

# Comprehensive carbon footprint analysis of the value chains of forest industry

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# Objectives

- to look for new value chains for forest industry, which
    - are based on domestic wood supply
    - increase the quantity and improve quality of raw material in a sustainable manner
    - increase the value of end product
    - improve the cost-efficiency of activities and processes
    - are environmental-friendly and resource-efficient
  - to develop comprehensive methods to analyze
    - consumption of resources and energy
    - carbon footprint
- of the whole value chain

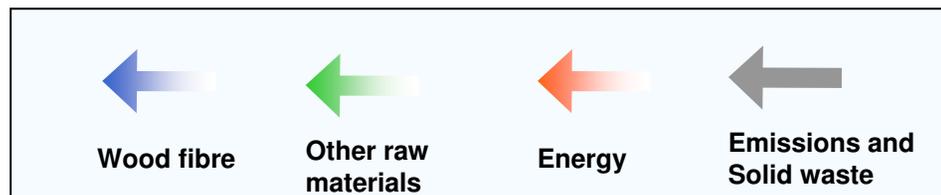
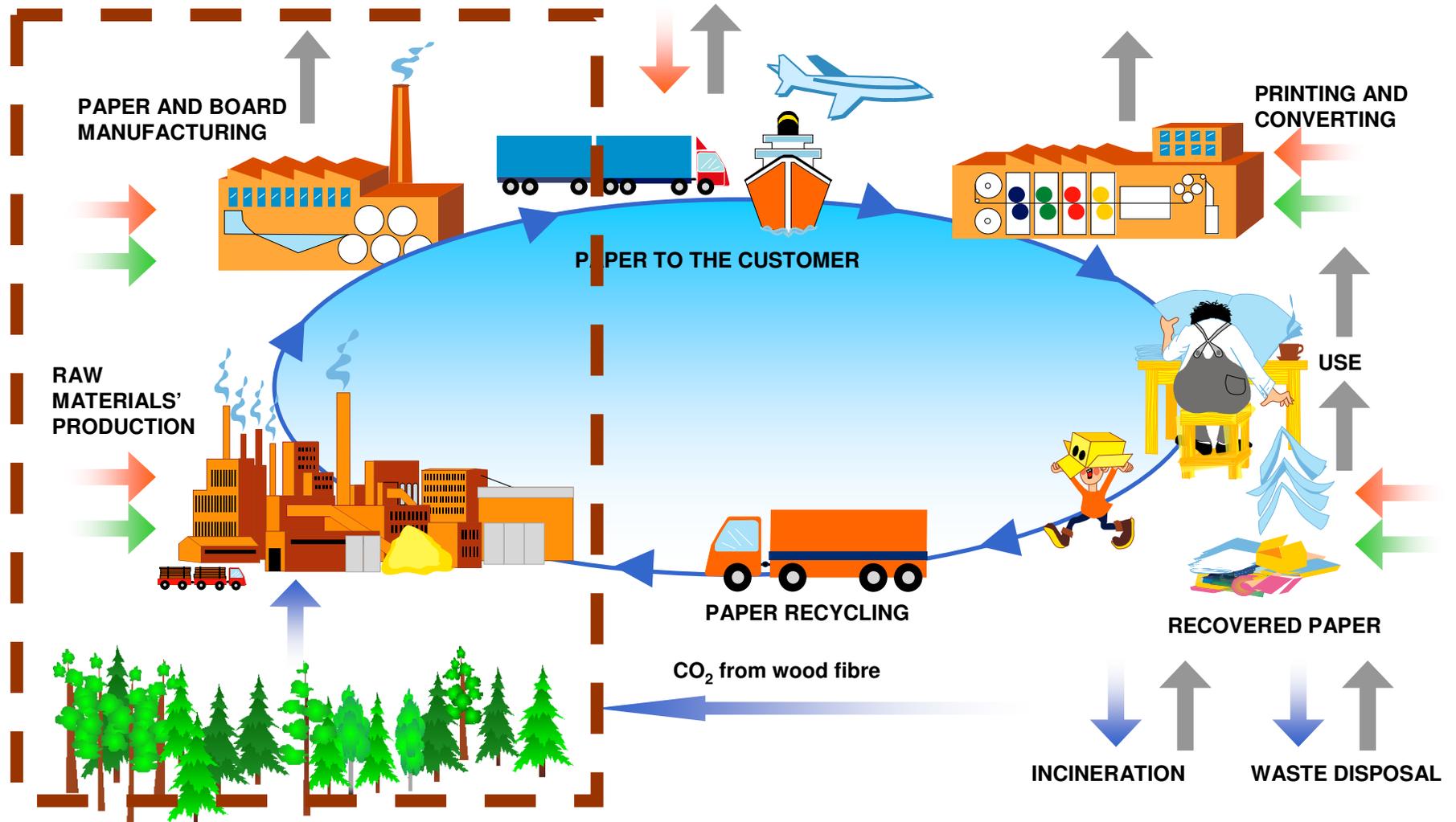


# Carbon footprint of the value chains - implementation of the analysis

- Forestcluster's research program: **"Intelligent, resource-efficient production technologies" (EffTech)**
  - "New value chains"-project
- Joint effort of Metla and VTT
  - Metla: expertise in forests and wood supply chain (resources, management, carbon sequestration)
  - VTT: expertise in sustainability assessment (life cycle analysis, carbon footprint, eco and energy efficiency, sustainability )
- Active participation of Forestcluster's industrial partners throughout the project
  - steering group
  - expert group



# What is a life cycle?



# Carbon footprint



Amount of **green house gases** produced  
along product's life cycle

- Includes fossil greenhouse gas emissions (e.g. CO<sub>2</sub> and CH<sub>4</sub>)
- Results are reported as carbon dioxide equivalents
- Can be calculated for products or companies



# Carbon footprint of wood supply



## 1. Emissions

- Silvicultural practices
  - regeneration
  - precommercial thinnings
- Harvesting
- Forwarding
- Biomass recovery
- Secondary haulage

photos: Arto Rummukainen & Pentti Niemistö/Metla



# Carbon footprint of wood supply

## 2. Carbon sequestration



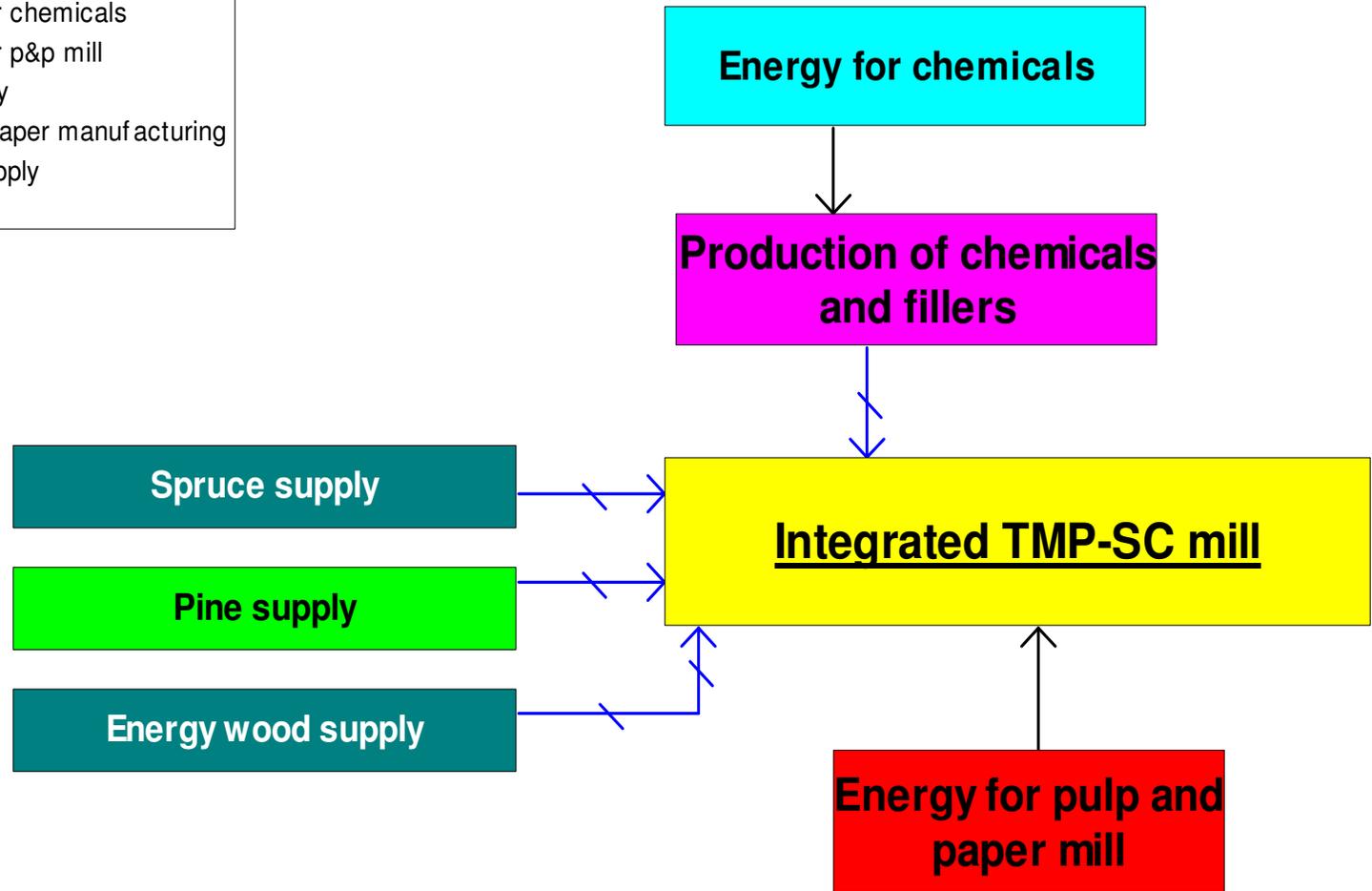
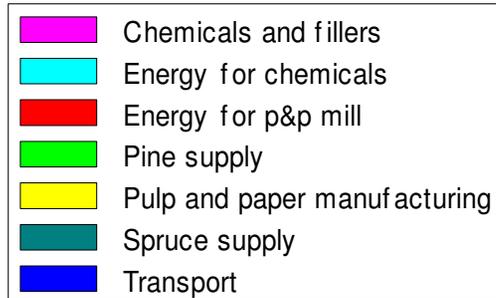
Managed stand



Unmanaged stand

photos: Erkki Oksanen/Metla

# Carbon footprint of a pulp and paper mill



## User-defined input

**Management options**

**Timber assortment criteria**

**Economical parameters**  
- wood prices  
- unit costs

**Logging parameters**  
- logging method  
- time and energy consumption

## MOTTI-s Stand simulation

**Prediction of dynamics and biomass production of forest stands**

Regeneration - Growth - Mortality

## Analysis

### Yield

- stemwood by assortments  
- biomass by compartments

### Quality

- wood & biomass

### Economics

- cost efficiency  
- profitability

### Carbon

- sequestration  
- footprint

### Biodiversity

**Output of the results**



# KCL-ECO Software in LCA-calculations

Unit processes of SC-paper life cycle: cradle to gate -approach

KCL-ECO - [Stage9.eco]

File Edit Object Flowsheet Report Chart Window Help

Essential parameters: 0,6 Collection rate (fraction) recycled paper=0,6\*newspaper

### TUTORIAL FLOWSHEET, STAGE

This example was made to demonstrate the features of KCL-ECO. The flowsheet does not represent a real situation, neither do the modules shown represent any real mills or plants.

### SUMMARY OF Entire system

Values calculated per 1000 kg of newspaper

Variable:	Inputs:	Outputs:	Unit:
<b>Emissions to air</b>			
CO2, biogenic	1503,71	1325,34	kg
CO2, fossil		2618,04	kg
methane		14,5535	kg
SO2		9,77618	kg
<b>Emissions to water</b>			
BOD		2,1817	kg
COD		23,5524	kg
<b>Fuels</b>			
diesel oil	11,7437		kg
hard coal	529,36		kg
<b>Materials/Products</b>			
printing ink	15		kg
recycled paper		80	kg
<b>Solid wastes</b>			
waste, ind. perm.		219,676	kg
waste, mun. perm.		264	kg

Last update: 12/17/07 14:43:07

### Sources of CO2 emissions

Legend: Waste Management (orange), Forestry (yellow), Transports (purple), News/Pulp Production (red), El. Power Generation (green)

CO2, biogenic: 1325,34 [kg]  
 CO2, fossil: 2618,04 [kg]

CALCULATION SUCCESSFUL | Solving time = 0,00 seconds.

start Intranet ... Mail - Mic... Document... LCA-pres... KCL-ECO ... Eforwood... KCL-ECO ... 14:45



# Case study: Value chain of paper industry utilizing domestic spruce as raw material

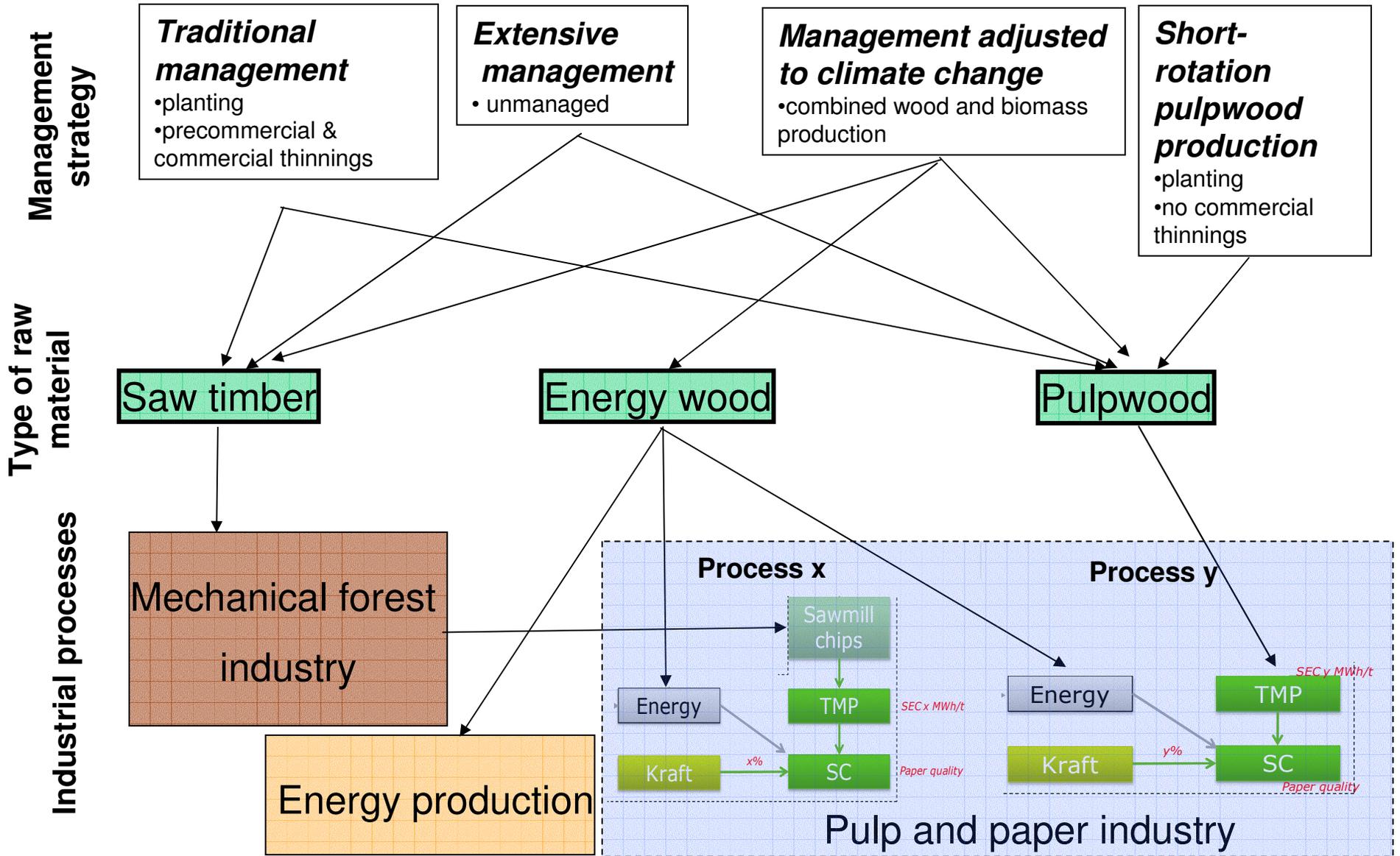
- alternative wood supply scenarios calculated for a hypothetical uniform forest area located in southern Finland
    - consists of even-aged pure spruce stands
    - even age-class distribution of forest stands
- = > constant annual harvested removals of wood and biomass**

photo: Erkki Oksanen/Metla



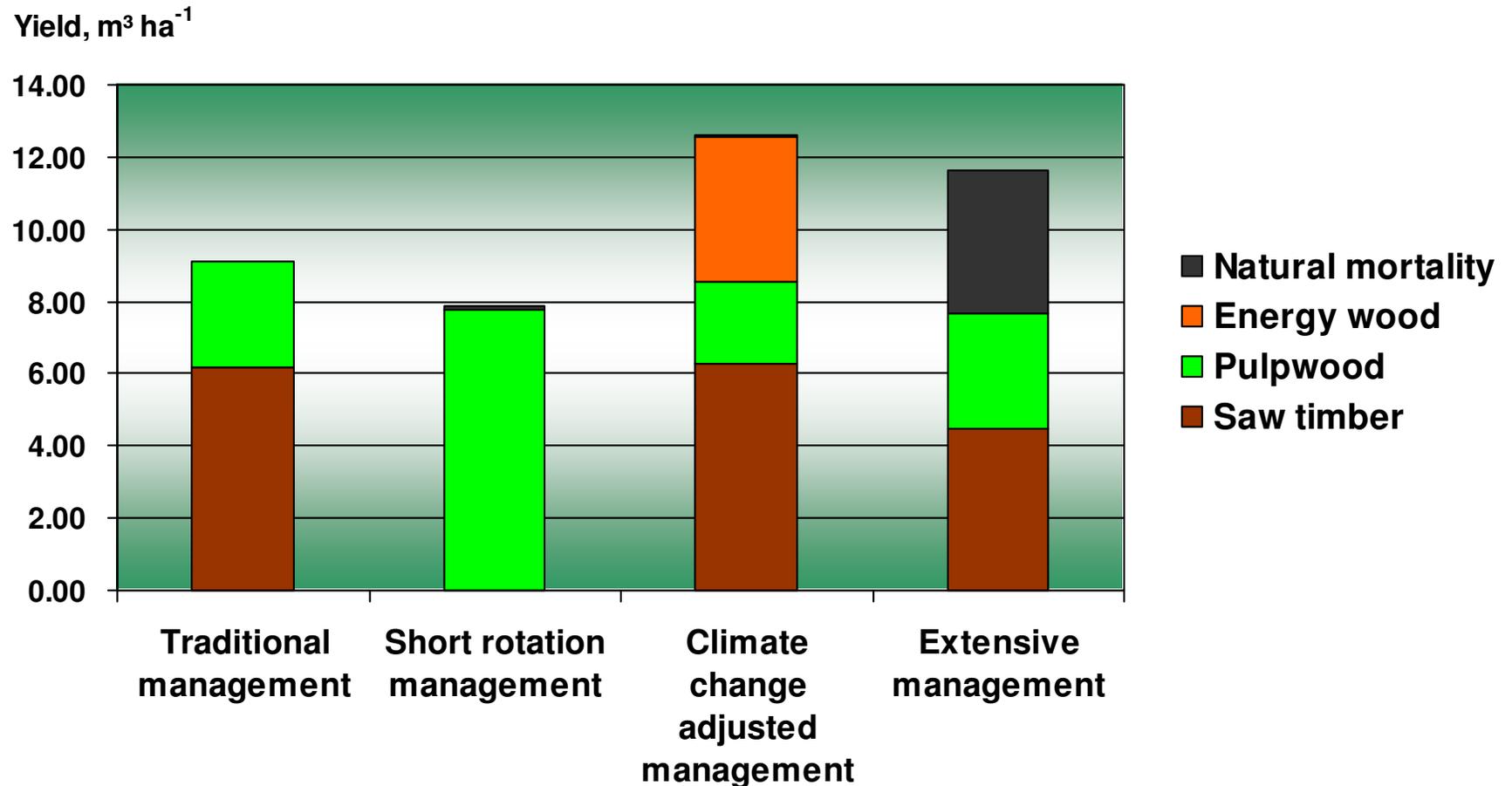
# First case of wood product/process chain

## Alternative wood supply chains from spruce stands in Southern Finland



# An example of the analysis results

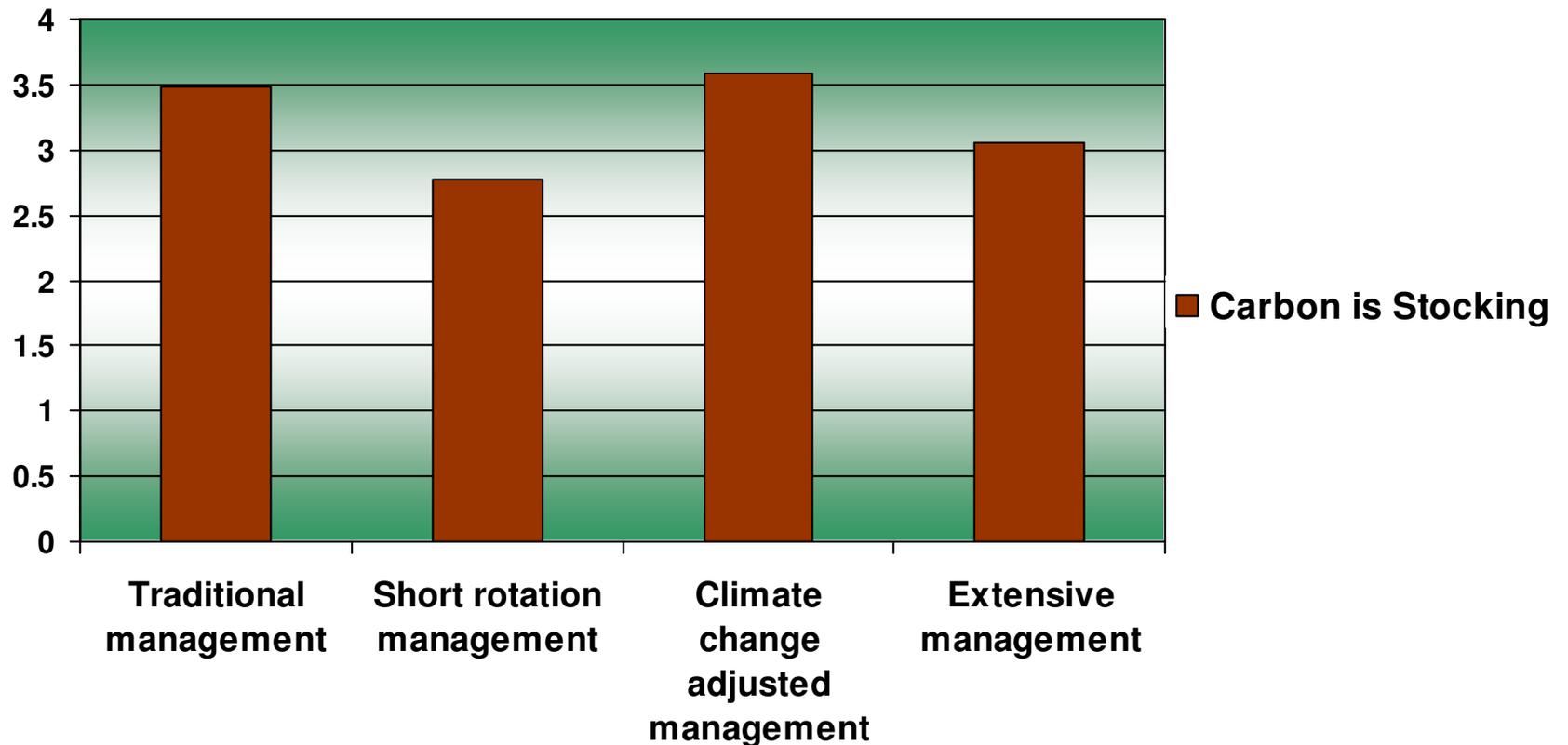
## Mean annual wood production



# An example of the analysis results

## Mean annual carbon accumulation in growing biomass

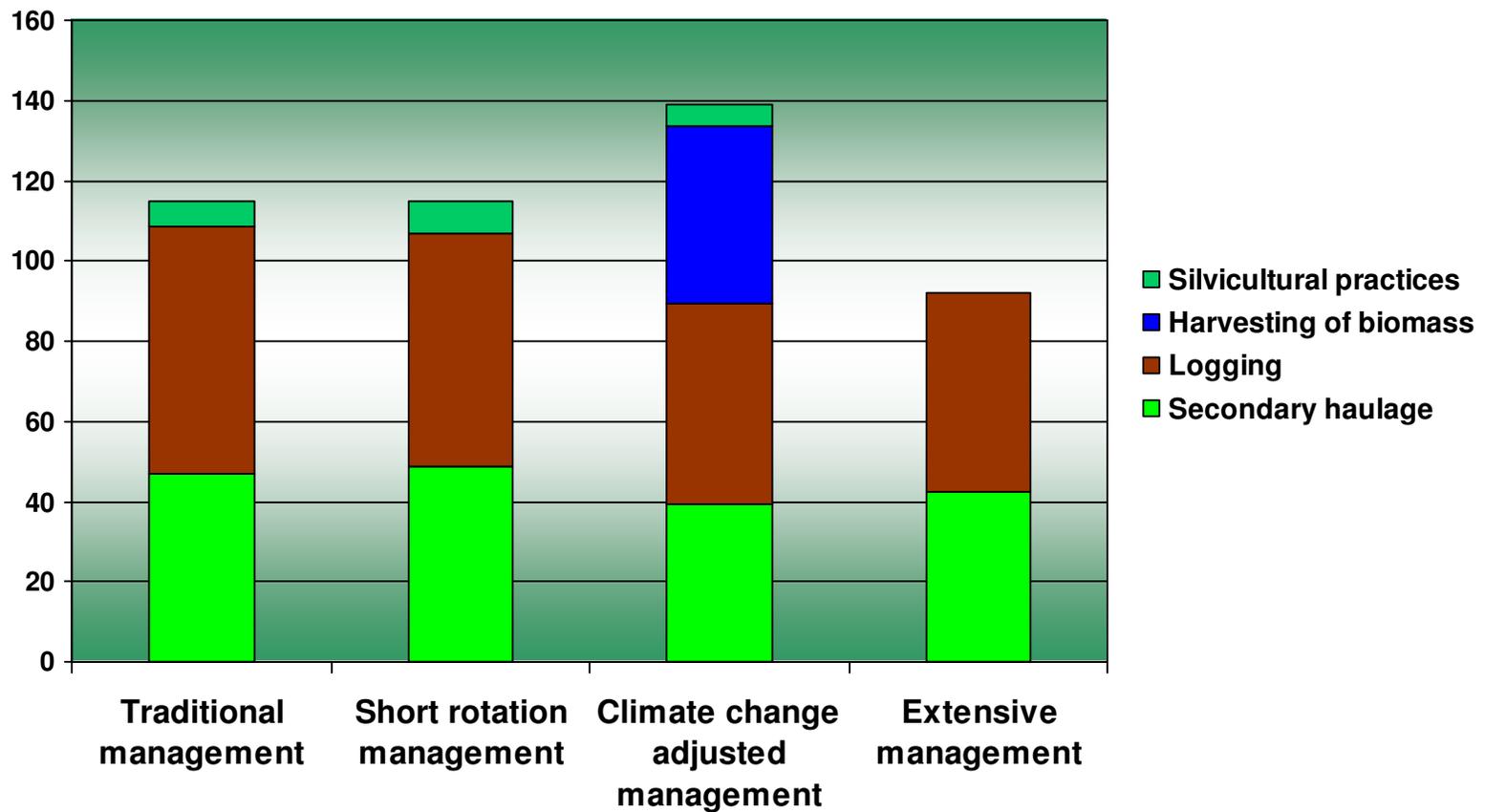
Carbon,  $10^3 \text{ kg ha}^{-1}$



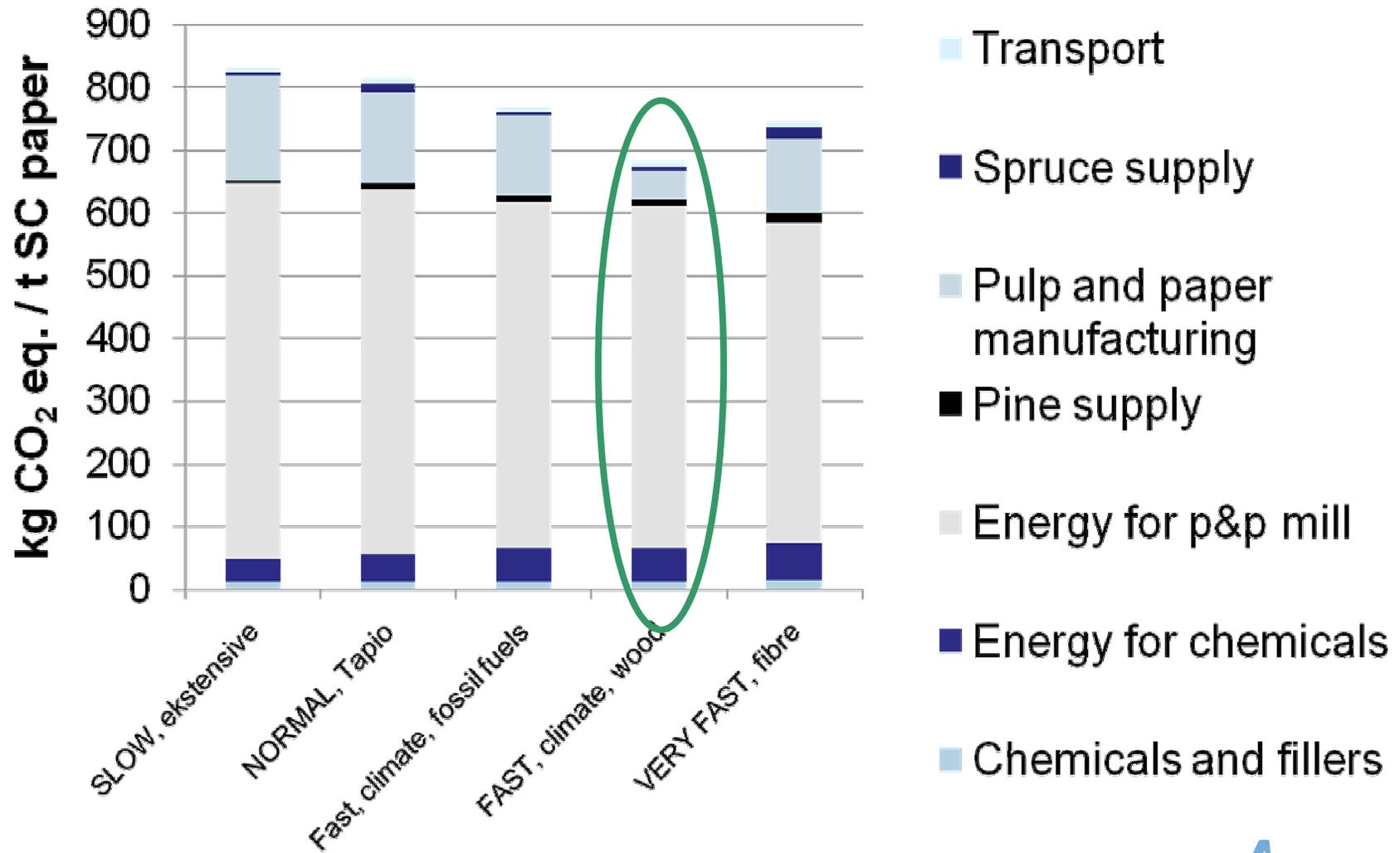
# An example of the analysis results

## Mean annual CO<sub>2</sub> emissions from management operations

kg CO<sub>2</sub> eq ha<sup>-1</sup> year<sup>-1</sup>



## Life cycle results for SC paper: cradle to gate



# Conclusions

- we developed a comprehensive and flexible method for carbon footprint analysis
- demonstrated the impact of different activities within the value chains on the carbon footprint
- we created a network and new operations model for smooth co-operation
  - work continues in the 2nd stage of EffTech program: upscaling the analysis to national level



A photograph of a forest path with sunlight filtering through the trees. The path is dirt and grass, winding through tall, thin trees. Sunlight creates bright patches on the ground and foliage.

# Thank You!

...and to the research team:

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Hannu Salminen	Metla
Jouni Siipilehto	Metla

photo: Erkki Oksanen/Metla