The Carbon Footprint of Wood Chips for Energy Recovery

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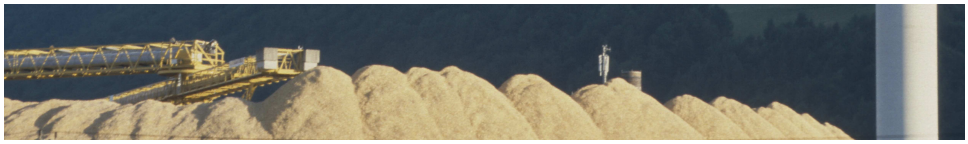

LCA of wood chips was part of the project:

Supply of forest wood chips:

economical and environmental assessment (LCA) of current supply chains

(3 years; Budget: 500.000 €)

Main task of the project was to identify the strengths and weaknesses of current supply chains as well as assessing their economical and environmental impacts.

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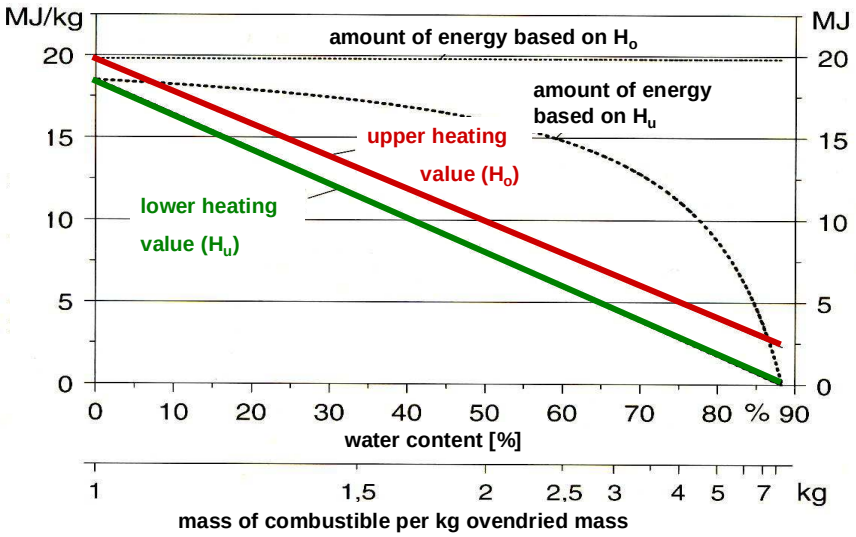
Relationsship between heating values and water content



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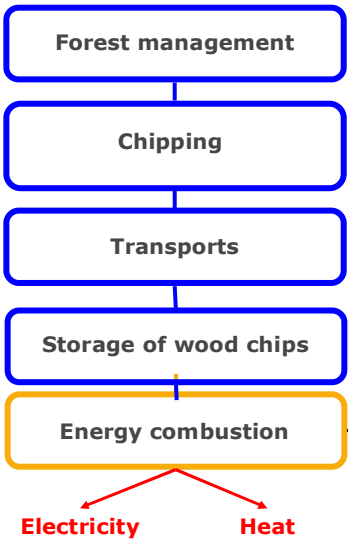
Supply chain – modules of investigation (LCA)



different harvesting and hauling systems were investigated

steady state chipping and mobil chipping on the forest roads

transport by tractors and different trucks

loss of mass and heating value eg. by fungi

Ash treatment

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ZiB1

Harvesting traditional

ZiB2

Harvesting and hauling - mechanized

Folie 5

ZiB1 Bernhard Zimmer; 22.07.2009

Folie 6

ZiB2 Bernhard Zimmer; 22.07.2009

Feller-buncher-sytems - thinnings

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Bunching of forest residues

Wood chips – forest chips

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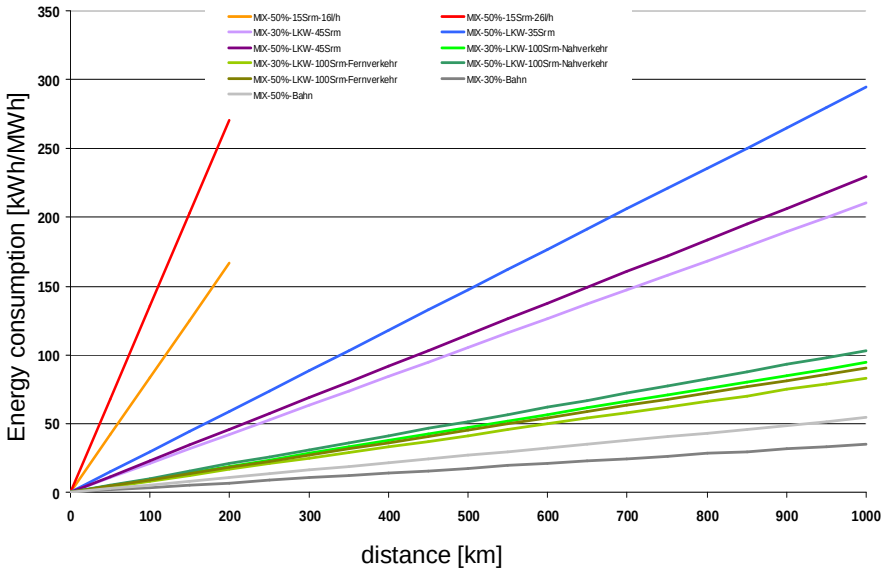
Chipping

Transport by tractor and agricultural systems

Transport by trucks

Transport by railway – long distance transports

Transports: specific primary energy consumption



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Combined heat and power generation (up to 60 MW)

Das Biomasse-Heizkraftwerk Schilling in Schwendi – ein Gesamtkunstwerk Fotos: Ilsleib

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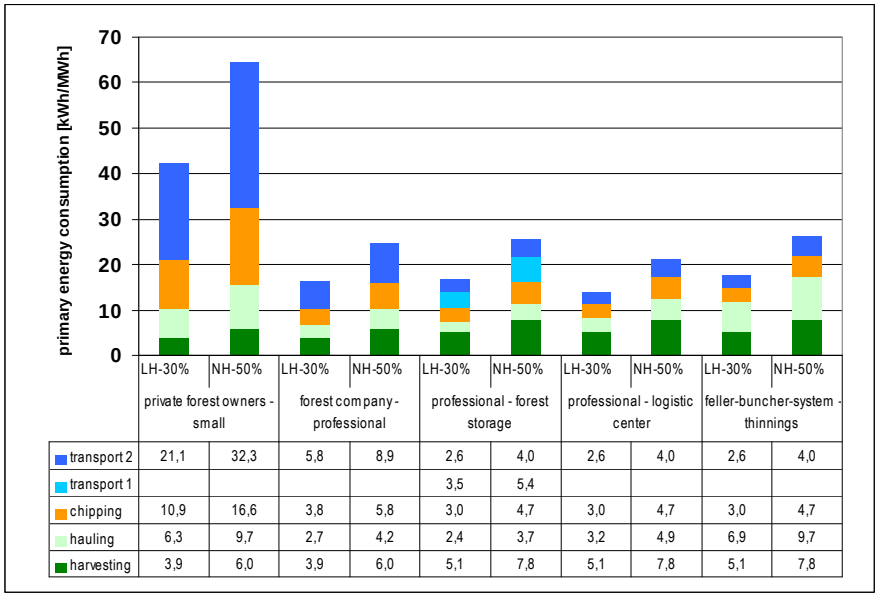
Specific primary energy consumption



	LH-30%	NH-50%	LH-30%	NH-50%	LH-30%	NH-50%	LH-30%	NH-50%	LH-30%	NH-50%
	private forest owners - small		forest company - professional		professional - forest storage		professional - logistic center		feller-buncher-system - thinnings	
transport 2	21,1	32,3	5,8	8,9	2,6	4,0	2,6	4,0	2,6	4,0
transport 1					3,5	5,4				
chipping	10,9	16,6	3,8	5,8	3,0	4,7	3,0	4,7	3,0	4,7
hauling	6,3	9,7	2,7	4,2	2,4	3,7	3,2	4,9	6,9	9,7
harvesting	3,9	6,0	3,9	6,0	5,1	7,8	5,1	7,8	5,1	7,8

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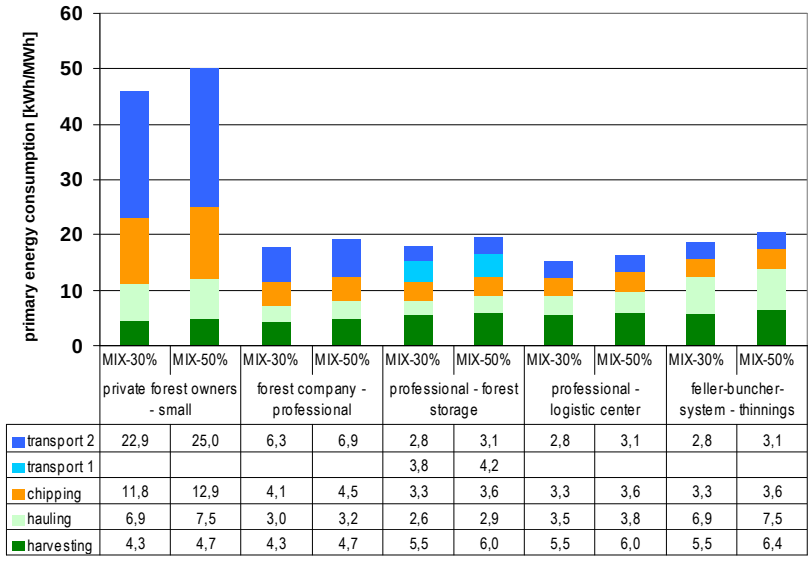
Specific primary energy consumption



	MIX-30%	MIX-50%	MIX-30%	MIX-50%	MIX-30%	MIX-50%	MIX-30%	MIX-50%	MIX-30%	MIX-50%
	private forest owners - small		forest company - professional		professional - forest storage		professional - logistic center		feller-buncher-system - thinnings	
transport 2	22,9	25,0	6,3	6,9	2,8	3,1	2,8	3,1	2,8	3,1
transport 1					3,8	4,2				
chipping	11,8	12,9	4,1	4,5	3,3	3,6	3,3	3,6	3,3	3,6
hauling	6,9	7,5	3,0	3,2	2,6	2,9	3,5	3,8	6,9	7,5
harvesting	4,3	4,7	4,3	4,7	5,5	6,0	5,5	6,0	5,5	6,4

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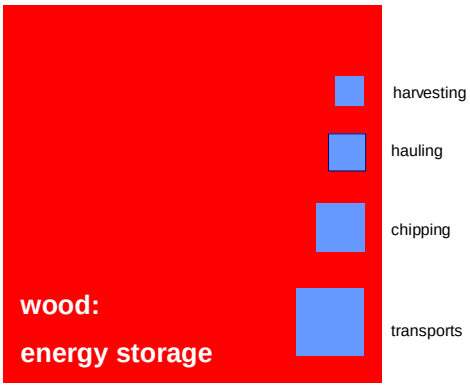
Primary energy consumption versus H_u

softwood – water content x=50%)

scenario: „private forest owners“



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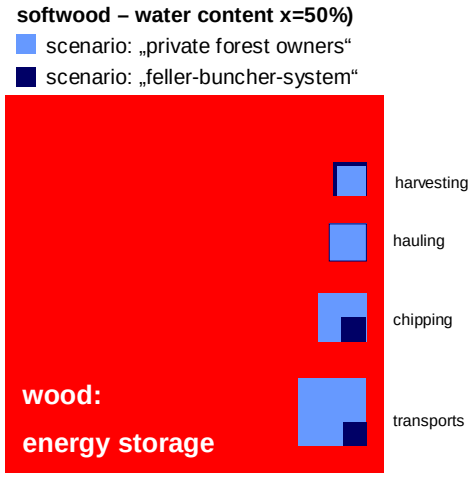
Primary energy consumption versus H_u



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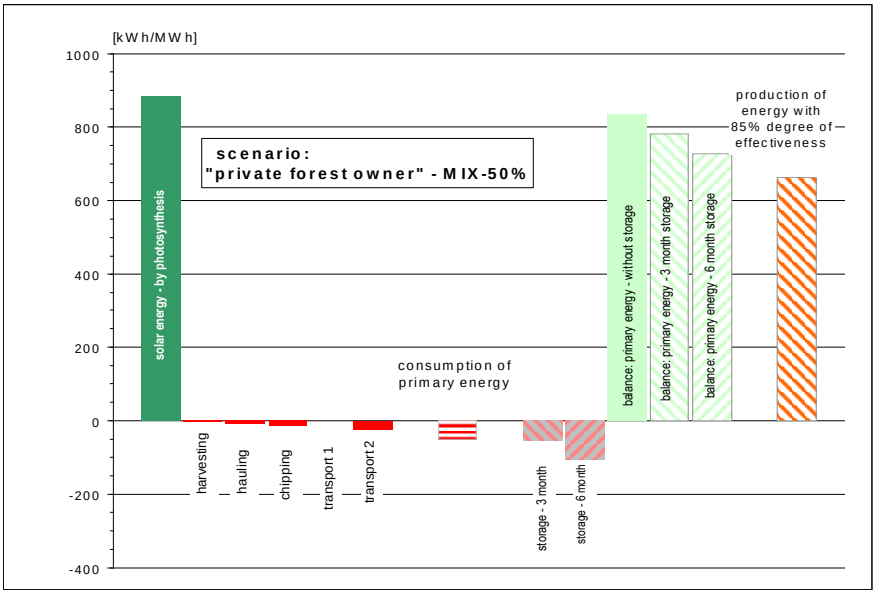
Energy balance of the supply chain



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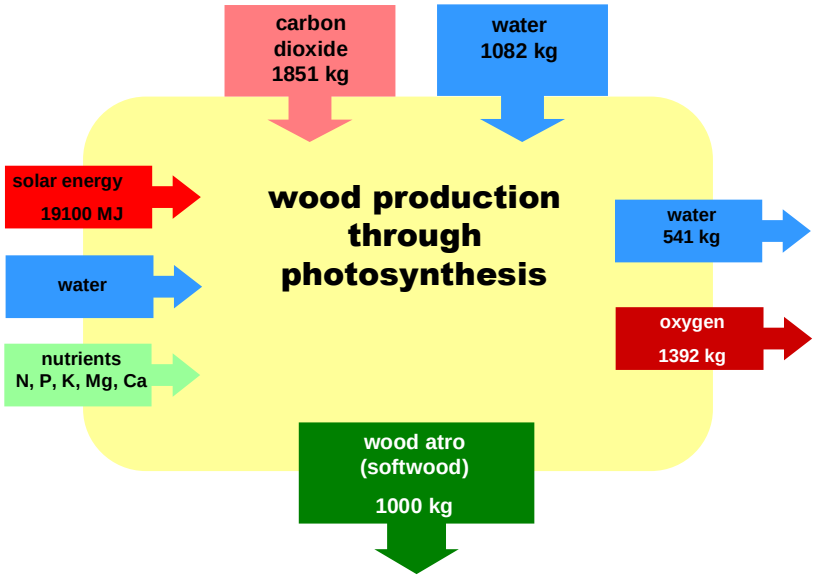

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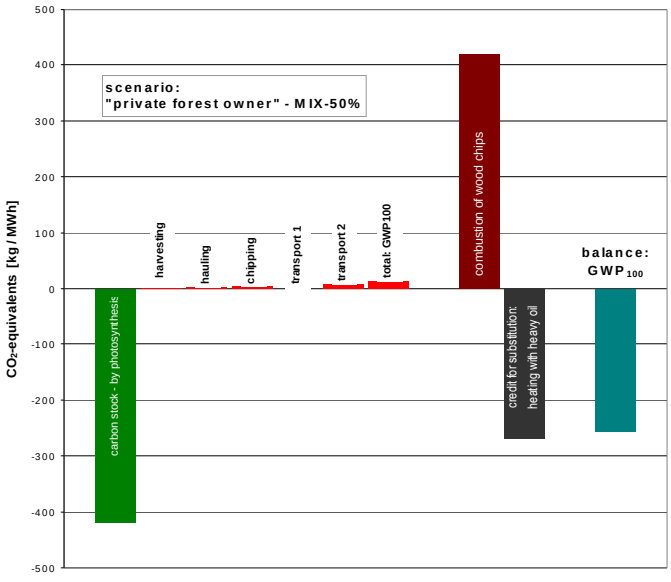
Global warming potencial – GWP_{100}



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Conclusions

Energy from wood chips is not only renewable and so called „CO_2-neutral“.

Energy from wood has the additional benefit of the substitution of fossil fuels (e.g. heating-oil, natural gas) and therefore an „C-plus-effect“.

From worldwide point of view: as long as any energy is produced by fossil fuels this substitution effect can be considered.

The carbon footprint can take negative values. This shows the importance of wood utilization in connection with the discussion on climate change.

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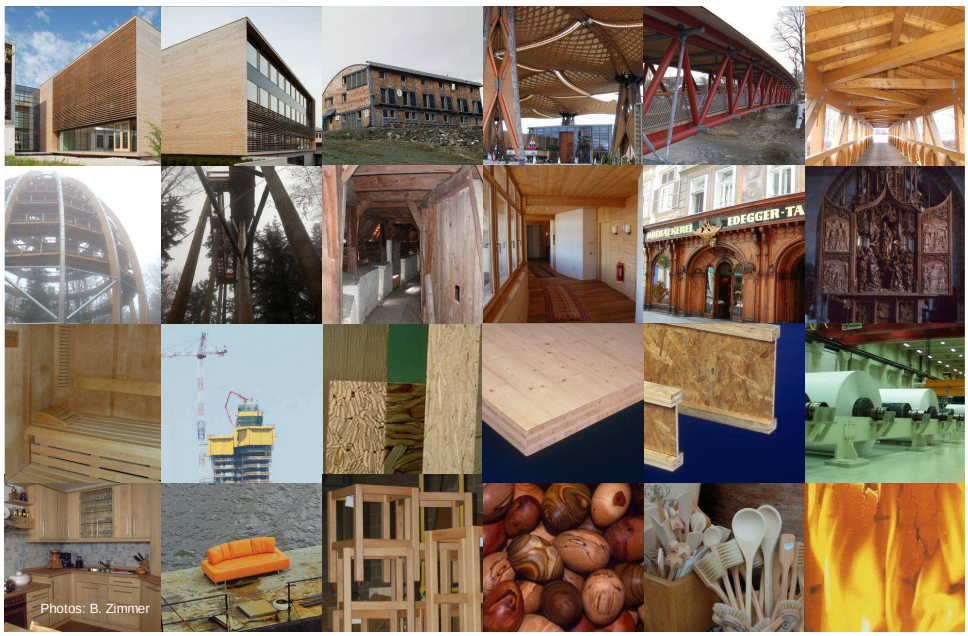
Thank you for your attention



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Composition of Wood

©B

One ton of $wood_{otro}$:

- 500 kg carbon
- 430 kg oxygen
- 60 kg hydrogen
- 10 kg other elements

Wood production through photosynthesis

Photosynthesis:

$$6\ CO_2 + 12\ H_2O \rightarrow C_6H_{12}O_6 + 6\ O_2 + 6\ H_2O$$

Theoretical approach

to the calculation of material flows in the wood formation process:

$$8{,}4\ CO_2 + 12\ H_2O \rightarrow C_{8,4}H_{12}O_{5,4} + 8{,}7\ O_2 + 6\ H_2O$$

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Forestry

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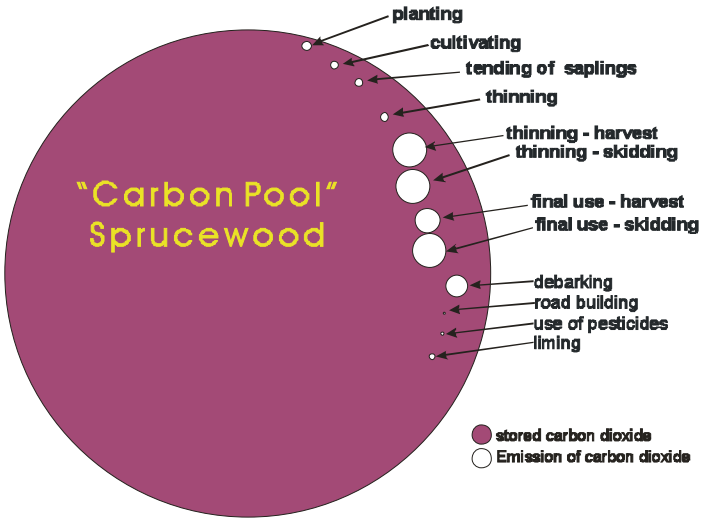
Roundwood



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Transports

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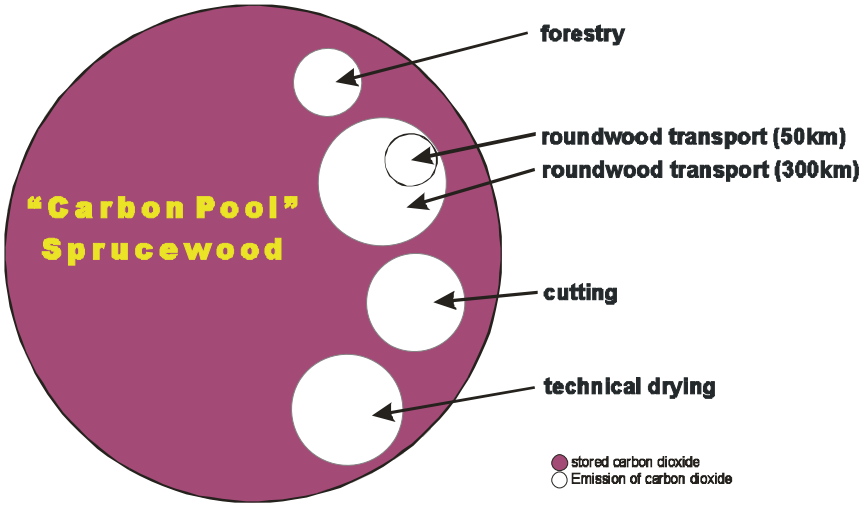
Sawn timber



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