

# Delivery of sustainable supply of non-food biomass to support a resource-efficient Bioeconomy in Europe

## Sustainability Impact Assessment of a large bioproduct mill in Central Finland

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# Comparison

Category	Existing mill	Bioproduct mill
Investment size	NA	EUR 1.2 billion
Pulp production	0.5 mill. t	1.3 mill. t
Resource demand	2.4 mill. m <sup>3</sup> /a	6.5 mill. m <sup>3</sup> /a
Truck supplied	1 440 000 m <sup>3</sup> /a	4 001 000 m <sup>3</sup> /a
Railway supplied	621 000 m <sup>3</sup> /a	1 451 000 m <sup>3</sup> /a
Number of trucks	103/day	260/day
Number of trains	1-2/day	4/day
Employment	1,000	2,500
Electrical self sufficiency	135%	240%
Truck transport distance	121 km	195 km
Imports	5%	NA
PEFC	93%	NA

≈2,5

## Baseline scenario (2007)

- BAU scenario
- Existing mill operational
- Forest management unchanged

### Differences:

- Resource demand (ca. 4 000 000 m<sup>3</sup>)
- Forest management
- Transport distances

## Alternative scenario (2021)

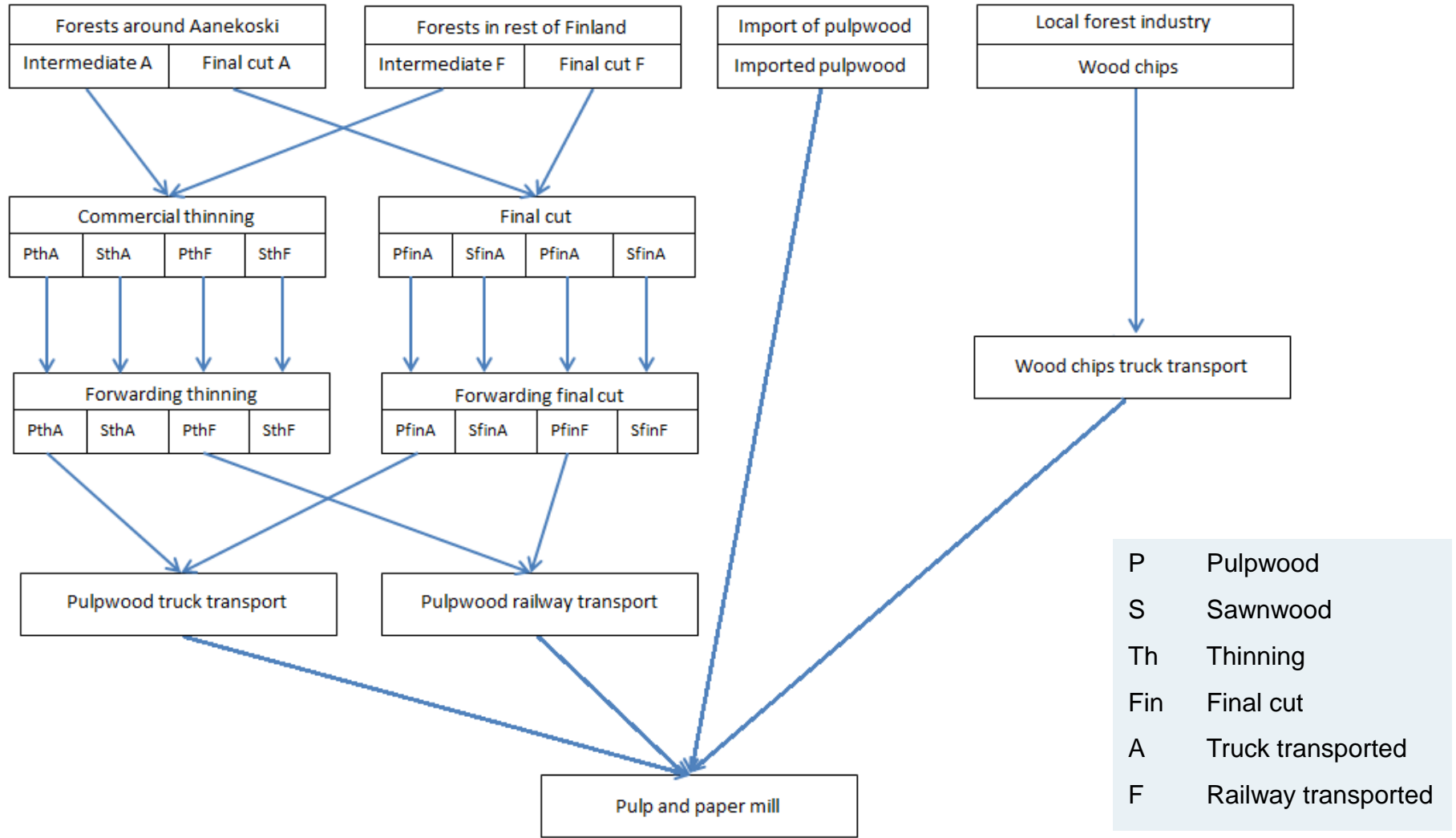
- Bioproduct mill operational
- Forest management intensified

### Similarities:

- Chain topology (classical pulp mill supply chain)
- Most of the processes indentically defined



# Supply chain topology



P	Pulpwood
S	Sawnwood
Th	Thinning
Fin	Final cut
A	Truck transported
F	Railway transported



## Baseline scenario (2007)

- “Realized cutting removals (TH)” scenario in MELA
- This scenario outlines the development of forest resources if the current (2011-2013) roundwood and energy wood harvesting levels are carried out into the future.
- Roundwood removals consist of industrial roundwood and roundwood for households harvested from the area in question.

## Alternative scenario (2021)

- “Maximum sustainable removal (SK)” scenario in MELA
- The maximum sustainable removal is defined by maximizing the net present value with 4 % discount rate subject to non-declining periodic total roundwood and energy wood removals, saw log removals and net income.
- There are no sustainability constraints concerning tree species, cutting methods, age classes or the growth/drain - ratio in order to efficiently utilize the dynamics of forest structure.



# List of processes

1. Forests around Äänekoski	MELA simulator
2. Forests in rest of Finland	MELA simulator
3. Commercial thinning	
4. Regeneration felling	<ul style="list-style-type: none"><li>• Berg and Karjalainen 1993 (productivity, fuel consumption, air pollution and GHG emissions)</li><li>• Eurostat (wages and labour costs)</li><li>• State of EU forests (number of fatal and non fatal accidents)</li></ul>
5. Forwarding of thinning logs	
6. Forwarding of regeneration felling logs	
7. Pulpwood truck transport	



## List of indicators:

- **S2Biom recommendations**
- **Scenario and case study characteristics**
- **Concerns voiced by different stakeholders**
- **Finnish bioeconomy cluster recommendations**
- **Selected indicators were compared with list of ToSIA indicators (DCP)**



- **Occupational accidents (fatal and non-fatal)**
- **Traffic accidents**
- **Total workplaces (employment absolute number)**
- **Labour costs**
- **Air pollution (NO<sub>x</sub>)**
- **GHG emissions**
- **Competition index**
- **Biodiversity index**
- **Transport distance trucks (loaded and unloaded)**

## Competition index

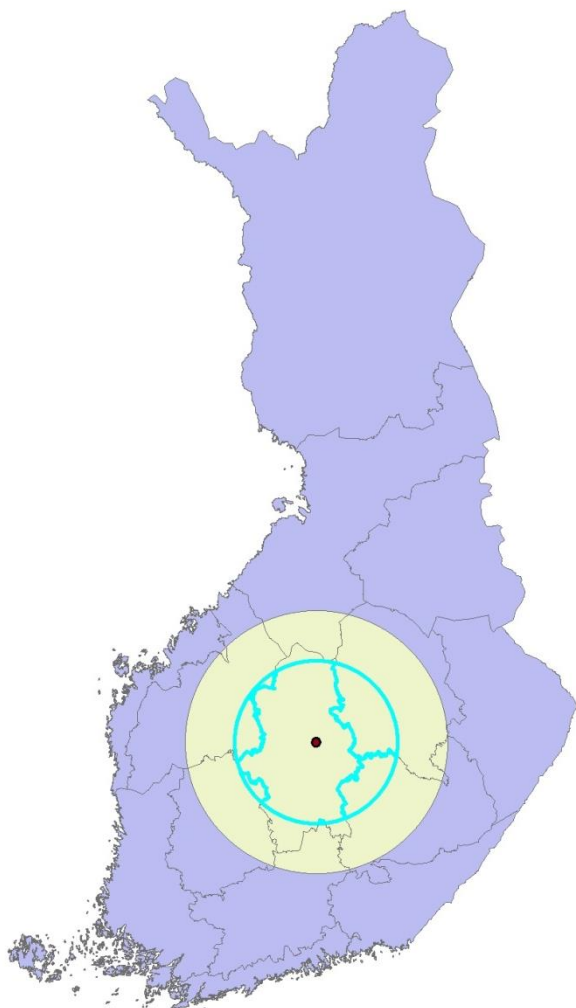
- Share of mill feedstock demand in totally available amount of resource.
- Calculated only for the truck supply area



## Biodiversity index

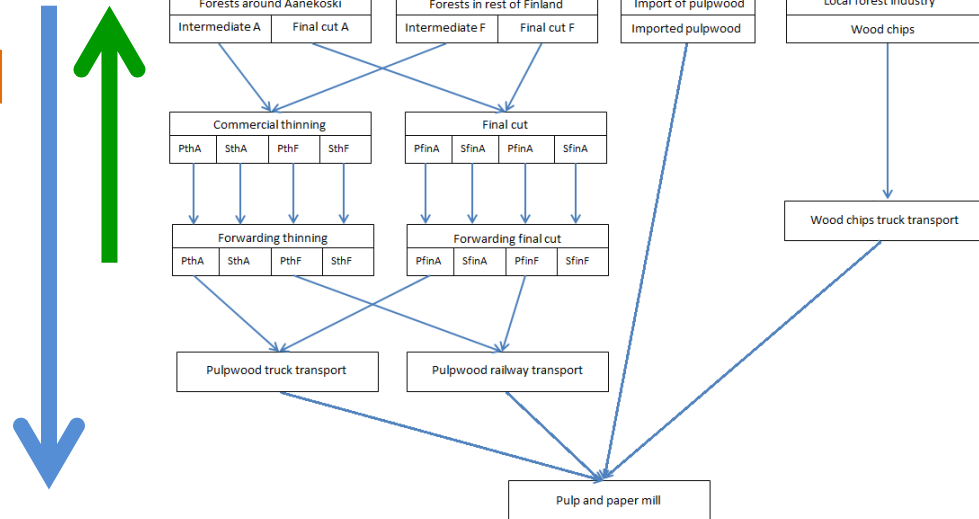
- Share of forests older than 100 years in total forest area.
- Calculated only for truck supply area
- Deadwood is a proxy indicator for invertebrate biodiversity, since it is a habitat for a wide array of organisms. The amount of deadwood is an excellent indicator of the conservation value of a forest. (EEA-European environment agency)
- Decaying wood in any stage is considered to be a key biodiversity element in managed forests and crucial for integrated forest management (Kraus and Krumm 2013).
- Old managed forests in Finland have higher share of deadwood than the younger stands (Uotila et al. 2001).

# Biodiversity and competition indices



Forestry center	Share of area (%)
Hame-Uusimaa	0,05
Pirkanmaa	2,94
Etela-Savo	14,31
Etela-pohjanmaa	8,63
Keski-Suomi	86,34
Pohjois-Savo	29,96
Forestry center	Share of area (%)
Rannikko	1,20
Hame-Uusimaa	17,67
Pirkanmaa	49,22
Etela-Savo	54,26
Etela-Pohjanmaa	53,70
Keski-Suomi	100,00
Pohjois-Savo	78,43
Pohjois-Karjala	0,02
Pohjosi-Pohjanmaa	9,91

- **Pulpwood harvested together with sawnwood**
- **Split share ratios and initialization data calculated from bottom up**
- **Indicator calculation calculated from the top down**



**!** → **Region**  
→ **Cut type**  
→ **Assortment share**

# Results (socio-economic)

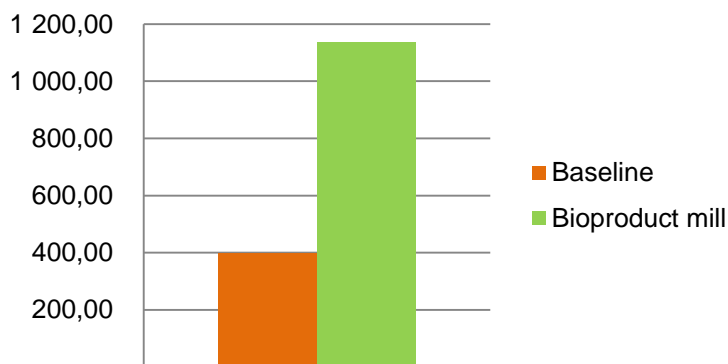
## Total workplaces

Value	Baseline	Bioproduct mill
Total	398,10	1135,59
per m <sup>3</sup>	0.0001693	0.0001674
Delta	737.49	
Ratio	2.85	

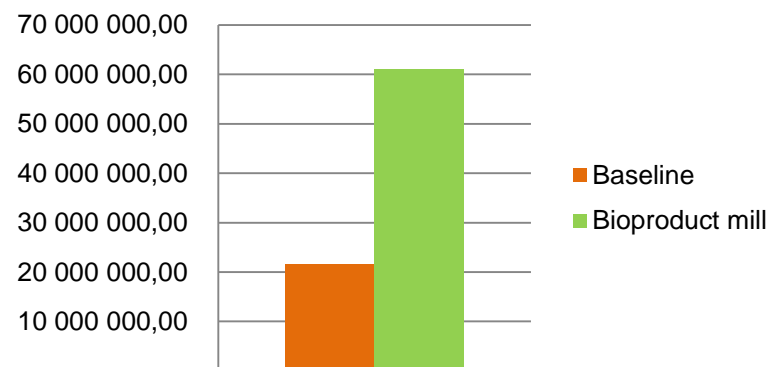
## Labour costs

Value	Baseline	Bioproduct mill
Total (€)	21 524 871	60 978 012
€ per m <sup>3</sup>	9.16	8.99
Delta	39 453 141.73	
Ratio	2.83	

### Total workplaces



### Labour costs (€)



# Results (social)

## Occupational accidents fatal

Value	Baseline	Bioproduct mill
Total	0,05	0,13
per m <sup>3</sup>	0	0
Delta	0.08	
Ratio	2.63	

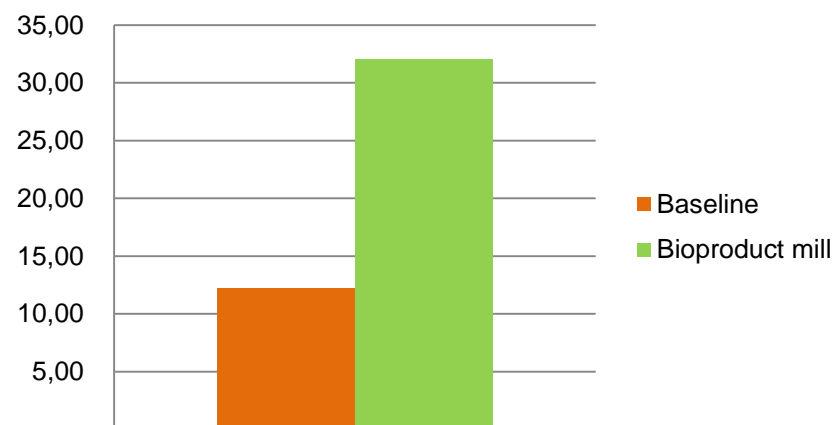
## Occupational accidents non-fatal

Value	Baseline	Bioproduct mill
Total	12.21	32.05
per m <sup>3</sup>	0.0000052	0.0000047
Delta	19.85	
Ratio	2.63	

## Traffic accidents

Value	Baseline	Bioproduct mill
Total	0.55	<b>2.45</b>
per m <sup>3</sup>	0.0000002	0.0000004
Delta	1.91	
Ratio	<b>4.48</b>	

## Occupational accidents



# Results (environmental)

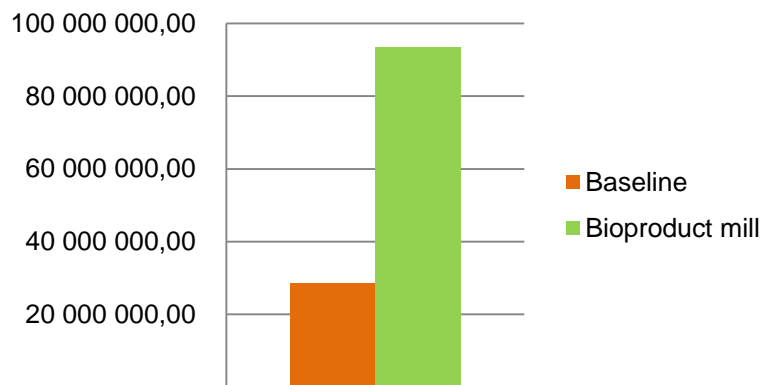
## GHG emissions

Value	Baseline	Bioproduct mill
Total	28 387 839.13	93 332 856.63
per m <sup>3</sup>	12.07	<b>13.76</b>
Delta	64 945 017.50	
Ratio	<b>3.29</b>	

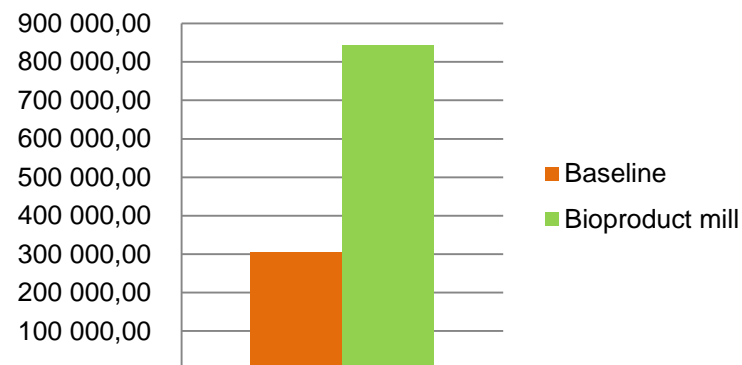
## Air pollution (NO<sub>x</sub>)

Value	Baseline	Bioproduct mill
Total	303 708.96	843 161.40
kg per m <sup>3</sup>	0.13	0.12
Delta	539 161.40	
Ratio	2.78	

### GHG emissions



### Air pollution





## Truck transport distance (km)

Value	Baseline	Bioproduct mill
Loaded	121	195
Unloaded	45.38	73.13
Radius	93	150
Delta	74.00	

Average truck speed							
Full load				Empty			
Road type	speed (km/h)	share		Road type	speed (km/h)	share	
asphalt	66	0,9	59,4	asphalt	66	0,78	51,48
gravel	27	0,08	2,16	gravel	34	0,12	4,08
forest road	9	0,02	0,18	forest road	13	0,1	1,3
w average speed			61,74	w average speed			56,86

	Loaded travel	Empty travel	SUM	Unit
Distance	121	45,375	166,375	km
Hours	1,959831552	0,798012663	2,757844214	h
Productivity	17,47741941			m3/h

	Loaded travel	Empty travel	SUM	Unit
Distance	195	73,125	268,125	km
Hours	3,15840622	1,286053465	4,44446	h
Productivity	10,84496			m3/h

# Biodiversity index

- **Share of forests older than 100 years in total forest area.**
- **Calculated only for truck supply area of the bioproduct mill**
- **Old managed forests in Finland have higher share of deadwood than the younger stands (Uotila et al. 2001.).**
- **Deadwood is a proxy indicator for invertebrate biodiversity, (EEA-European environment agency)**
- **Decaying wood in any stage is considered to be a key biodiversity element in managed forests.**

Value	Baseline	Bioproduct mill
Total	10.7%	7.5%

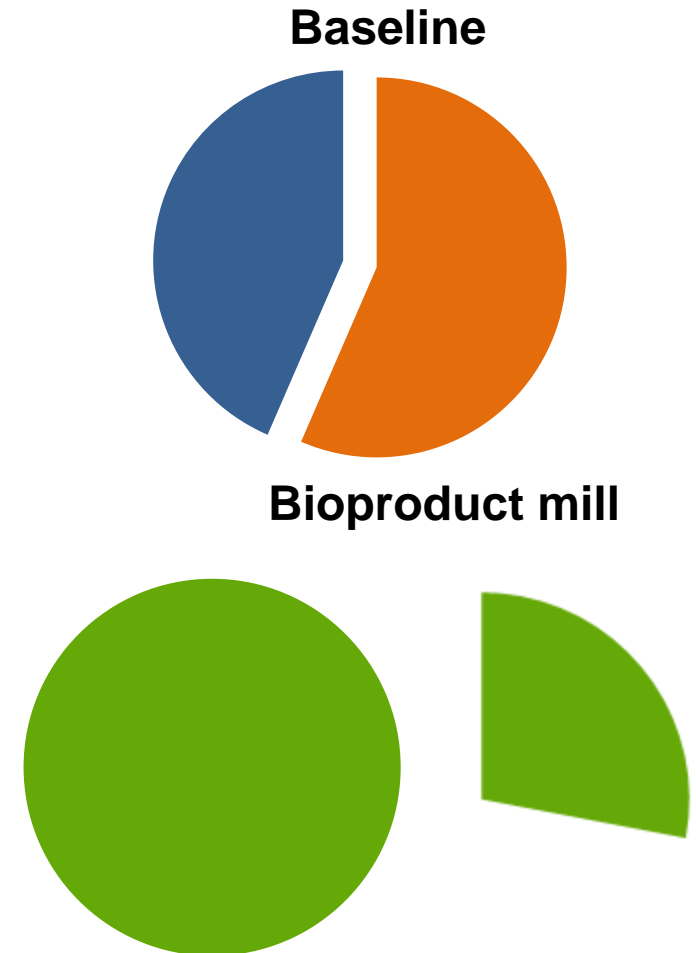
Forests in Central Finland already very intensively managed!



# Competition index

- **Share of mill feedstock demand in totally available amount of resource.**
- **Calculated only for the truck supply area**

Value	Baseline	Bioproduct mill
Total	56.51%	128.90%
Delta	72.39%	



- **Positive effects on employment and local economy**
- **Negative impact on biodiversity indicator chosen**
- **Negative impacts that are proportional to increase in productivity on number of traffic and workplace accidents, air pollution and GHG emissions.**
- **Negative impacts on availability of raw material for competing uses within truck supply area.**

