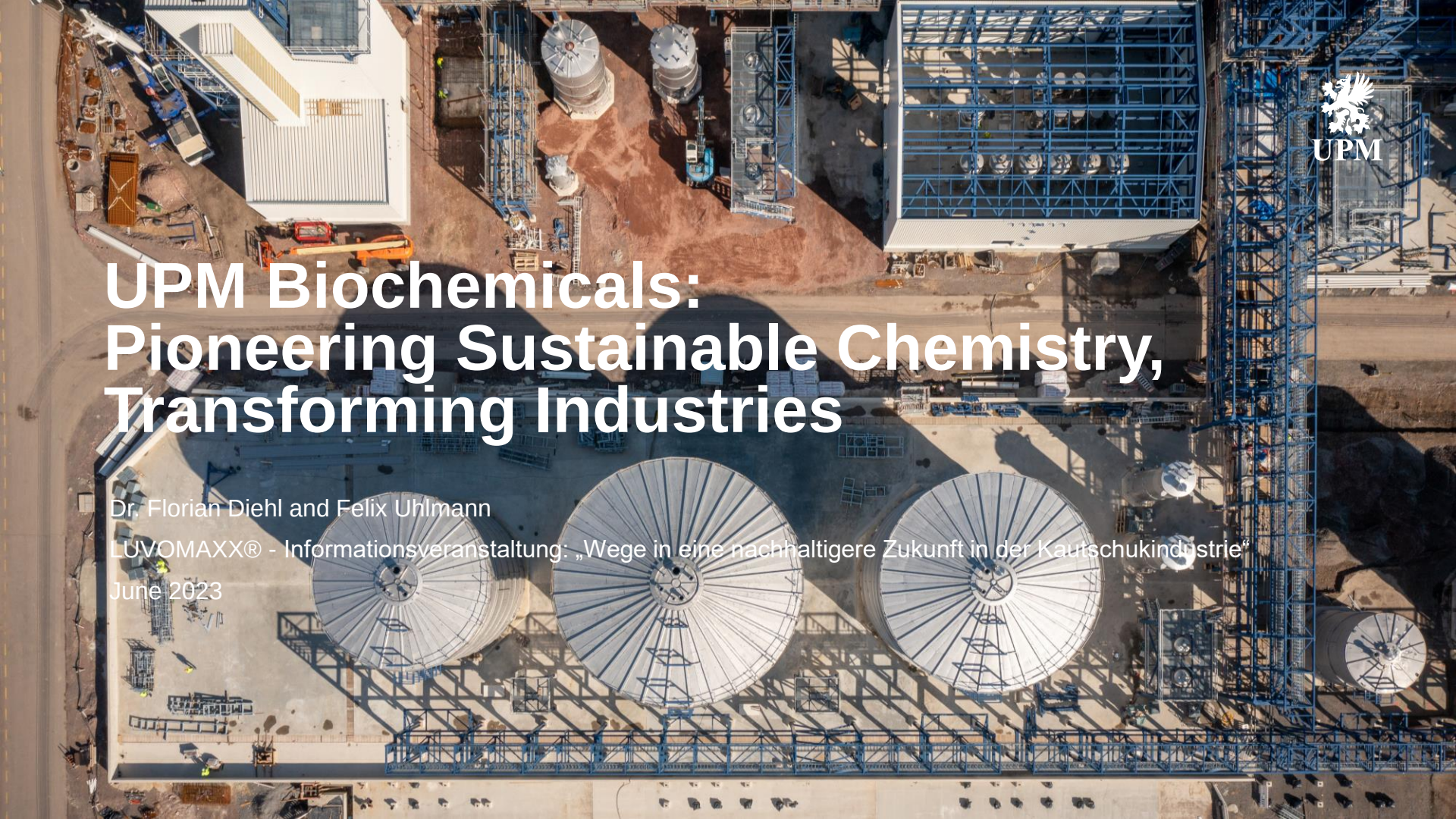


UPM Biochemicals: Pioneering Sustainable Chemistry, Transforming Industries

Dr. Florian Diehl and Felix Uhlmann

LUVOMAXX® - Informationsveranstaltung: „Wege in eine nachhaltigere Zukunft in der Kautschukindustrie“

June 2023

This is UPM:
We create a future beyond fossils!

- **Sales 2022: 11.7 bn €**
- **Headquarter: Helsinki, Finland**

Wood-based raw materials

Low-carbon energy

BUSINESSES:

- UPM FIBRES
- UPM ENERGY
- UPM RAFLATAC
- UPM SPECIALTY PAPERS
- UPM COMMUNICATION PAPERS
- UPM PLYWOOD
- UPM BIOREFINING

55 production plants

17,200 employees in 44 countries

RENEWABLE AND RECYCLABLE PRODUCTS FOR:

- PACKAGING
- LABELLING
- TRANSPORTATION
- ELECTRIFICATION
- CONSTRUCTION
- COMMUNICATION
- TISSUE AND HYGIENE PRODUCTS
- MANUFACTURING
- BIOPLASTICS
- BIOMEDICALS

10,500 customers

170 million end-users globally

Our climate commitment

WE ACT THROUGH FORESTS

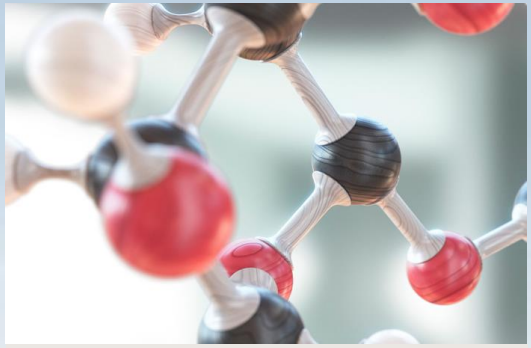
Committed to climate-positive forestry and enhancing biodiversity

.

WE ACT THROUGH EMISSION REDUCTIONS

-65% from own CO_2 emissions

-30% from CO_2 emissions of supply chain



WE ACT THROUGH PRODUCTS

Innovative products

Scientifically verifying the climate impact of all our products

SCIENCE BASED TARGETS
DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

BUSINESS AMBITION FOR 1.5°C

OUR ONLY FUTURE

THE CLIMATE PLEDGE Paris... 10 years Early

We ensure forest growth

100% traceability covered by a **third-party verified Chain of Custody**

No wood from tropical rainforests or forests converted to plantations

100% from **sustainable sources**

Guaranteed sustainability by **FSC and PEFC certifications**

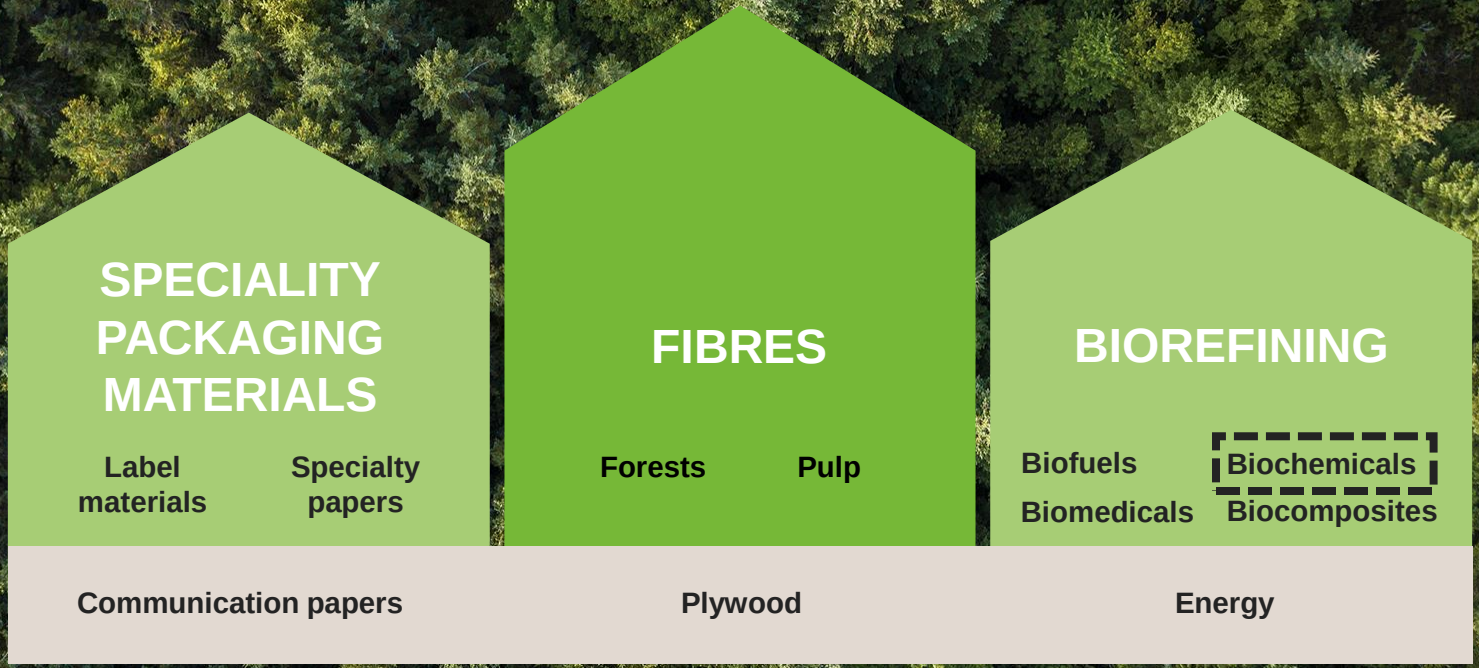
Forest **biodiversity preserved**

100 new trees every minute

We plant **55 million trees** every year

more than **100 trees** per minute

Our Businesses:
Long-term value creation driven by spearheads for growth

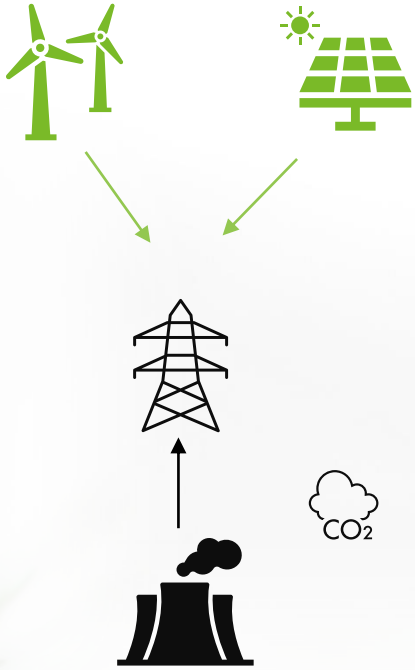


Sustainability in the materials sector

Felix Uhlmann, 29.06.2023

UPM BIOFORE - BEYOND FOSSILS

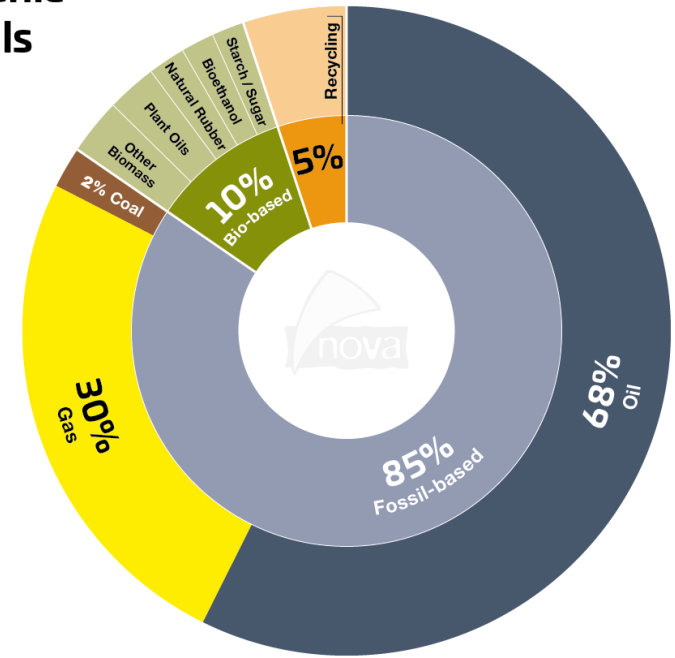
Decarbonization vs Defossilization



Carbon in the material sector

Global Carbon Demand for Organic Chemicals and Derived Materials
by Type of Feedstock

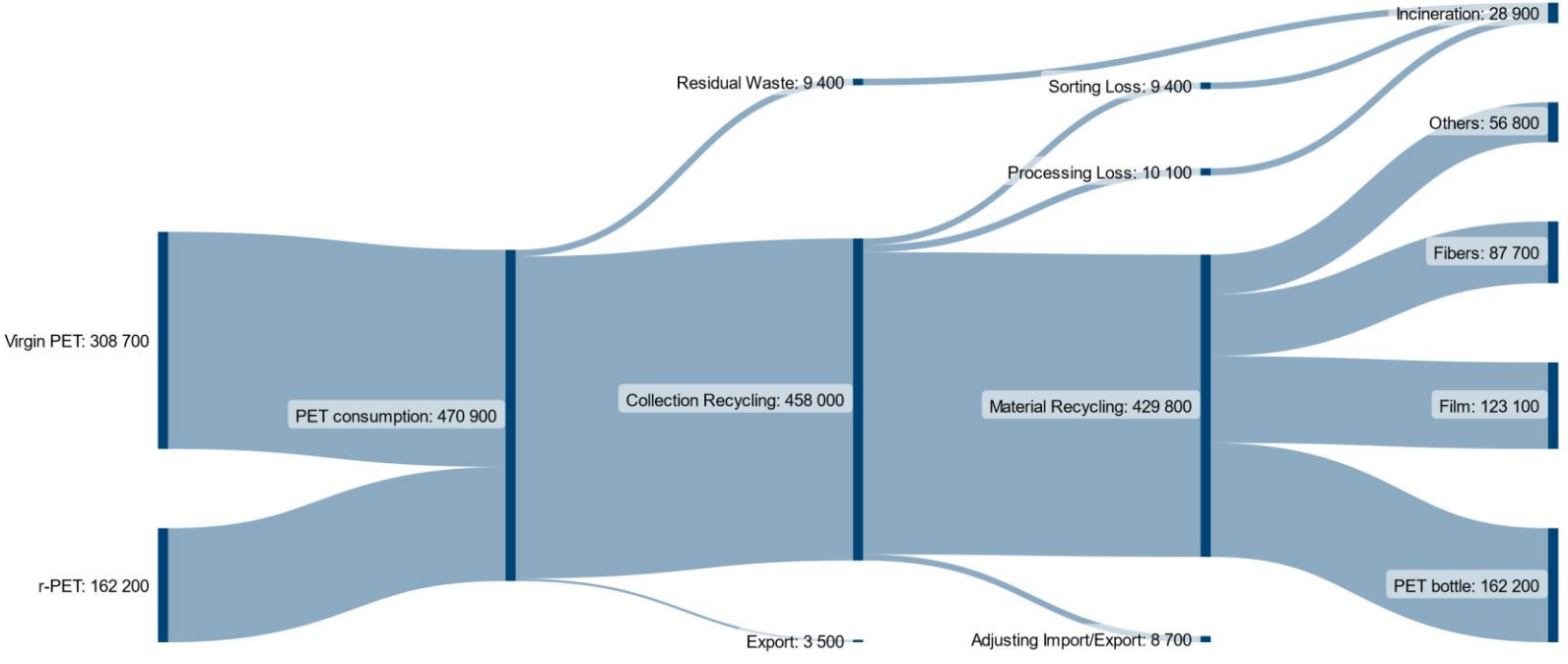
Total: **450 Mt embedded C/yr**



Reference Years: **2015 – 2020**

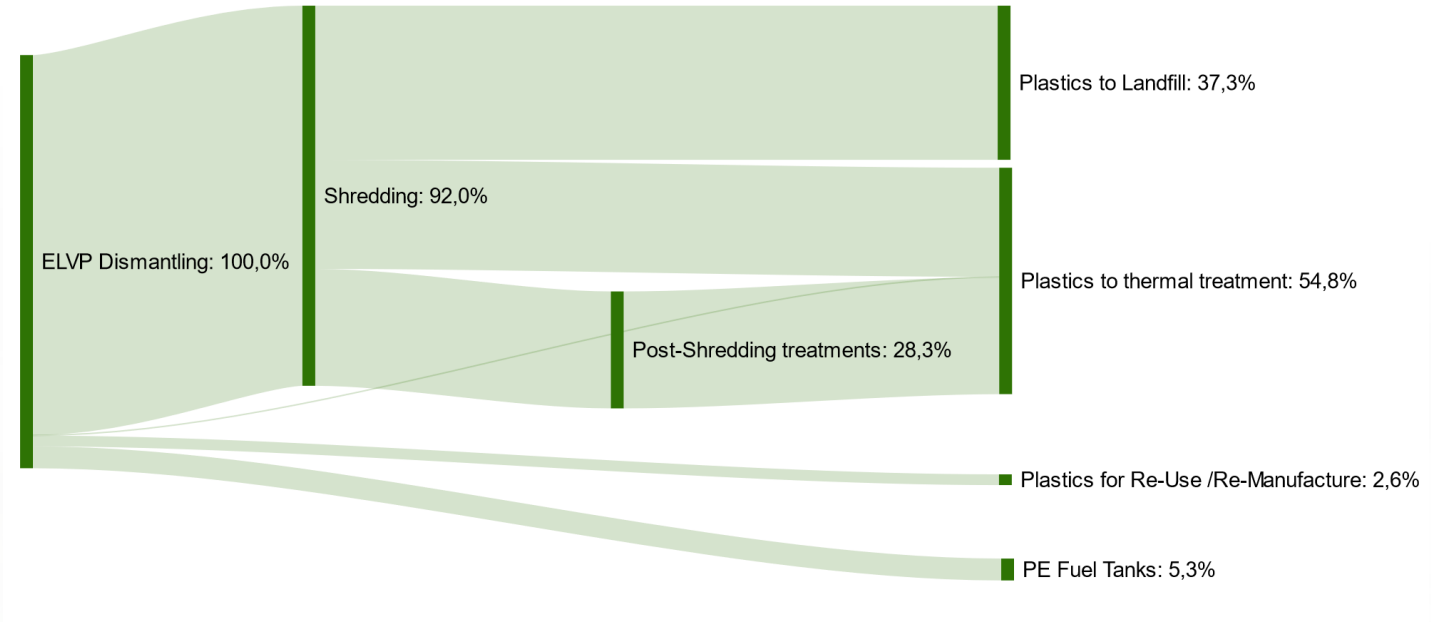
Main Sources: **Piotrowski et al. (2015), Hundertmark et al. (2018), Levi and Cullen (2018), Skoczinski et al. (2021)**
available at **www.renewable-carbon.eu/graphics**

Current linear materials sector



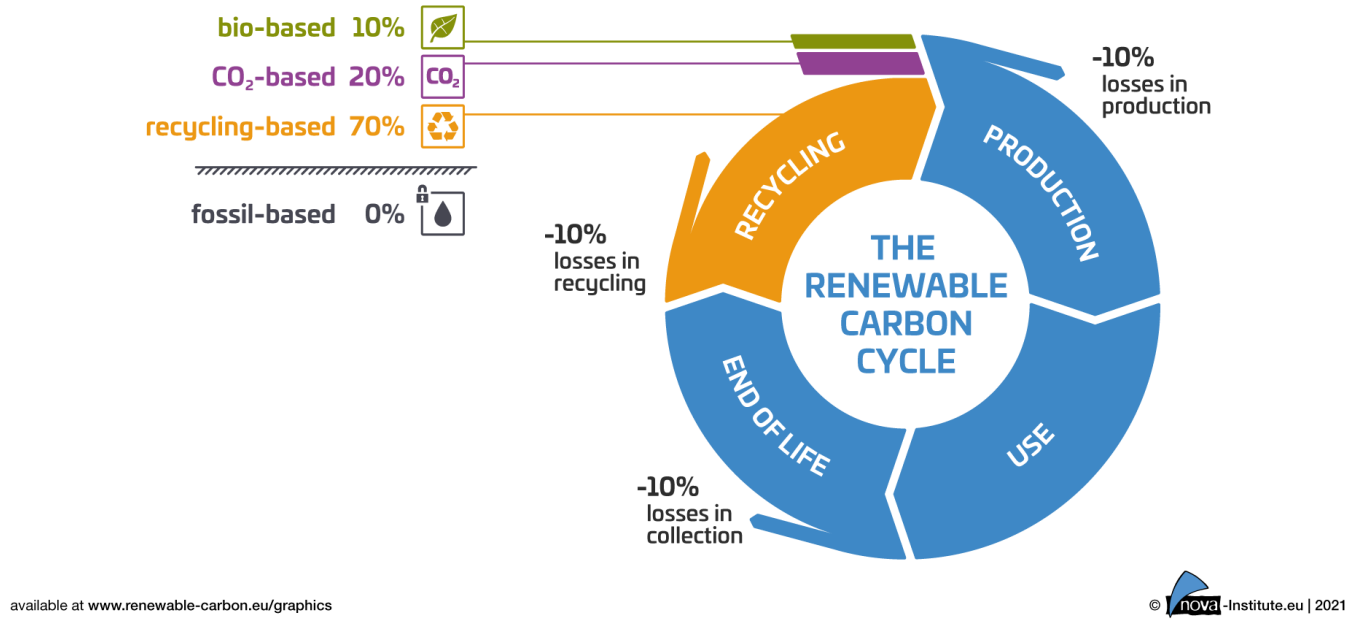
Based on: “Aufkommen und Verwertung von PET-Getränkeflaschen in Deutschland 2019”; GVM 2020

End-of-Life of Plastics in Vehicles in EU



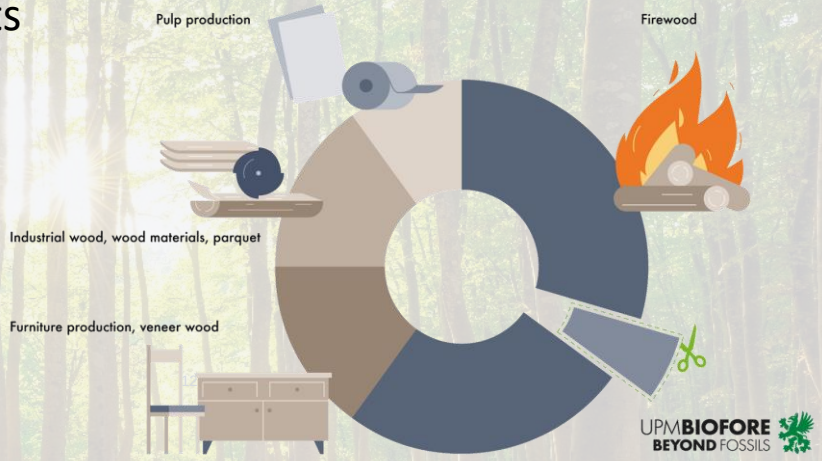
Source: https://doi.org/10.1016/j.spc.2021.09.025

Circular economy - key to sustainable carbon cycles

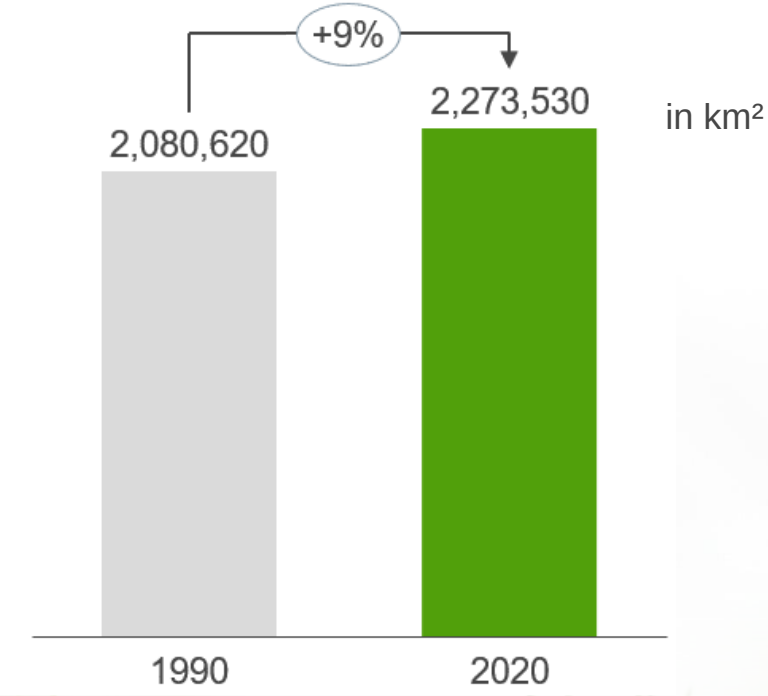


Beechwood – the sustainable feedstock

- Beech is core tree species of climate-stable forests
  - share in German forests will increase from 16% to 21% in 2050
- Limited industrial use of beech wood
  - > 60% are incinerated today
- Beech wood from certified forests of the region
  - well established sustainability certification scheme

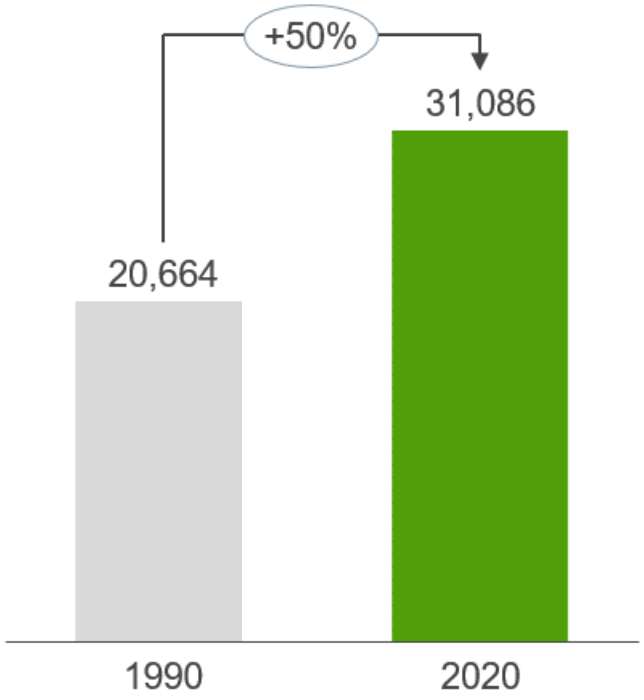


Forest area in Europe 1990-2020



Source: https://foresteurope.org/wp-content/uploads/2016/08/SoEF_2020.pdf

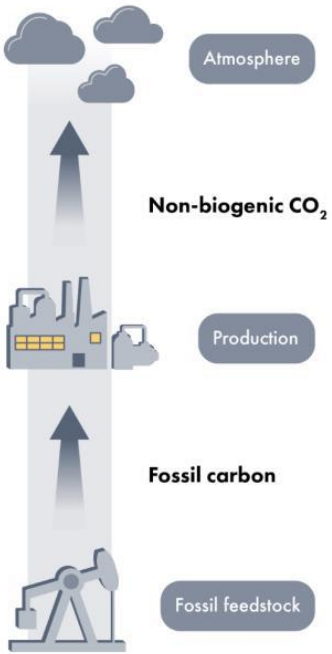
Trend in total growing stock in Europe 1990-2020

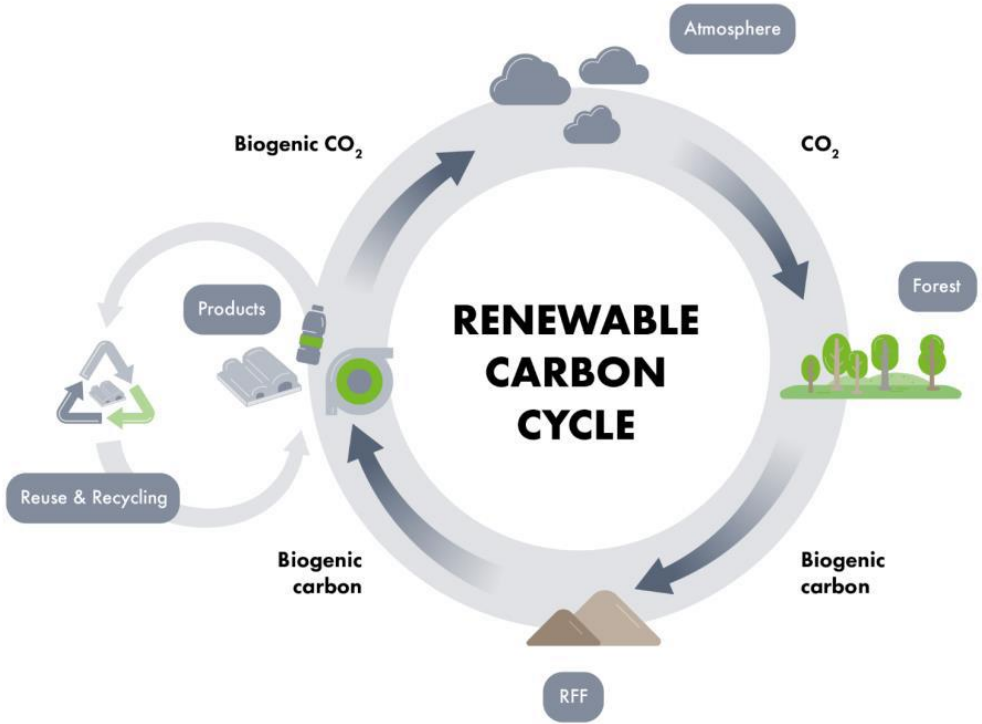


in million m^3

Source: https://foresteurope.org/wp-content/uploads/2016/08/SoEF_2020.pdf

Integral Part of Renewable Carbon Cycle





Beech wood from regional, 100% sustainably managed and FSC®/PEFC™ certified forests with verified chain of custody

UPM

UPM Biochemicals

THE ORIGIN OF OUR WOOD

UPMBIOCHEMICALS

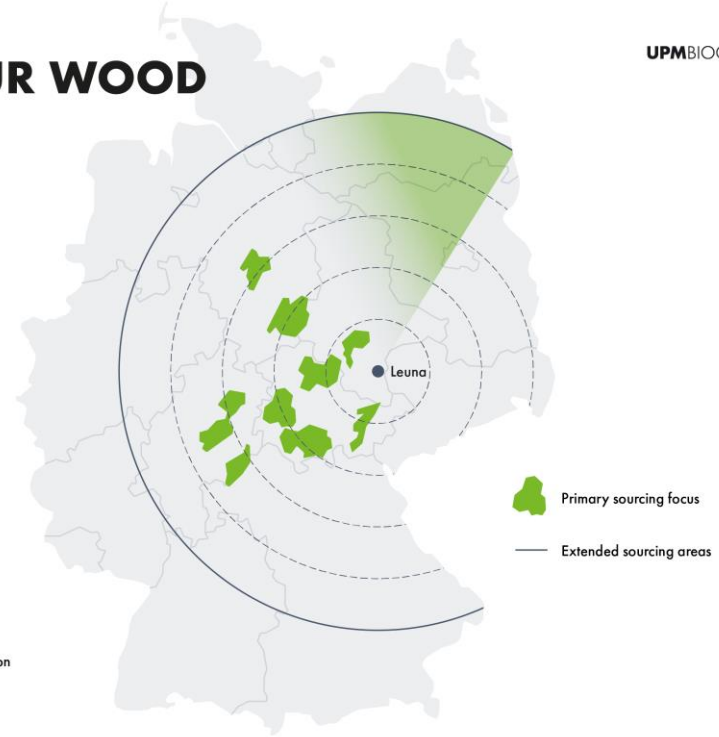
Beechwood from forest management in federal, state and private forests

Residues from sawmills and other wood producers

100% of the wood is FSC® and PEFC certified

Full chain of custody and traceability

Transparent supply chains with regional partners and focus on emission-optimized transportation modes



UPM Leuna biorefinery:
Pioneering sutainable chemistry, transforming industries

750 million €
investment

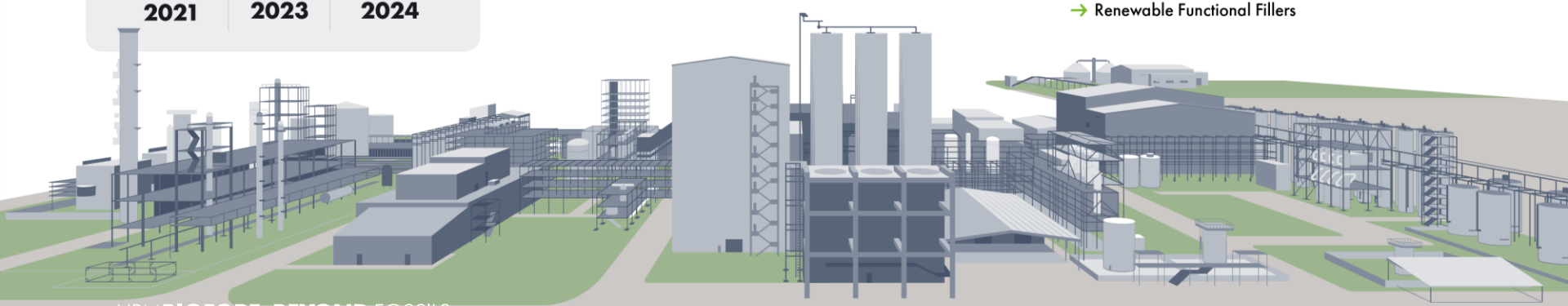
> 100
employees
at the Leuna site

Production volume:
220,000
tons per year

Start of construction January	Start late	Production ramp-up
2021	2023	2024

Beechwood-based products:

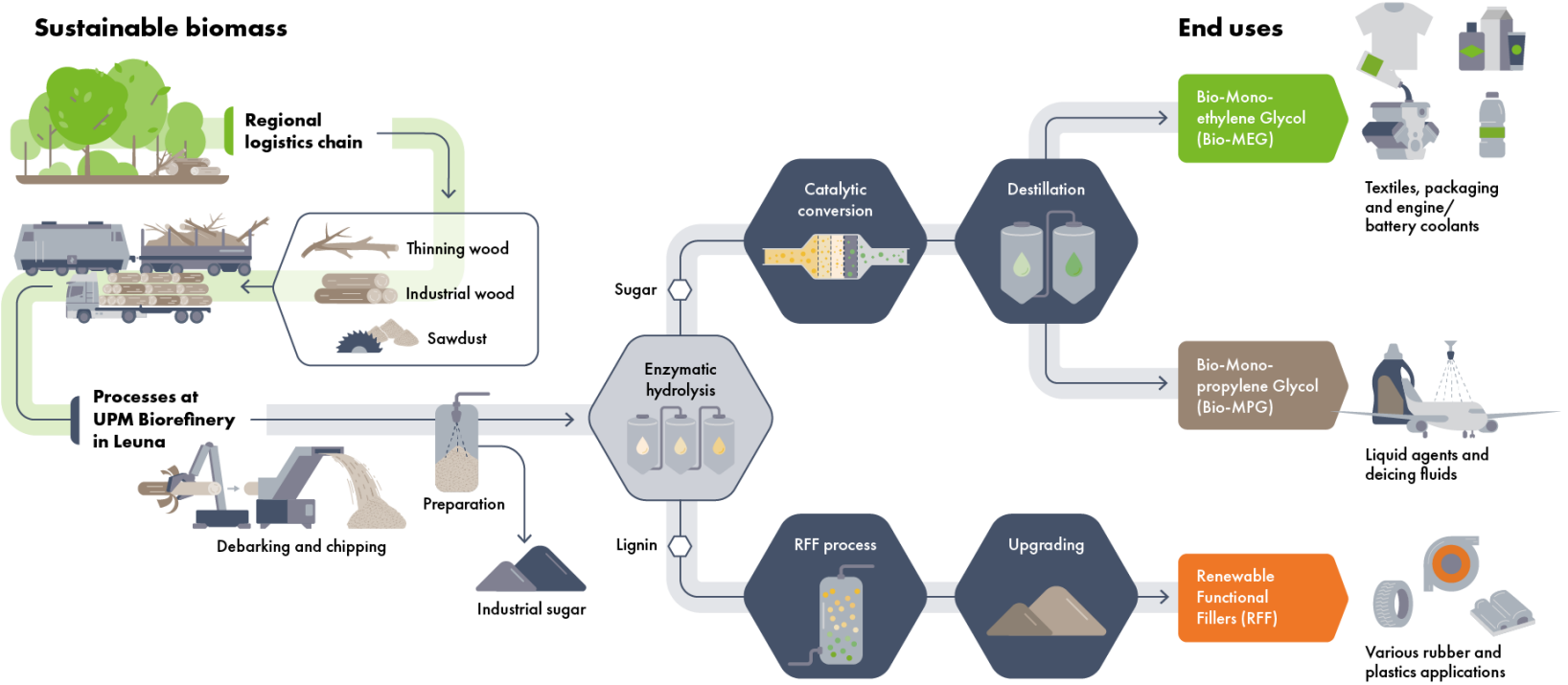
- → Bio-Monoethylene Glycol
- → Bio-Monopropylene Glycol
- → Renewable Functional Fillers



UPM Leuna biorefinery construction site is roughly 20 times the size of a football field

UPM Leuna biorefinery construction site: Commissioning of wood handling area has already started

UPM Leuna biorefinery:
Unique technology converting wood to biochemicals



UPM BioMotion™ **RFF:**
A New Generation of Renewable Functional Fillers (RFF) for Sustainable Rubber Applications

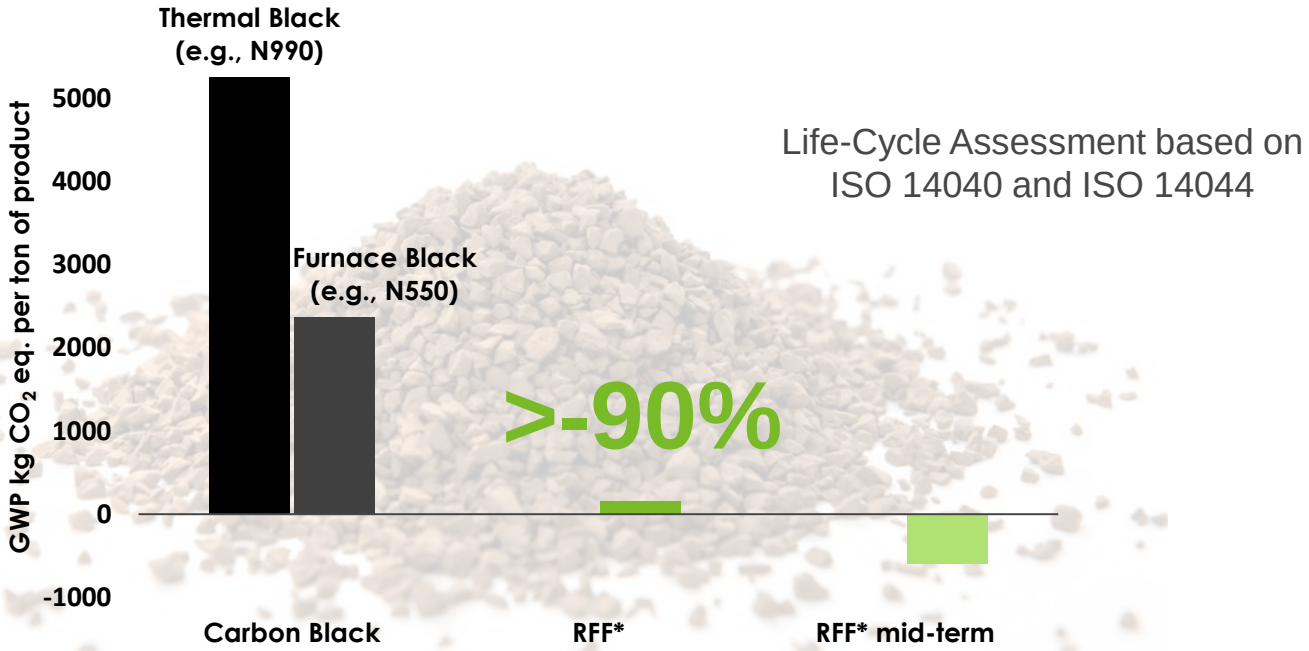
UPM BioMotion™
Renewable Functional Fillers (RFF)

UPM BioMotion™ **RFF: A step-change in sustainability for rubber and plastics industry**

- **CO_2-neutral** based on current LCA
- **Renewable carbon content** (certified by DIN CERTCO)
- **Reinforcing** filler with **low material density** (≤ 1.3 g/cm³)
- **100% electrical insulating**
- **High purity:** free of PAHs, very low VOCs and sulfur-content
- **Natural coloring** as well as UV and oxidation **protection**

UPM BioMotion™ RFF possess approximately 90% lower GWP compared to standard furnace carbon black

scope: “cradle to gate”



Life-Cycle Assessment based on ISO 14040 and ISO 14044

*As the biorefinery is currently in the process of being built, the LCA results will enable UPM to understand where potential environmental hotspots and improvement potential lie. Our LCA will be gradually updated with primary data, from manufacturing and supplier specific data for purchased raw materials as soon as they become available.

Current Portfolio of UPM's Renewable Functional Fillers (RFF)

Preliminary specifications	**UPM** BioMotion™ **X10**	**UPM** BioMotion™ **X20**	**UPM** BioMotion™ **X40**
Specific Surface Area	**11 m²/g**	**23 m²/g**	**40 m²/g**
pH Value	6 - 10	6 - 10	6 - 10
Sulfur Content	< 0.2%	< 0.2%	< 0.2%
Benzo[a]pyrene	< 0.1 ppm	< 0.1 ppm	< 0.1 ppm
each of 22 FDA PAHs	< 1 ppm	< 1 ppm	< 1 ppm
Loss on Drying	< 3%	< 3%	< 3%
Bulk Density	> 250 kg/m³	> 250 kg/m³	> 200 kg/m³

UPM BioMotion™ RFF: numerous application possibilities in various markets

ELASTOMERS

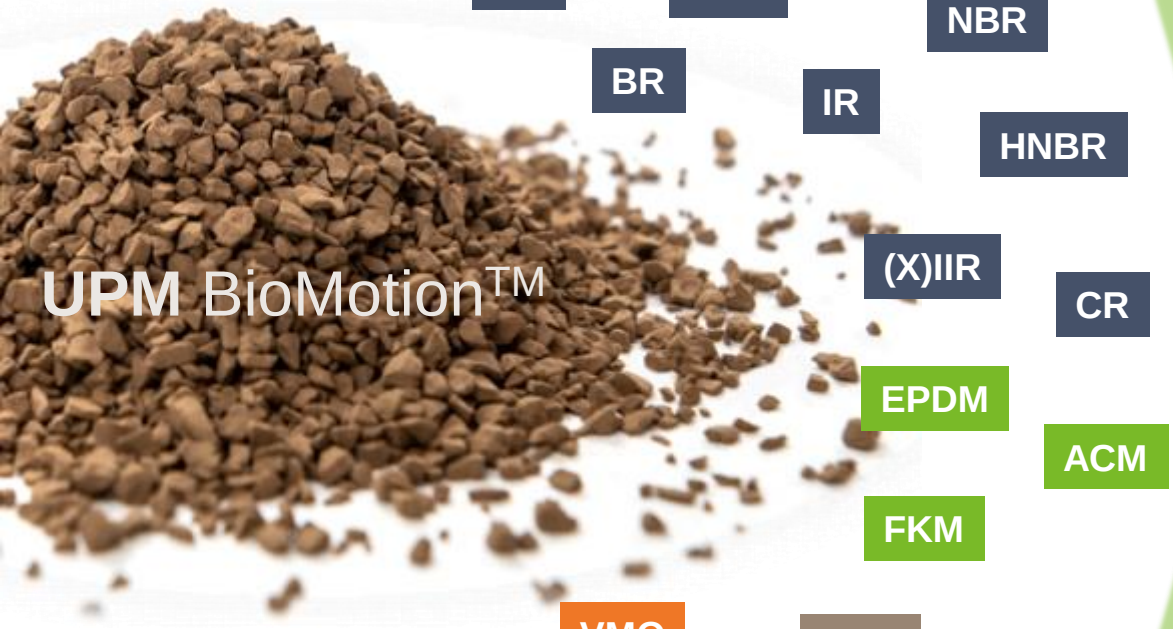
THERMOPLASTIC ELASTOMERS (TPE)

THERMOPLASTICS

OTHERS

- Automotive
- Transportation
- Building & Construction
- Consumer
- Agriculture
- Packaging
- Personal Care
- Electronics

RFF in rubber applications



NR
SBR
NBR
BR
IR
HNBR
(X)IIR
CR
EPDM
ACM
FKM
VMQ
ECO

Profiles
Weather strips
Hoses
O-rings
Precision sealings
Cables
Gaskets
Membranes
Plugs
Flooring
Footwear
Bushings
Wiper blades
Insulators
Tapes
Belts
Nipples
Linings

UPM BioMotion™ **RFF in automotive rubber profiles**

UPM BioMotion™ RFF enable profile producers to fulfill future OEM requirements with direct and indirect benefits

> 50%
WEIGHT REDUCTION when shifting from steel to Aluminum or Magnesium in car doors

> 40 kg
WEIGHT SAVINGS per car

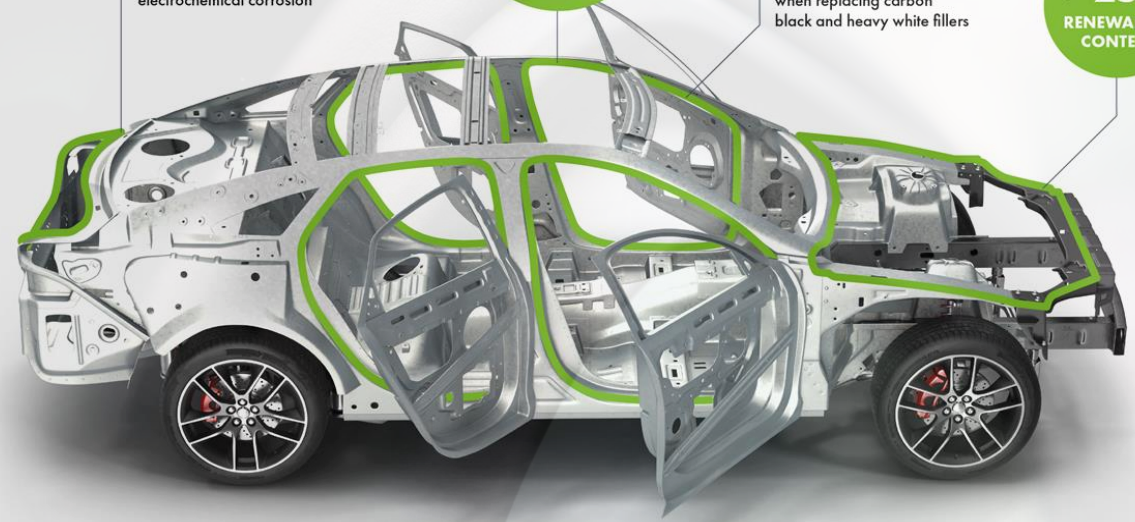
~ 40%
REPLACEMENT LEVEL
of steel doors by 2025

> 10^9 Ω*cm
VOLUME RESISTIVITY required for next generation weatherstrips to effectively avoid electrochemical corrosion

> 50%
lower compound **CO_2 FOOTPRINT** compared to today's weatherstrips

> 10 %
ADDITIONAL WEIGHT & MATERIAL SAVINGS
in weatherstrips per car when replacing carbon black and heavy white fillers

> 25%
RENEWABLES CONTENT

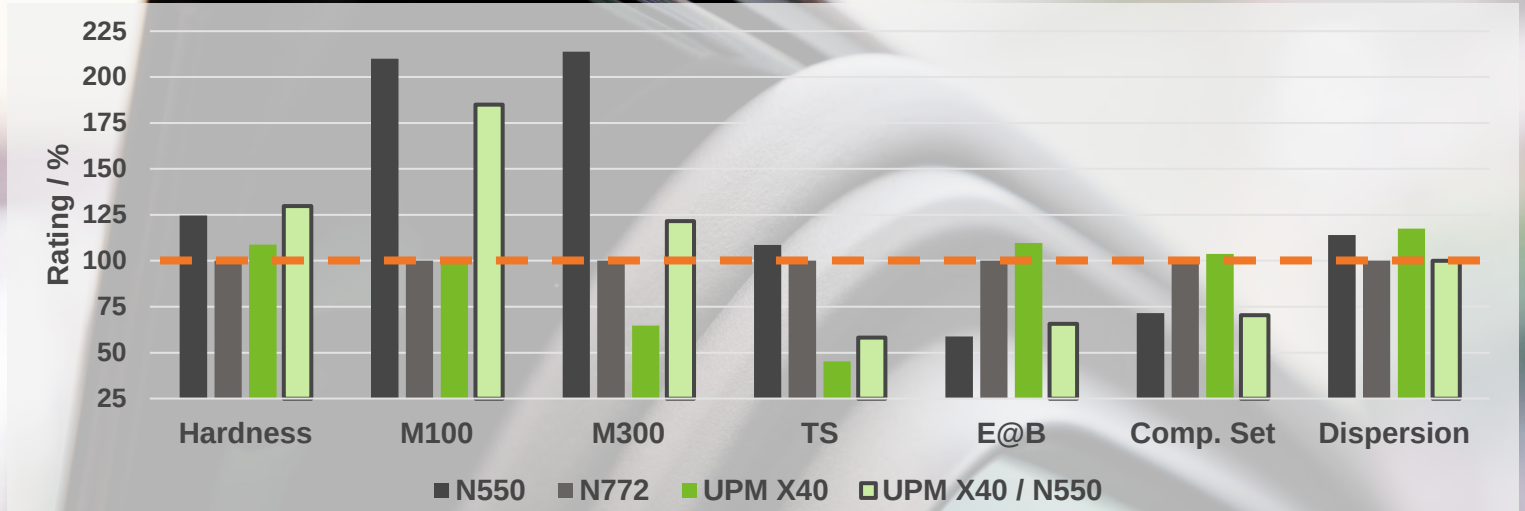


UPM BioMotion™ **RFF in automotive rubber profiles**

- Model compound
  - based on **non-polar EPDM** (medium ML(1+4) & ENB content)
  - **variation** of **functional fillers**
  - **removal** of any high-density **white filler** i.e., Talc (-100%)
  - **reduction** of softener **oil** content (– 33%)
  - **sulfur** cured
- Mixing procedure
  - internal lab mixer
  - standard two-stage lab mixing process
- Curing parameters
  - T = 160°C, t = t90 + 5 min

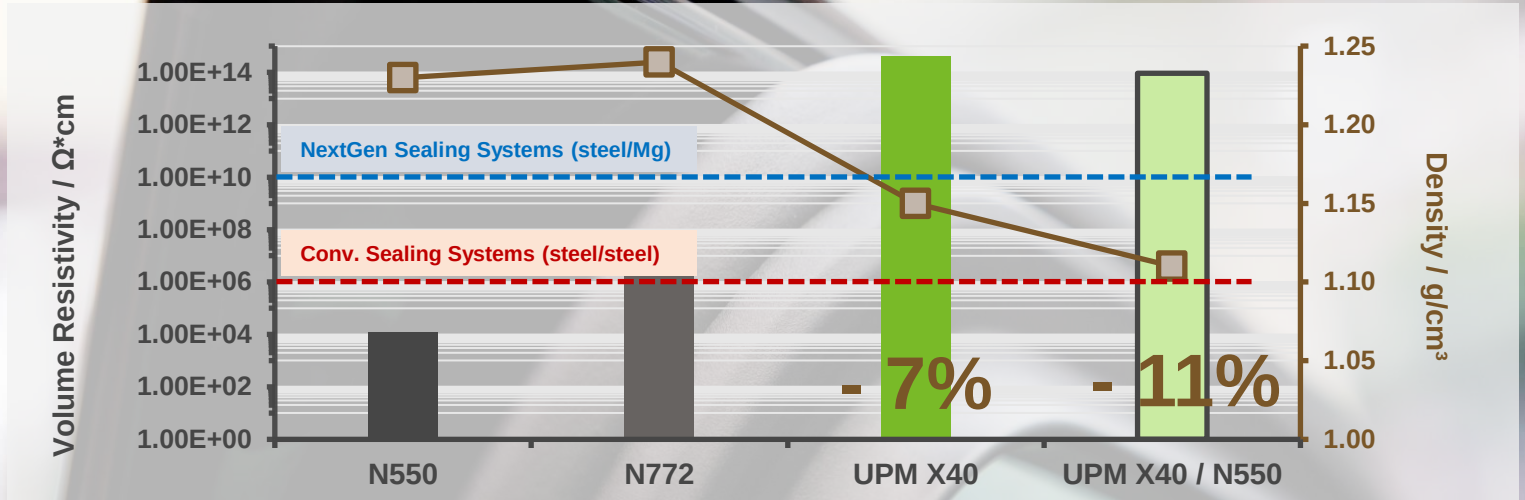
Ingredients	Loading / phr			
EPDM	150	150	150	150
N550	**115**	**-**	**-**	**35**
N772	**-**	**115**	**-**	**-**
UPM X40	**-**	**-**	**115**	**115**
Talc	**55**	**55**	**55**	**-**
Paraffinic Oil	**25**	**25**	**25**	**-**
CaO-80	5.5	5.5	5.5	5.5
PEG 4000	2	2	2	2
ZnO + Stearic Acid	5 + 2	5 + 2	5 + 2	5 + 2
Sulfur	1.5	1.5	1.5	1.5
MBT	1	1	1	1
TP-50	2.7	2.7	2.7	2.7
TBzTD-70	1.5	1.5	1.5	1.5

UPM BioMotion™ RFF in automotive rubber profiles



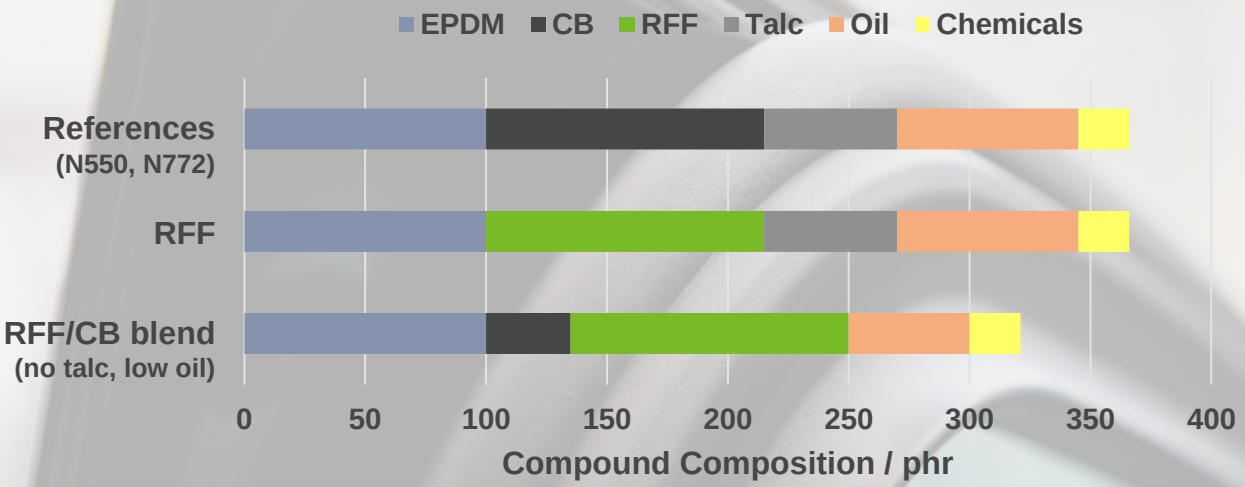
- 1:1 exchange of CB by RFF in non-polar EPDM results in rubber properties matching both, N550 & N772 performance characteristics (except for lower tensile strength)
- hardness, stress-strain properties & compression set of RFF in non-polar EPDM can be adjusted to N550 level by addition of small amounts of CB, removal of white filler & lowering oil content

UPM BioMotion™ RFF in automotive rubber profiles



- RFF compounds meet the requirements of next generation sealing systems for higher volume resistivities to avoid electrochemical corrosion when using light metals
- RFF even allows for the complete removal of heavy white functional fillers enabling significant additional weight gains compared to the reference compound

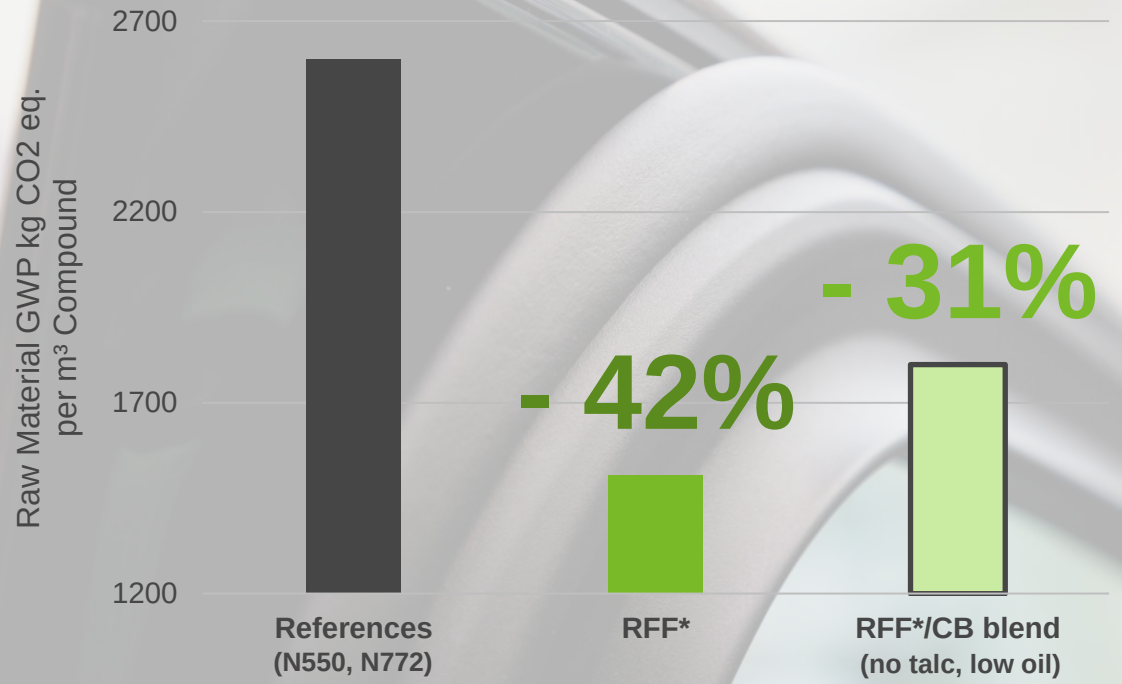
UPM BioMotion™ RFF in automotive rubber profiles



Renewable Content
0%
31%
36%

- in addition, applying RFF introduces a renewables content of up to 36% in the investigated rubber compounds leading to a significantly lower carbon footprint
- UPM's RFF enables renewable contents in final compounds of > 85% in combination with bio-based rubbers & plasticizers

UPM BioMotion™ RFF reduce rubber compound carbon footprints drastically



*Current status of life cycle assessment is based on process simulation and pre-commercial trials and represents current best knowledge of the UPM Biorefinery process. A critical review with independent third party according to ISO 14044 successfully completed.

UPM BioMotion™ RFF in automotive rubber profiles at DKT/IRC 2022

UPM

UPM BioMotion™ **RFF in peroxide cured NBR**

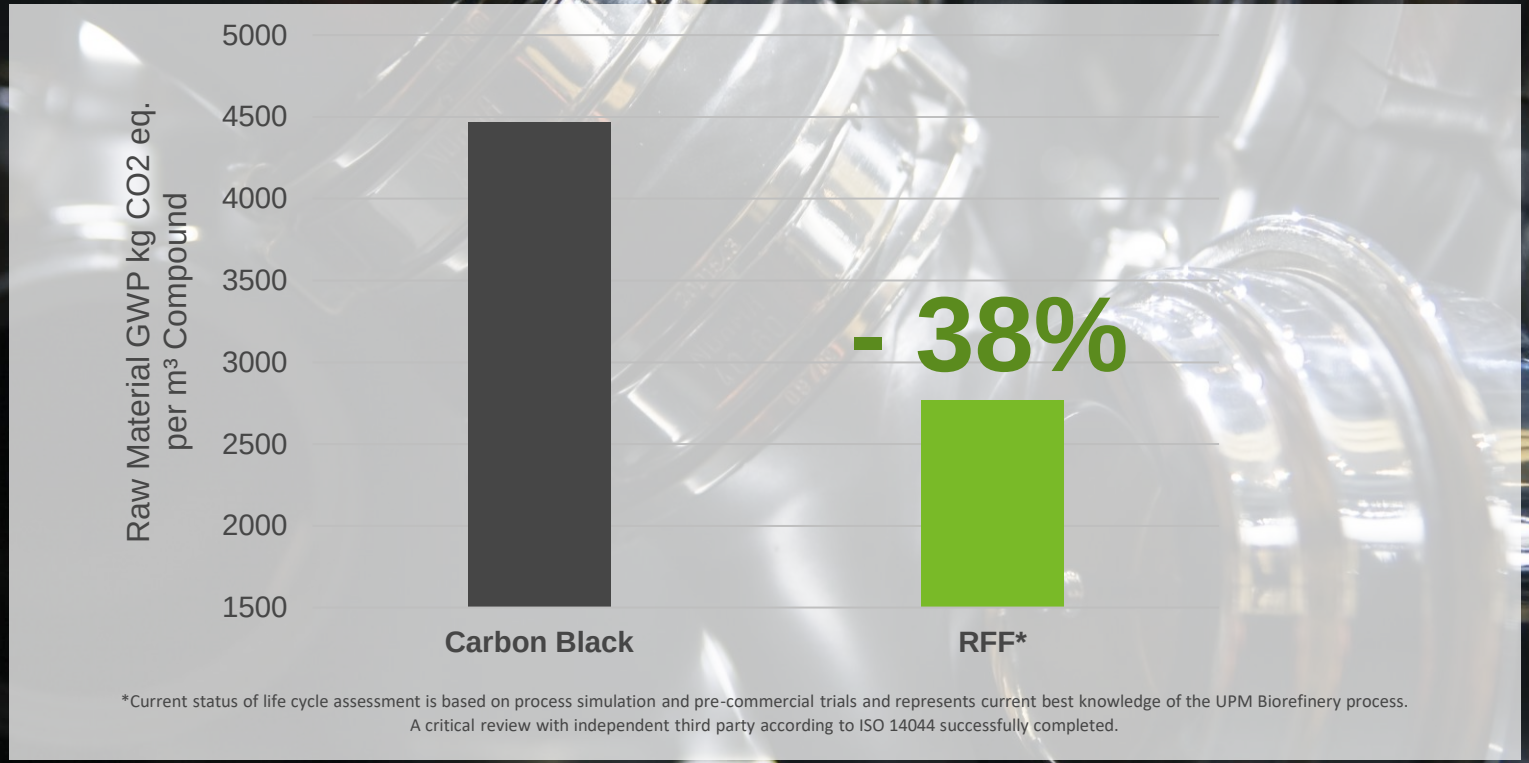
- Model compound
  - peroxide cured nitrile rubber
  - inactive (N990) carbon black
  - iso-gravimetric filler exchange with RFF of lowest specific surface area (UPM X10)
- Mixing procedure
  - internal lab mixer & open mill
  - standard two-stage lab mixing process
- Curing parameters
  - T = 160°C, t = t90 + 5 min

Ingredients	Loading / phr	
NBR (3945)	100	100
N990	**40**	**-**
UPM X10	**-**	**40**
ZnO	2.5	2.5
Stearic Acid	2.5	2.5
Ozone protection wax	3.0	3.0
6PPD	1.5	1.5
TAIC	4.3	4.3
Dicumyl peroxide	7	7

UPM BioMotion™ **RFF in peroxide cured NBR**

- Peroxide curing is possible for RFF, with slightly reduced scorch and same curing time
- Higher hardness and moduli at low strains, reduced tensile strength
- Decrease of density by ~ 6% and renewable material content of 26%
- No impact of heat ageing (100°C/72h) or swelling in non-polar media on performance

UPM BioMotion™ RFF reduce rubber compound carbon footprint drastically



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RFF can replace up to 100% of fossil-based fillers!

EPDM Weatherstrip

>20wt% RFF

30% lower

10% weight reduction

NBR Hoses

26wt% RFF

49% lower

10% weight reduction

EPDM Wipers

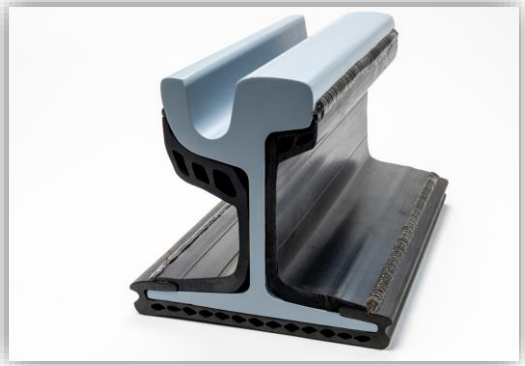
26wt% RFF

26% lower

5% weight reduction

RFF can replace up to 100% of fossil-based fillers!






UPM BioMotion™ **RFF in rubber flooring**

Artigo rubber flooring for UPM Biochemicals booth at Renewable Materials Conference 2023

INDUSTRY OPINION ON UPM BioMotion™ RFF

"UPM is a reliable partner with strong technical expertise and close collaborations to help us discover sustainable solutions for the new generation of rubber products."

NATIONAL HALMSTAD — National

"After two years of cooperation of joint applicative research to incorporate RFF to our compound designs allowed us to reduce our fossil content and consequently CO_2 footprint with an associated decrease in density."

STANDARD PROFIL — STANDARD PROFIL

"Sustainability is a crucial topic for all of us, and RFF offer new ways to reduce the carbon footprint of our products; there is a high demand for sustainable end-products across the entire industry."

POLYMER-TECHNIK ELBE GMBH — PTE

"SFC Solutions is a leading automotive rubber manufacturer bringing sustainable solutions to the automotive and non-automotive industry. Together with UPM, we are taking an advanced step to introduce Renewable Functional Fillers to follow the mega trend of sustainability."

SFC SOLUTIONS — SFC Solutions

"UPM's Renewable Functional Fillers are a new generation of filler which will help IVG to move towards creating more sustainable products for the rubber industry."

I.V.G. COLBACHINI — ivg colbachini spa

"RFF: one step to meet our sustainability goals."

DICHTUNGSTECHNIK WALLSTABE & SCHNEIDER GMBH & CO. KG — Wallstabe & Schneider

UPM BioMotion™
Renewable Functional Fillers (RFF)

TRANSFORMING RUBBER AND PLASTICS FROM WITHIN!

Contact us: RFF@upm.com
www.upmbiochemicals.com/renewable-functional-fillers/

UPM BIOFORE
BEYOND FOSSILS