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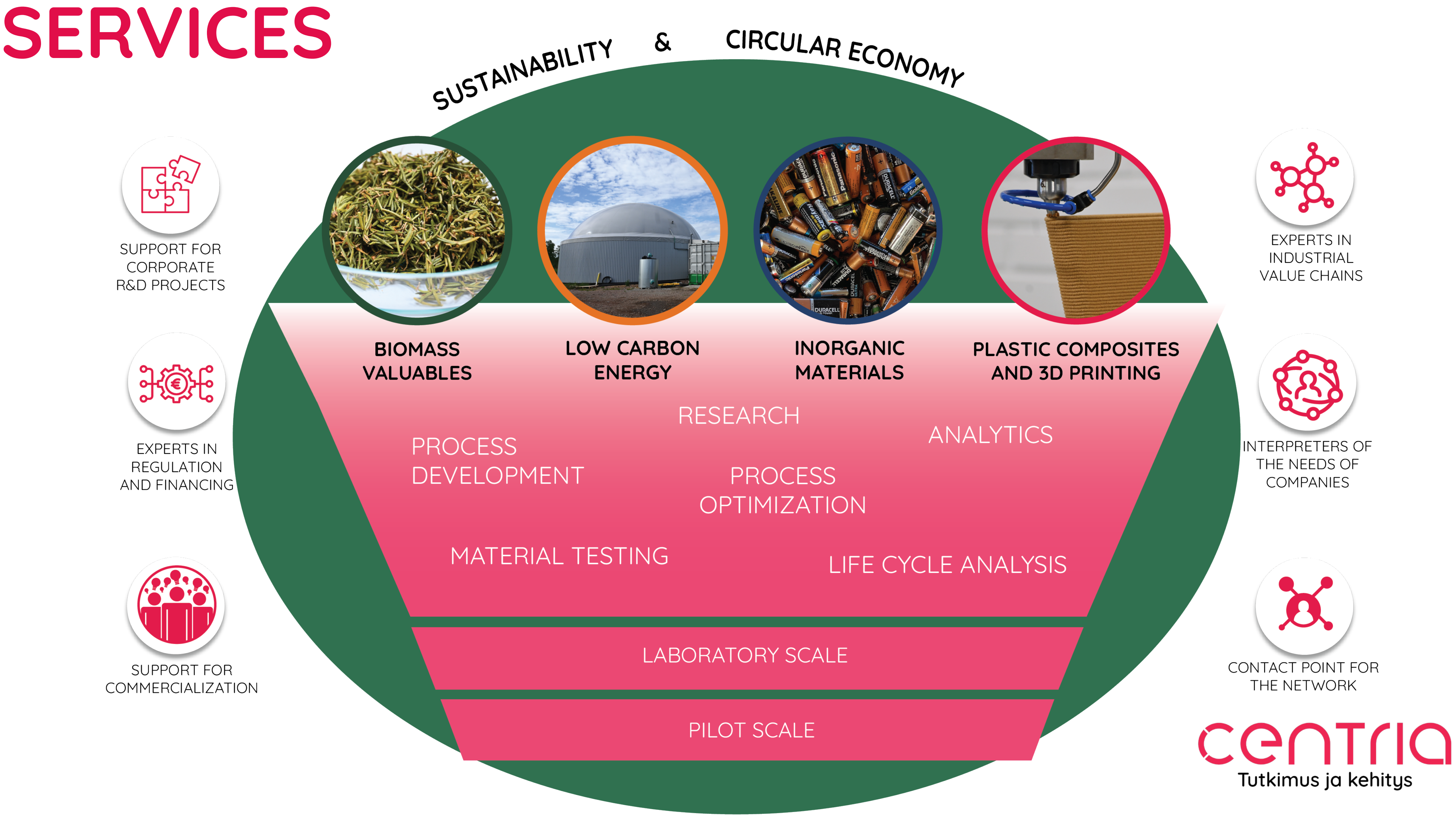
Tutkimus ja kehitys

Uudet muovit teollisuudessa

Tervetuloa!

- Opening words
  Services of the Centria Chemistry and bioeconomy team
  Heidi Kanala-Salminen
- Biobased plastics and their development
  Egidija Rainosalo
- Analysis, testing and laboratory services
  Egidija Rainosalo
- 3D printing of large objects with a robot
  Matti Ojala
- Sustainability as a Competitive Edge
  Hanna Tölli
- Composite Recycling and life Cycle Assessment (LCA)
  Rathish Rajan


SERVICES
SUSTAINABILITY & CIRCULAR ECONOMY
SUPPORT FOR CORPORATE R&D PROJECTS
EXPERTS IN REGULATION AND FINANCING
SUPPORT FOR COMMERCIALIZATION
BIOMASS VALUABLES
LOW CARBON ENERGY
INORGANIC MATERIALS
PLASTIC COMPOSITES AND 3D PRINTING
RESEARCH
PROCESS DEVELOPMENT
ANALYTICS
PROCESS OPTIMIZATION
MATERIAL TESTING
LIFE CYCLE ANALYSIS
LABORATORY SCALE
PILOT SCALE
EXPERTS IN INDUSTRIAL VALUE CHAINS
INTERPRETERS OF THE NEEDS OF COMPANIES
CONTACT POINT FOR THE NETWORK
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EXPLORE OUR LABORATORIES VIRTUALLY

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Biobased plastics and their development

Egidija Rainosalo

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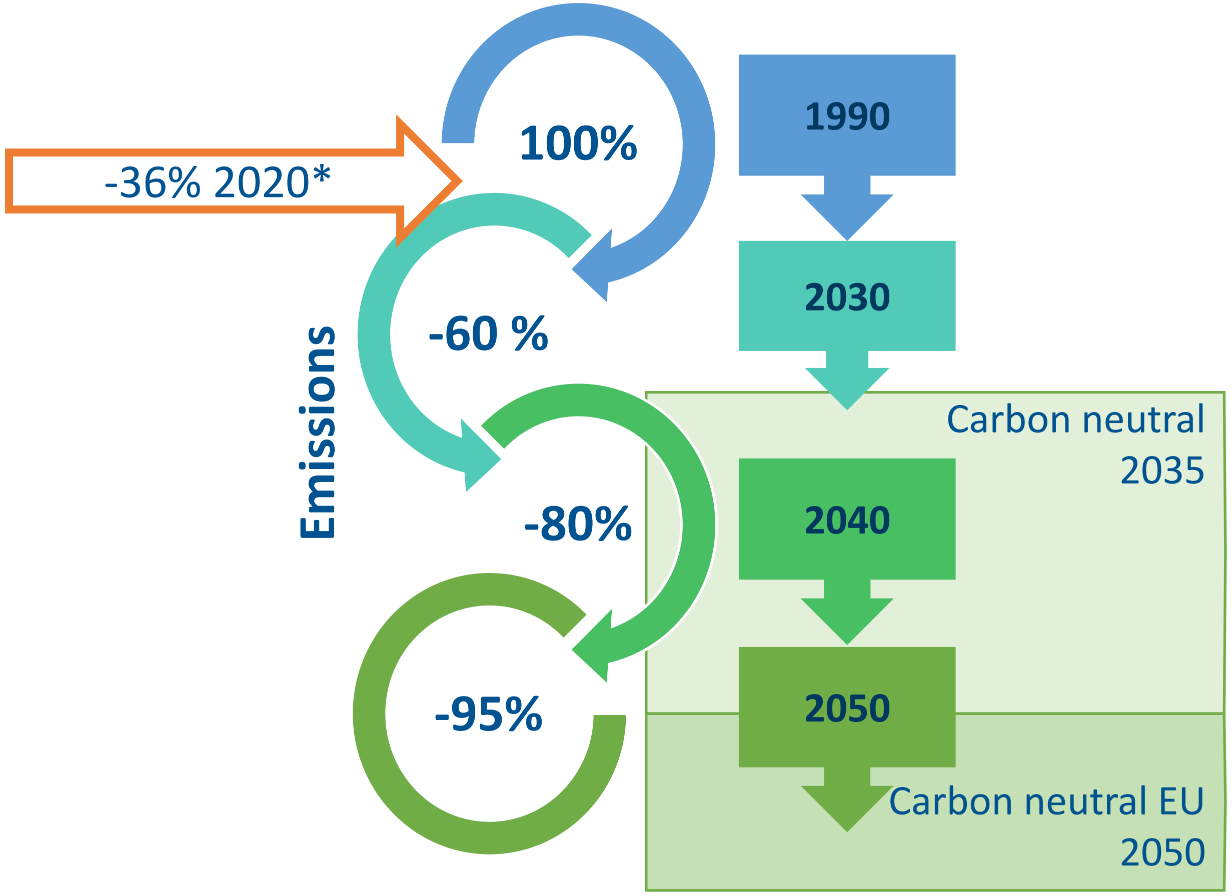
Net zero carbon timeline according to Finland's Climate Act (423/2022)



* https://www.ymparisto.fi/fi/ympariston-tila/ilmastonmuutos/kasvihuonekaasujen-paastot

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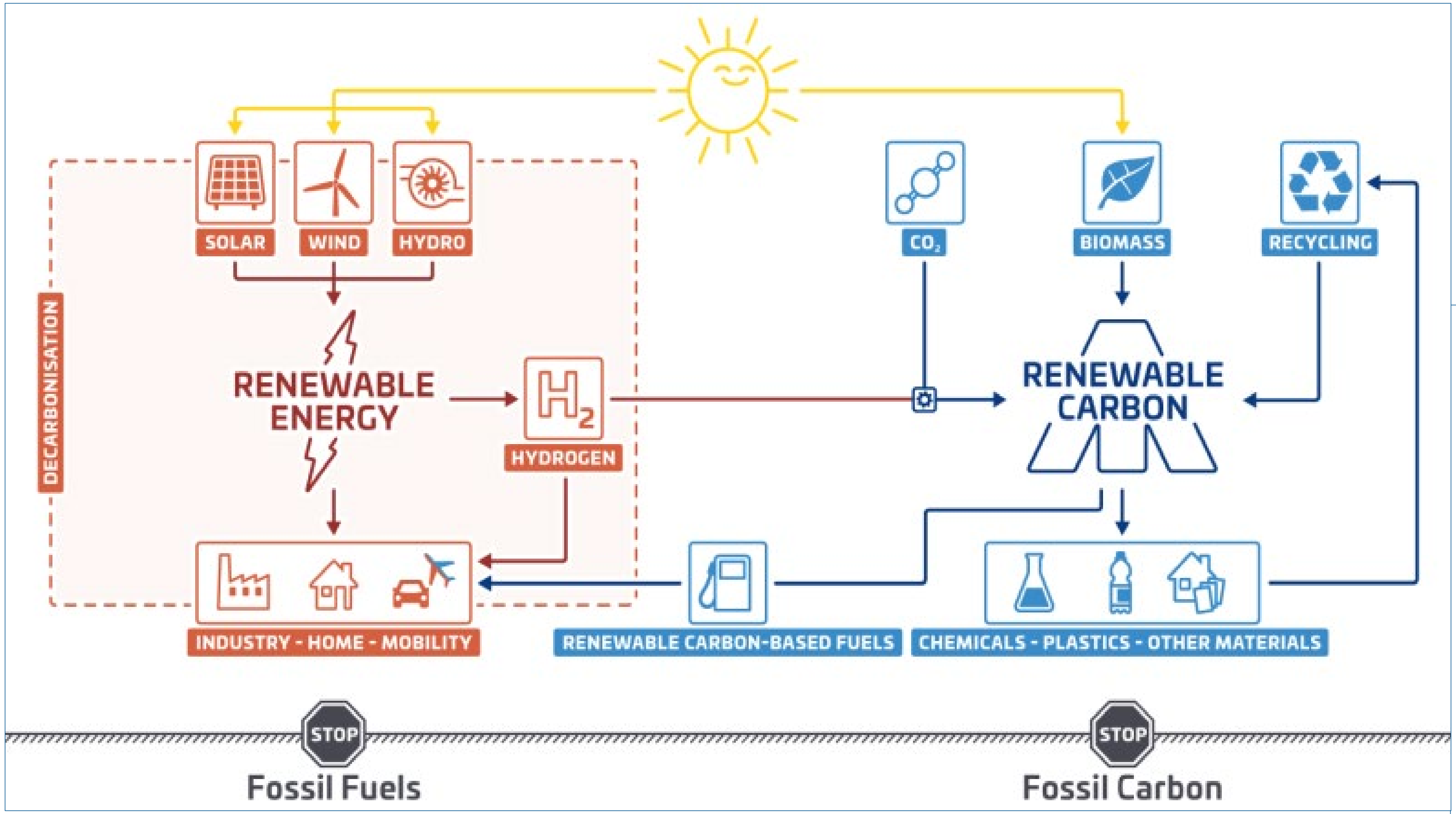
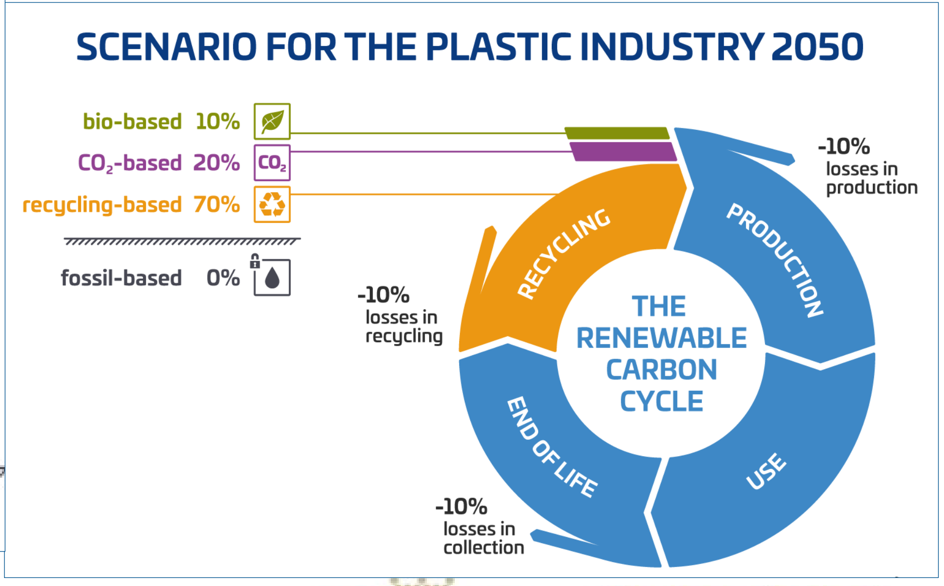
Renewable Energy and Renewable Carbon*





www.bio-based.eu/graphics

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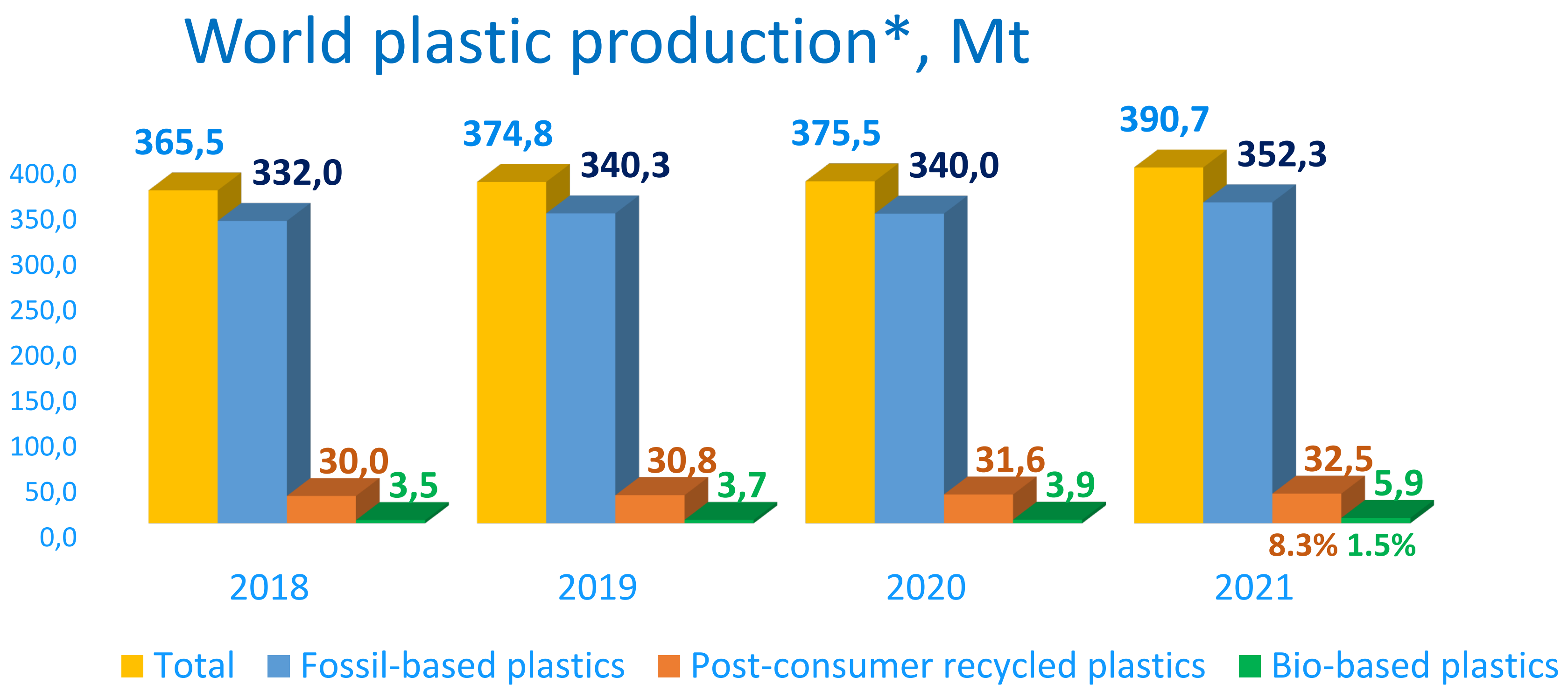

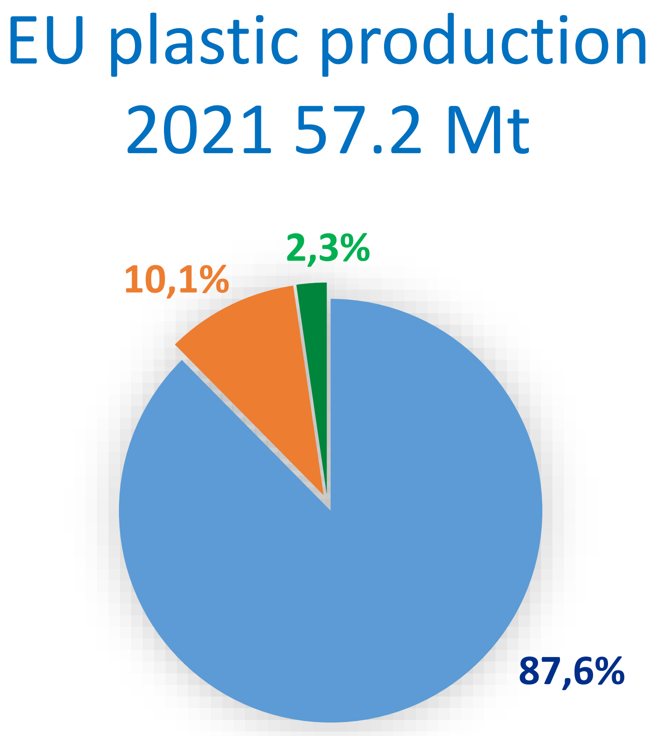

* Excl. textile

Ref: Plastics-The Facts 2022. Plastics Europe

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Bio-based material definition

- ✓ Part or all fossil based raw materials are replaced by materials derived from biomass
- ✓ No harmonized minimum bio content defined for material to be called biomaterial

- ✓ Marking in labeling as % of biocarbon, measured according **EN 16640**
- ✓ Possible marking, provided by some certificated laboratories e.g. TÜV AUSTRIA or DIN CERTCO)
  - the total organic carbon content of the product is at least 30% (TÜV AUSTRIA)
  - the carbon content of a renewable raw material (biobased) is at least 20 % from all organic carbon (TÜV AUSTRIA or DIN CERTCO)

OK biobased TÜV AUSTRIA ★	OK biobased TÜV AUSTRIA ★★	OK biobased TÜV AUSTRIA ★★★	OK biobased TÜV AUSTRIA ★★★★
between 20 and 40% biobased	between 40 and 60% biobased	between 60 and 80% biobased	more than 80% biobased

BIOBASED 20 - 50 % DIN Geprüft

- ✓ The approach based on the biomass. **EN 16785-1**.

biobased %

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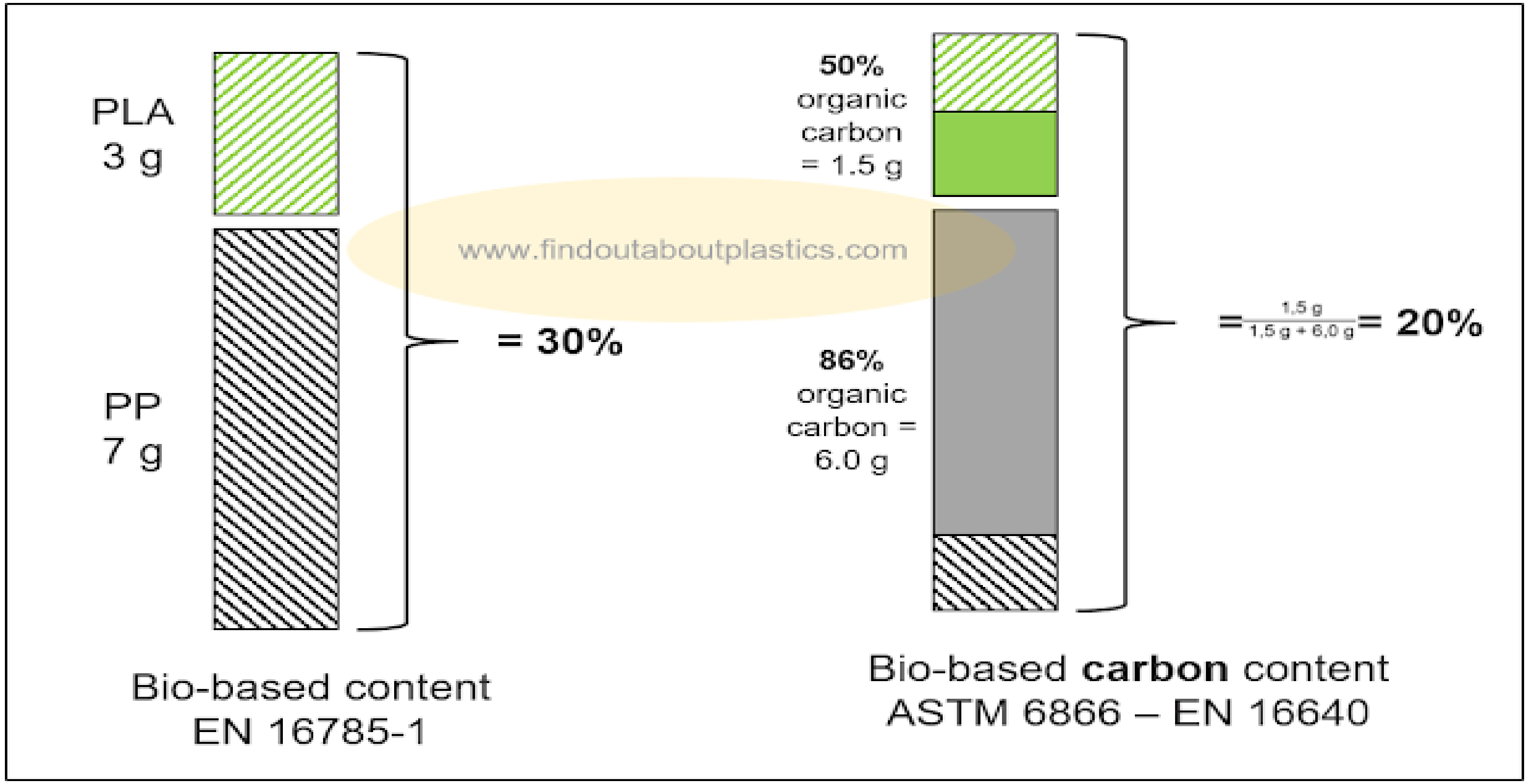
EN 16785-1 vs EN 16640 (also ASTM D6866)



Blended of materials in a ratio of 30/70%.

- PLA plant-origin, contains 50% carbon
- PP fossil-origin, contains 86% carbon

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Bio-based ≠ Biodegradable

Biodegradable - EN 13432 (packaging) and EN 14995 (general)

✓ in municipal or industrial composting facility (controlled temperature, pH):

- 90% of dry material disintegrate within 12 weeks to particle size smaller than 2 mm
- 6 months the sample's CO_2 production level has to reach 90% of that of the reference material.

✓ in soil (also EN 17033 for not removable mulching films)

Home composting - EN 17427

Marine environment - ISO 22766

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Ways to increase bio-based content

Fully or partly biobased matrix polymers

Biobased platform chemicals: C3-C6

Natural fibres as fillers and reinforcement

Wood based
- Cork, wood, cellulose fibres

Bast fibres
- Flax, hemp, kenaf, etc.

Short fibres and long fibers

Bio-based functional additives

- Graphene, carbon nanotubes, carbon black to improve electrical and thermal conductivity
- Antioxidants and UV stabilisers
- Antimicrobial additives

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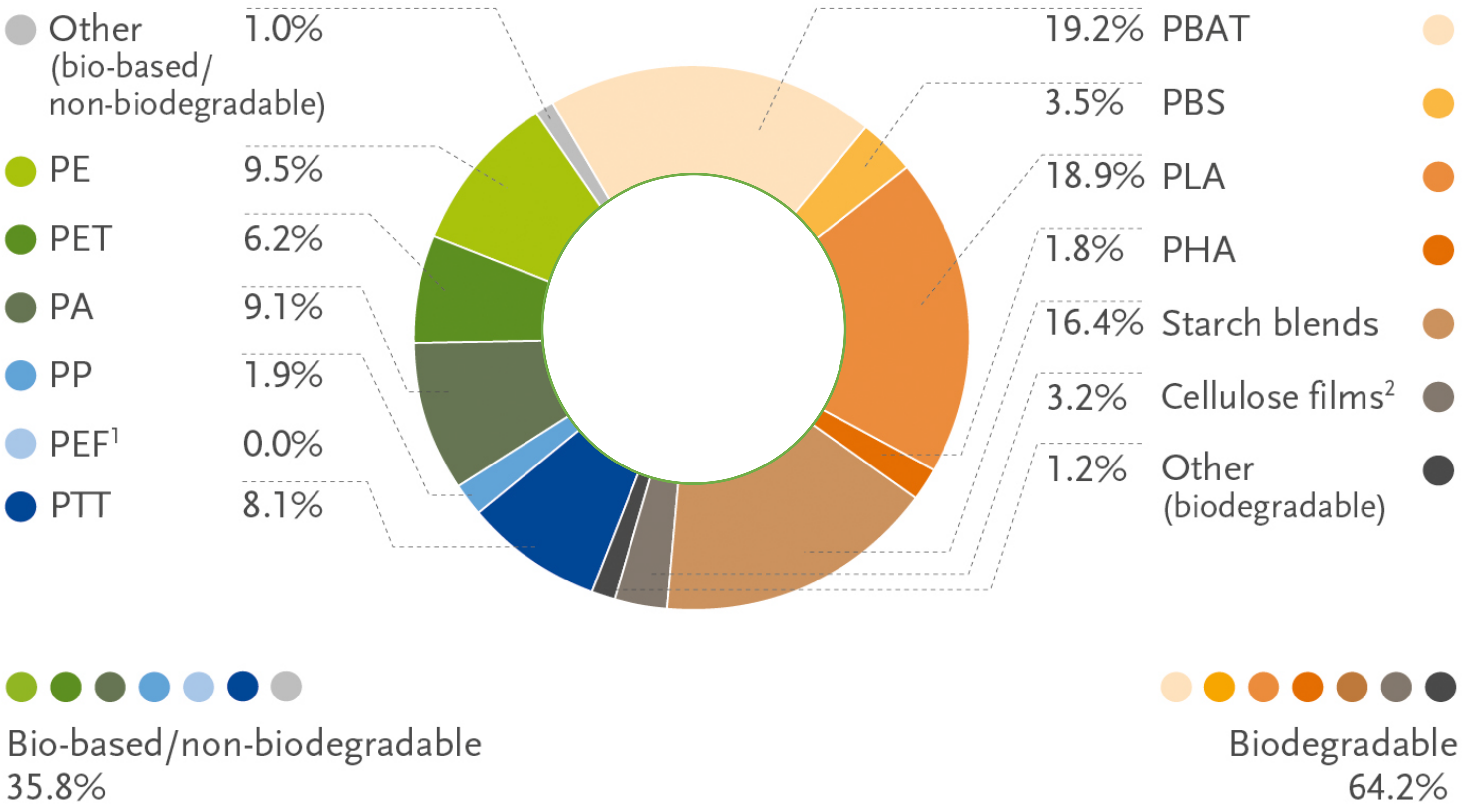
Global distribution of bioplastics 2021



[1]PEF is currently in development and predicted to be available at commercial scale in 2023. *[2] Regenerated cellulose films*

Source: European Bioplastics, nova-Institute (2021)
More information: ***www.european-bioplastics.org/market*** *and* ***www.bio-based.eu/markets***

Production of thermoplastics is 89% of all plastics

Some suppliers http://bio-based.eu/ibib/

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Bioplastic-thermoplastic	Thermoplastic biocomposites	Thermoset matrix	Flax reinforcement	Other
Brightplus	UPM	Sicomin Epoxy Systems	EcoTechnilin	Fibenol
ABM Composite Arctic Biomaterials	Stora Enso		Bcomp	

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Biocomposite development tools at Centria

- ❑ Twin screw compounder capacity ca 100 kg/day
- ❑ 3D printing filament production for FDM
- ❑ Large scale additive manufacturing (LSAM)
- ❑ Lamination: hand roles and vacuum infusion tools
- ❑ Coating Technologies
    - ✓ pilot factory (Ylivieska)
    - ✓ corona spray gun

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Bioplastics for LSAM

General requirements

- Biobased materials
- Recyclable
- Energy efficient

Specific requirement

- Low thermal expansion
- Chemical resistance

Products: boat parts and moulds for composite production

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Materials tested

Manufacturer, Material	Polymer	Filler	Filler w%	Material code in tests
C73, prod. by BrightPlus (alternative to PLA)	Bio 99.5%	WF	20*	C73+W20
K35B, prod. by BrightPlus (alternative to ABS, PP)	Bio 65.0%	WF	20*	K35B+W20
D55, prod. by BrightPlus, (alternative to PP)	Bio 80.0%	WF	20* 30*	D55+W20 D55+W30
DuraSense® 3D Plus 50 Prod. by Stora Enso	PP	WF	30* 30* 30* 50 50* 50*	Dura 30% Dura 30% + 0.1% UV Dura 30% + 0.2% UV Dura 50% Dura 50% + 0.1% UV Dura 50% + 0.2% UV
UV protected PP30GF, prod. CEAD	PP	GF	30	PP30% GF
PolyCore ASA-3012, prod. Polymaker	ASA	GF	20	ASA-3012 20% GF

** Compounded at Centria*

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Benefits and challenges of natural fibres in bioplastics

Benefits

- Improved stiffness
- Reduce thermal expansion/shrinkage in thermoplastics
- Replace glass fibre with lighter in weight material
- Less energy to produce per unit weight than glass fibre
- Natural feel, smell and appearance
- Suits the same machinery
- Recyclable

Challenges

- Water absorption
- Short fibres often reduce impact resistant
- Processing temperature is about 200°C, choice of plastics limited

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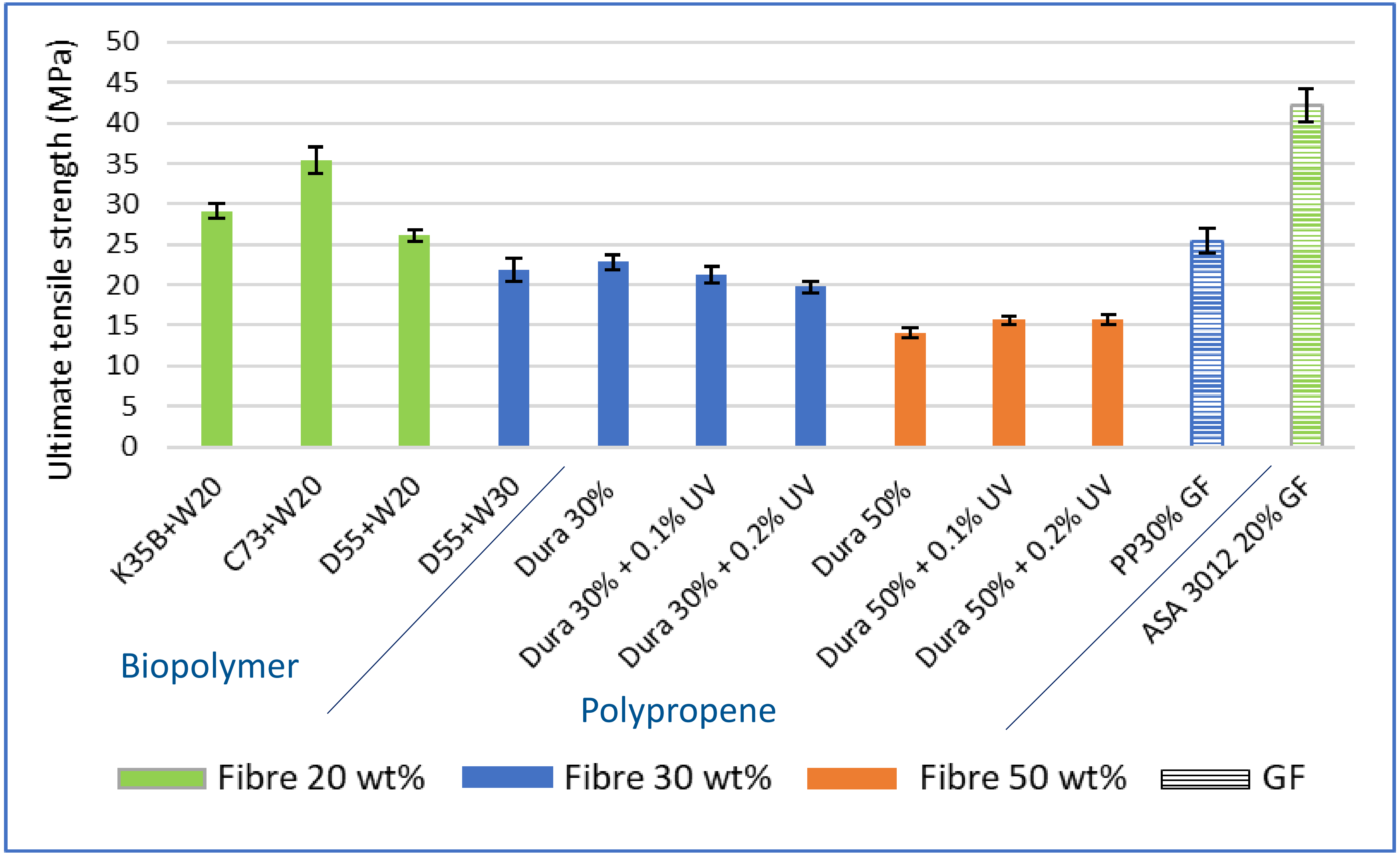
Tensile strength of tested bioplastics



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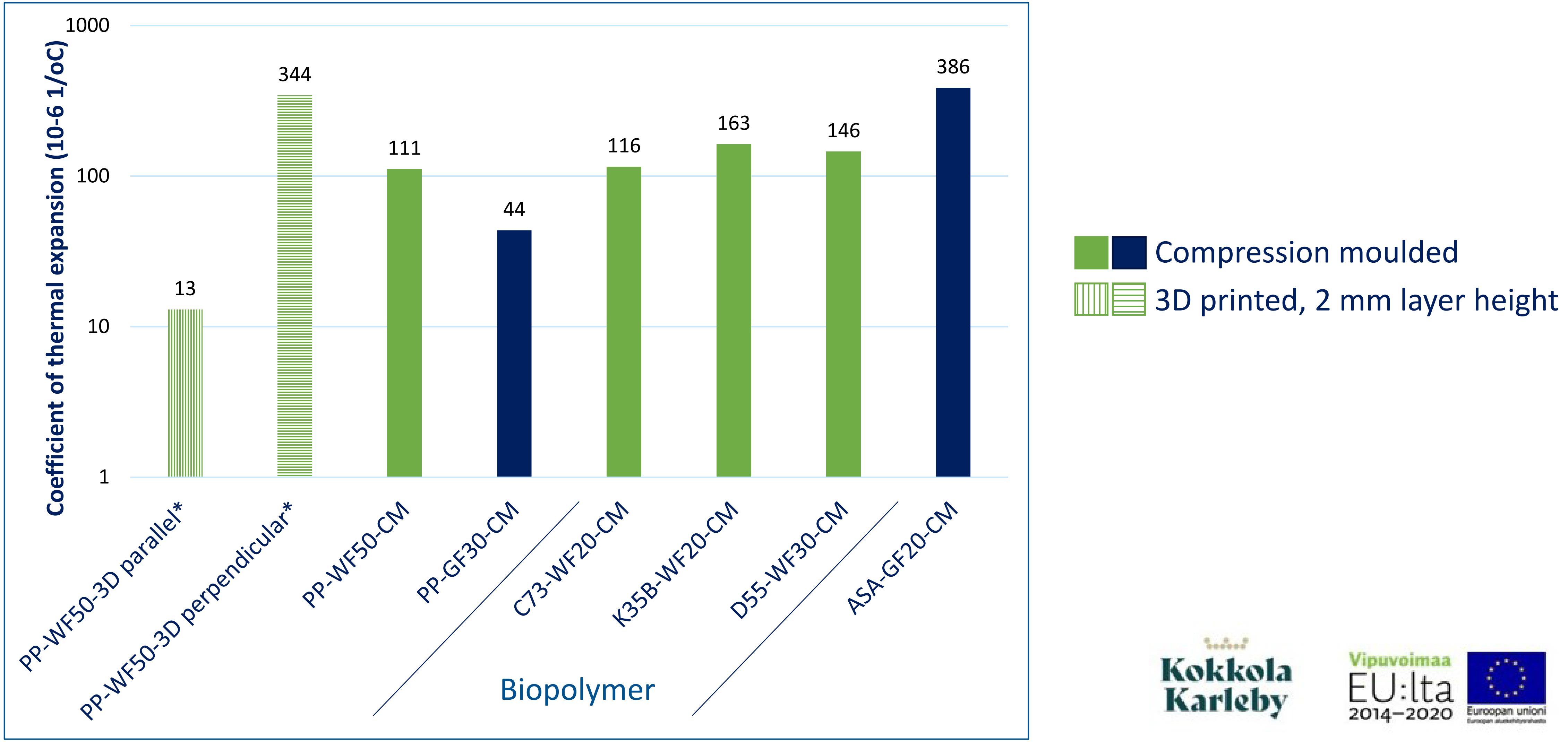
Coefficient of thermal expansion (CTE), 25-140°C



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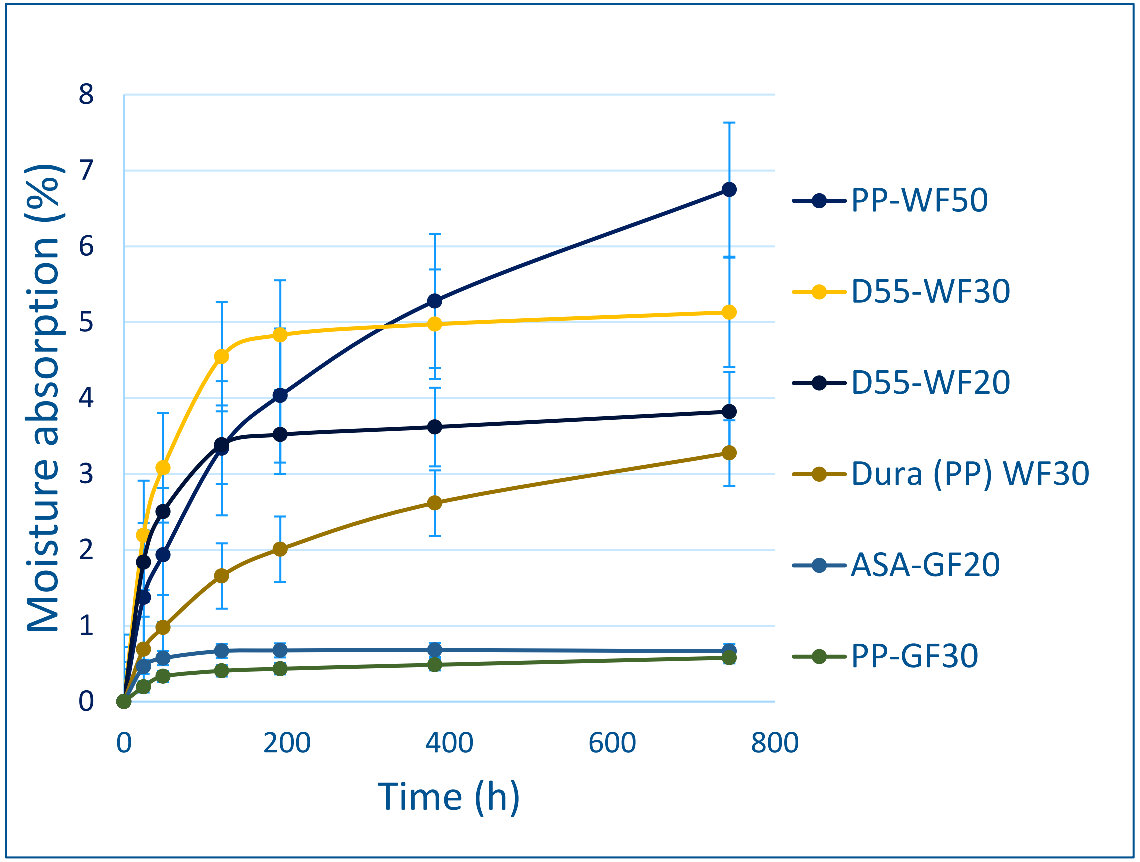
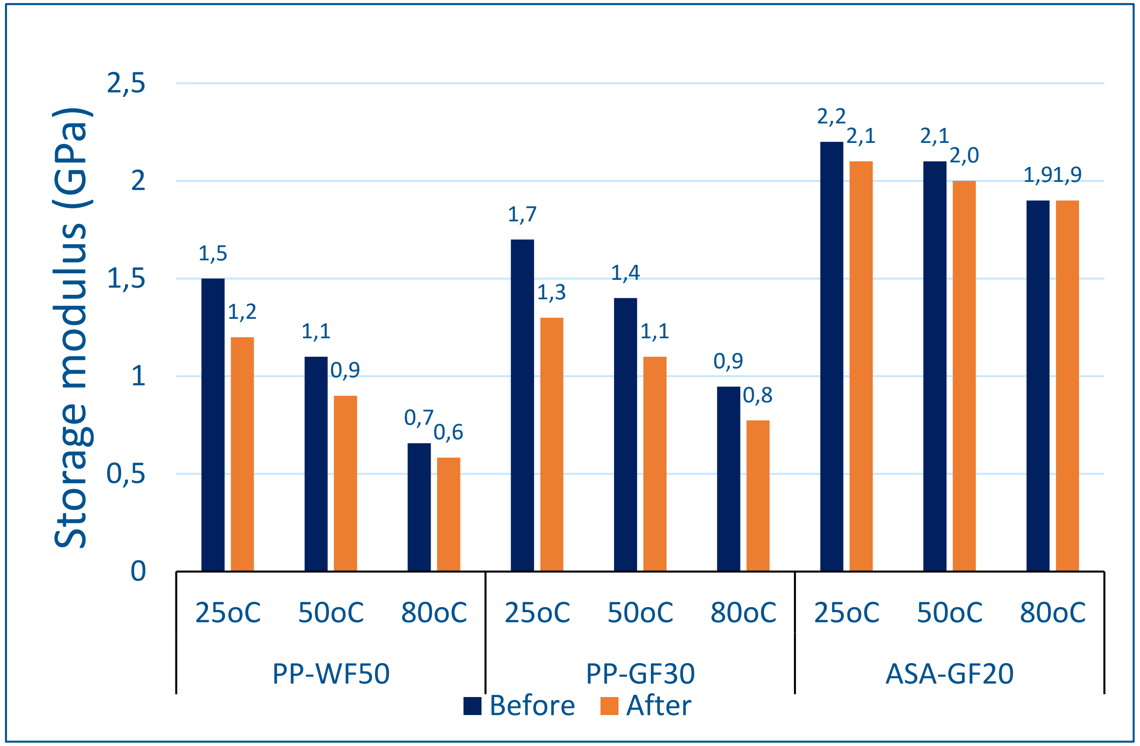
Moisture absorption and storage modulus of bioplastics





Biopolymer after exposure was too fragile for making the sample

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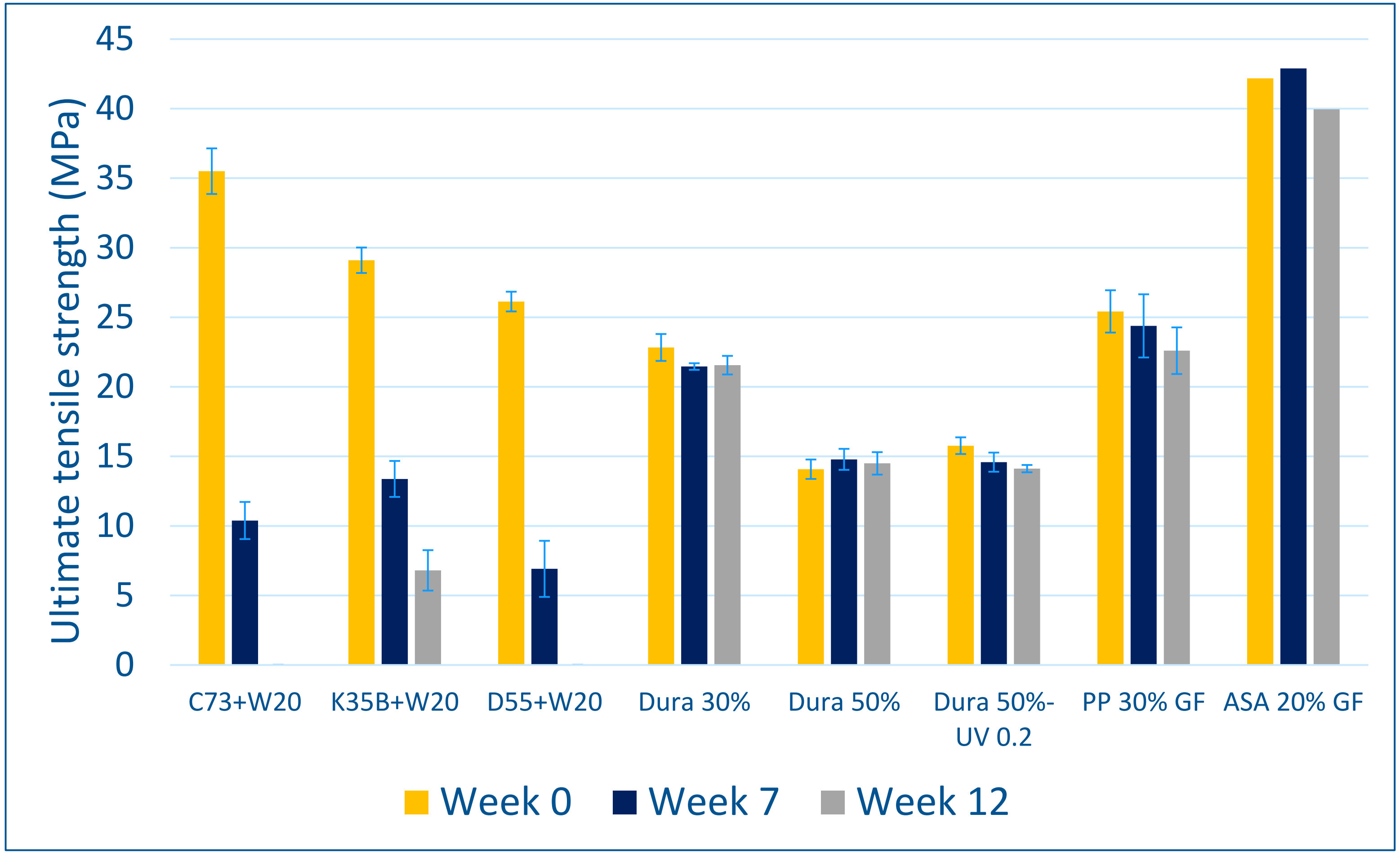
Tensile strength of the composites before and after the UV exposure test



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Conclusion of weathering tests

Material	Weathering (Temp and humidity)	UV resistance
Brightplus biopolymer + wood fibre	Poor	Poor
Polypropene + wood fibre	Good	Good
Polypropene + glas fibre	Good	Good
ASA + glass fibre	Good	Good

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Analysis, testing and laboratory services

Egidija Rainosalo / Mervi Liesi

Analysis, testing and laboratory services

- About 20 specialists in laboratories Kokkola and Ylivieska
    - Analysis and material testing
        - From raw material to finished product
        - The challenges of processes
    - Research work ja development methods
    - Testing production methods
    - Product development, process scaling
- Analysis and tests are done according to the standard, the customer's own methods and our internal methods
- Single analysis to versatile service packages
- The way of working is based on standard ISO 17025

Analysis and testing

- Analysis to identify and quantify composition

  Compositional analysis for liquid, solid and gaseous materials

  Fibre and filler content, VOCs, additives, amount of active functional groups, identification of unknown materials and fillers (GCMS,FTIR), elements content, heavy metals (ICPMS) etc.

- Structural analysis

  modular rheometer for viscoelastic behaviour, gel time etc., Electromicroscopy with analyser (SEM-EDS), optical reverse, stereo, and polarization microscopes, melt flow index (MFI)

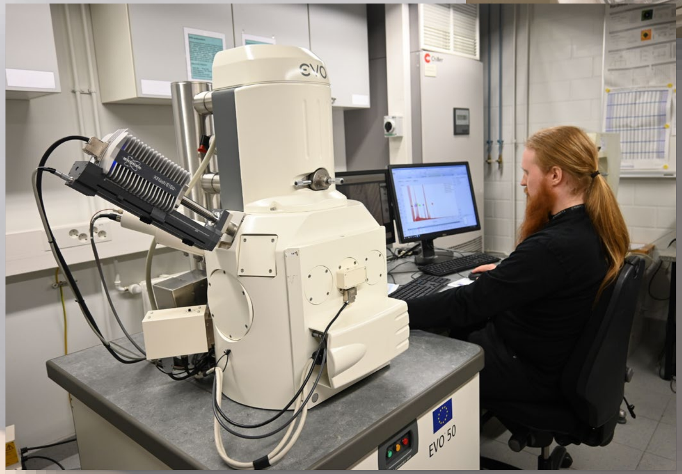
- Thermal properties of materials

  DSC, TGA, DMTA, STA/FTIR, bomb calorimeter

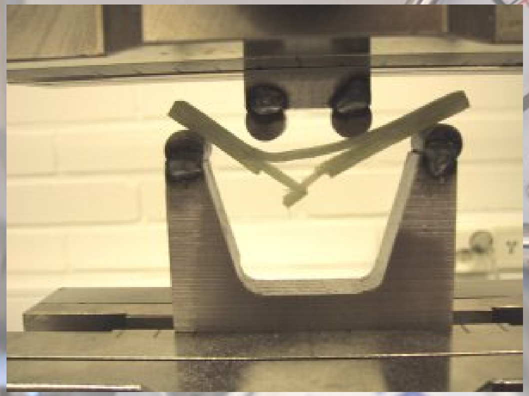
  Degree of curing, glass transition and melting temperature T_g (DSC), thermal decomposition temperature (TGA), the heat deflection temperature HDT (DMA), etc.

  Identification of specific organic substances evolved during thermal decomposition (STA-FTIR) etc.



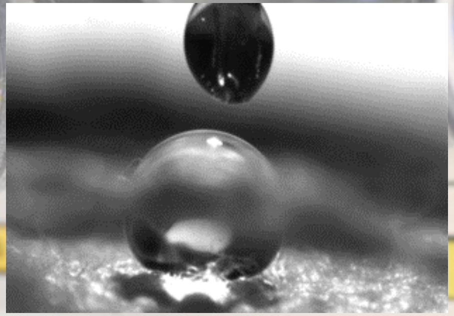



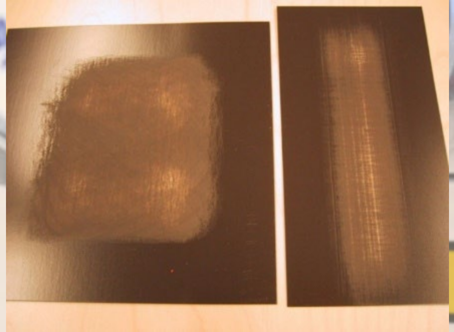
Analysis and testing

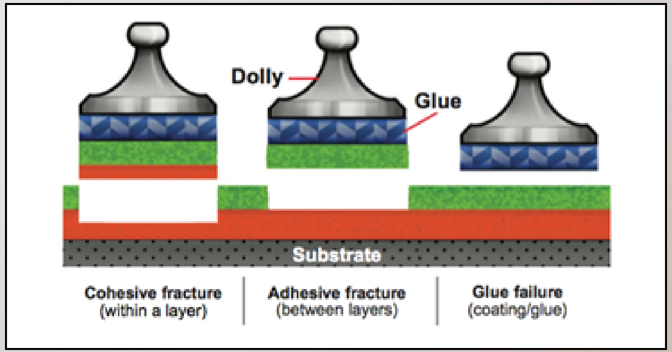


- **Mechanical testing of materials**
  tensile tester (max 5N-240 kN load), vibration fatigue (max 400 kg, 5-2000 Hz, max acceleration 50 G),

- **Testing of coatings**
  Hardness (Vickers, Shore, pencil test), abrasion (Taber), Pendulum damping tester (König), pull-off adhesion tester, wetting, coating thickness, gloss.







Environmental testing

- Testing of ageing and environmental influence
  Climate chambers (up to 54 m^3 size), Xenon light chamber, UV chamber, salt spray chamber
- Electromagnetic properties
  Electrical resistivity, EMC laboratory: conducted and radiated emission/ immunity, ESD, EFT and SURGE, Magnetic fields, Mobile EMC tester for vehicles
- Fire resistance test chamber

3D printing of large objects with a robot

Matti Ojala

3D printing of large objects with a robot

Using robotics into the 3D printing process, it becomes possible to print objects of much larger dimensions and more complex shapes than what conventional 3D printers can handle.

The University of Maine
Advanced Structures & Composites Center
Printing area 30,5 x 6,7 x 3m
World´s largest 3D printer 2019

https://umaine.edu/biomaterials/facilities/

Typical industries and solutions

Large 3D printing is typically used where there is a need for the production of large, complex, and intricate parts. These often include industries such as aerospace, boat, and automotive manufacturing.

Abu Dhabi based Al Seer Marine has a 36-meter-long robotic 3D printer, developed by CEAD. It is capable of printing parts up to 36 meters long, 4 meters wide, and up to 3 meters high.

https://amchronicle.com/insights/rethinking-manufacturing-with-large-scale-additive-manufacturing-at-al-seer-marine/

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Typical industries and solutions

Printing big complex parts in a single piece could be impossible. One solution is to print objects in smaller parts and then combine them into the final piece.

Hungarian-based Rapid Prototyping utilizes a gantry-type combined machine with a 3D printer and a 5-axis milling machine.

Machine has total working area 4,85 x 2,635 x 1,46 m

https://en.rapidprototyping.hu/

Printing hardware

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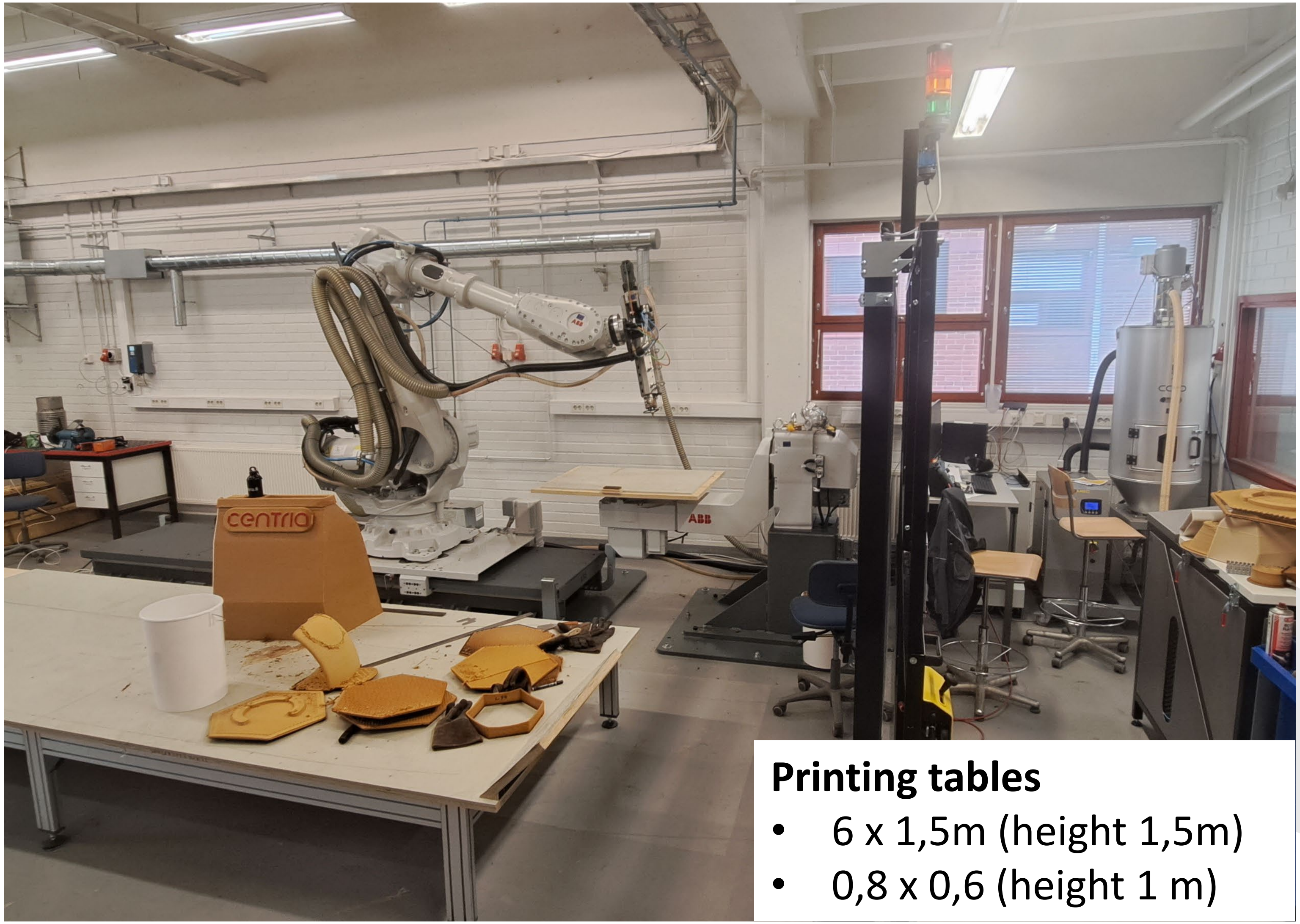

Robot ABB IRB6700

175kg / 3.05m

TrackMotion IRBT6004, 2,7m

2-axis workpiece positioner IRBP A500

Extruder for printing CEAD E25

- 80-400°C
- Throughput 5-12 kg/h
- Nozzles – 2-18 mm
- Material dryer/feeder 50-185°C, 100 l

Printing tables

- 6 x 1,5m (height 1,5m)
- 0,8 x 0,6 (height 1 m)

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Software

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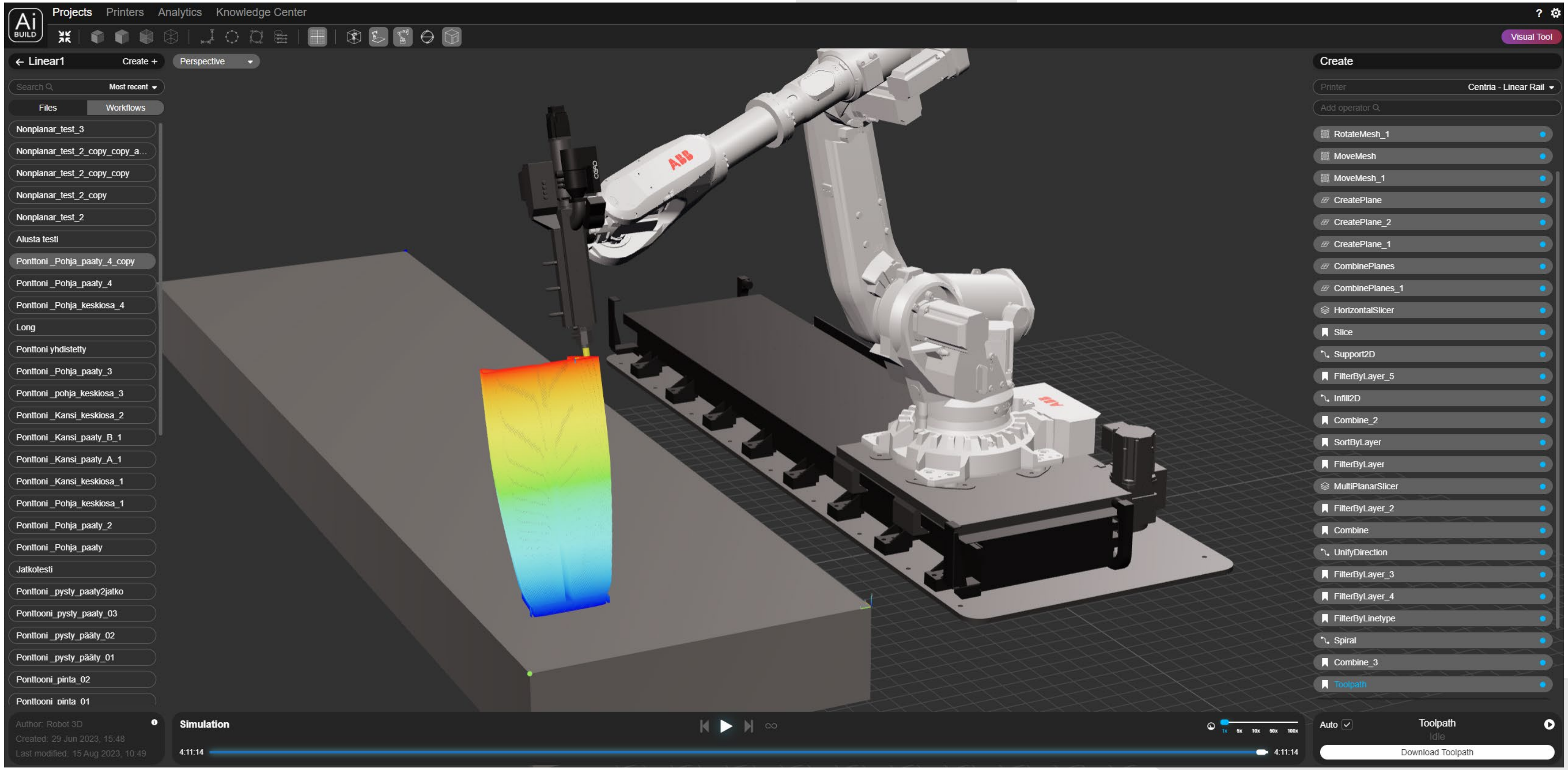

AiSync

Cloud based digital twin of printing enviroment

Simplified toolpath generation via visual programming interface

Visual printing simulation and collision avoidance

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Boat steering console

Size: 56x45x65 cm
Nozzle: 6 mm
Layer height: 3 mm
Duration about: 4 hours

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Example: from design to printed moulds

- Material: Stora Enso Durasense 3D plus 50
- Nozzle: 6 and 4 mm
- Duration: 2 and 3,8 h
- Weights: 4,1 and 3,1 kg

- Designed from using provided surface models
- Integrated mould body and attachment points for milling
- Printed in normal mode

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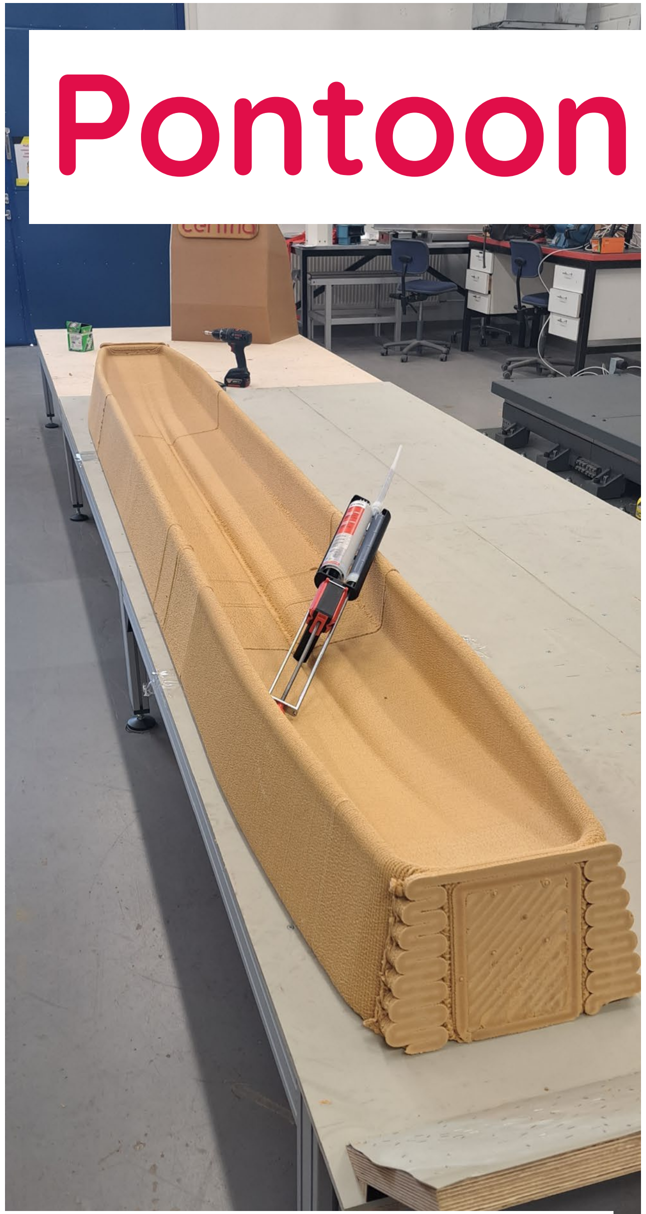
Pontoon mould



Size: 390 x 51 x 21 cm
Printed in 3 parts
Nozzle: 9 mm
Layer height: 4 mm
Total printing time 12 h
Milled after printing to final dimensions.
Milling time 1 h

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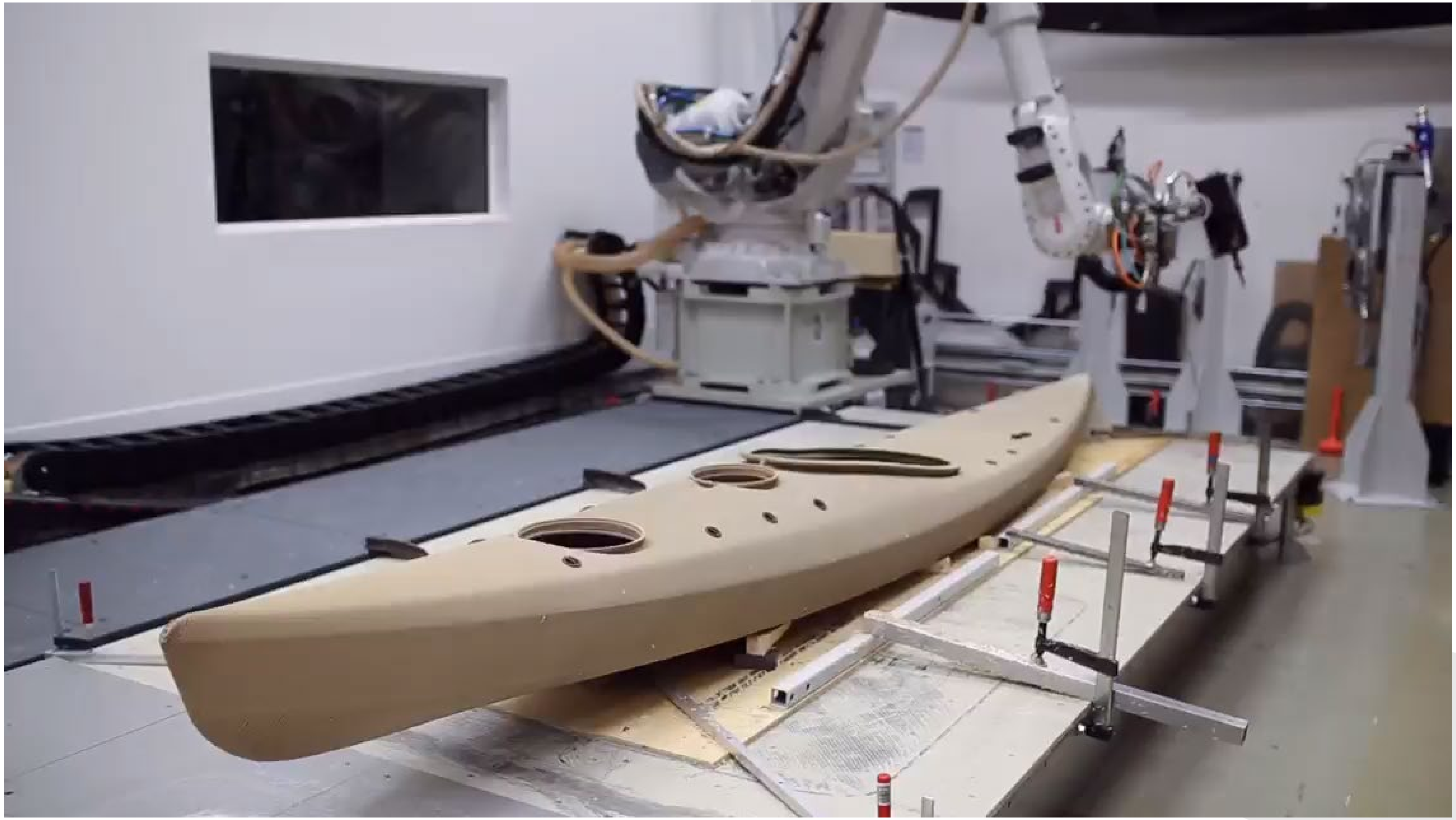
Future plans



In future projects, we will combine additive and extractive production technology in the same package. A good example of such an application is the combined 3d printing and milling concept of RISE Research Institutes of Sweden.

https://www.ri.se/en/what-we-do/projects/3d-printed-kayak-based-on-fibraq-reinforced-recycled-plastic

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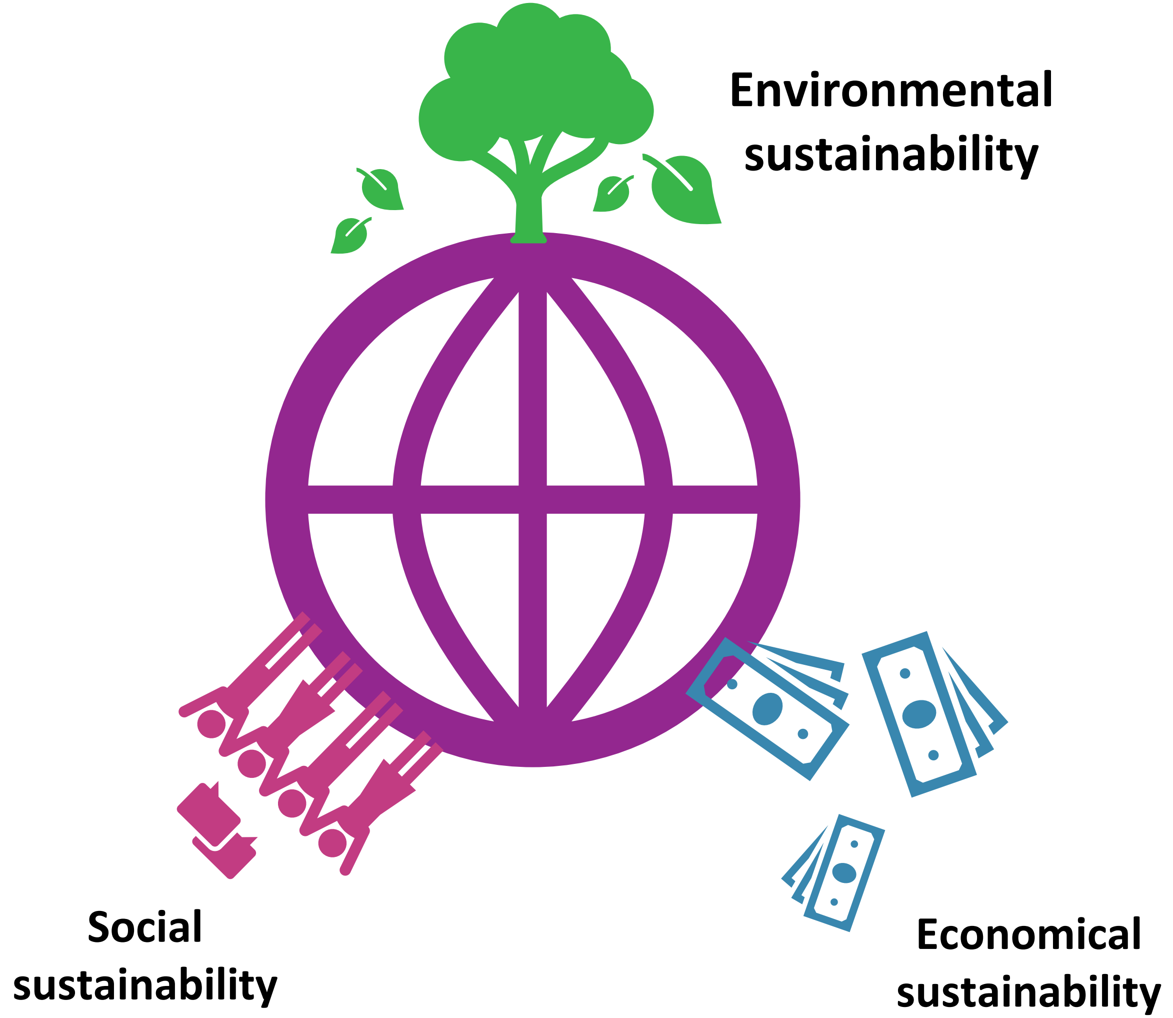
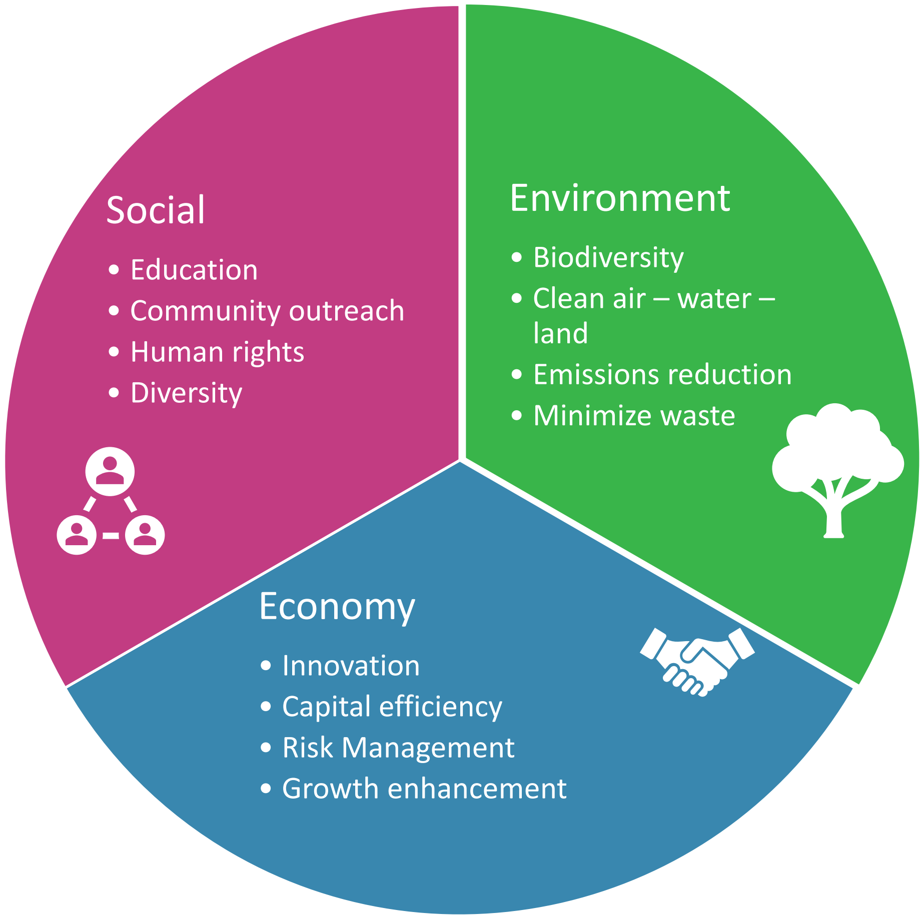
Sustainability as a Competitive Edge

Hanna Tölli


Environmental
sustainability
Social
sustainability
Economical
sustainability

Achieving sustainability requires all three

Environmental health & safety
Global climate change crisis management
Environmental policy



Job creation
Skills enhancement
Local economic impact
Social investments

Resource efficiency
Product stewardship
Life-cycle management
Regional materials

CLEAR

HONEST

SOLUTION-ORIENTED

OPEN and TRANSPARENT

There is no need for responsibility communication, but responsible communication

Centria’s RDI to help and support on your sustainability and circular economy journey

”Our partners require us to report our carbon footprint, but we don’t have the resources to find out the differences between the various calculation methods.”

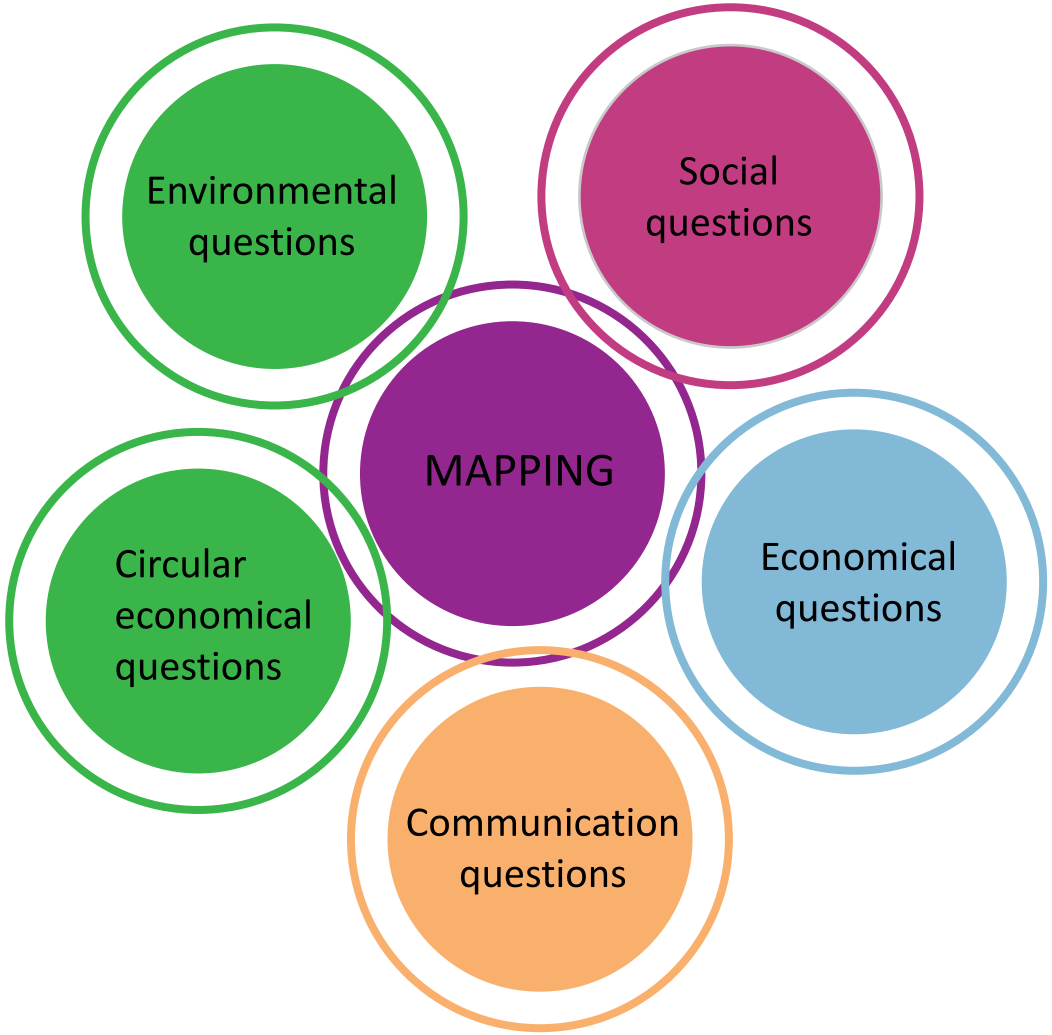
”We ourselves also want to monthly monitor our emission data.”

”We are particularly interested in the life-cycle of work clothes after we have found them to be unusable... It would be good to have a model for this.”

”For some time, we have been interested in finding out the status on recycling of carbon fiber and composite materials in our country and in the world.”

”However, we did not have the resources for this evaluation, so the help from the project came at just the right time.”

Centria's RDI to help and support on your sustainability and circular economy journey



Jukkola Systems Oy
15. huhtikuu ·

Kiitos Centrialle vierailusta kiertotalouden ja vastuullisuuden teemoilla. Oli ilo esitellä toimintaamme ja saada askelmerkkejä eteenpäin menemiseksi.

Olemme yrityksenä tehneet merkittäviä toimia jotta tuotantomme olisi mahdollisimman kestävää. Tuotamme aurinkopaneelien avulla yli tarpeemme sähkön. Muina aikoina ostamme vihreää sähköä. Kierrätämme myös kaikki koneet ja laitteet, jotta ne päätyvät uudelleen käyttöön uusina tuotteina.

Pian meillä on mahdollisuus myös ilmoittaa asiakkaillemme tuotteidemme hiilijalanjäljen.

Muistakaa tutustua YouTube kanavaamme ja näette esimerkkejä mitä energiansäästö toimia olemme tehneet asiakkaillemme.

Kiitos eritoten Hanna Tölli

#centria #kiertotalous #kestäväkehitys #energiansäästö

Centria's RDI to help and support on your sustainability and circular economy journey

LCC calculations

LCA calculations

New training

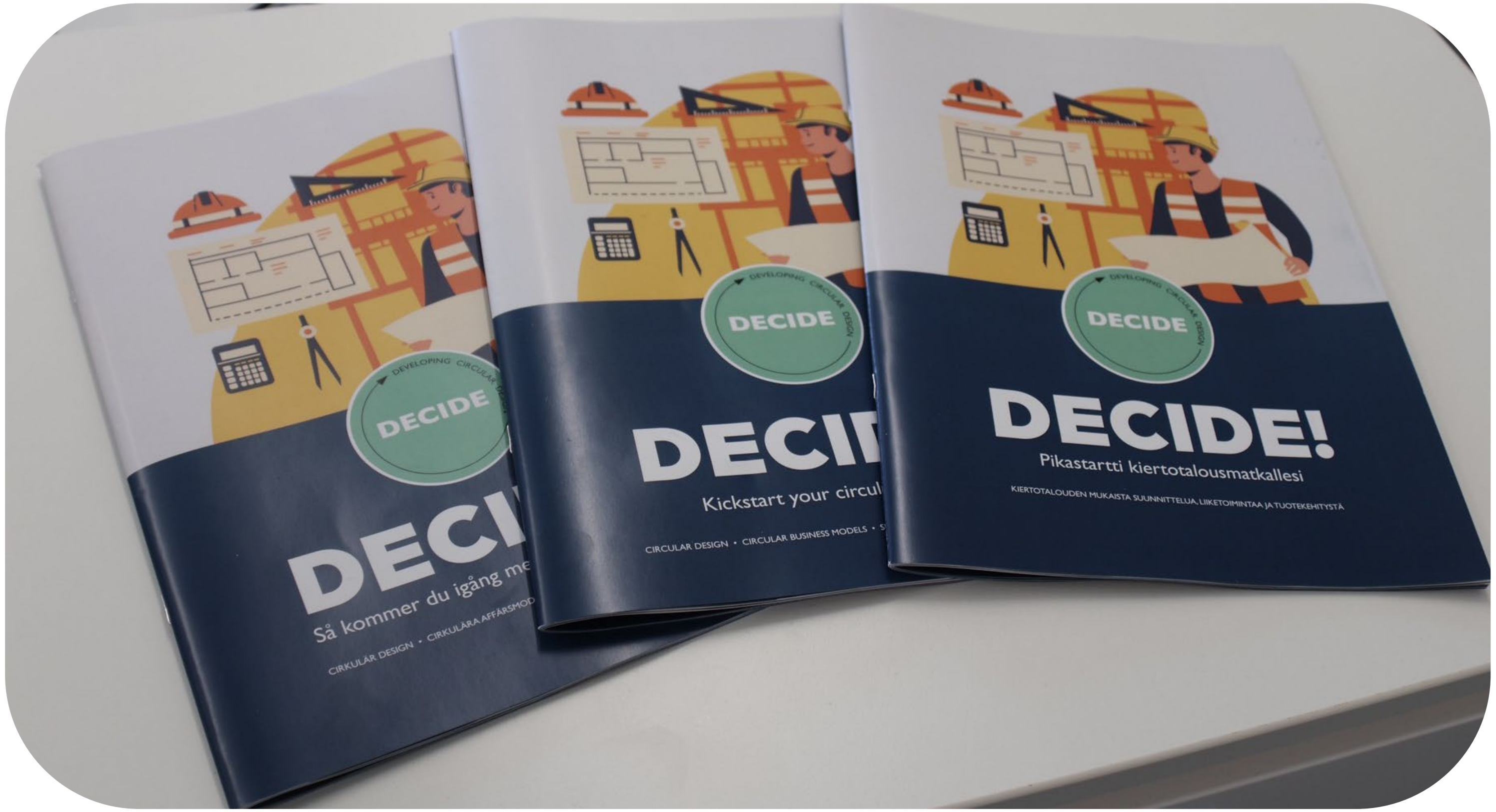
New solutions

Laboratory testing

New technology

It all begins with design.

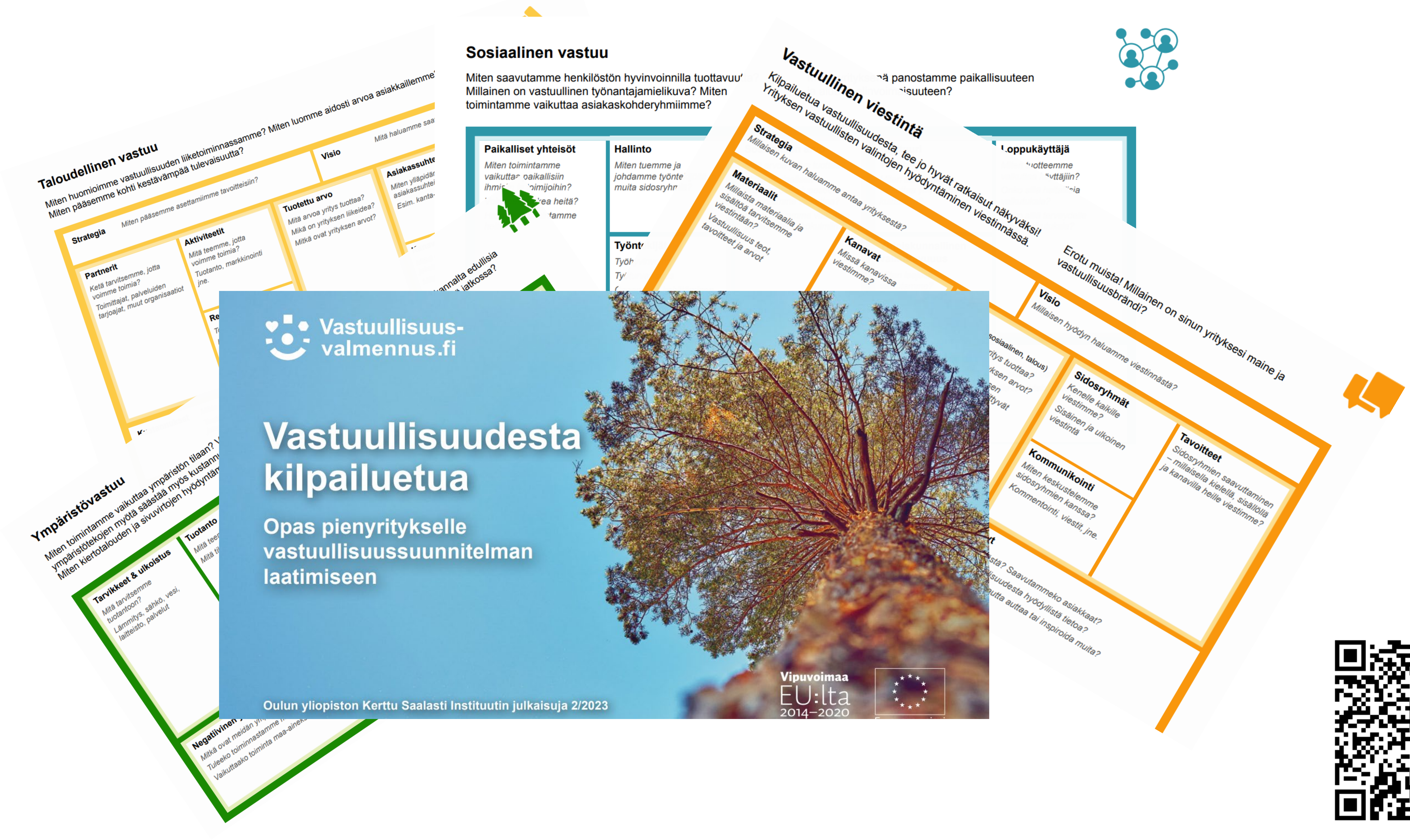
Kickstart your circular journey



Download your own copy:

Develop your business towards circular economy

	Elävöitä/Regenerate				
2.	Korjaa/Repair	Käytä uudelleen/ Reuse	Vähennä/Reduce	Harkitse/Rethink	Kieltäydy/Refuse
1.	Palauta/Recover	Kierrätä/Recycle	Uusi käyttökohde/ Repurpose	Uudelleen valmista/ Remanufacture	Kunnosta/Refurbish



Taloudellinen vastuu
Miten huomioimme vastuullisuuden liiketoiminnassamme? Miten luomme aidosti arvoa asiakkaillemme?
Miten pääsemme kohti kestävämpää tulevaisuutta?
Sosiaalinen vastuu
Miten saavutamme henkilöstön hyvinvoinnilla tuottavuutta?
Paikalliset yhteisöt
Hallinto
Loppukäyttäjä
Vastuullinen viestintä
Kilpailuetua vastuullisuudesta, tee jo hyvät ratkaisut näkyväksi!
Yrityksen vastuullisten valintojen hyödyntäminen viestinnässä.
Erotu muista! Millainen on sinun yrityksesi maine ja vastuullisuusbrändi?
Strategia
Visio
Sidosryhmät
Kommunikointi
Tavoitteet
Ympäristövastuu
Tarvikkeet & ulkoistus
Vastuullisuus-
valmennus.fi
Vastuullisuudesta kilpailuetua
Opas pienyritykselle vastuullisuussuunnitelman laatimiseen
Oulun yliopiston Kerttu Saalasti Instituutin julkaisuja 2/2023
Vipuvoimaa EU:lta 2014–2020

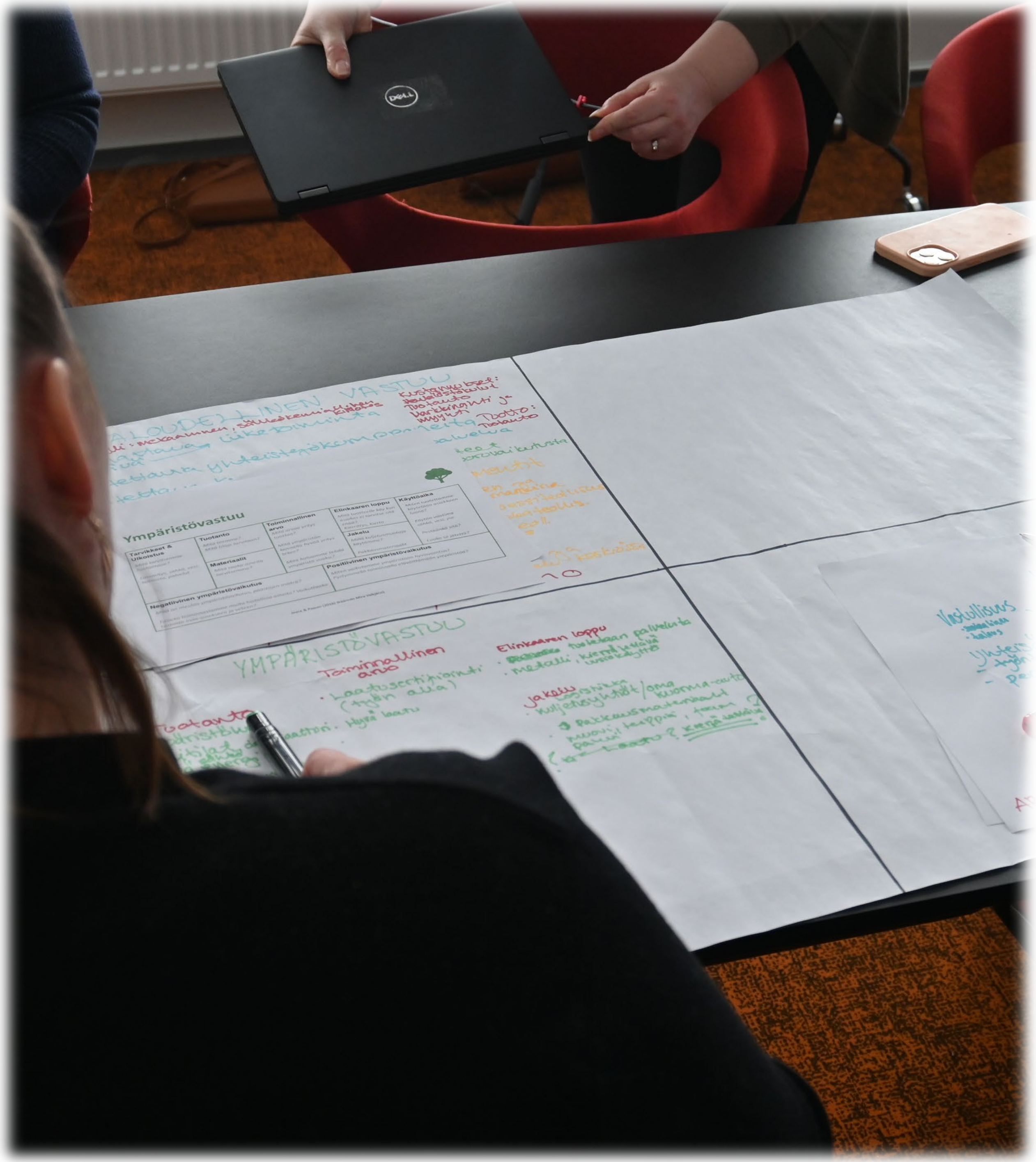
Vastuullisuuden johtaminen ja viestintä pk-yrityksissä
Sustainability management and communications in SME's

The purpose of the project is to help SMEs in the transition to sustainability by: developing and increasing their knowledge of the topic, enhancing their ability to lead in an efficient and responsible manner in change situations and give them tools to communicate about their sustainability related actions.

SUSTAINCHANGE
centria ammattikorkeakoulu
Kokkola Karleby
Elinkeino-, liikenne- ja ympäristökeskus
Vipuvoimaa EU:lta 2014–2020
Euroopan unioni
Euroopan sosiaalirahasto

Benefits

- a comprehensive information package on sustainability
- Learn how to lead and develop the competitive advantage of your business in times of change
- You get to develop your own business and plan sustainability communication
- Get a certificate and peer support to make the sustainability transition during and after the project
- E-guide to sustainability communication
- ”Vastuullista muutosta” Podcasts on Spotify open to all



Networking the best advantage

Register here:

Composite Recycling and Life Cycle Assessment (LCA)

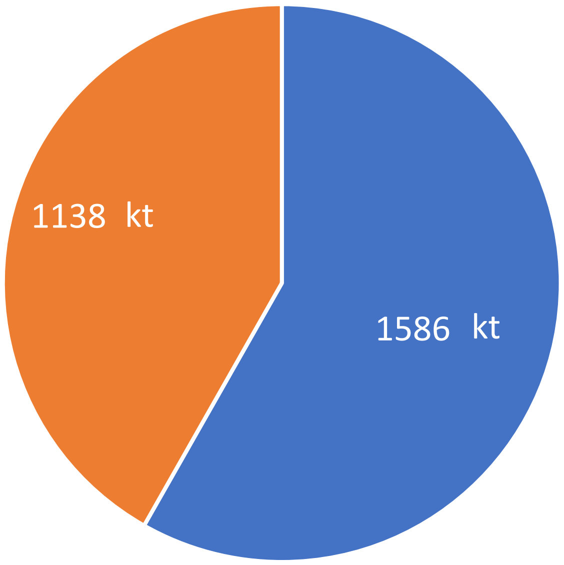
Rathish Rajan

Composite Recycling and Life Cycle Assessment (LCA)

- Composite facts 2022
- Driving factors
- Challenges
- Status of recycling
- 3D printing as manufacturing and recycling method
- Environmental impact of recycling methods

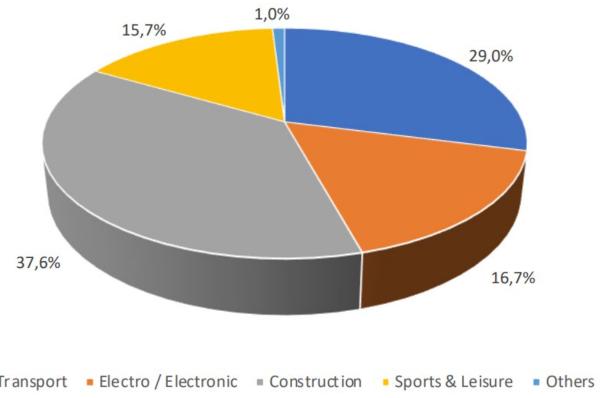
Facts 2022

EU Production 2022

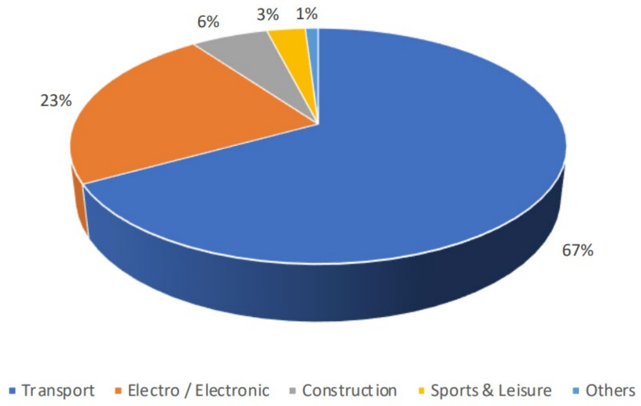


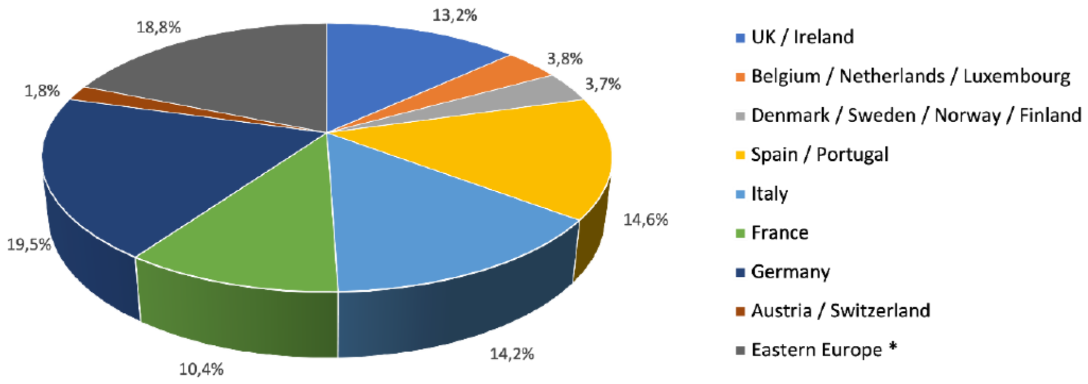
■ Thermoplastic composites ■ Thermoset composites

Thermoset composite market - 2022



Thermoplastic composite market - 2022





* Poland, Czech Republic, Hungary, Romania, Serbia, Croatia, Macedonia, Latvia, Lithuania, Slovakia and Slovenia

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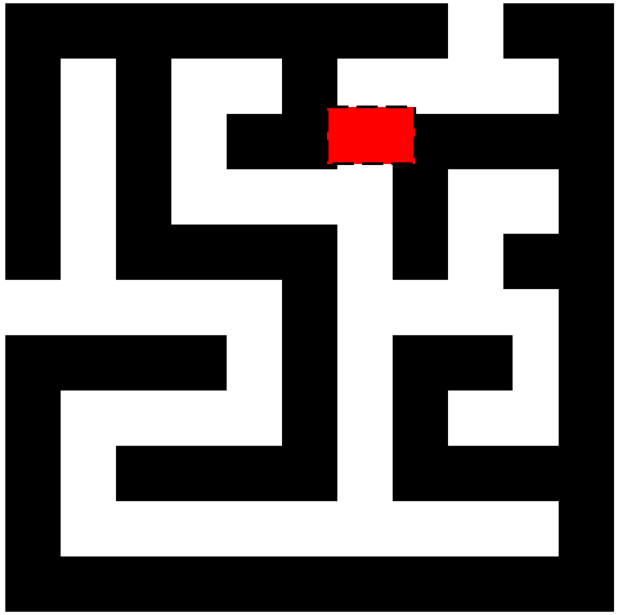
Source: Annual market report for fibre reinforced plastics / composites - AVK 04/2023

Driving Factors for Recycling

- environmental concerns
- existing legislations
- resource conservation
- brand promotion

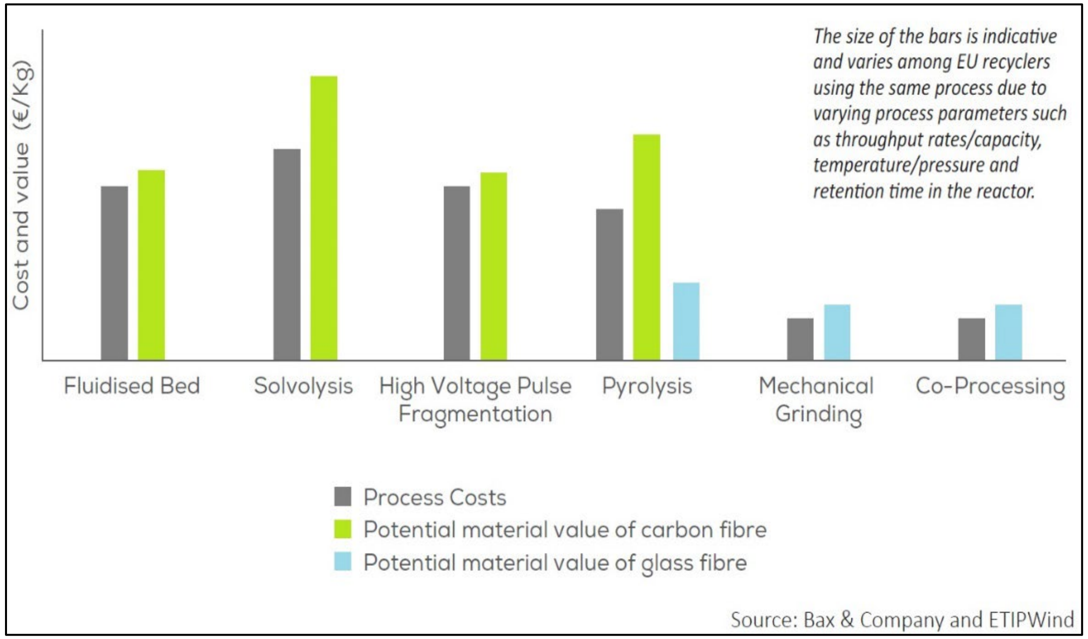
Challenges

- technological challenges
- limited recycling facilities
- economic viability
- difficulty in collection of waste



Status of Recycling in Europe

- cement kiln co-processing
- availability of stable composite waste stream?
- need cross-sector co-operation within composite industry



Wind Europe · EuCIA · UP/VE · Glass Fibre Europe · EPOXY · EBI · CEMBUREAU

Position paper
June 2023

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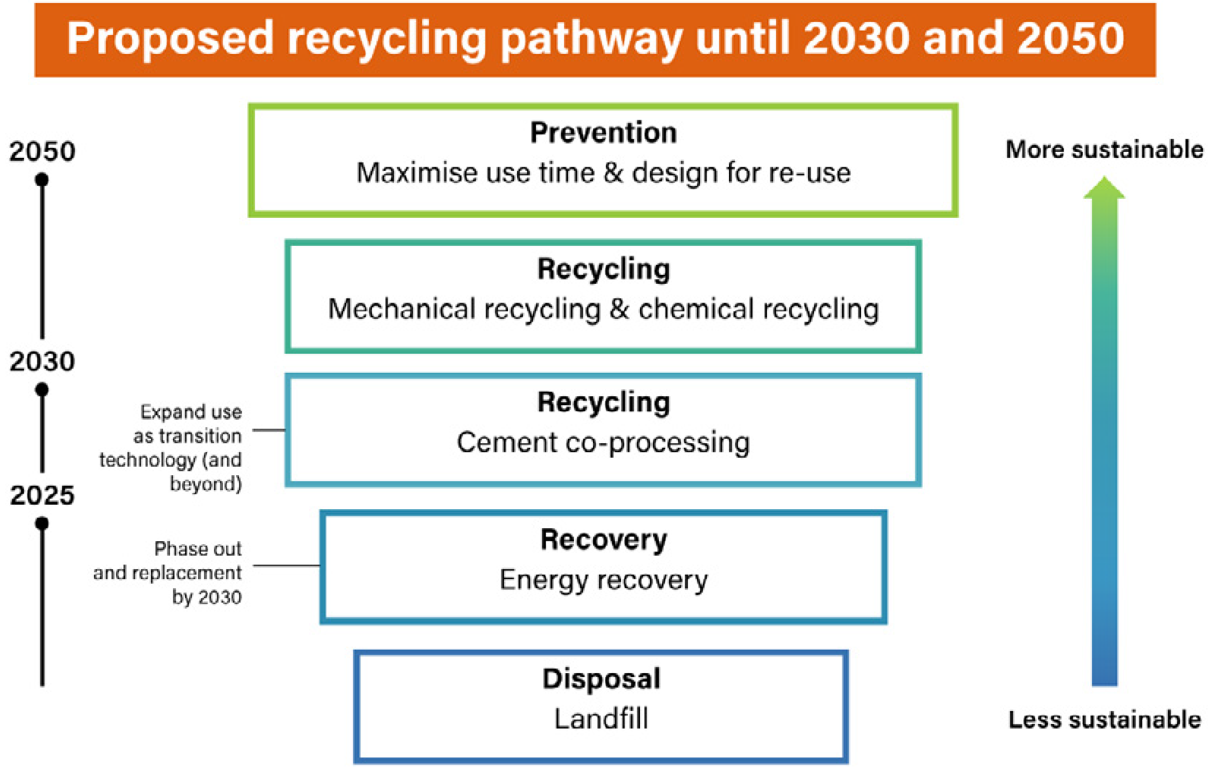
European boat industry - Roadmap

- phase out landfilling and energy recovery by 2030
- expand use of cement kiln route from 2025 and beyond
- adoption of additional recycling solutions from 2030

A circular approach in recycling



Source: A roadmap on the implementation of the circular economy for end-of-life recreational boats
https://circulareconomy.europa.eu/platform/sites/default/files/2023-07/Roadmap%20on%20the%20implementation%20of%20circular%20economy%20-%20EOL%20recreational%20boats.pdf

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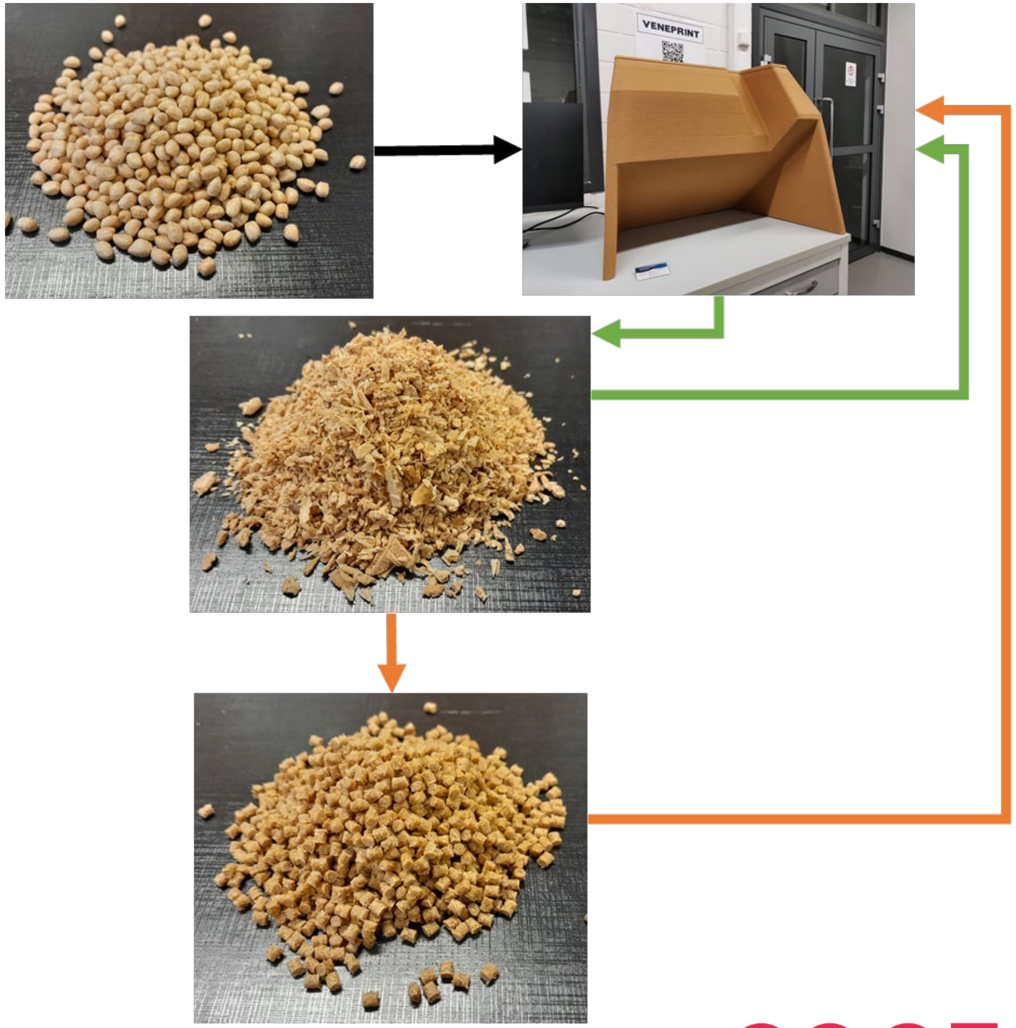
3D Printing as a manufacturing and recycling method

- suitable for manufacturing large boat components
- experimentally proven to be suitable for making new components from regrinds without loss in material property
- material property loss can be compensated by using appropriate additives through compounding



Pictures: Simo Huhtanen

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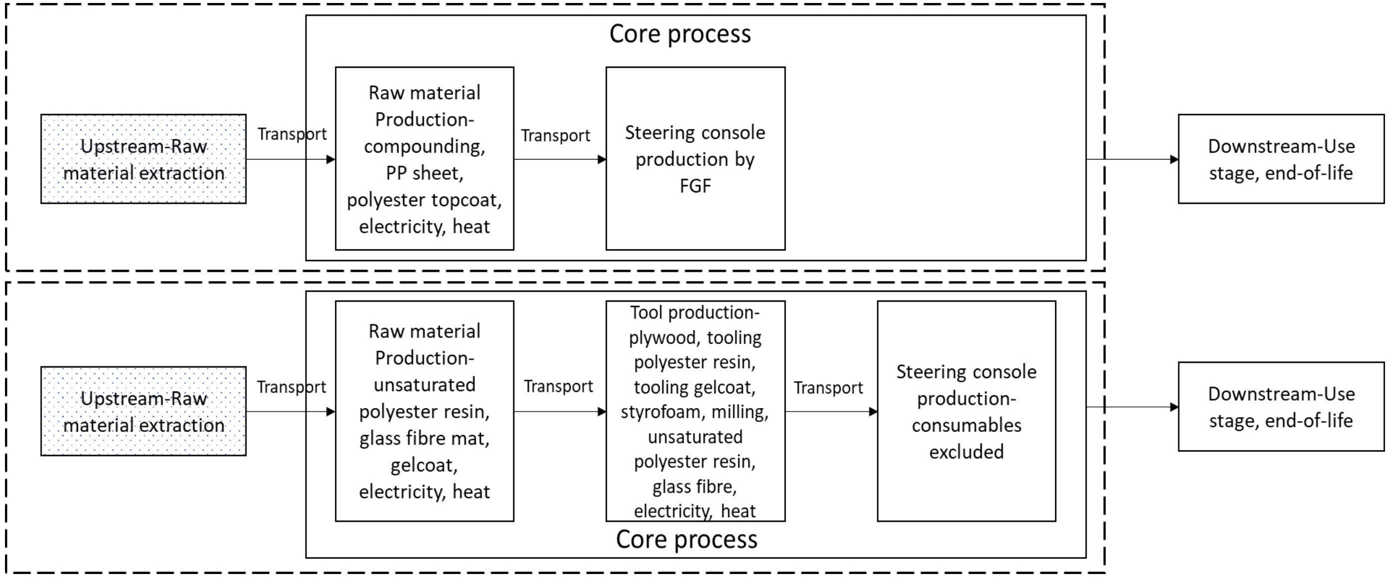
Environmental impact – steering console case study

Goal

The study aims to compare two manufacturing methods used for producing steering consoles to select the one based on overall environmental performance.

Functional unit

"steering console with a total area of 1.85 m^2 for a boat with a lifetime of 20 years."



*FGF-Fused granular fabrication

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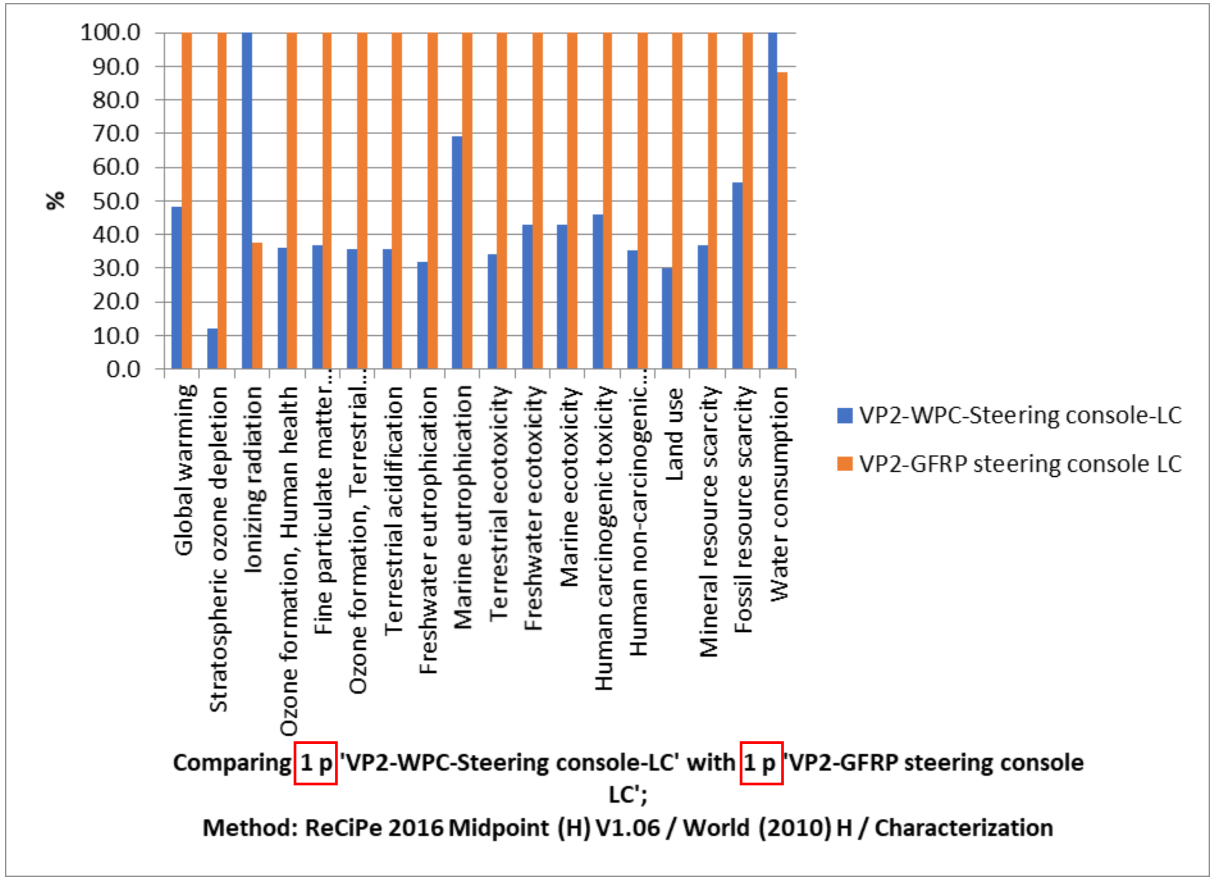
LCIA Results

3D printing with WPC shows lower impacts in 16 out of 18 categories.

Electricity consumption and the source of electricity has high impact on 3D printed product.

The higher impact in the water use category for 3D-printing is attributed to both the wood plastic composites and the share of nuclear power in electricity



The comparison of life cycle impact results calculated with the Recipe 2016 midpoint method for the steering console produced in two different manufacturing methods

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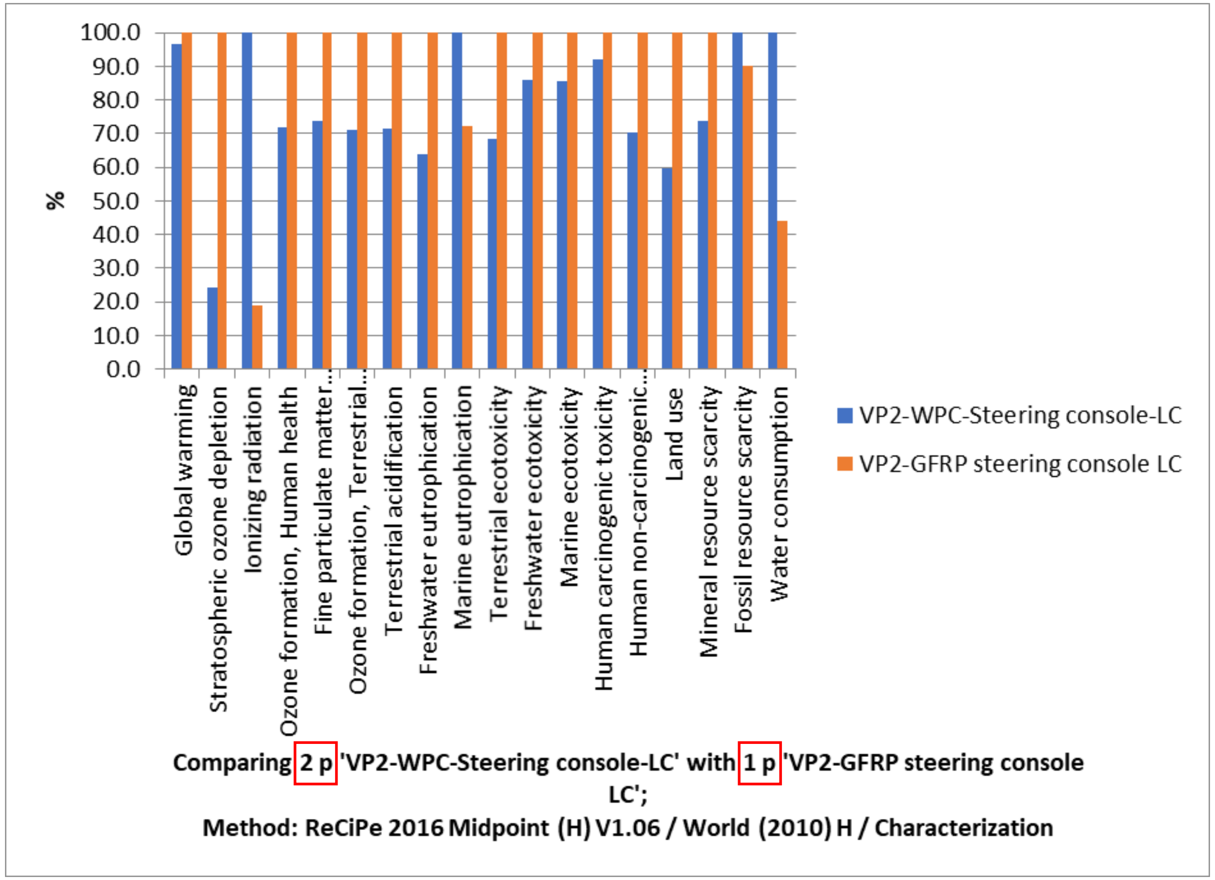
LCIA Results
Boat lifetime 40 years

3D printing with WPC shows lower impacts in 14 out of 18 categories.

The fossil resource scarcity is assigned mainly to using fossil-based raw material to produce wood plastic composite-based-steering console.

The impacts on water systems from nuclear power include discharge of warm cooling water.



Comparing steering console made from 3D-printing and conventional method by ReCiPe 2016 Midpoint (H) method considering doubled lifetime of boat

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Environmental impact of recycling methods

- high voltage fragmentation method consumes significant electricity
- GHG emissions owing to pyrolysis ranged from 1.52 to 5.40 kg-CO2 eq/kg
- GHG emissions from solvolysis ranged from 1.53 to 5.96 kg-CO2 eq/kg while that of the Hitachi Chemical was 1.92 kg-CO2eq/kg.


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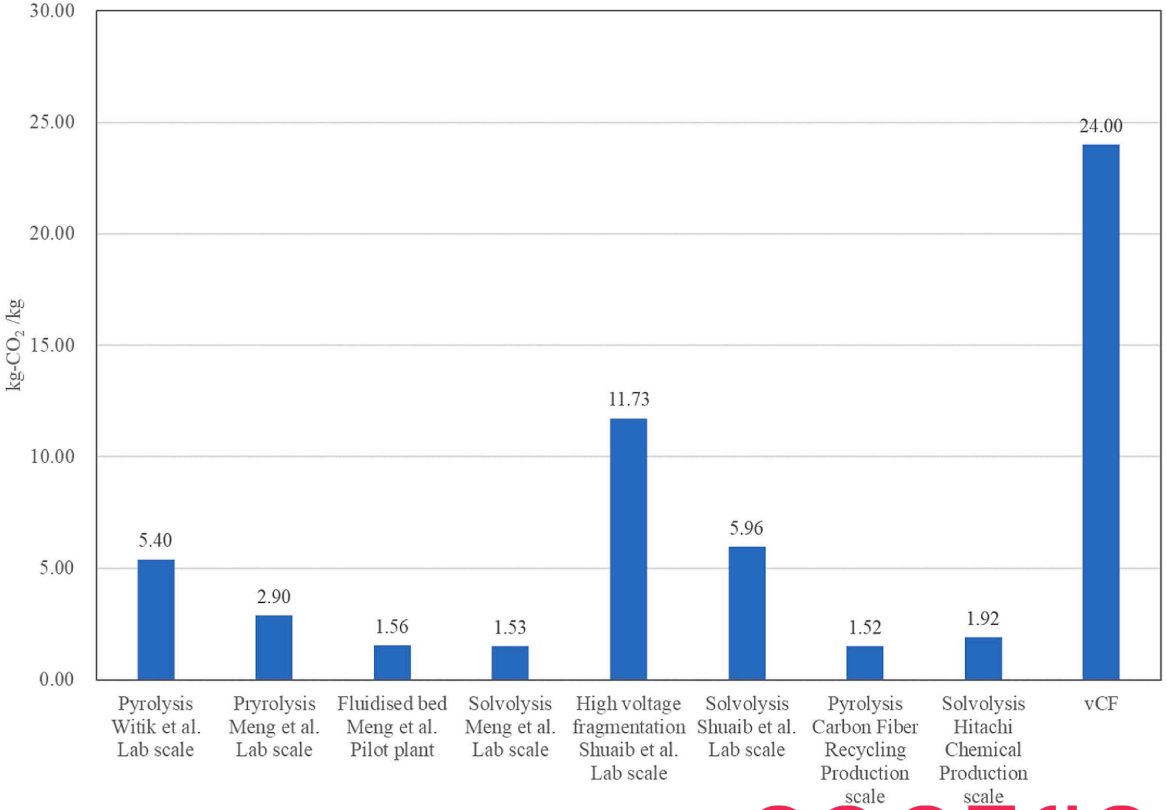
journal homepage: www.elsevier.com/locate/jclepro

Cradle-to-Gate life cycle assessment of recycling processes for carbon fibers: A case study of ex-ante life cycle assessment for commercially feasible pyrolysis and solvolysis approaches

Kotaro Kawajiri *, Michio Kobayashi
National Institute of Advanced Industrial Science and Technology, Japan



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Act now to be ready for the future!

Euroopan unioni
Euroopan aluekehitysrahasto
Vipuvoimaa EU:lta 2014–2020

Kiitos!

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