ARCADA

Interreg Co-funded by the European Union

Central Baltic Programme

BalticReed

Baltic Reed Innovations

Baltic Reed Åland 18.9.2024

Content

- Arcada
- AUS research and innovations
- Arcadas role in Baltic reed and innovations

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THIS IS ARCADA UNIVERSITY OF APPLIED SCIENCES

Paula Linderbäck

ARCADA

Strategy 2030

At the forefront – We put education and culture to work for a rewarding & sustainable life

VISION

A globally relevant higher education institution based in Helsinki, working at the forefront of change and development.

Through education and research, we create smart solutions for a rewarding and sustainable life.

MISSION

We are a Swedish-language university of applied sciences for a multicultural Finland

VALUES

Inclusive and encouraging environment

Respectful and ambitious culture

Humane and agile approach

arcada.fi

GOALS 2030

Future-driven Swedish-language higher education institutione in Helsinki

Nordic cooperation for global relevance

GOALS 2030

Smart solutions for a dynamic professional life and a vivid Swedish culture

Career support for a rewarding and sustainable life

ARCADA

ARCADA IN NUMBERS

2700
Degree students

170
Members of staff

500
Graduates

Why students choose Arcada

- PERSONAL GUIDANCE FROM EXPERT LECTURERS
- PRACTICAL KNOWLEDGE, WITH STRONG THEORETICAL BASIS
- CLOSE CONNECTION TO WORKING LIFE
- DEGREES THAT ARE HIGHLY VALUED BY EMPLOYERS
- GREAT STUDENT COMMUNITY AND STUDENT LIFE
- SAFE AND EQUAL
- THE MOST INTERNATIONAL UAS IN FINLAND IN RELATION TO SIZE

In 2020, **15%**

of our degree students came from abroad

Arcada is an International UAS – in fact, the most international UAS in Finland in relation to size, with 120 partner universities around the world

- **We offer 3 Bachelor’s & 4 Master’s Degree Programmes in English**
- **We also offer student, teacher and expert exchange. We welcome about 70 exchange students each year**
- **We take part in numerous international research projects**
- **Our 400 international students represent more than 60 different nationalities**

The role of science in universities of applied sciences in Finland

In addition to **degree education**, the second main task of universities of applied sciences is **research, development, and innovation activities**

The official duty of a university of applied sciences is to engage in **applied research**, development, and innovation activities that **promote working life** and regional development, as well as renew the economic structure of the region, along with artistic activities.

Science does not exclude practicality

Source: tieteentekijat.fi

University of applied sciences in international research scale

Universities of applied sciences are also deeply networked with national and international networks and centers of expertise

Universities of applied sciences are seeking funding for research, development,

and innovation (RDI) projects from international funding sources

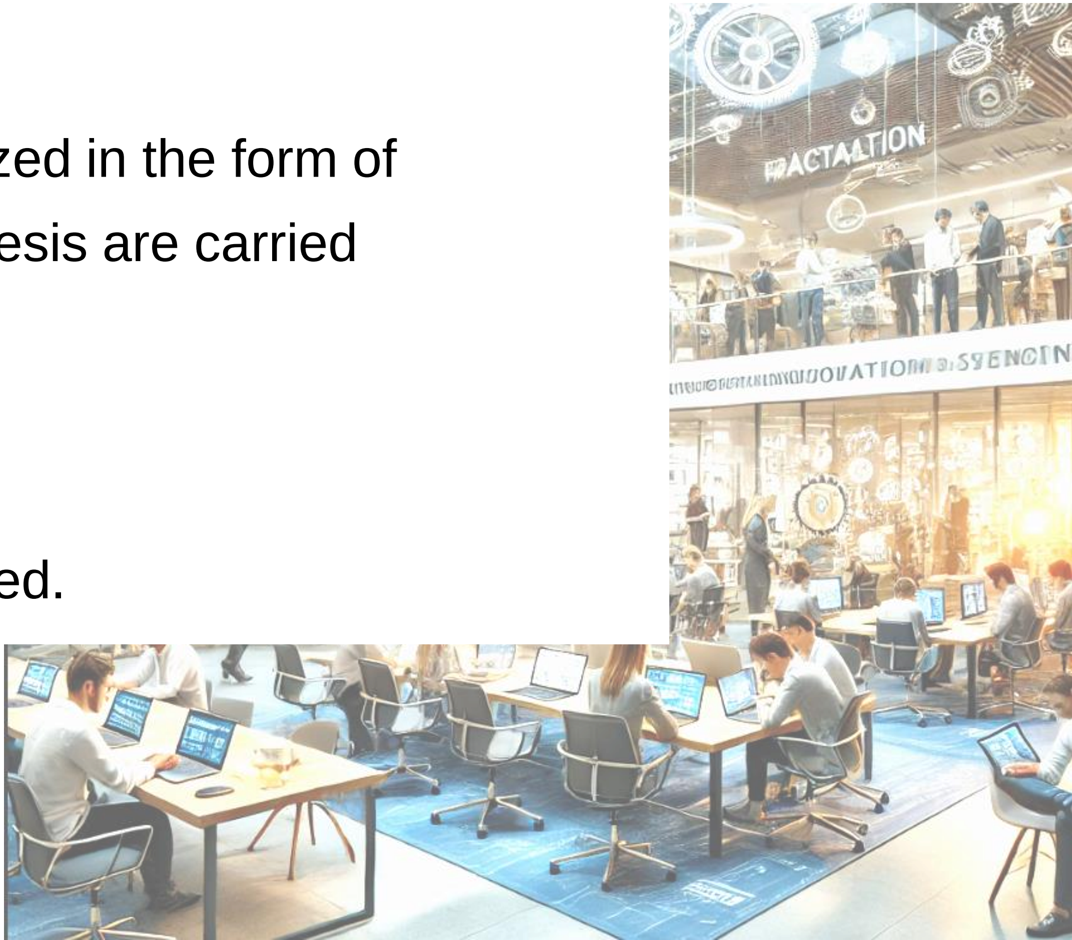
Source: TKI-tuki

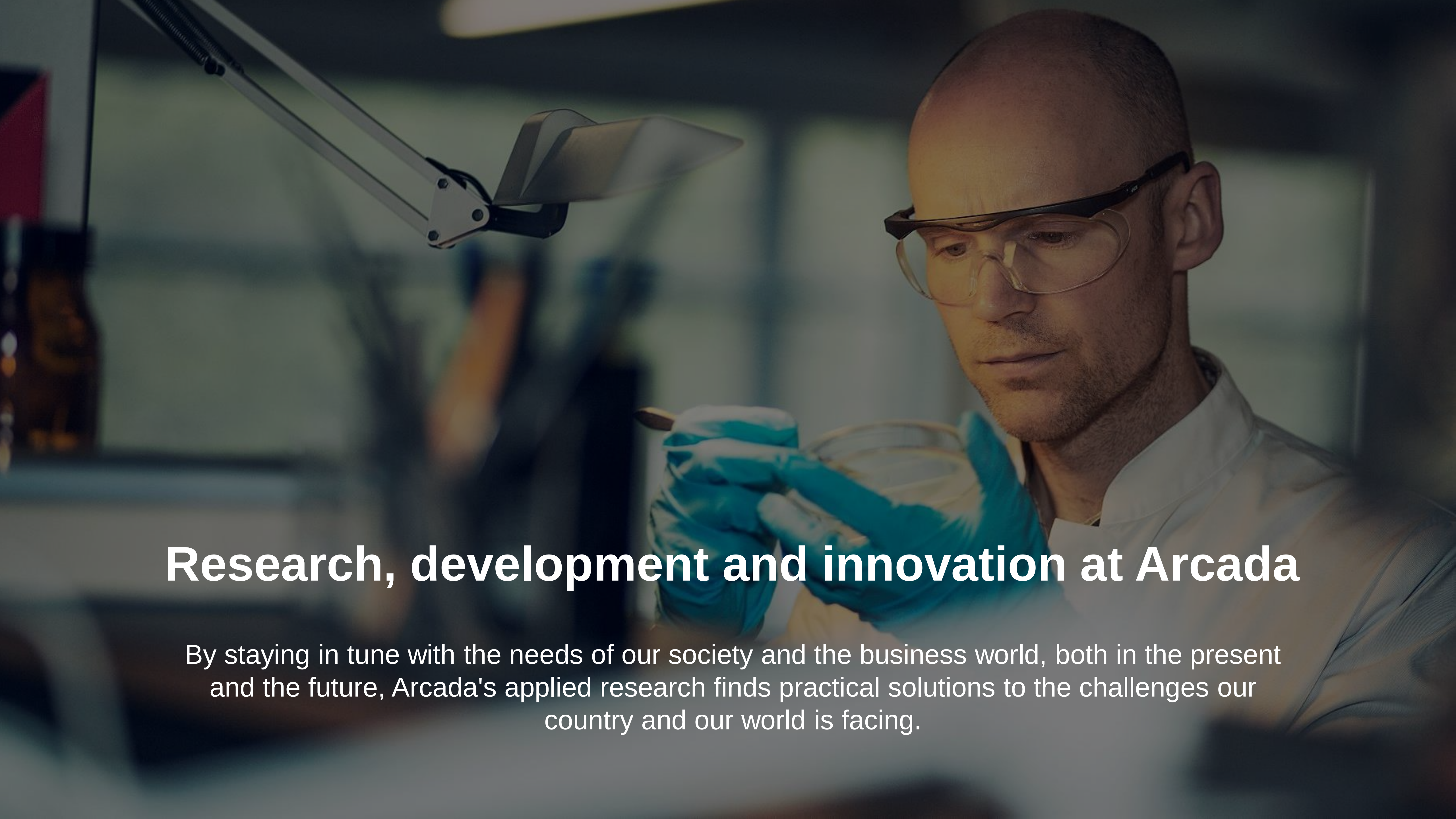
University of applied science-collaboration with private sector

Research, development, and innovation (RDI) activities are also critically connected to education and teaching

Teaching at universities of applied sciences is often organized in the form of projects received from working life, and bachelor/master thesis are carried out as development projects for workplaces

Through RDI work, the connection between the content of Education and the latest knowledge and expertise is ensured.





Research, development and innovation at Arcada

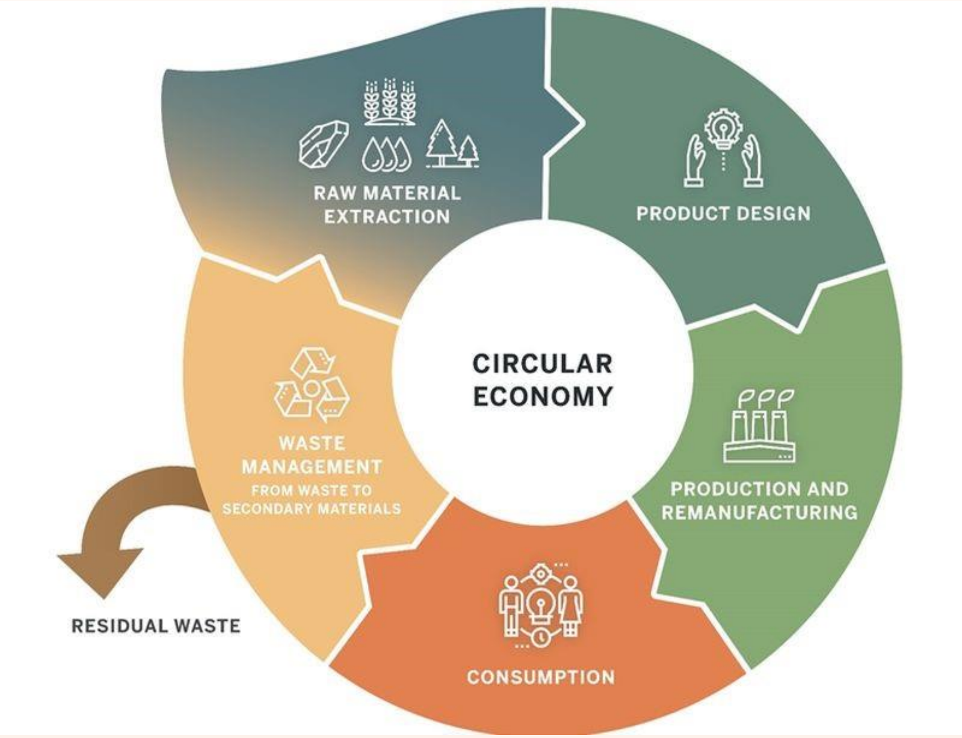
By staying in tune with the needs of our society and the business world, both in the present and the future, Arcada's applied research finds practical solutions to the challenges our country and our world is facing.

Mechanical and sustainable engineering

The bachelor's degree programme **Mechanical and Sustainable Engineering** at Arcada has a clear focus – sustainable materials and engineering design. In this programme, engineering, sustainability and digitalisation have been merged together to benefit our modern-day society.

Research focus Circular economy for engineering

Eliminate waste and pollution	Circulate products and materials	Regenerate nature
Private sector	Reverse waste stream	Nutrient recovery
utilizing waste streams	Plastic recycling, mechanical tests	Phase out fossil fuel based plastics
Biobased polymers, fibers, films, algae, reed, potato peel		



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Key product value chains Circular Economy action plan

Figure: The 7 key product value chains as a matter of priority (priority product groups) of the 2020 Circular Economy Action Plan 12 In December 2015, the Commission presented its first Circular Economy Action Plan, including several legislative proposals on waste.

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European plastic strategy

- The **European Plastic Strategy** in 2022: **policy framework** on the sourcing, labeling, and use of **biobased, biodegradable, and compostable plastics**, as part of the **European Green Deal**, **Circular Economy Action Plan**, and the broader **Plastics Strategy**.
- Enhance the sustainable use of plastics by clarifying when and how bioplastics can offer environmental benefits,
- Ensuring that these materials meet strict sustainability standards
- Focus on Clarification and Innovation
- Promote a carbon-neutral bioeconomy

europeanbioplastics

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EUBP STATEMENT on the EU policy framework on biobased, biodegradable and compostable plastics

In 2022, the European Commission adopted a policy framework on the sourcing, labelling and use of biobased plastics, and the use of biodegradable and compostable plastics. The policy framework was announced in the European Green Deal, Circular Economy Action Plan, and Plastics Strategy with the aim to contribute to a sustainable plastics economy. In particular, it aims to improve the understanding around bioplastics. The framework clarifies where these innovative materials can provide environmental benefits, under which conditions, and for which applications, while holding them to the same strict standards as any other material.

There is currently no EU law in place applying to bioplastics specifically, although some legislation, such as EU Taxonomy, the Single Use Plastics Directive, EU Taxonomy, the Plastic Carrier Bags Directive, the Packaging and Packaging Waste Directive as well as the Waste Framework Directive address some aspects and applications of biobased, biodegradable and compostable plastics. And while the Commission's Communication for the EU policy framework is non-legislative, i.e., is not legally binding, it reflects the Commission's views and intentions on these materials and will guide future EU policy making, such as the initiatives on green claims, ecodesign for sustainable products, carbon removal, or microplastics.

EUBP position

European Bioplastics (EUBP) and its members welcome the Commission's initiative to develop a first comprehensive

Find out more

- Comments on biobased plastics
- Comments on compostable plastics
- Comments on biodegradable plastics
- Full statement and comments

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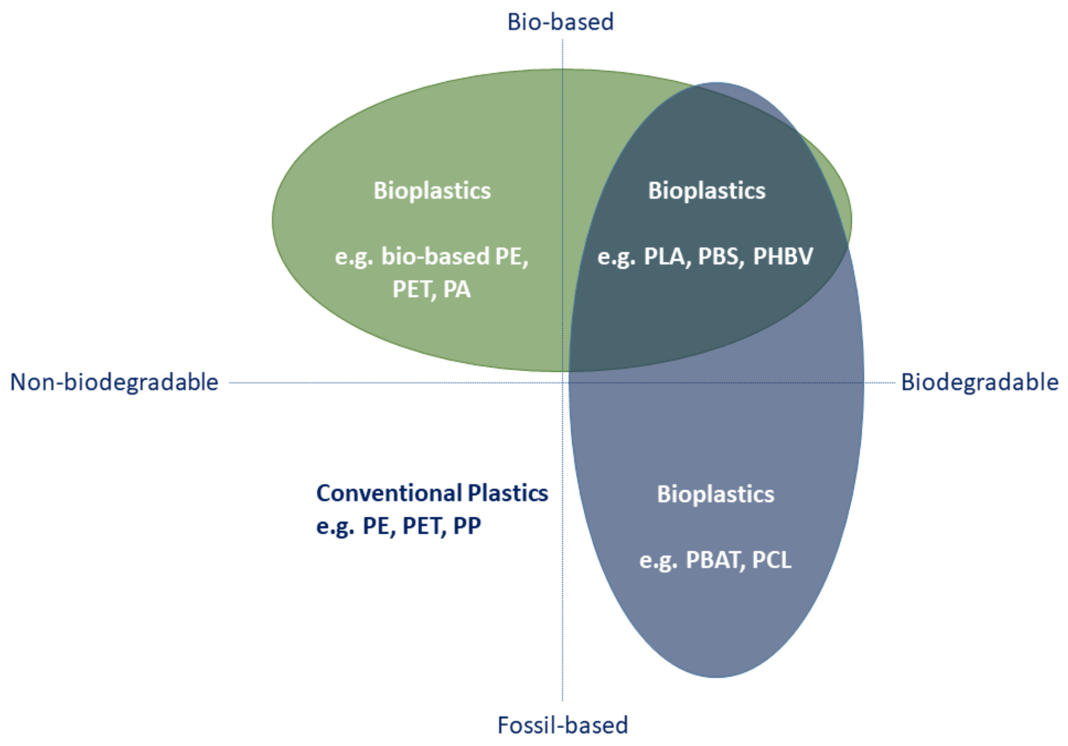
Bio-based plastic

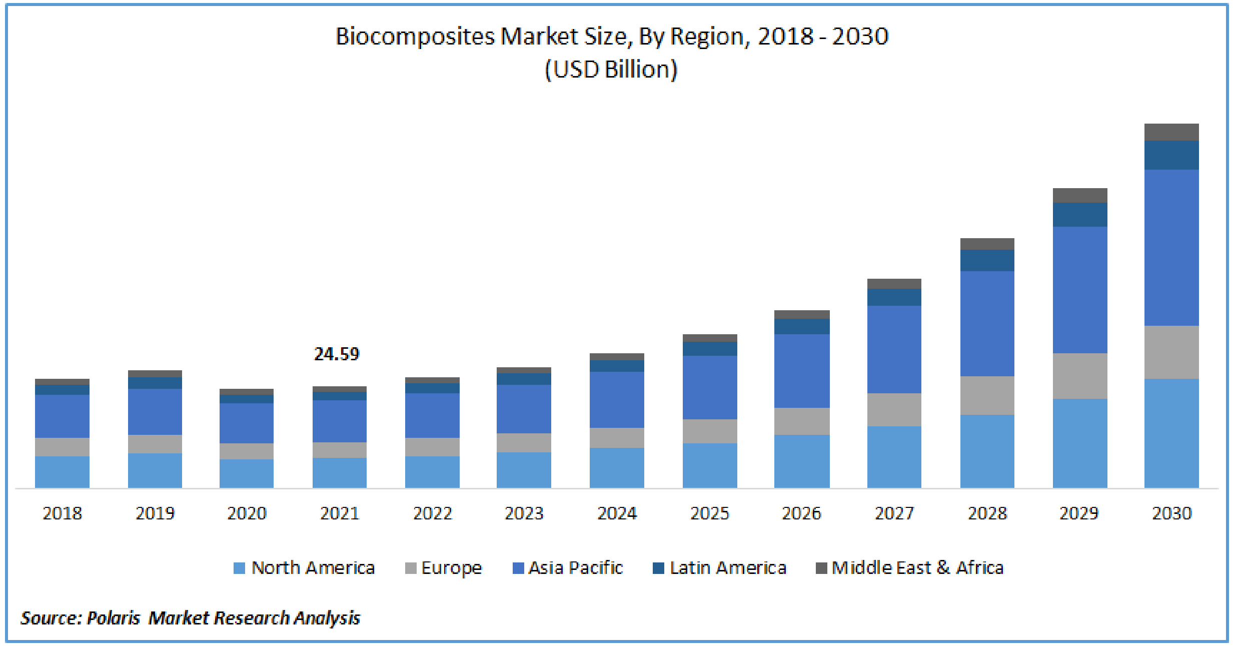
European Commission has set an **aspirational target** for at least **20% of the carbon used in chemical and plastic products** to come from **sustainable, non-fossil resources** by 2030.

This goal is part of the broader effort to achieve **climate neutrality** and reduce the EU's reliance on fossil resources. The strategy focuses on integrating **biobased materials** alongside **recycled content** to contribute to a **circular economy**.

The move to incorporate biobased carbon into plastics is designed to reduce **greenhouse gas emissions** while supporting innovation in sustainable materials



Bioplastic foresight



The bioplastics market will expand production capacity by 12.4% CAGR to 11.6 megatonnes in 2035

Bioplastics 2025-2035: Technology, Market, Players, and Forecasts

Biobased PLA, PET, PEF, polyesters, polyolefins, polyamides, polyurethanes, PHA, and polysaccharides, for packaging, automotive, textiles, agriculture, consumer goods, and other applications in the circular economy.

Key areas for biobased plastics

- Packaging
- Plastics
- Manufacturing
- Medical
- Agriculture
- Automotive
- Textiles
- electronics

Examples


rtum Bio2X thinks big with straw
's Bio2X programme concentrates on chemical fractionation of residual straw into
alue bioproducts that apply the technology developed by Chempolis Oy. By separati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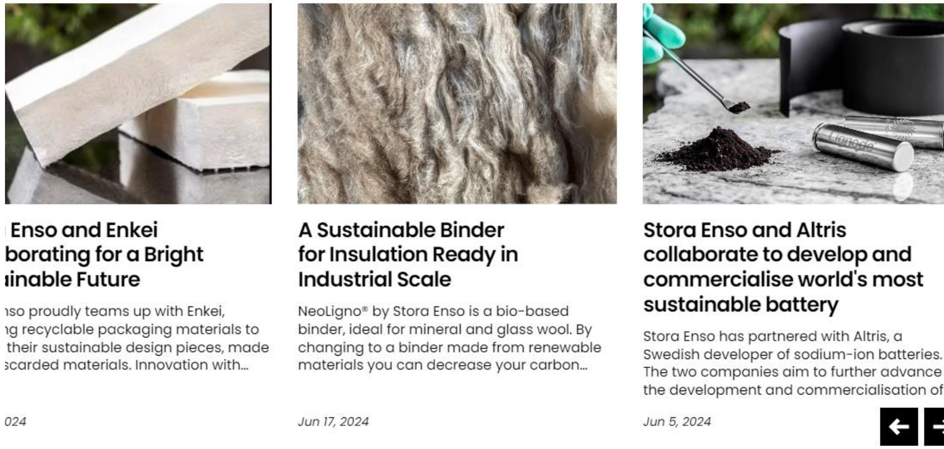
Enso and Enkei
borating for a Bright
inable Future
nso proudly teams up with Enkei,
g recyclable packaging materials to
their sustainable design pieces, made
scarded materials. Innovation with...
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A Sustainable Binder for Insulation Ready in Industrial Scale
NeoLigno® by Stora Enso is a bio-based binder, ideal for mineral and glass wool. By changing to a binder made from renewable materials you can decrease your carbon...
Jun 17, 2024
Stora Enso and Altris collaborate to develop and commercialise world's most sustainable battery
Stora Enso has partnered with Altris, a Swedish developer of sodium-ion batteries. The two companies aim to further advance the development and commercialisation of
Jun 5, 2024


ore gathers biomass refiners
e textile industry

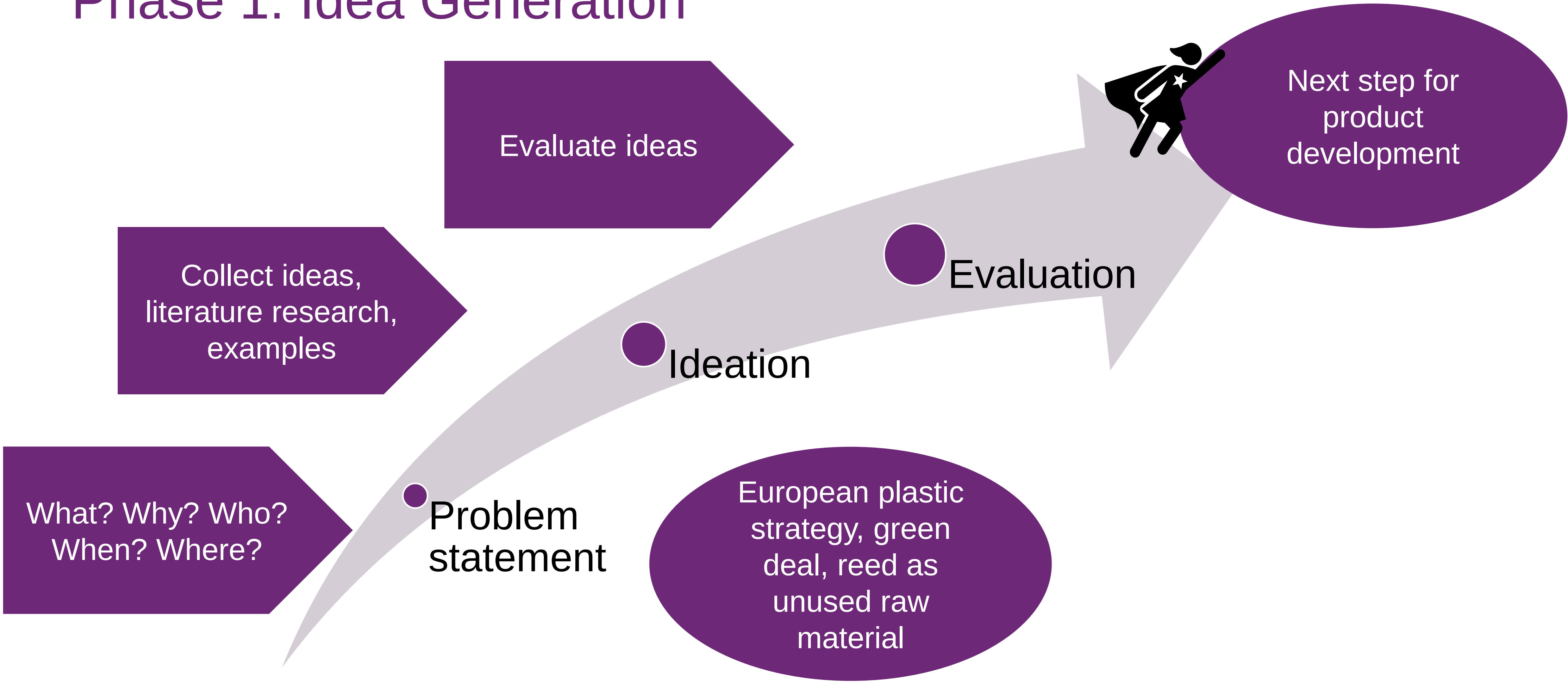
Working with research as a base for product innovation

Phase 1: Idea Generation

Phase II: Material development through research and prototyping

Phase III: Towards commercialization

Phase 1: Idea Generation



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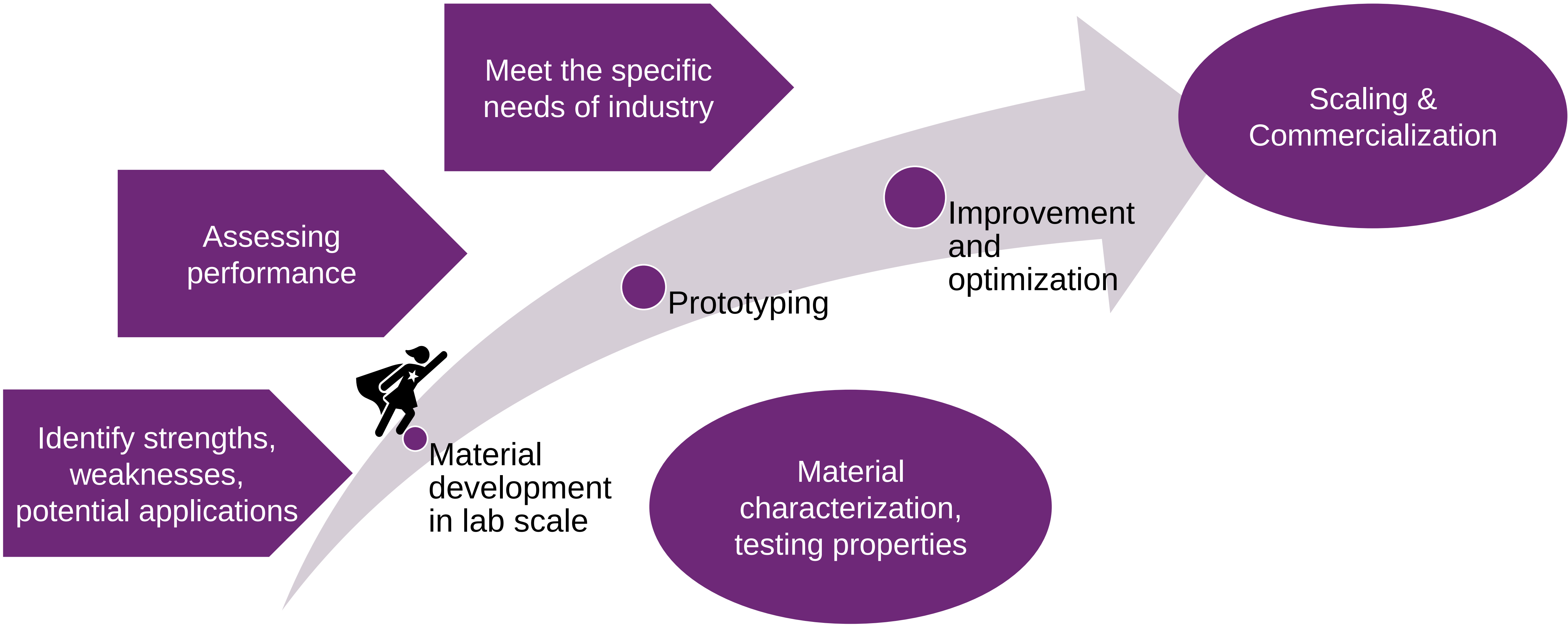
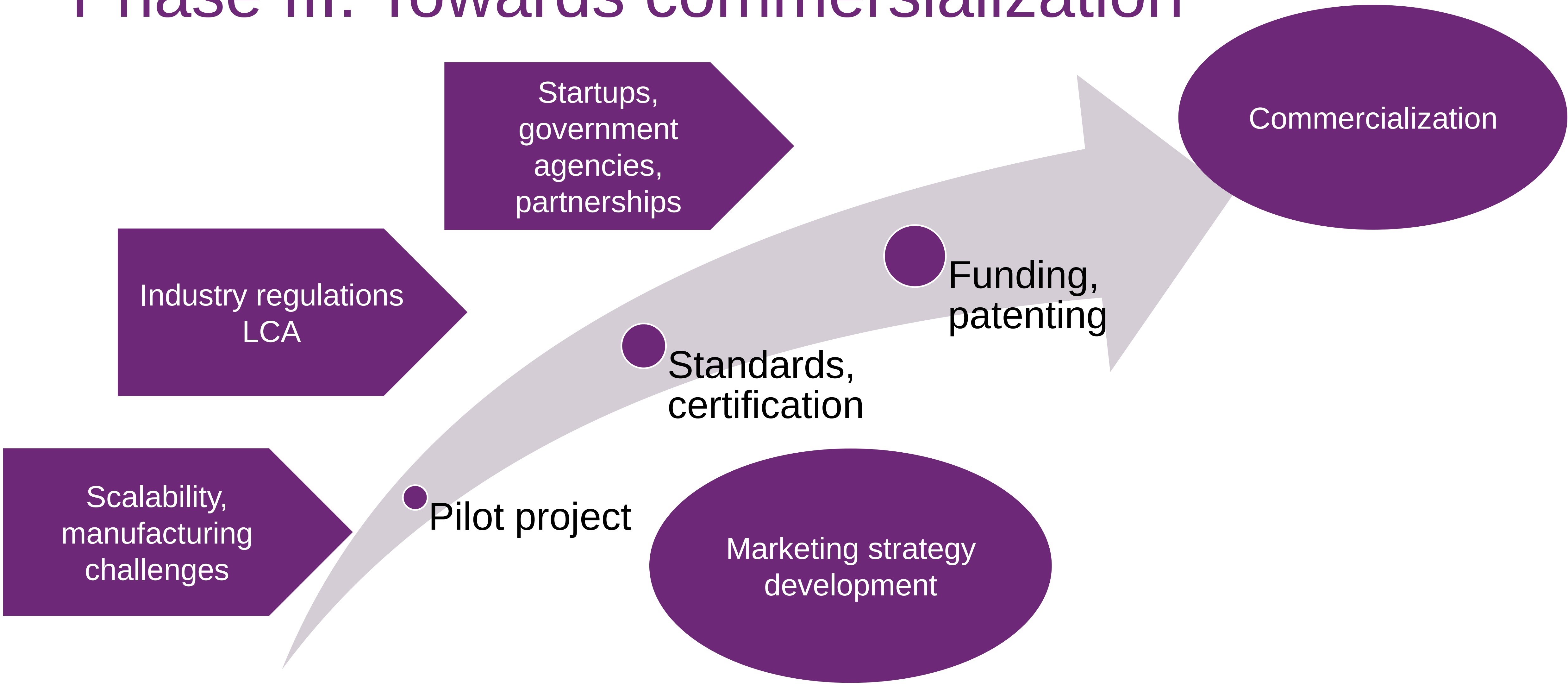
Phase II: Material Development through Research and Prototyping



Phase III: Towards commercialization



Our working hypothesis: Common reed as novel BioSource for new applications

Reed, as a **perennial grass**, is a lignocellulosic, low-cost feedstock that can grow in diverse environments, including **marginal lands**. It holds great potential for future biomaterial applications, making it a prime candidate for the modern **biobased economy**.

Reed can be used to produce a wide range of **high-value products**, including **biopharmaceuticals, nutrient supplements**, and **biopolymers**.

In terms of **biomaterials**, it can be applied in **construction** (building materials), **insulation**, **mulching**, **biodegradable products** for gardening, and **animal bedding**.

Additionally, reed offers potential as an **energy carrier** for producing **advanced biofuels** and generating **heat and power**, and it can contribute to producing **soil organic fertilizers** and **green chemistry products**.

The Importance of Perennial Grasses as a Feedstock for Bioenergy and Bioproducts
Salvatore L. Cosentino, ... Myrsini Christou, in Perennial Grasses for Bioenergy and Bioproducts, 2018

Where are we now?

Phase 1: Idea Generation & Problem statement

Which material could be replaced by common reed?

What can we do of common reed?

Problem statement

Ideation

Evaluation

Isolation, sound, heat

Green chemicals

Student hackathon

Flowerpots

Reed reinforced plastics?

Urn

Reed as unused raw material

Unsustainable forest business

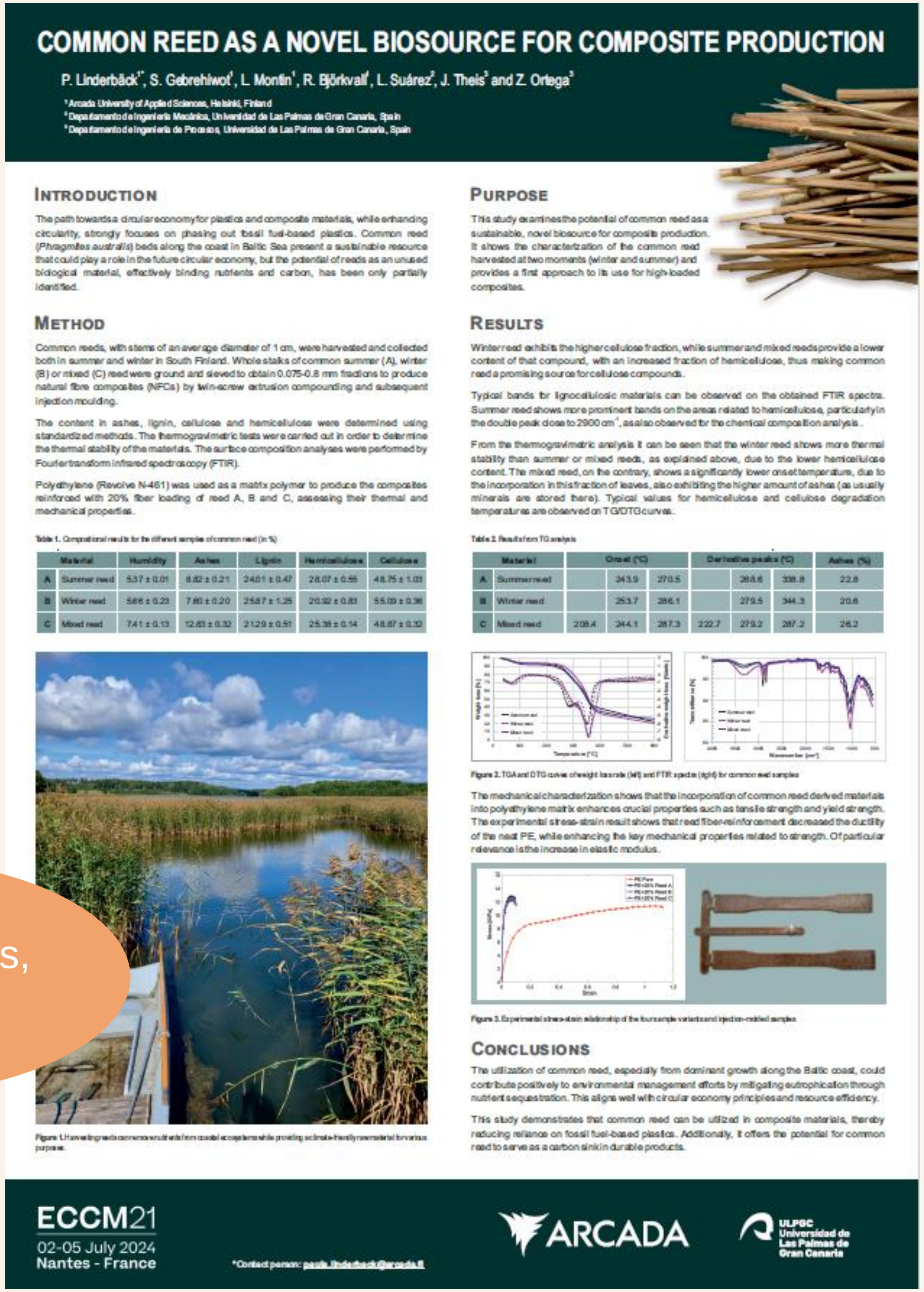
New bioplastic innovation are needed

Phase 2: Material development

Identify strengths, weaknesses, potential applications

Material characterization

Searching company partners, investors, co developers



COMMON REED AS A NOVEL BIOSOURCE FOR COMPOSITE PRODUCTION

P. Linderbäck[1*], S. Gebrehiwot[1], L. Monfin[1], R. Björkvall[1], L. Suárez[2], J. Theis[3] and Z. Ortega[3]

[1] Arcada University of Applied Sciences, Helsinki, Finland
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Introduction

The path towards a circular economy for plastics and composite materials, while enhancing circularity, strongly focuses on phasing out fossil fuel-based plastics. Common reed (*Phragmites australis*) beds along the coast in Baltic Sea present a sustainable resource that could play a role in the future circular economy, but the potential of reeds as an unused biological material, effectively binding nutrients and carbon, has been only partially identified.

Method

Common reeds, with stems of an average diameter of 1 cm, were harvested and collected both in summer and winter in South Finland. Whole stalks of common summer (A), winter (B) or mixed (C) reed were ground and sieved to obtain 0.075-0.8 mm fractions to produce natural fibre composites (NFCs) by twin-screw extrusion compounding and subsequent injection moulding.

The content in ashes, lignin, cellulose and hemicellulose were determined using standardized methods. The thermogravimetric tests were carried out in order to determine the thermal stability of the materials. The surface composition analyses were performed by Fourier transform infrared spectroscopy (FTIR).

Polyethylene (Revolve N-461) was used as a matrix polymer to produce the composites reinforced with 20% fiber loading of reed A, B and C, assessing their thermal and mechanical properties.

Table 1. Compositional results for the different samples of common reed (in %)

Material		Humidity	Ashes	Lignin	Hemicellulose	Cellulose
A	Summer reed	5.37 ± 0.01	6.82 ± 0.21	24.01 ± 0.47	28.07 ± 0.55	48.75 ± 1.03
B	Winter reed	5.86 ± 0.23	7.80 ± 0.20	25.87 ± 1.25	20.92 ± 0.83	55.03 ± 0.38
C	Mixed reed	7.41 ± 0.13	12.83 ± 0.32	21.29 ± 0.51	25.38 ± 0.14	48.87 ± 0.32

Figure 1. Harvesting reeds removes nutrients from coastal ecosystems while providing a climate-friendly raw material for various purposes.

Purpose

This study examines the potential of common reed as a sustainable, novel biosource for composite production. It shows the characterization of the common reed harvested at two moments (winter and summer) and provides a first approach to its use for high-loaded composites.

Results

Winter reed exhibits the higher cellulose fraction, while summer and mixed reeds provide a lower content of that compound, with an increased fraction of hemicellulose, thus making common reed a promising source for cellulose compounds.

Typical bands for lignocellulosic materials can be observed on the obtained FTIR spectra. Summer reed shows more prominent bands on the areas related to hemicellulose, particularly in the double peak close to 2900 cm^{-1}, as also observed for the chemical composition analysis.

From the thermogravimetric analysis it can be seen that the winter reed shows more thermal stability than summer or mixed reeds, as explained above, due to the lower hemicellulose content. The mixed reed, on the contrary, shows a significantly lower onset temperature, due to the incorporation in this fraction of leaves, also exhibiting the higher amount of ashes (as usually minerals are stored there). Typical values for hemicellulose and cellulose degradation temperatures are observed on TG/DTG curves.

Table 2. Results from TG analysis

Material		Onset (°C)			Derivative peaks (°C)			Ashes (%)
A	Summer reed		243.9	270.5		268.6	338.8	22.8
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Conclusions

The utilization of common reed, especially from dominant growth along the Baltic coast, could contribute positively to environmental management efforts by mitigating eutrophication through nutrient sequestration. This aligns well with circular economy principles and resource efficiency.

This study demonstrates that common reed can be utilized in composite materials, thereby reducing reliance on fossil fuel-based plastics. Additionally, it offers the potential for common reed to serve as a carbon sink in durable products.

ECCM21
02-05 July 2024
Nantes - France

*Contact person:

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Material development

- Packaging
- Plastics
- Manufacturing
- Medical
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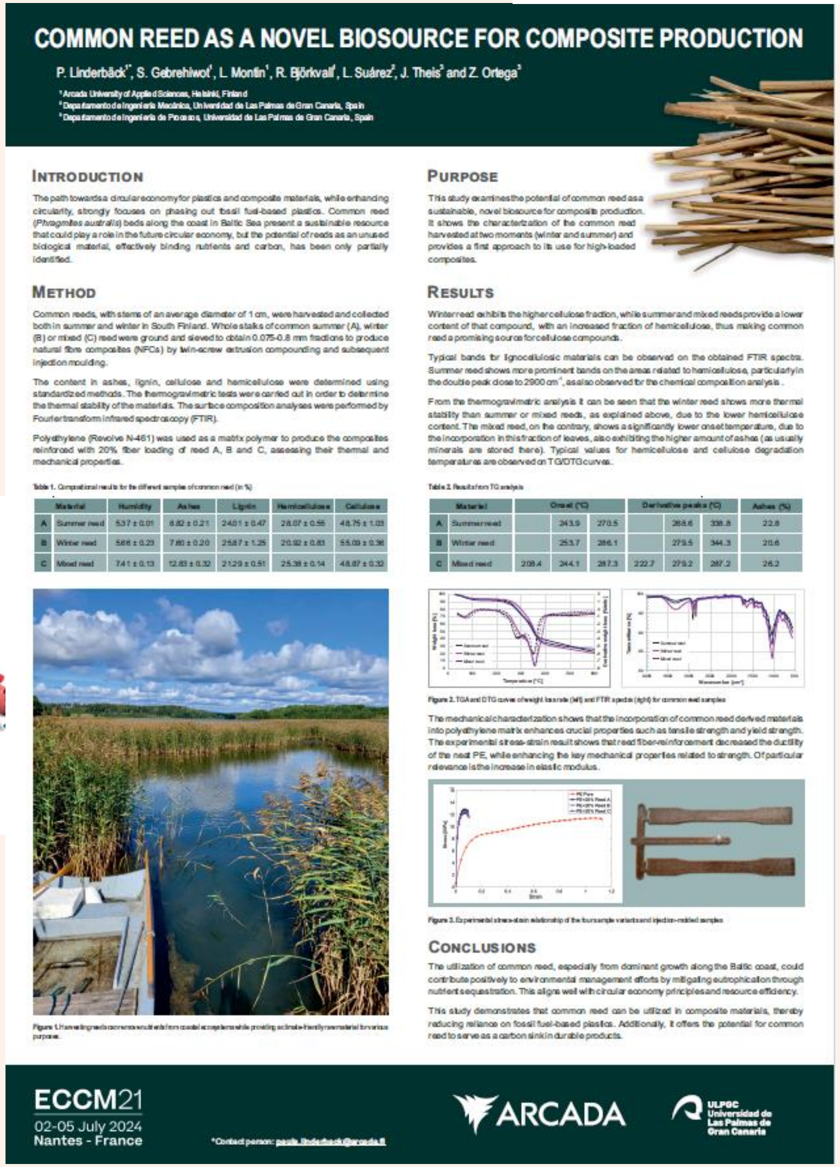

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Figure 1. Harvesting reeds ...

Purpose

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What kind of results we can produce in this project?

Arcadas material research team strenghts: Material testing

LCA

Material characterization, mechanical properties

Co funding applications

Biodegradation test?

Permeability?

Process development?

Business model development

Arcadas collaboration: Business economics, marketing

Material development

Packaging

Plastics

Manufacturing

Medical

Agriculture

Automotive

Textiles

electronics

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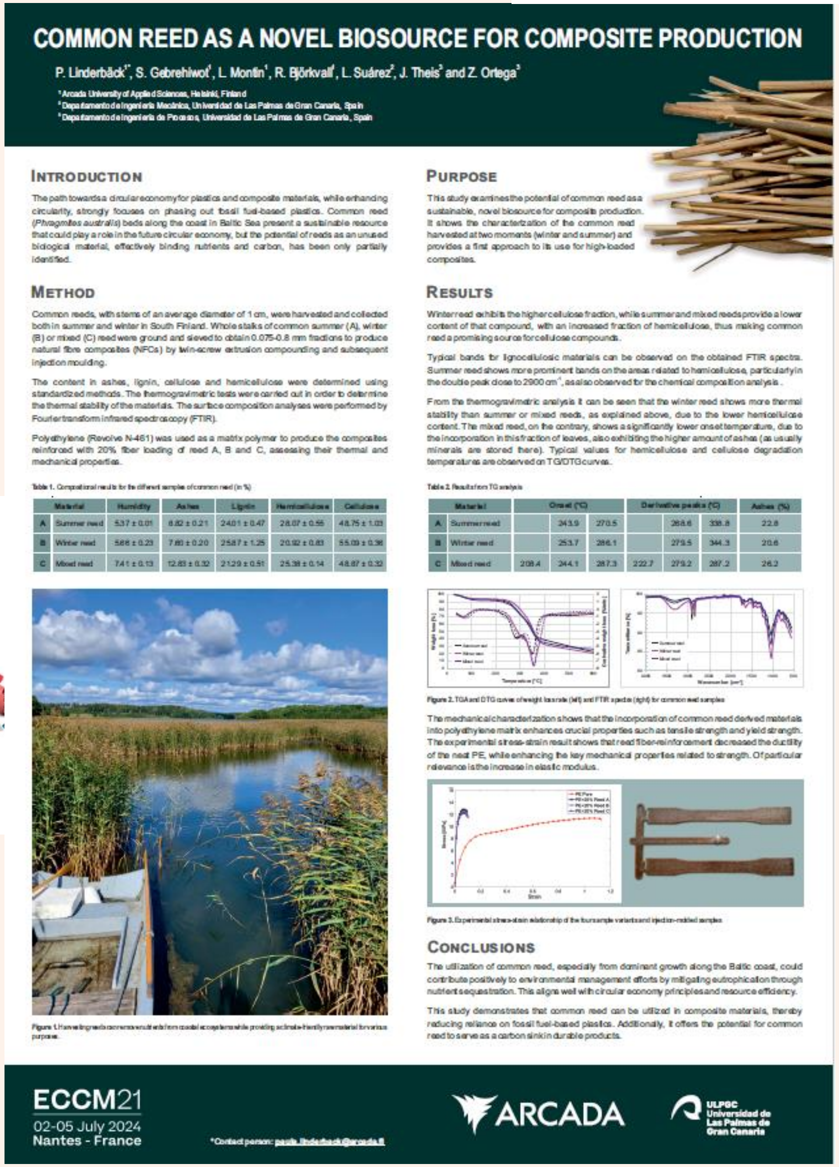

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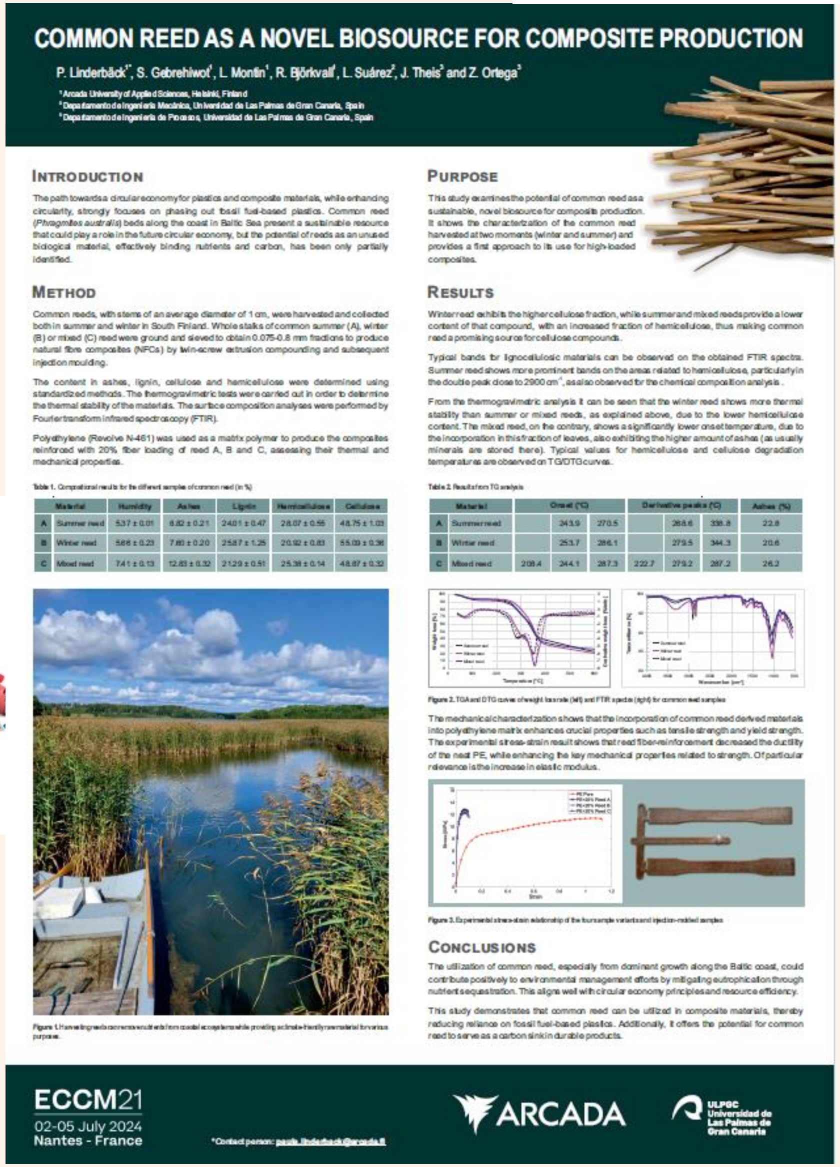
Textiles

electronics



COMMON REED AS A NOVEL BIOSOURCE FOR COMPOSITE PRODUCTION

P. Linderbäck[1*], S. Gebrehiwot[1], L. Monfin[1], R. Björkvall[1], L. Suárez[2], J. Theis[3] and Z. Ortega[3]

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Introduction

The path towards a circular economy for plastics and composite materials, while enhancing circularity, strongly focuses on phasing out fossil fuel-based plastics. Common reed (*Phragmites australis*) beds along the coast in Baltic Sea present a sustainable resource that could play a role in the future circular economy, but the potential of reeds as an unused biological material, effectively binding nutrients and carbon, has been only partially identified.

Purpose

This study examines the potential of common reed as a sustainable, novel biosource for composite production. It shows the characterization of the common reed harvested at two moments (winter and summer) and provides a first approach to its use for high-loaded composites.

Method

Common reeds, with stems of an average diameter of 1 cm, were harvested and collected both in summer and winter in South Finland. Whole stalks of common summer (A), winter (B) or mixed (C) reed were ground and sieved to obtain 0.075-0.8 mm fractions to produce natural fibre composites (NFCs) by twin-screw extrusion compounding and subsequent injection moulding.

The content in ashes, lignin, cellulose and hemicellulose were determined using standardized methods. The thermogravimetric tests were carried out in order to determine the thermal stability of the materials. The surface composition analyses were performed by Fourier transform infrared spectroscopy (FTIR).

Polyethylene (Revolve N-461) was used as a matrix polymer to produce the composites reinforced with 20% fiber loading of reed A, B and C, assessing their thermal and mechanical properties.

Table 1. Compositional results for the different samples of common reed (in %)

Material		Humidity	Ashes	Lignin	Hemicellulose	Cellulose
A	Summer reed	5.37 ± 0.01	6.82 ± 0.21	24.01 ± 0.47	28.07 ± 0.55	48.75 ± 1.03
B	Winter reed	5.88 ± 0.23	7.60 ± 0.20	25.87 ± 1.25	20.92 ± 0.83	55.03 ± 0.38
C	Mixed reed	7.41 ± 0.13	12.83 ± 0.32	21.29 ± 0.51	25.38 ± 0.14	48.87 ± 0.32

Results

Winter reed exhibits the higher cellulose fraction, while summer and mixed reeds provide a lower content of that compound, with an increased fraction of hemicellulose, thus making common reed a promising source for cellulose compounds.

Typical bands for lignocellulosic materials can be observed on the obtained FTIR spectra. Summer reed shows more prominent bands on the areas related to hemicellulose, particularly in the double peak close to 2900 cm^{-1}, as also observed for the chemical composition analysis.

From the thermogravimetric analysis it can be seen that the winter reed shows more thermal stability than summer or mixed reeds, as explained above, due to the lower hemicellulose content. The mixed reed, on the contrary, shows a significantly lower onset temperature, due to the incorporation in this fraction of leaves, also exhibiting the higher amount of ashes (as usually minerals are stored there). Typical values for hemicellulose and cellulose degradation temperatures are observed on TG/DTG curves.

Table 2. Results from TG analysis

Material		Onset (°C)			Derivative peaks (°C)			Ashes (%)
A	Summer reed		243.9	270.5		268.6	338.8	22.8
B	Winter reed		253.7	286.1		279.5	344.3	20.6
C	Mixed reed	208.4	244.1	287.3	222.7	279.2	287.2	26.2

Figure 2. TGA and DTG curves of weight loss rate (left) and FTIR spectra (right) for common reed samples

The mechanical characterization shows that the incorporation of common reed derived materials into polyethylene matrix enhances crucial properties such as tensile strength and yield strength. The experimental stress-strain result shows that reed fiber-reinforcement decreased the ductility of the neat PE, while enhancing the key mechanical properties related to strength. Of particular relevance is the increase in elastic modulus.

Figure 3. Experimental stress-strain relationship of the four sample variants and injection-molded samples

Conclusions

The utilization of common reed, especially from dominant growth along the Baltic coast, could contribute positively to environmental management efforts by mitigating eutrophication through nutrient sequestration. This aligns well with circular economy principles and resource efficiency.

This study demonstrates that common reed can be utilized in composite materials, thereby reducing reliance on fossil fuel-based plastics. Additionally, it offers the potential for common reed to serve as a carbon sink in durable products.

ECCM21
02-05 July 2024
Nantes - France

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Material development

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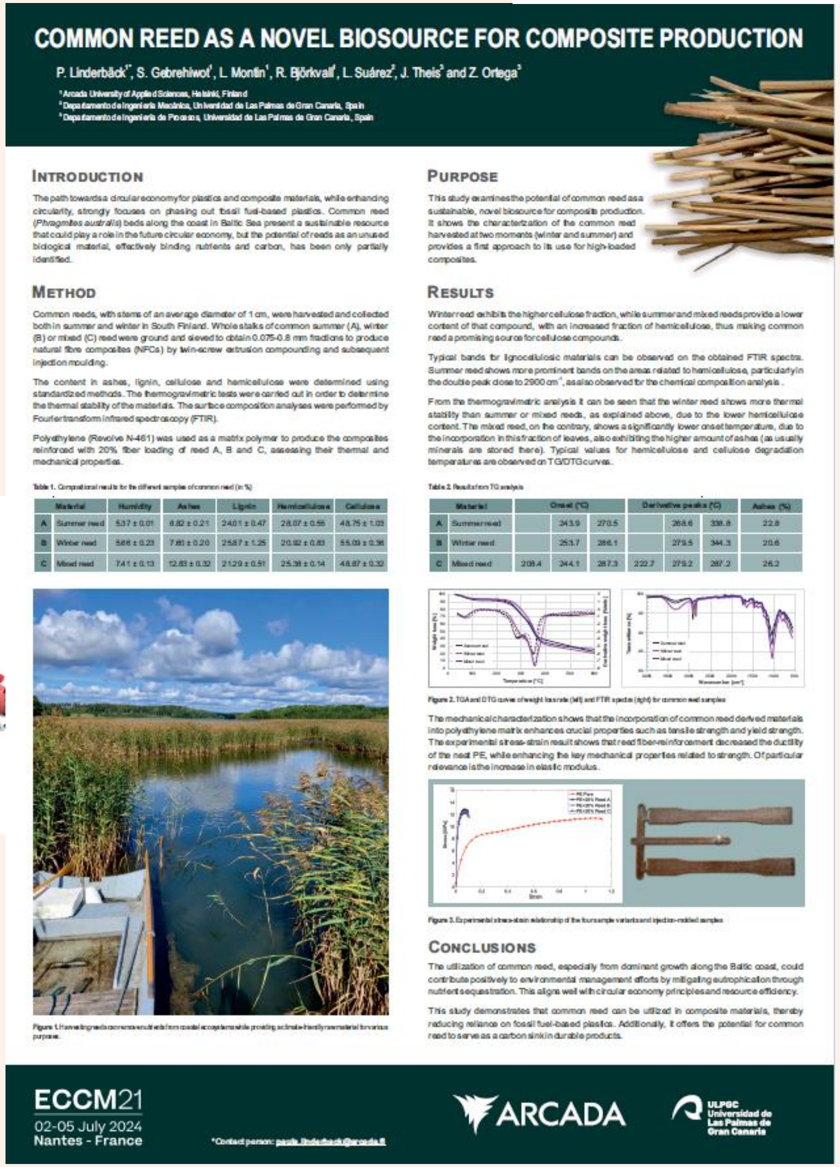

How can the results increase the reed use?

Once the reed-derived materials demonstrate mechanical viability, this opens doors for creating **business models** around the reed value chain.

This is not the whole solution, but part of the value chain development

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How can we work with companies with product development and offer support

- Identify industry needs
  - by understanding the needs of industries where reed-based materials can add value, such as **construction, packaging, automotive**, **textiles**, and **agriculture**. Identify companies that are looking for sustainable, lightweight, or biodegradable material alternatives (Thesis topic)
- Leverage pilot projects and demonstrations
  - Develop prototypes, practical applications of our reed-based materials (thesis topic)
  - **Pilot collaborations**
  - **industry conferences**
- Partnership with manufacturers?
- Partnership with startups and entrepreneurs
- Public-private partnerships
- Co-branding and market trials

Next steps

- Working further with companies -> pilot product, demos (LCA)
- Phase I: II Hackathon to product ideation.. (any proposals how?)
- Phase II: Deeper analysis of materials (biodegradation, water permeability, 3 D printing for product demo)
- Phase III: Product development in collaboration with marketizing

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Questions?

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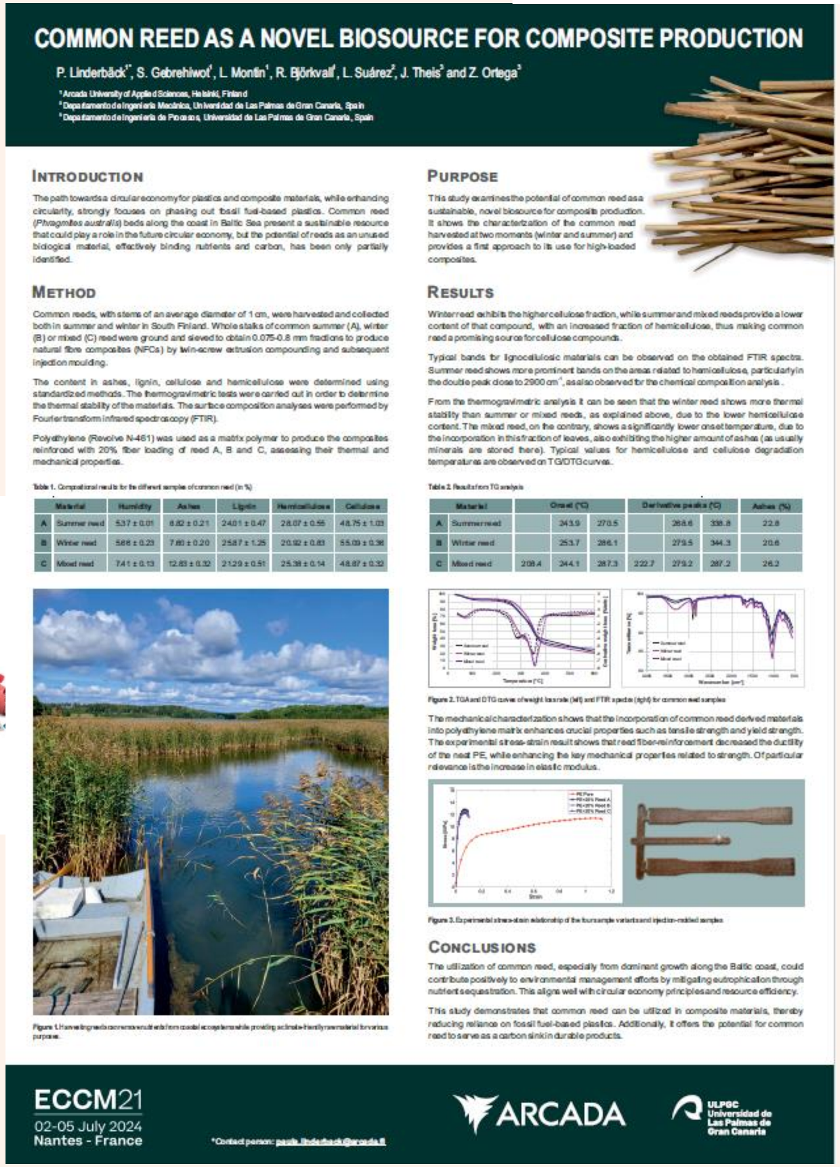

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