

Carbon Fiber from Renewable Raw Materials

Carbontech Live Webinar: Development and Applications of Green Composites

July 9th 2020

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CORDENKA

THE RENEWABLE MATERIALS COMPANY

The topics of this presentation



- A brief introduction to Stora Enso and Cordenka GmbH & Co. KG
- Carbon fiber from a tree by Stora Enso, Neofibre™
 - Technology
 - Value proposition
 - Expected performance at commercial scale
- Drivers for decreasing greenhouse gas emission levels
- Effect of Carbon Fiber on CO₂ footprint – Case: Wind energy rotor blade
- Conclusions



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A brief introduction to Stora Enso and Cordenka

CORDENKA®

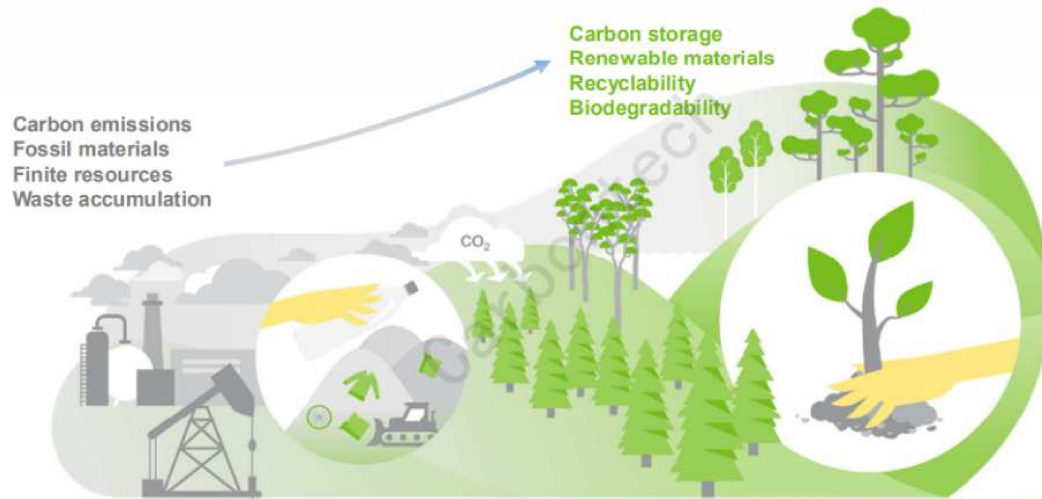
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It all starts in the forest



From a fossil world to a renewable future



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Stora Enso's divisions



Packaging Materials



Packaging Solutions



Biomaterials



Wood Products



Forest



Paper

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Stora Enso in brief

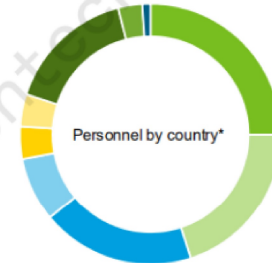


Sales in 2019
EUR 10.1 billion



■ Europe 73%
■ Asia Pacific 17%
■ North America 3%
■ South America 2%
■ Other 5%

Employees
26 000



■ Finland 25%
■ Sweden 20%
■ China 19%
■ Poland 8%
■ Germany 4%
■ Russia 4%
■ Other Europe 16%
■ Americas* 3%
■ Other countries 1%

Shares listed on Nasdaq
in Helsinki and Stockholm

*Including employees of our 50%-owned joint operations Veracel and Montes del Plata

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Cordenka in brief



Sales
EUR 170 million



Employees
700

Capacity
32.000 t
(55% of global Rayon capacity)



Product
Rayon yarn for
- UHP tires
- Hoses
- Carbon fibre
- Composites



Raw Material
100% from wood



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Carbon Fiber Development at Stora Enso

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High performance CF from forest-based raw materials proven at lab scale

- Stora Enso is developing technology for manufacturing high-performing carbon fiber with low carbon footprint from forest-based raw materials, cellulose and lignin
- Present R&D results indicate that performance levels of standard modulus and high modulus carbon fibers can be achieved.
- The process is scalable as it is based on unit operations that are employed today by different industries
- Stora Enso is upscaling the process and is building partnerships with experts along the value chain

Produced at laboratory scale:



Precursor stabilized fiber carbon fiber

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Our value proposition

Neofibre™ is a novel carbon fiber with

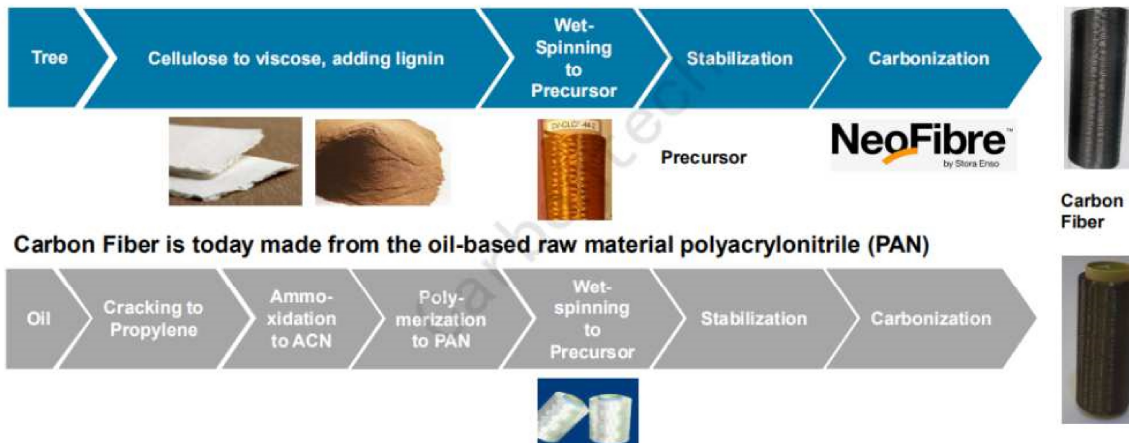
- ⇒ high performance
- ⇒ at competitive price
- ⇒ at low carbon footprint
- ⇒ based on renewable raw materials



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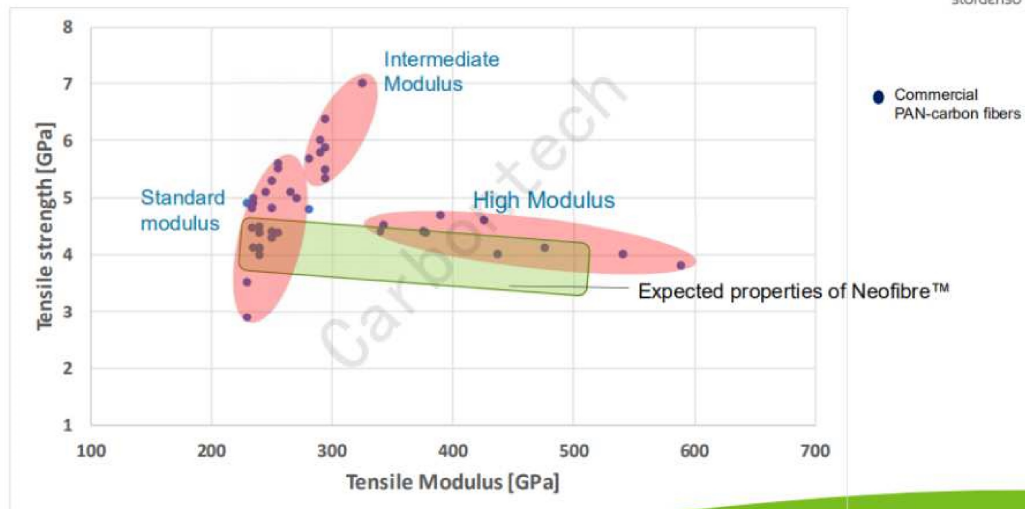
Carbon fiber from a tree by Stora Enso: NeoFibre™



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Expected performance for Neofibre™ by Stora Enso



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Upscaling the process with partners



- Pilot-scale precursor spinning at Cordenka GmbH & Co KG
 - Leading supplier of high-performance industrial rayon
 - JDA signed in March 2020
 - Cooperation announced in press release 06.05.2020
- Thermal conversion to carbon fiber at the Institute of Lightweight Engineering and Polymer Technology (ILK) at the Technical University of Dresden
- The objective is to have a throughput rate of 20 kg high-performance CF per year for first material qualification tests



ILK Institut für
Leichtbau und
Kunststofftechnik

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Precursor fibre at pilot scale from Cordenka



Laboratory scale



Pilot scale

Drivers for decreasing greenhouse gas emission levels

EU 2030 climate and energy framework



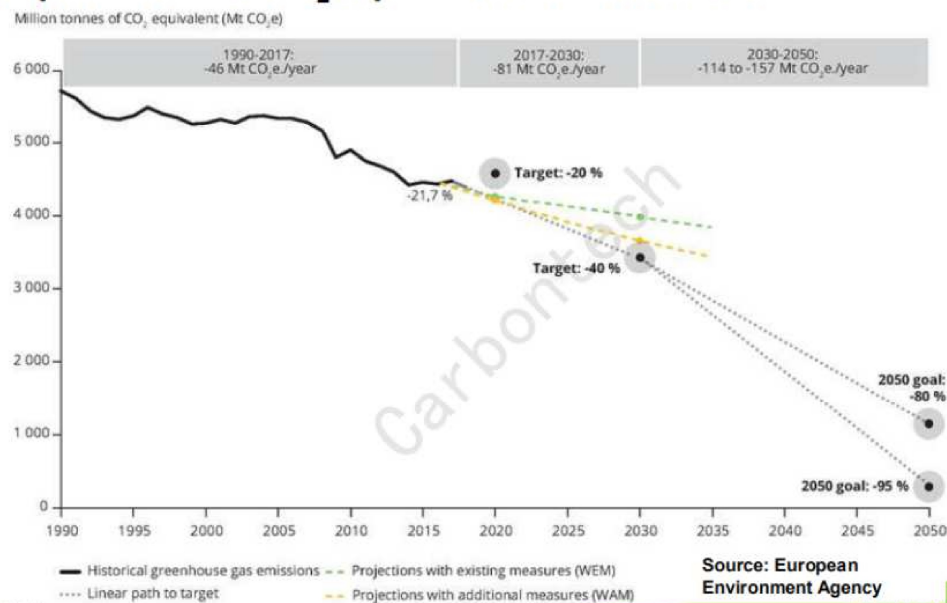
- EU's contribution to Paris Agreement (keeping temperature increase below 1,5 °C)
- At least 40% cuts in greenhouse gas emissions by 2030 (from 1990 levels)
- Member States are required to adopt integrated national energy and climate plans (NECPs) for the period 2021-2030.
- EU sets a total limit for greenhouse gases companies can emit each year and requires **monitoring** and **reporting** of these emissions
- **A fixed number of allowances** are issued for each company and each year companies must hold enough allowances to cover their emissions - or face significant penalties.

Source: https://ec.europa.eu/clima/policies/strategies/2030_en

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Development of EU CO₂ equivalent emission levels



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Climate change is fundamentally reshaping the world of finance



- Climate change makes the world unpredictable
 - Can cities afford infrastructure needs as climate risk reshapes the market for municipal bonds
 - What will happen to long-term mortgage – a key building block of finance – if lenders can't estimate the impact of climate risk over such a long timeline
 - What happens to inflation, and in turn interest rates, if the cost of food climbs from drought and flooding?

⇒ Climate Risk is Investment Risk

- Profound reassessment of risk and asset values
- Sustainability has become integral to portfolio construction and risk management

<https://www.blackrock.com/se/individual/larry-fink-ceo-letter>

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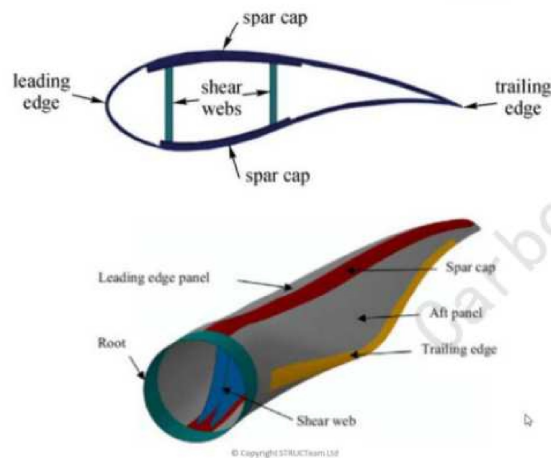
Impact of Carbon Fiber on CO₂ footprint Case: Wind energy rotor blade Cradle-to-gate



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Design of a wind energy rotor blade



- Spar caps can be made from glass fiber or carbon fiber
- 20% of global carbon fiber demand is used for this specific application
- Carbon fiber increases stiffness and makes it possible to design larger, lighter and thinner blades with better aerodynamics
- This gives a higher energy output for the mill and decreases the Cost of Energy

Carbon footprint of some construction materials

Material	Embodied CO ₂ eq. (kg CO ₂ /kg material)	Source
Carbon Fiber	30	http://www.elgcf.com/assets/documents/ELGCF-Presentation-Composite-Recycling-LCA-March2017.pdf
Glass Fiber	1,5	https://www.glassfibreeurope.eu/wp-content/uploads/2016/11/LCA-report-CFGF-products_20161031_PwC.pdf
Stainless steel, (75% recycled)	1,9	https://www.worldstainless.org/files/issf/non-image-files/PDF/ISSF_Stainless_Steel_and_CO2.pdf
Aluminum (30% recycled)	13,5	https://ec.europa.eu/clima/sites/clima/files/ets/allowances/docs/bm_study-aluminium_en.pdf

Effect of carbon fiber on CO₂ footprint of 80 m rotor blade



- Using carbon fiber for spar caps instead of glass fibre
 - Lowers blade weight from 35 tons to 30 tons
 - Increases CO₂ footprint of rotor blade by 35%

Conclusions



- Global trend towards tighter mandatory CO₂ reduction targets to achieve the goals of the Paris Agreement
- Investors have recognized that climate risk means investment risk. Sustainability has become integral to portfolio construction and risk management
- Today's carbon fiber has a very high carbon footprint compared to other construction materials and may significantly increase the carbon footprint of the final product.
- Stora Enso is developing Neofibre™ a novel carbon fiber with low carbon footprint together with industrial partners
- The Joint Development Project with Cordenka GmbH & Co. KG is an important step in that direction