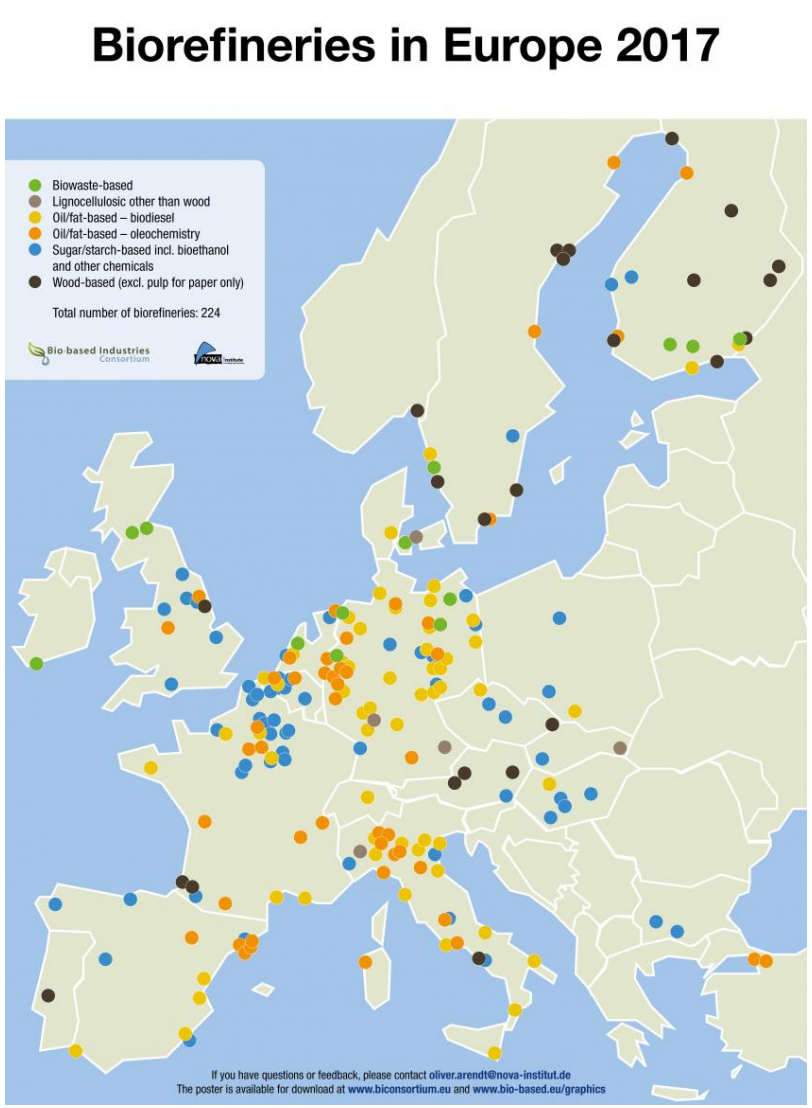
Biorefineries around EU

- Many biorefineries
- Most of them linked to agricultural bioeconomy
- Biorefineries based on forest resources mostly in Northern Europe

[Mapping European Biorefineries | Bio-Based Industries Consortium (biconsortium.eu)]



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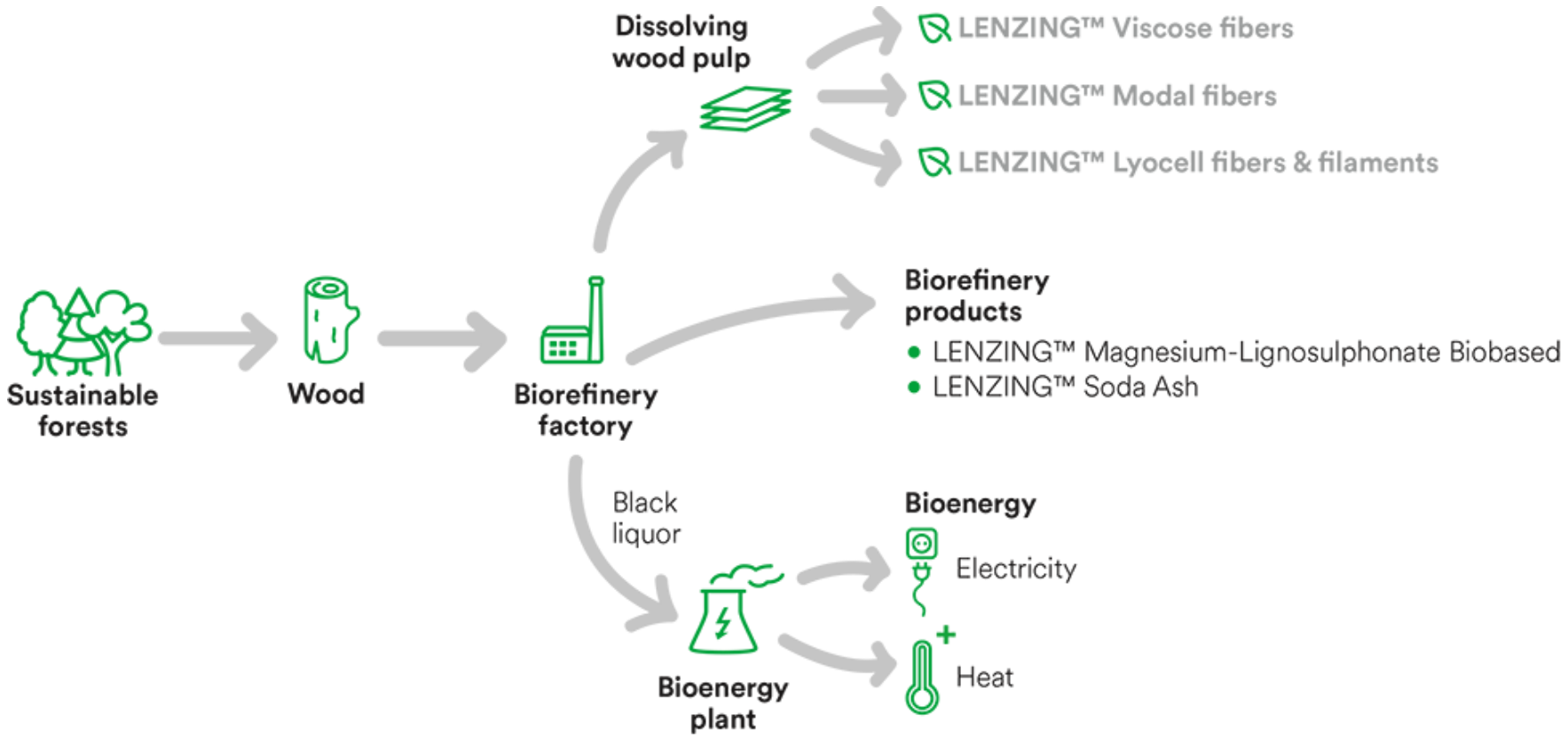
Lenzing Biocel Paskov



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Lenzing Biocel Paskov

LENZING™ Acetic Acid Biobased	food industry, pharmaceutical and cosmetics industry, chemical industry, solvents, textile industry
LENZING™ Furfural Biobased	primary product for furfuryl alcohol, solvent in the refining of lubrication oil, solvent for anthracene and resins, destillation of butadiene, herbicide production
LENZING™ Magnesium-Lignosulphonate Biobased	animal food industry, ceramics industry, production of fireproof bricks, tanning agent industry, chipboard and fiber board industry, auxiliary materials for the construction industry, fertilizer industry
LENZING™ Soda Ash	glass industry, pulp and paper industry
LENZING™ Sodium Sulphate	Detergent, cleaning-agent, and glass industries
Xylose (wood sugar)*	sweetener in food and pharma industry

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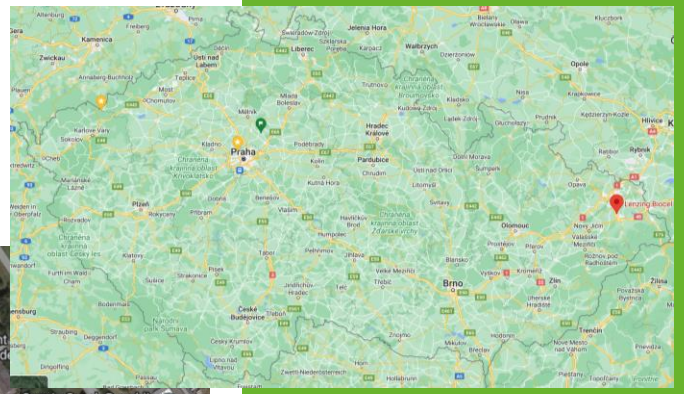
Lenzing Biocel Paskov



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Thank you for your attention

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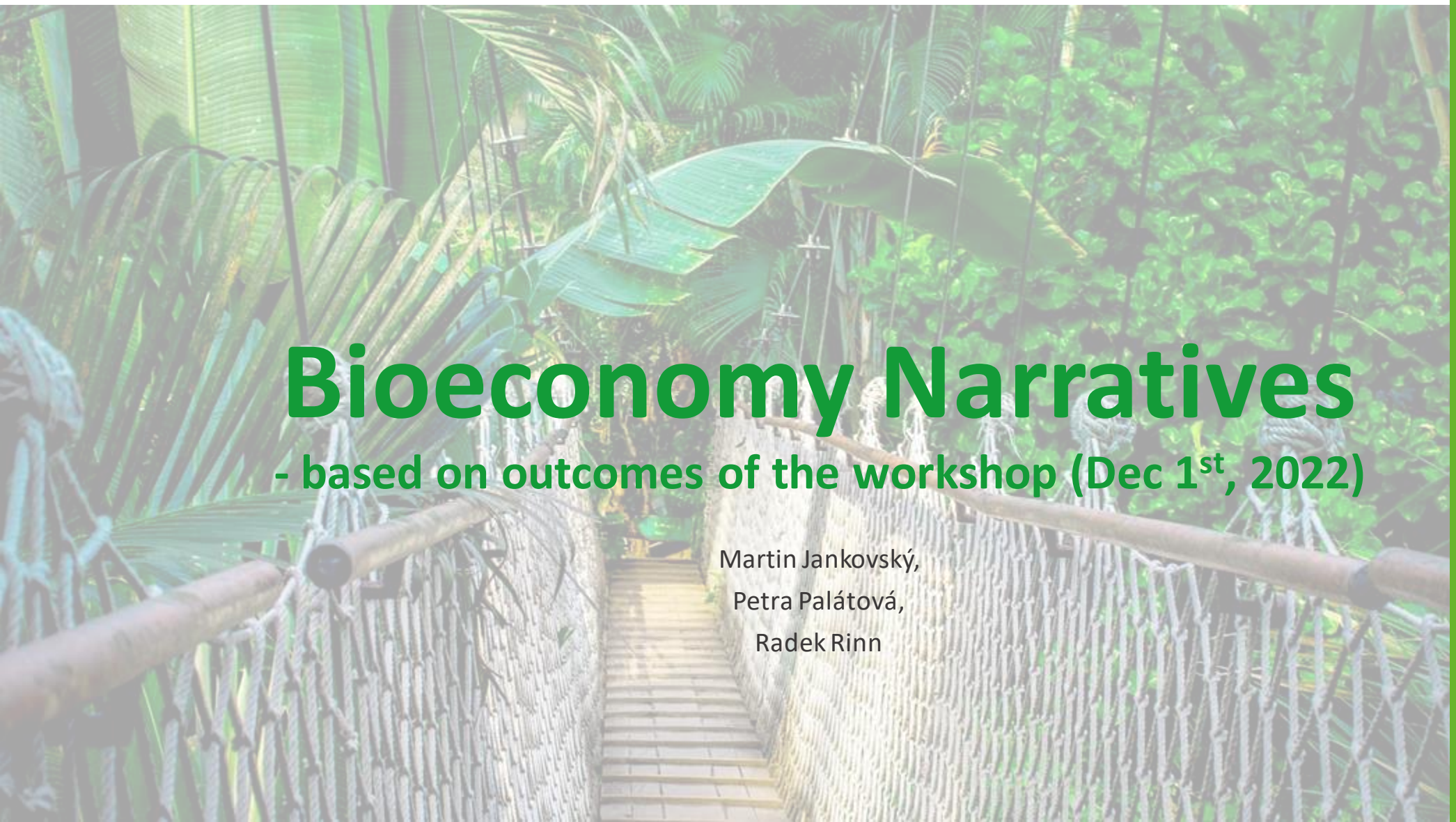

Bioeconomy Narratives

- based on outcomes of the workshop (Dec 1st, 2022)

Martin Jankovský,
Petra Palátová,
Radek Rinn

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Discussion points - bioeconomy

- Which industries are a part of bioeconomy in your country?
- What goals of bioeconomy are relevant for your country?
- What kind of support is needed for bioeconomy to meet the stated goals?
- Which barriers for bioeconomy are present in your country?
- What opportunities for development will bioeconomy bring to your country?
- Which industries should be a part of the bioeconomy to meet the goals?

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Discussion points - forest bioeconomy

- Which ecosystem services are relevant for your country?
- What are the goals of forest bioeconomy in your country?
- Which bioresources and services have the potential to be used in forest bioeconomy?
- Which industries are relevant for forest bioeconomy in your country?
- What kind of support is needed for forest bioeconomy to meet the stated goals?
- What bioeconomy outcomes will be achieved by usage of these bioresources and services in your country?

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Bioeconomy narratives in Thailand

Bioeconomy in Thailand is represented by food-processing, agriculture, aquaculture, (renewable) energy, health, wood and recreation (eco-tourism) and should aim at sustainability (in connection to SDGs), economic growth including job creation (esp. in rural areas), carbon neutrality and use of renewable resources (incl. being self-sufficient for wood sources). The identified goals can be achieved by applying financial support (from domestic and foreign sources), investment in infrastructure (high-tech), policy incentives (e.g., subsidies, tax reduction) and human capacity building in the future industries (bio-based industries including carbon-related services) and taking into consideration the improvement of digital technologies, R&D and educational system in the future. The transition is hindered by several barriers, such as insufficient raw material availability, lack of know-how, lack of investment and labor shortage. There is also a need to decrease the trade barriers and support policy deployment and increase awareness and understanding of bioeconomy. However, it will bring better environment with less emissions, better economy attracting investment and enabling income distribution to the regions, creation of value added, possibly attracting external investments, food and energy security and sustainable tourism that could lead to the development of Thailand.

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Bioeconomy narratives in Laos

Bioeconomy in Laos is represented by recreation, food-processing, health, agriculture, aquaculture, renewable energy and NTFP and should aim at green economy, carbon neutrality and creation of jobs in rural areas. The identified goals can be achieved by applying financial support, support from policy-makers, human resources development (research) and investment in infrastructure and in the food industries. There is also a need for improvement in digital technologies and enable access to open sources. The transition is hindered by insufficient infrastructure and logistics, trade barriers, market mechanism, and quality of the products (standardization), however, it will bring better environment, food and nutrition security, work safety, improved natural resources management in tourism and diversification and opportunities for deployment of green economy and SMEs in food, agriculture and eco-tourism industries that will lead to the development of Laos.

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Forest Bioeconomy (FBE) narratives in Thailand

For forest bioeconomy in Thailand, **provisioning** (timber for various industrial purposes, NTFP), **cultural** (eco-tourism) and **regulating** ecosystem services are the most important to reach FBE goals – ecosystem conservation, climate change mitigation and well-being. Because of this, food (bamboo, honey, mushrooms, fish, insects), medicinal plants and wood including services improving quality of water, air and soil have the highest potential to be used. These bioresources and services can be used in wood industry (+ wood in construction and for energy purposes), eco-tourism and food-processing industry in their present form or after implementing supporting measures (investment, improvement of technologies and information including participation of policy-makers and digitalization). Transitioning to increased use of these bioresources and services will lead to increase in income, better living conditions and more systematic quality (assuring standardization and increasing competitiveness).

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Forest Bioeconomy narratives in Laos

For forest bioeconomy in Laos, **cultural, provisioning** and **regulating** ecosystem services are the most important to reach increase in green areas, development of forest products, improving situation of SMEs and improve climate, well-being and sustainable tourism. Because of this, food (bamboo, honey, mushrooms, fish, insects), medicinal plants and wood including services improving quality of water, air and soil have the highest potential to be used. These bioresources and services can be used in wood industry (+construction and energy), eco-tourism and food-processing in their present form or after implementing supporting measures (investment, improvement of technologies and information including participation of policy-makers and enabling capacity building. Transitioning to increased use of these bioresources and services will lead to increase in income, better living conditions and more systematic quality (assuring standardization and increasing competitiveness).