



Carbon Fibres from Lignin - Lignin Replaces Oil and Steel

Peter Axegård

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INNVENTIA

Biorefinery – Simultaneous production of fibres, energy and chemicals

More value from wood

Biorefinery is the solution

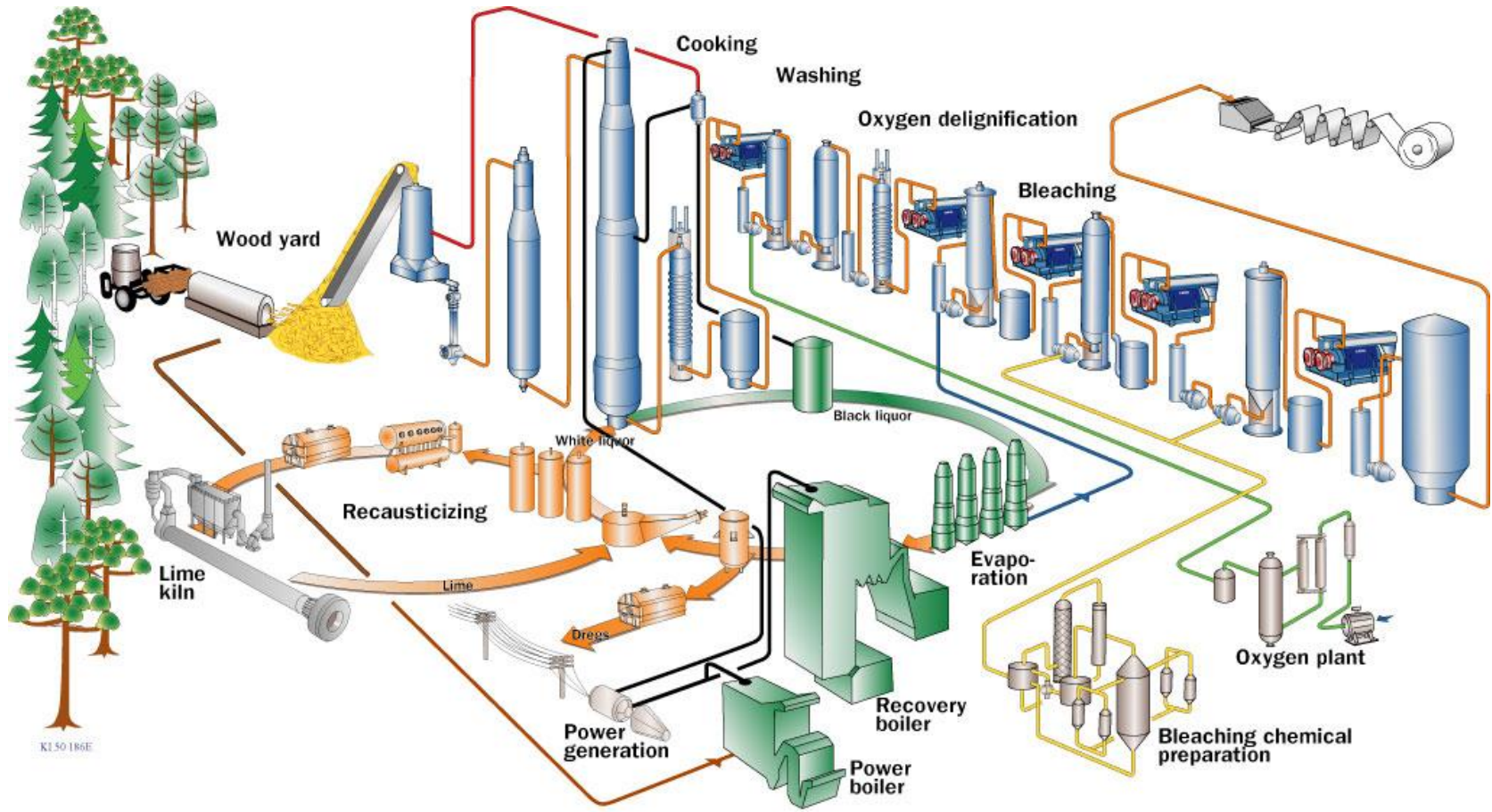
- New pulp mill products

Innventia approach

- Kraft/soda pulp mill platform
- Focus on the major components
- Efficient separation processes



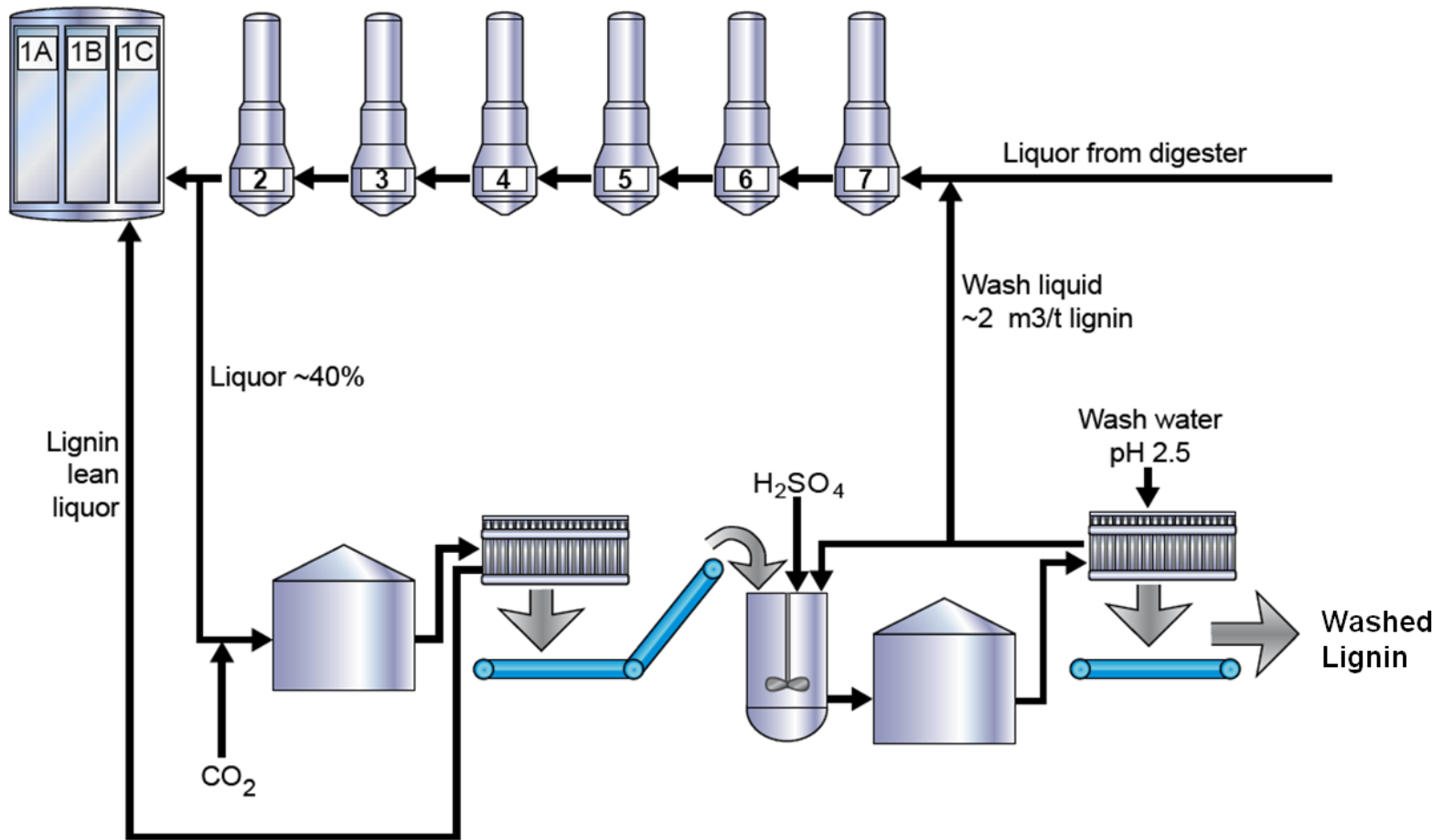
Kraft pulping process is a biorefinery platform



Global lignin potential 2012

Fibre type	Lignin potential kg/ADt	Lignin potential Mtonnes/year
Market HW	225	6.3
Market SW	325	7.8
Integrated pulp	225	25.9
Total		40

Lignin Production with the LignoBoost Technology



Source: Metso

Lignin from LignoBoost demonstration plant

Carbon	64 - 66
Sodium	0.05 - 0.4
Ash	0.3 - 1
Carbohydrates	0.5-1.5



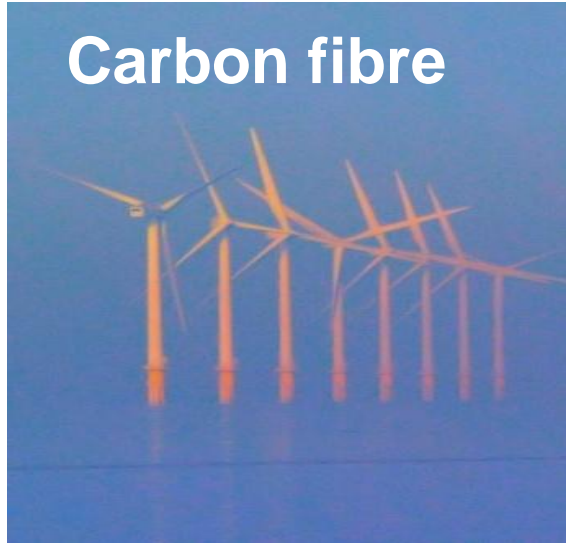
Elimination of oil in pulp mills

In Sweden 300.000 tonnes oil/y

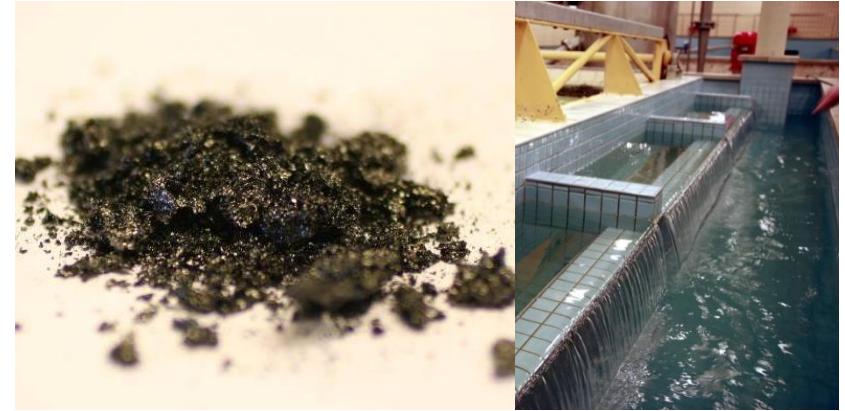


Kraft lignin – non-energy applications

Carbon fibre



Activated carbon



Fibre boards



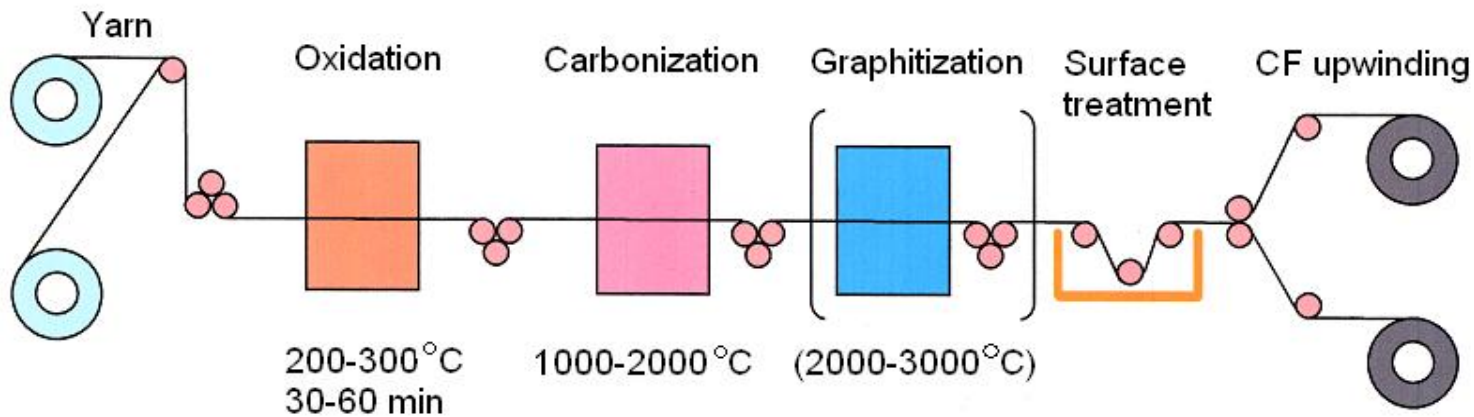
Asphalt emulsions



Carbon fibres manufacturing process

- **Continuous process in several steps**

- Mainly PAN or pitch
- > 90% carbon

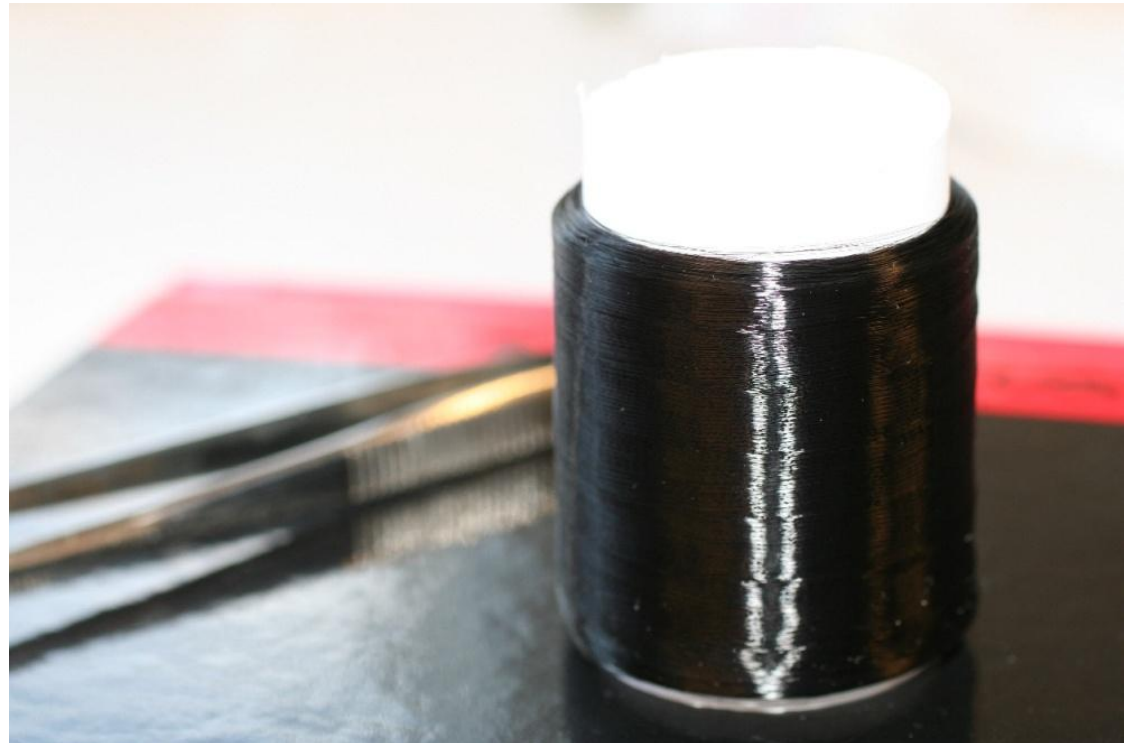


- **Non-renewable raw material**
- **45-60% of the cost**

Carbon fibres from softwood lignin

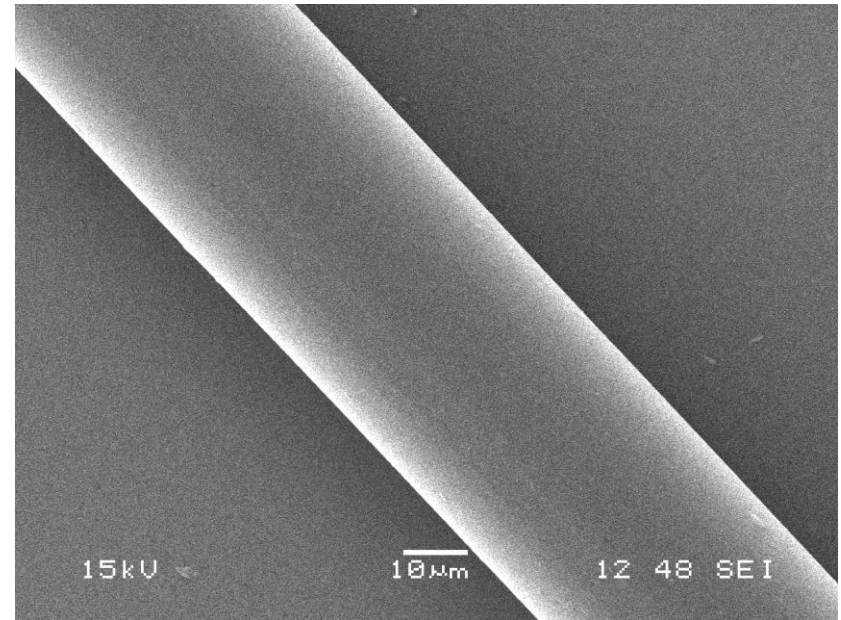
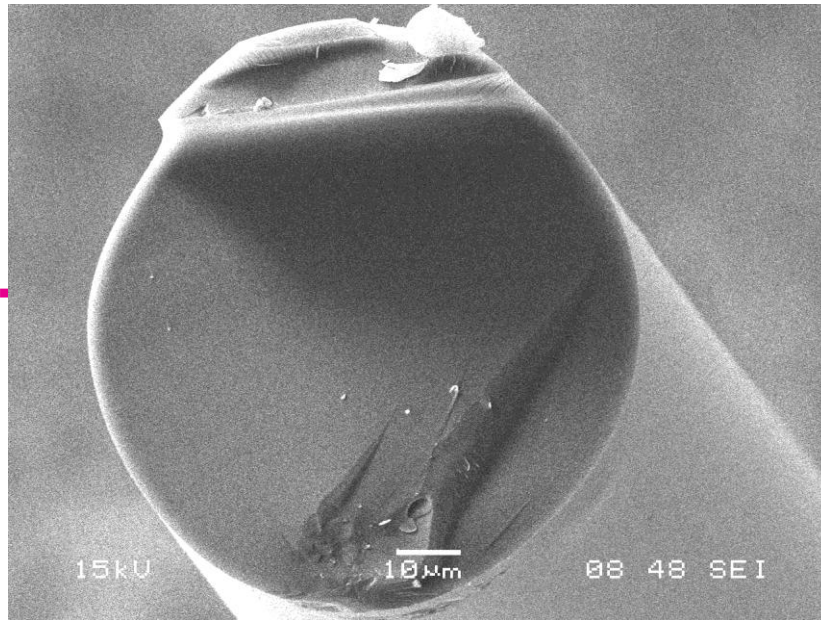
Melt spinning

- Laboratory extruder
- 3-100% lignin based softening agent



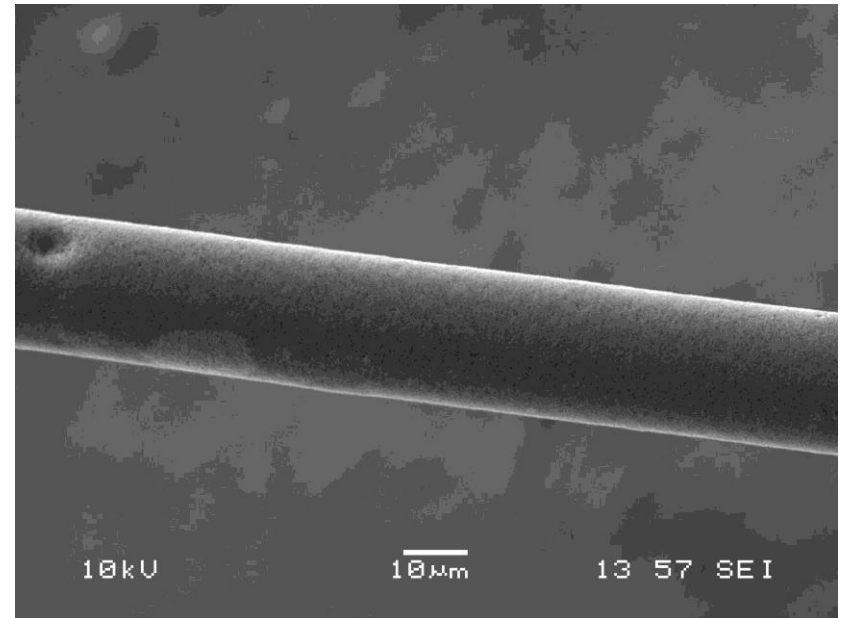
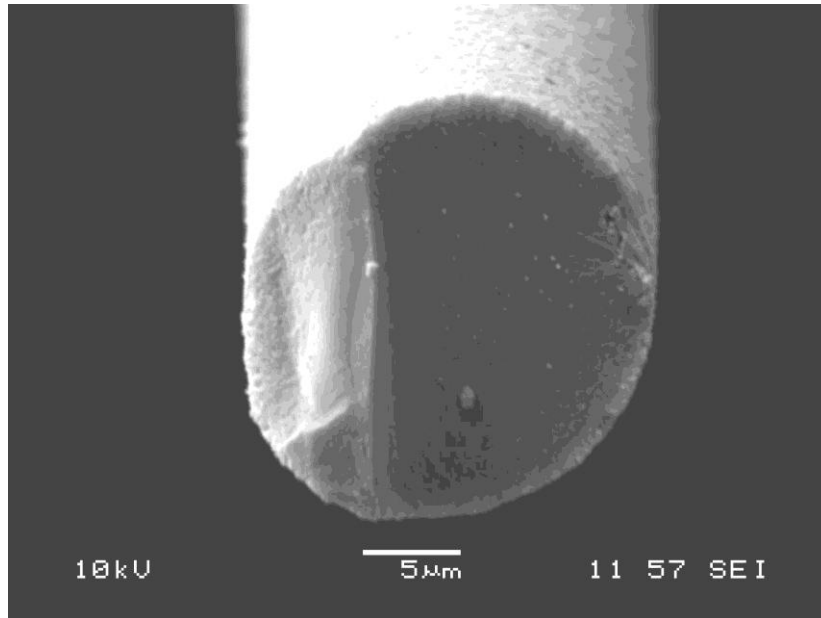
Softwood lignin fibres

- Homogeneous
- No pores or inclusions



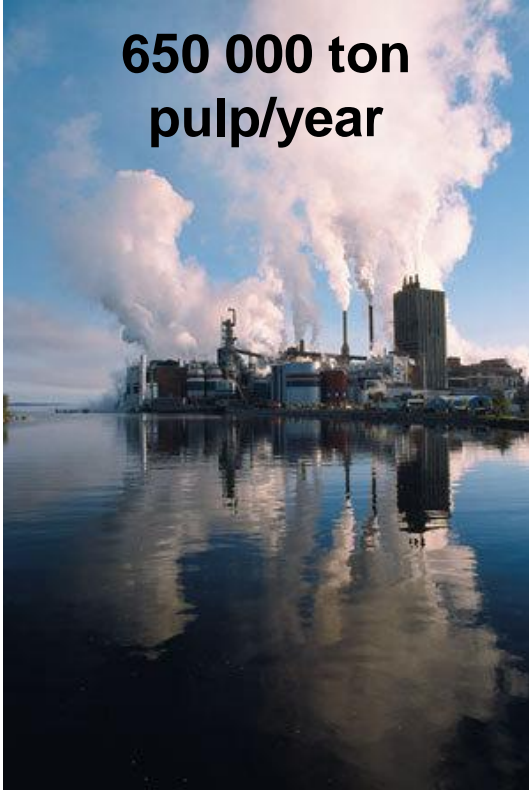
Carbon fibres from softwood lignin

- Homogeneous
- Some irregularities at the surface



Lignin can make a difference

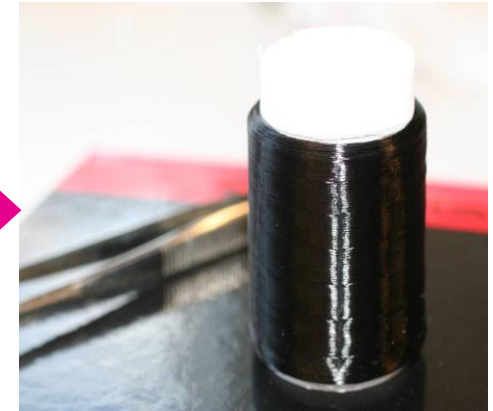
**650 000 ton
pulp/year**



**10% lignin
extracted**



**... 16 000 ton carbon
fibres**



**...can replace 40 %
steel in 160.000 cars**



Conclusions

- Lignin can replace oil as a fuel
- By replacing steel in cars 50 TIMES more oil can be saved
- LignoBoost lignin can be melt extruded to lignin fibres
- Carbon content 90 - 97%
- Huge potential in future light weight cars



Mass Balance in a Kraft Pulp Mill,

Organic substances in pulp and black liquor in kg

	SW	Birch	Euca	
Pulp fibres	1000	1000	1000	
Dissolved organic substances in black liquor				
Lignin	600	470	440	2/3 can be removed
Xylan	70	260	210	50 % can be removed

- **Cellulose fibres - main product**
- **Added value from other components- especially lignin**

Wood/plants – a Mine for Valuable Polymers

- lignin

	<i>Softwoods</i>		<i>Hardwoods</i>		<i>Agro/annual</i>	
	<i>Spruce</i>	<i>Pine</i>	<i>Euca. glob.</i>	<i>Euca. urogr.</i>	<i>Hemp</i>	<i>Bagasse</i>
Lignin, %	27	28	24	29	25	22

Physical/chemical properties vary with species and process

The LignoBoost Process

- **Process for production of lignin from kraft pulp mills**
- **Sold to Metso 2008**
- **High market potential**

Global kraft pulp fibre demand 2012

Fibre type	Mtonnes/ year
Market HW	28
Market SW	24
Integrated pulp	115
Total	167

Source: Metso/RISI Outlook Briefings November 2010

LignoBoost lignin – a new product

Typical fuel lignin composition, %

Carbon	64 - 66
Sodium	0.05 - 0.4
Ash	0.3 - 1
Sulphur	1 - 3
Nitrogen	0.05- 0.1
Carbohydrates	0.5-1.5

Purity can easily be improved if needed

Carbon fibres

Increasing demand for high-tech applications



Lignin based carbon fibres

