WOOD-BASED WASTE MANAGEMENT - IMPORTANT RESOURCES FOR CIRCULAR ECONOMY

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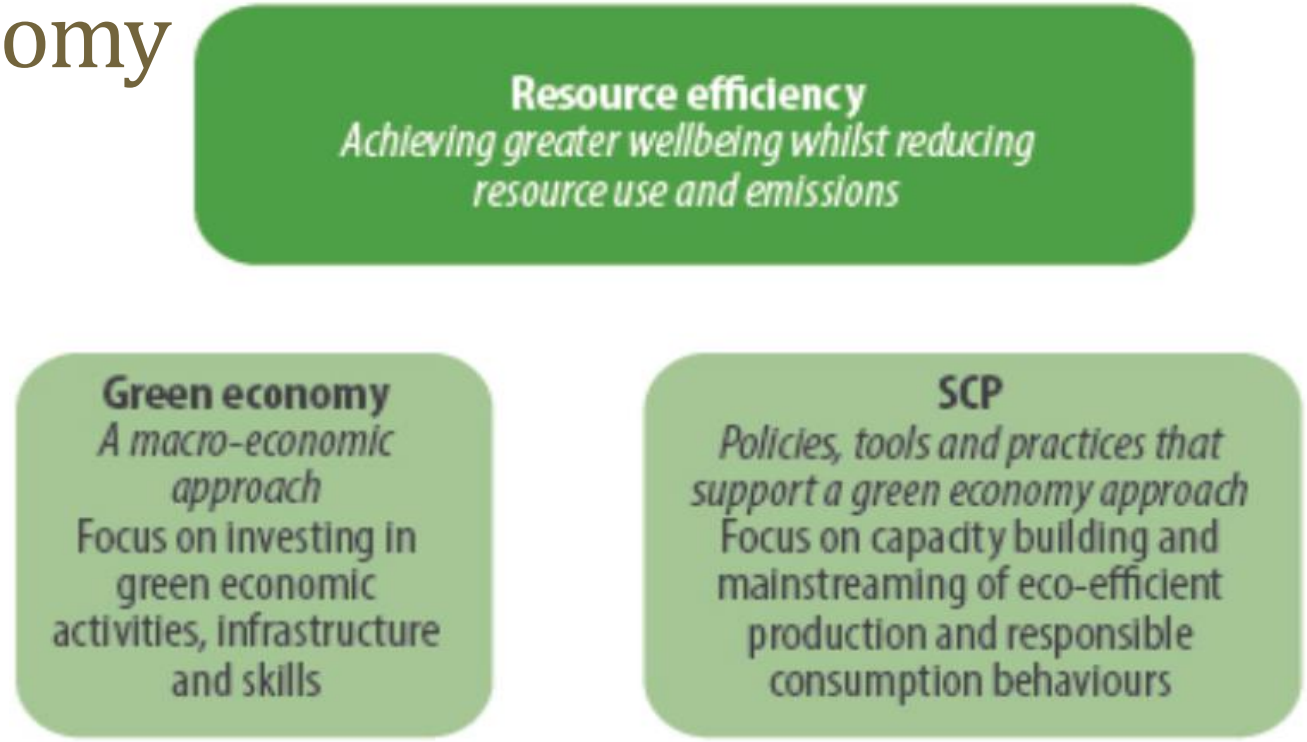
Contents

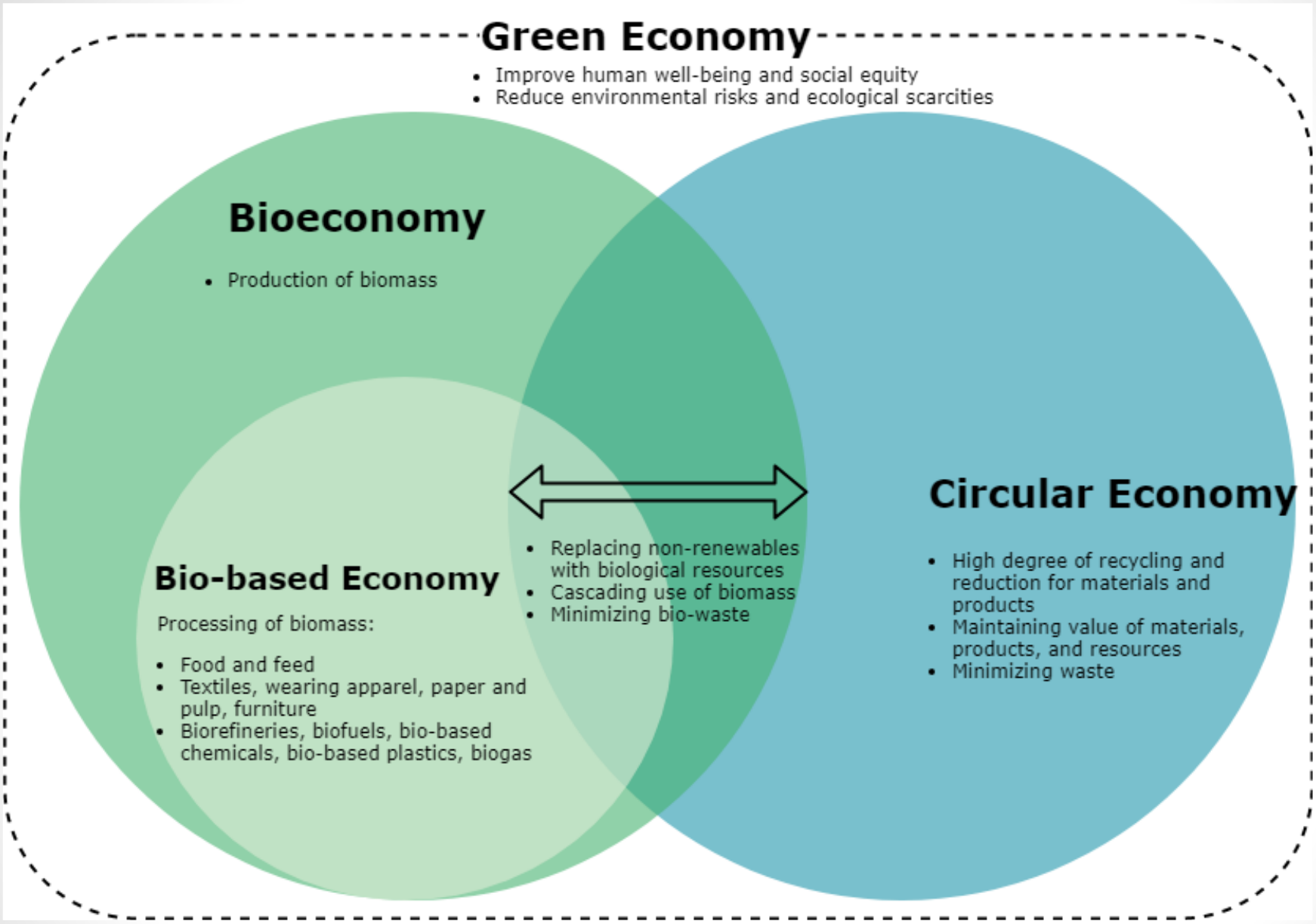
- Green Economy and Forest-based bioeconomy
- Wood-based waste management in the circular economy
- Analysis of wood flows and carbon storage in HWP
- Concept of cascading use of wood products
- Case study - wood flows in Slovakia
- Conclusions

Green Economy and Forest-based bioeconomy



The three main areas for the current work on Green Economy are:

- 1) Advocacy of macro-economic approach to ***sustainable economic growth*** through regional, sub-regional and national fora
- 2) Demonstration of Green Economy approaches with a central focus on access to ***green finance, technology and investments***
- 3) Support to countries in terms of development and mainstreaming of ***macro-economic policies to support the transition*** to a Green Economy


Green Economy
Improve human well-being and social equity
Reduce environmental risks and ecological scarcities
Bioeconomy
Production of biomass
Bio-based Economy
Processing of biomass:
Food and feed
Textiles, wearing apparel, paper and pulp, furniture
Biorefineries, biofuels, bio-based chemicals, bio-based plastics, biogas
Replacing non-renewables with biological resources
Cascading use of biomass
Minimizing bio-waste
Circular Economy
High degree of recycling and reduction for materials and products
Maintaining value of materials, products, and resources
Minimizing waste

Bioeconomy concept

2012 EU Bioenergy Strategy and Action Plan *Innovating for Sustainable Growth: a Bioeconomy for Europe*:

- *„the **production of renewable biological resources and their conversion** into food, feed, bio-based products and bioenergy. It includes agriculture, **forestry,** fisheries, food and **pulp and paper production**, as well as parts of chemical, biotechnological and **energy industries**"*

2012 EU Bioenergy Strategy aims to

- ***„**pave the way to a **more innovative, resource efficient and competitive society** that reconciles food security with the **sustainable use of renewable resources** for industrial purposes, while **ensuring environmental protection„***

Objectives

- ensuring food and **nutrition security**
- managing natural **resources sustainably**
- **reducing dependence on non-renewable**, unsustainable resources
- mitigating and adapting to **climate change**
- strengthening European **competitiveness** and **creating jobs**

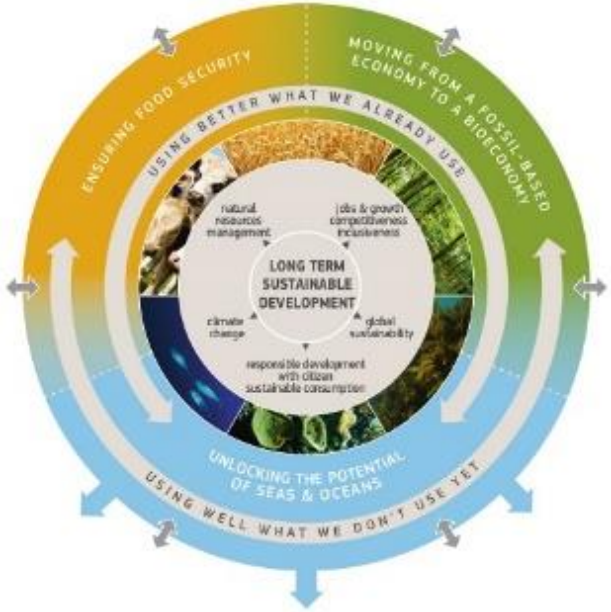
Bioeconomy concept

2018

EU

Updated

Bioenergy Strategy 2022



Proposed measures

- **strengthen the bio-based sectors,**
- **bioeconomies across Europe**
- **ecological boundaries**

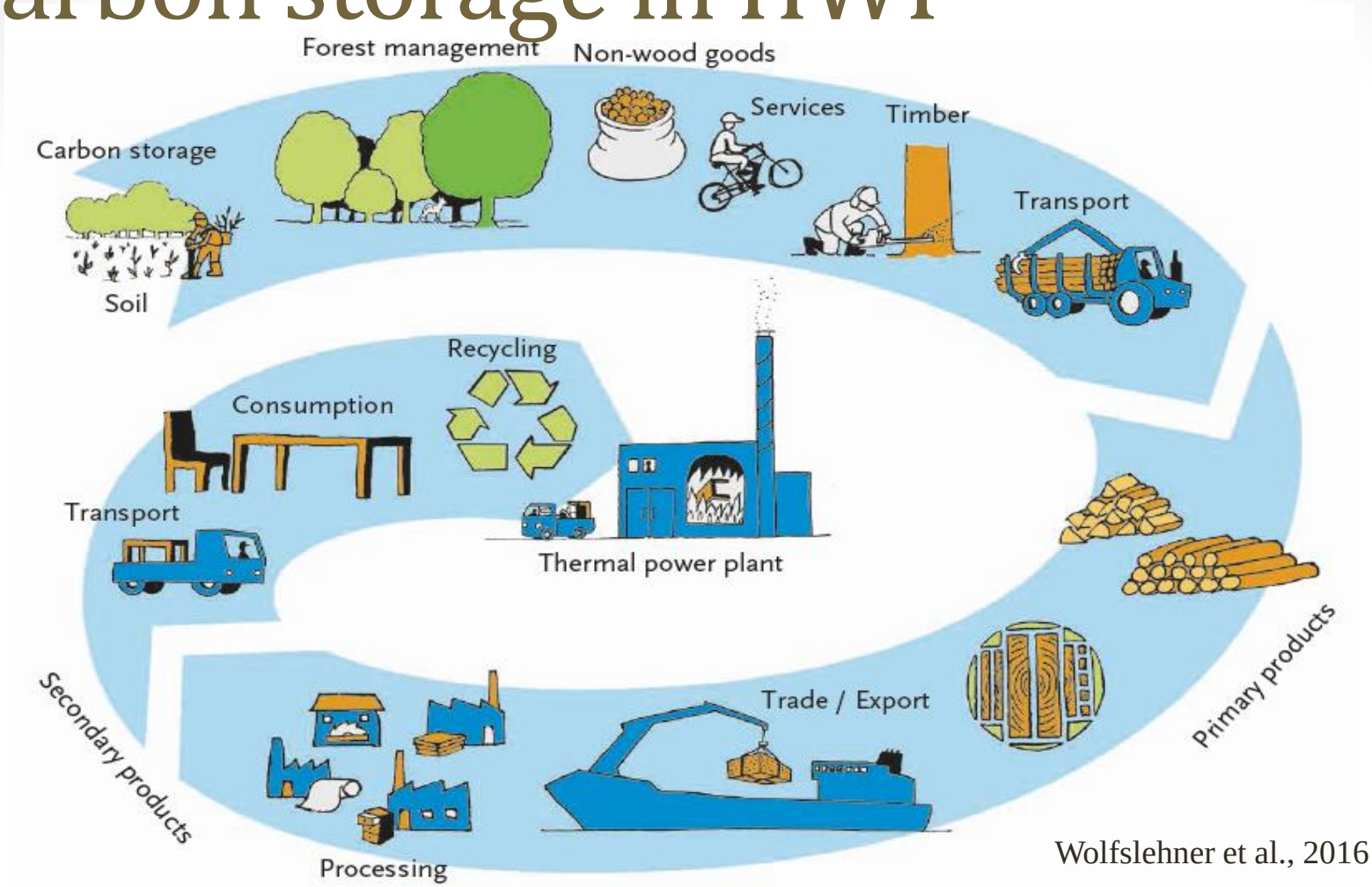
European Commission, 2022

Forest-based bioeconomy

Bioeconomy criteria	Forest-related topics
Ensuring food security	Provision of water for agriculture and fisheries to secure sustainable food production; Edible non-wood forest products; Forage and feed for livestock
Managing natural resources sustainably	**Using existing SFM criteria and indicators for SFM;** Forest ecosystem services; Social services like health/wellbeing; Desertification**; Illegal logging**; Green infrastructure
Reducing dependence on non-renewable resources	**Low carbon society:** carbon sequestration, carbon footprint, carbon neutrality**; Renewable goods and substitution of fossil products:** bio-based products, bioenergy, carbon in wood products**; Resource efficiency; Biomass availability; Energy security, independence from non-renewables**; Indirect land use change, displacement effects of EU biomass demand
Mitigating and adapting to climate change	Compliance with climate policy goals; **Resource efficiency; Carbon accounting**; Climate change effects: diseases, pests, fires; Resilience and risk
Increasing competitiveness and creating jobs	Jobs in rural and in urban areas; Forest sector workforce; Income generation; Green jobs, services to/from the sector; **Innovation and start ups; Diversification of forest-related bio-based products**; Emerging societal trends and new markets

Source: Winkel, G. (Ed.). 2017. What Science Can Tell Us 8.

Carbon storage in HWP



Wolfslehner et al., 2016

Harvested Wood Products (HWPs)

- wood-based materials **harvested from forests**, which are **used for products** such as furniture, plywood, paper and paper-like products, or for **energy.** a

Climate impact of carbon storage effect

Source: Reuter, 2008

HWP's contribution to mitigation of climate change:

- forming a **storage pool of wood-based carbon** and
- **substituting** environmentally damaging sources of material and energy such as **fossil fuels**.

1 kg of wood ≈ 500 g of carbon ≈ 1.7 kg of CO_2

Research of the Utilisation of Wood as Renewable Raw Material in the Context of Green Economy

Objective

- to propose and **develop optimal models of wood use** in the national context that would **take into account the main principles of the bioeconomy** and their application in different sectors of wood production, processing and utilisation

Relevance to the bioeconomy objectives

- **Reducing dependence on non-renewable resources**
  - biomass availability
  - resource efficiency
- **Mitigating and adapting to climate change**
  - carbon accounting in harvested wood products (HWP)

Methodology Approach

Biomass availability

- analyses of the **timber production potential**

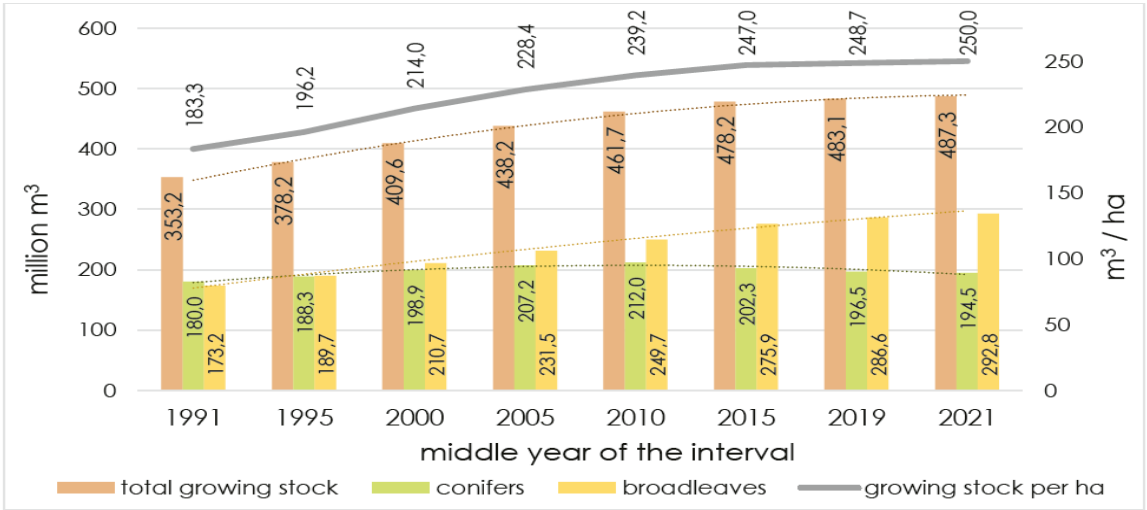
and the **prognosis** of its development

- **model distribution** of growing stock by **quality grades** of wood assortments
- **models of wood flows**

Trends of basic forestry data in Slovakia

	Forest area	Forest cover	Population	Forest area per capita	Growing stock	Growing stock per hectar
Year	ths. ha	%	mil.	ha	mil. m^3	$m^3.ha^{-1}$
1920	1 659.0	33.9	3.00	0.55	213.3	129
1950	1 771.2	36.1	3.46	0.51	251.2	142
2000	1 997.9	40.7	5.37	0.37	410.0	215
2021	**1 952.8**	**41.3**	**5.45**	**0.36**	**487.3**	**250**

Green Report 2022



Trends in growing stock and by main tree species

Harvesting

Total growing stock 487,3 mil. m^3

Total increment 11,98 mil. m^3

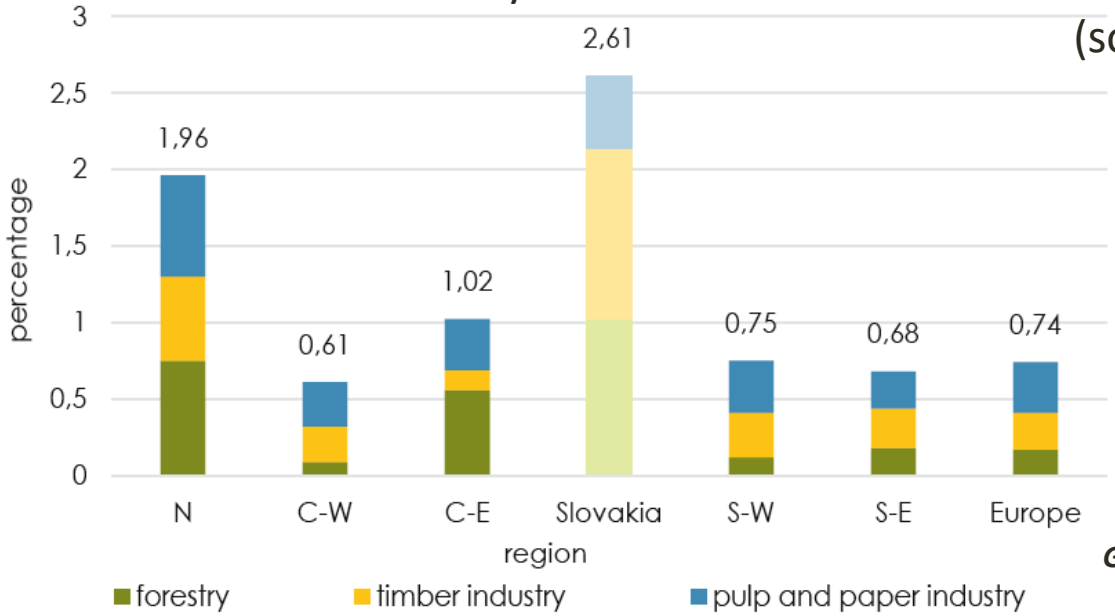
63,7%

Softwood	**50.5%**
Hardwood	**49.5 %**
Total felling	**7.64 mil. m^3**

Share of accidental felling – about 38%

Contribution of forestry-timber sector to GDP

(softwood 64 % in 2021)

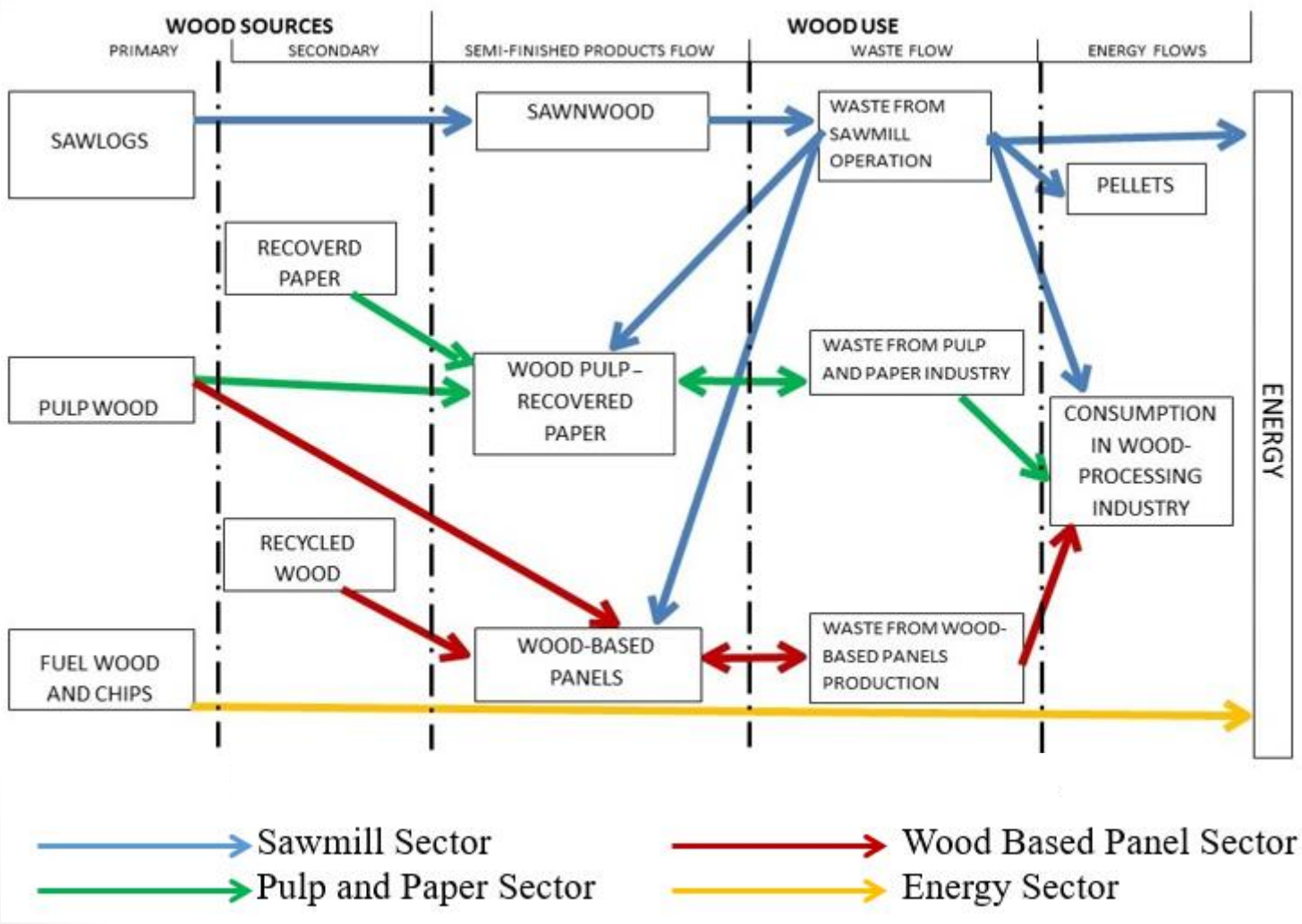


Green Report 2022

Categories of Wood Resources and Uses

Woody biomass and waste			Wood products
Sources		Uses	
Forest woody biomass	Coniferous roundwood (logs, pulp wood, other industrial wood, wood fuel)	Sawmill industry	Wood processing industry
	Non-coniferous roundwood (logs, pulp wood, other industrial wood, wood fuel)	Veneer and plywood industry	
	Forest chips	Particleboard and fibre board industry	
	Other logging residues	Wood fuel industry	
Used material (paper and other)	Post-consumer fibres	Pulp and paper industry	
Other woody biomass	Woody biomass outside forests	Power and heat	Energy users
Wood processing residues	Sawmill residues (sawdust, chips, particles)	Industrial internal	
	Pulp production co-products		
Processed wood fuel	Processed wood fuel	Private households	
Total			Total

Simplified structure of wood flows



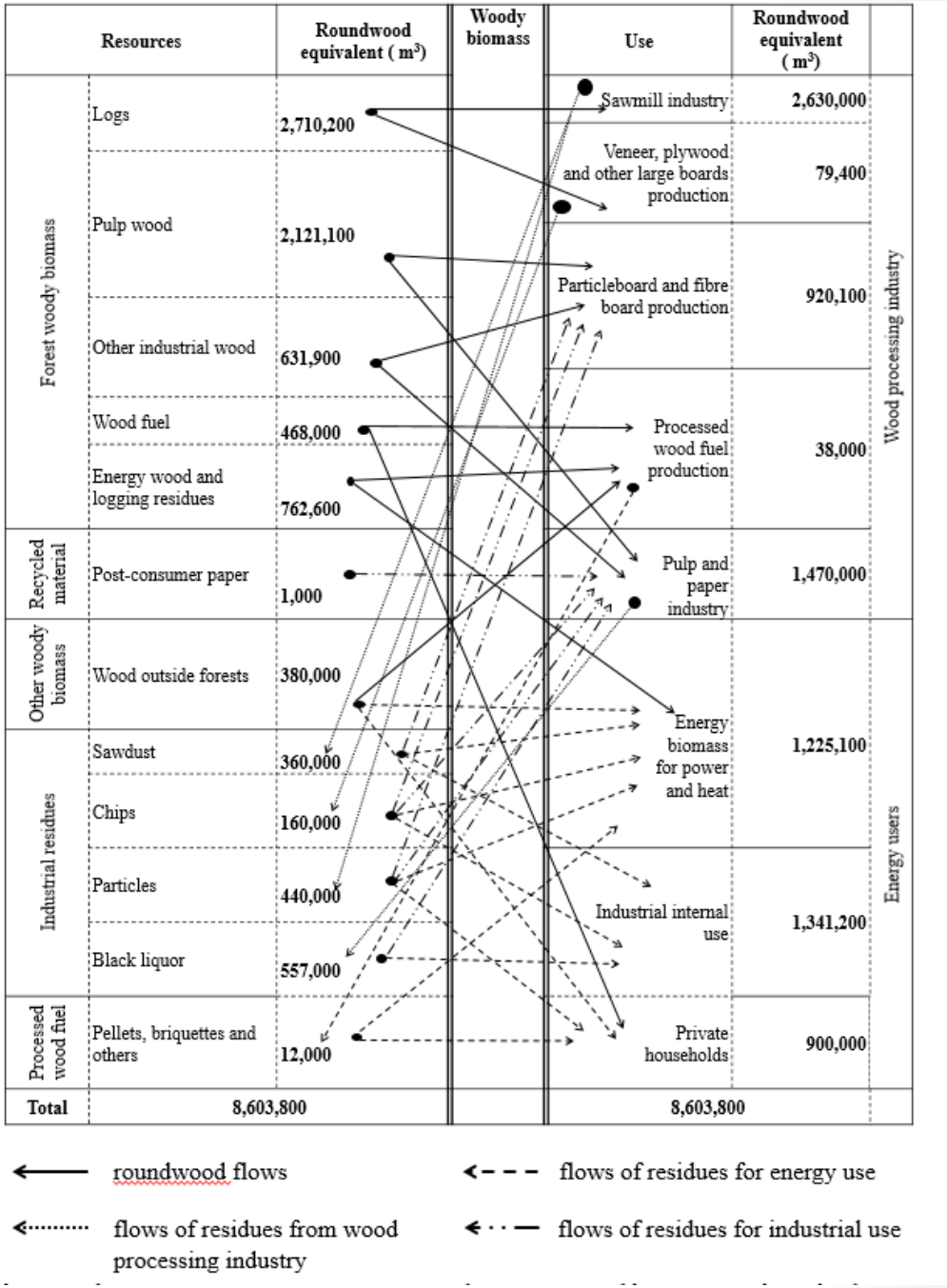
Domestic wood resources in Slovakia (in M3).

Wood Reources		Use of Wood	
Roundwood Production	7 448 000		
Roundwood Import	2 000 000	Roundwood Export	2 290 000
Recycled Paper	141 113		
		Domestic Consumption	7 299 113
Total sources	9 589 113	Total uses	9 589 113

Wood resource balance

- Total resources were 8.6 mil. m3 roundwood equivalents.
- Taking into account wood **cascading principles** through repeated utilisation of wood residues and energy flows (**cascade coefficient**) the total use of wood increased **1.46** times.

*This distribution of wood resources is considered the **„basic reference model“***



Wood flow analysis

Roundwood volume on the resource side is supplemented mainly by wood processing residues (18%) consisting primary of:

- industrial sawmill residues (11%),
- black liquor production (7%).

The results show that :

- sawmilling industry consumed 30%,
- wood based panels industry 13%,
- pulp and paper industry 17%
- energy sector 40% of the total domestic wood consumption.

Over 60% of it is used by industry and 40% by energy sector, dominated by internal industrial use (16%).

*This distribution of wood resources is considered the **„basic reference model“***

Carbon storage in HWP - methodology approach

Carbon storage in HWP

- estimation of carbon stocks and annual carbon stock changes in harvested wood products

„**Stock change approach“** applied“

- evaluation of the **annual change of the carbon stock in HWP** within the domestic consumption
- estimation of carbon stocks and annual changes in HWP pool is calculated separately for each of the HWP fractions: „**sawnwood“, „wood-based panels“ and „paper and paperboard“**
- the **first-order decay** (FOD) in combination with estimates of **half-lives** is applied (IPCC, 2006, 2013) – *sawnwood 35 years, WBP 25 years, paper products 2 years*

(A) $$C(i+1) = e^{-k}.C(i) + \left(\frac{1-e^{-k}}{k}\right).\text{inflow}\ (i)$$ s C(1900)=0,0

(B) $$\Delta C(i) = C(i+1) - C(i)$$

Where:

- i = year C(i) = the carbon stock in the particular Harvested Wood Product category at the beginning of year i, Gg C

- k = decay constant of FOD for each HWP category (HWPj) given in units yr-1 (k = ln(2)/HL, where HL is half-life of the HWP pool in years.

- Inflow (i) = the inflow to the particular HWP category (HWPj) during year i, Gg C yr-1 ΔC(i) = carbon stock change of the HWP category during year i, Gg C yr-1.

Development of optimal models of wood utilisation - scenarios

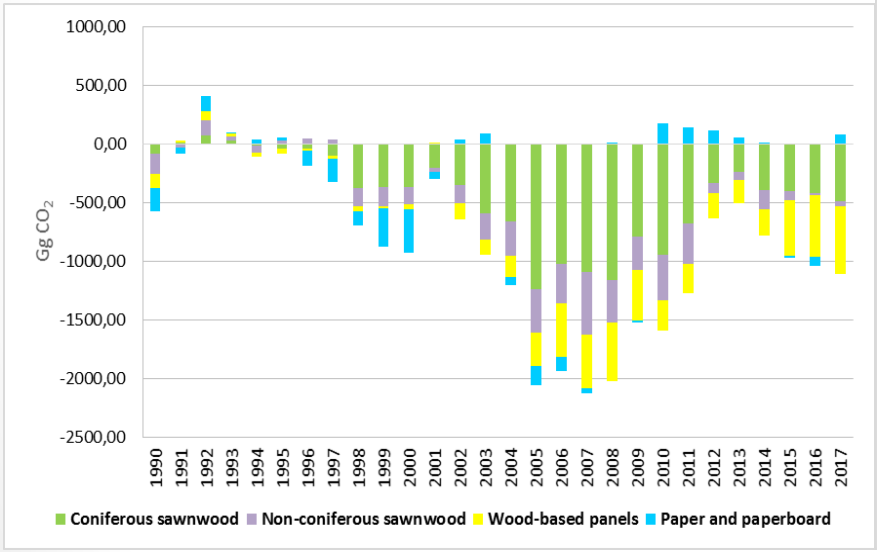
Alternative models will reflect different **scenarios** considering:

- **optimal value utilisation** of the available structure of raw wood assortments;
- **increase in domestic** wood processing and **consumption** (export vs. domestic consumption);
- effective application of **cascade wood use principles**;
- i**mprovement in the carbon balance** of the use of wood and sequestration of carbon in harvested wood products.

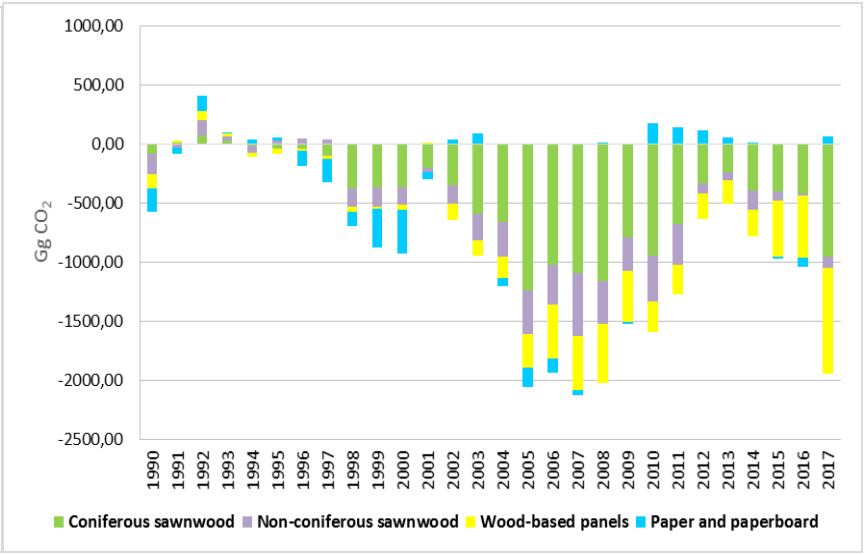
Cabron storage in HWP

- gains and losses of CO_2 from domestically produced and used HWP

Actual pattern of wood use



Optimal pattern of wood use



Development of optimal models of wood utilisation - scenarios

Analysis of key factors affecting the utilisation of wood in Slovakia

In the wood production:

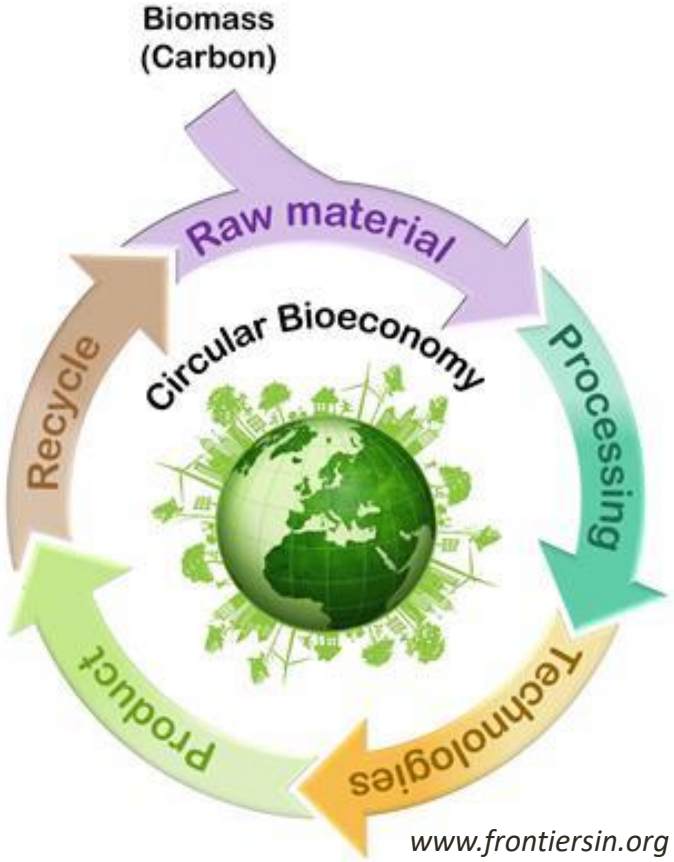
- **structure of assortments**
- **Legal restrictions**
- **Level** of **technical infrastructure**
- **state policy**
- **climate change**

In the wood processing and use:

- **State policy**
- **Technical level**
- **Competitiveness**.
- **Restrictions on processors**

In the supply chain:

- Accessibility and **transparency of information**
- **Quality of the market** environment.



www.frontiersin.org

Concluding remarks

- Timber supply tends to **adapt to rapidly changing market conditions** and the requirements of sectors processing and utilising wood
- Utilisation of wood from non-forest land and wood residues from wood processing industry results in **increasing share of bioenergy sector on total wood biomass consumption**
- There is no exact answer to explain how to use wood. It depend on the many factors which are **specific for each country**

Thank you for your attention!

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