BIOMAC:
European Sustainable Biobased Nano Materials Community

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. ***952941***

BIOMAC in a nutshell

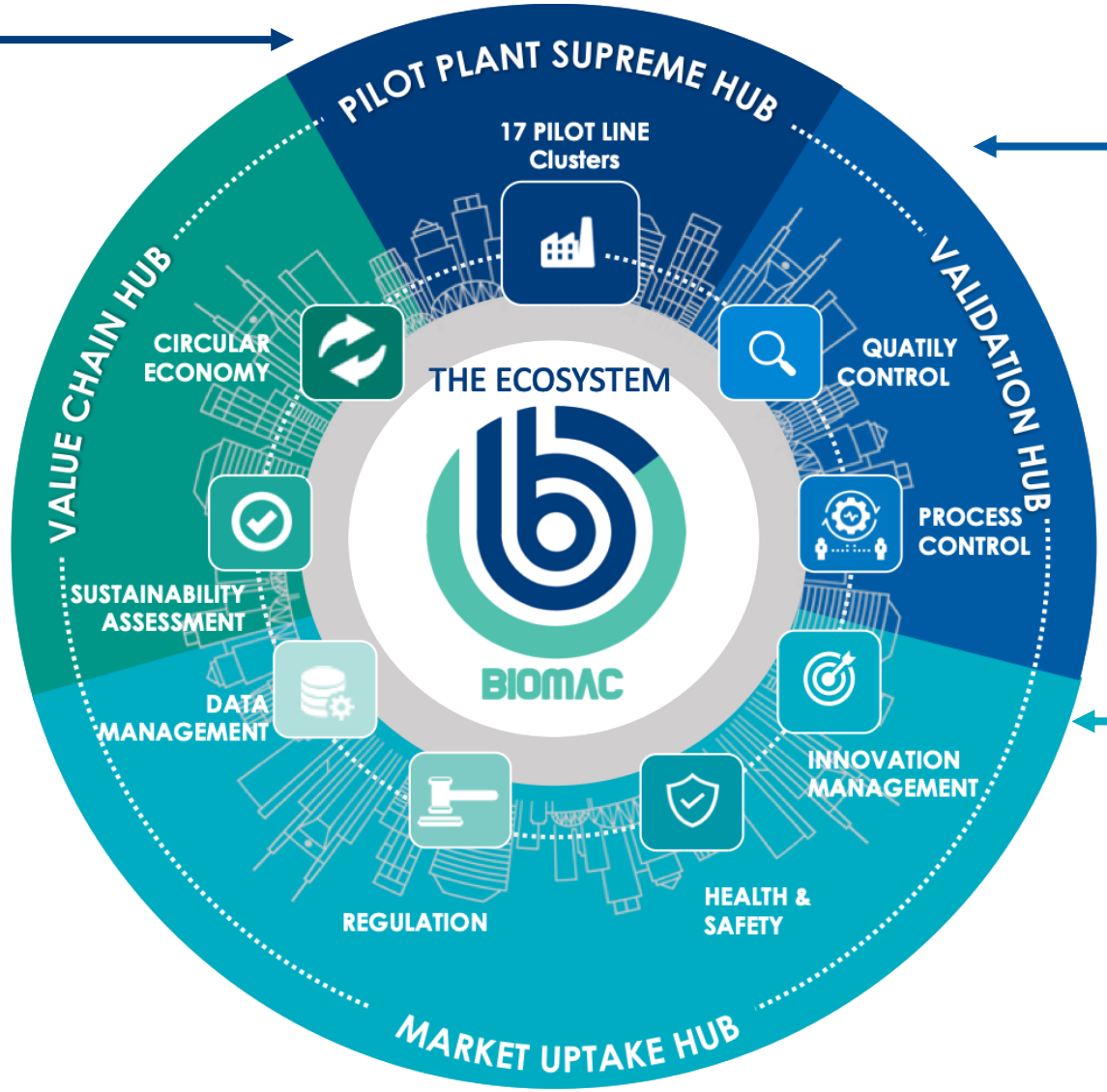
- **BIOMAC** is a Horizon 2020 project that will establish an **Open Innovation Test Bed (OITB)** to final Biobased Nanocomposites.
- **34 participants**. A budget close to **17 million €**.
- It is a collaborative **ecosystem** where technologies and solutions utilizing **nano-enabled bio-based materials (NBMs)** will be **upscaled** and **prepared for market applications**.
- The BIOMAC Ecosystem will provide **open access** to its facilities **(17 Pilot Lines)** and **complementary services** required for the development, testing and upscaling of materials and products in the field of nano-enabled bio-based products and materials.
- The Pilots Lines of BIOMAC cover the whole value chain, from biomass fractionation and intermediate chemicals to final Biobased Nanocomposites.

Structure of the OITB: 4 Hubs

a) *Biomass Fractionation and Nanocomposite Production Cluster*

b) *Intermediate Materials and Nanocomposite Production Cluster*

c) *Final Products Production and Formulation Hub*



a) *Quality control, characterization*

b) *Standardization*

c) *Process validation: modelling*

a) *Sustainability assessment*

b) *Supply management*

c) *Circular economy*

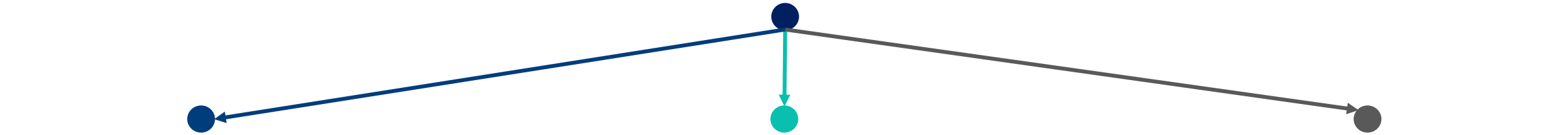
a) *Innovation management*

b) *Health and safety*

c) *Regulation*

d) *Data management*

Pilot Line Supreme Hub



Biomass Fractionation & Pre-treatment Cluster (BFPC)

LTU	BBEPP
PL1	PL5

Intermediate Materials & Nanocomposite Cluster (IMNC)

RISE	AUTH
PL2	PL3
CNANO	BBEPP
PL4	PL6
ATB	UEDIN
PL7	PL8
LIST	ITENE
PL10	PL13

Final Products & Formulation Cluster (FPFC)

LIST	AIMPLAS
PL9	PL11
FHWKI	ITENE
PL12	PL14
AIMEN	DTI
PL15	PL16
NNT	
PL17	

Biomass Fractionation – Monomer separation

- ***PL1: Semi-continuous organosolv-steam explosion pre-treatment*** fractionating lignocellulosic biomass to cellulose, hemicellulose and lignin
- ***PL5: Hydrothermal pre-treatment of biomass*** will be performed in order to obtain lignin, hemicellulose or cellulose rich fractions for PL7 and 10
- ***PL3: Sugar derived polyols and diols by catalytic hydrogenation/hydrogenolysis.*** High-pressure, continuous flow reactors for production of polyols/sugar alcohols (sorbitol, xylitol) and hydrogenolysis to glycols/diols
- ***PL6: Recovery / Separation of the different liquid fractions from different pilot lines***
- ***PL7: Enzymatic Hydrolysis & Microbial Fermentation*** *for SA and LA using starch, cellulose to fermentative sugars glucose (C6) and xylose (C5), Fermentation metabolizing sugars to LA and SA, Separation and purification*

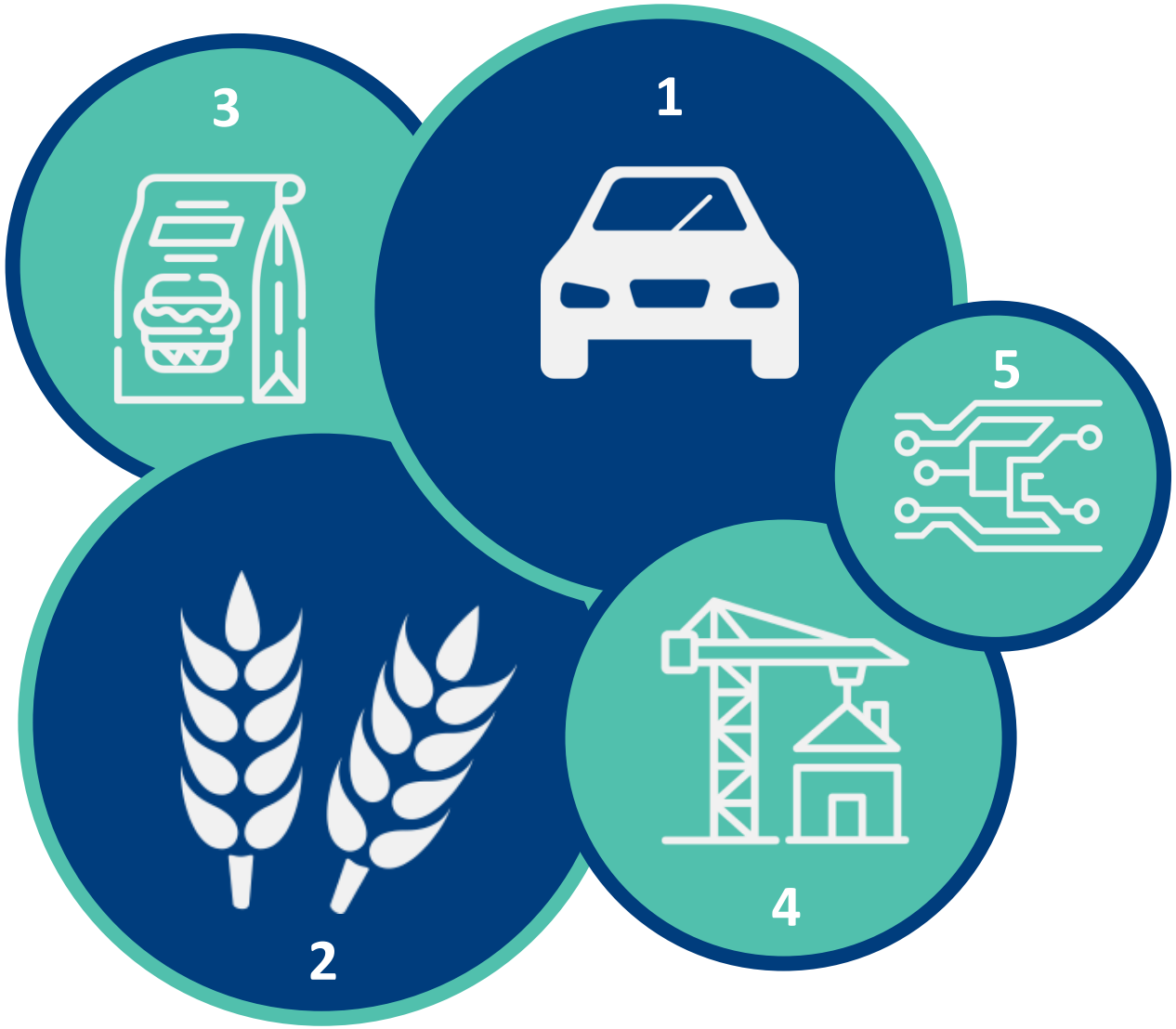
Nanomaterials

- ***PL2: Hydrolysis of fibre sludge and bacterial nanocellulose production.*** FS will be enzymatically hydrolysed, and the released sugars will be converted to BNC
- ***PL10: Mechanical milling and production*** *of different grades of nano fibrillated cellulose NFCs producing cellulose fibers with various compositions at lowest energy consumption*
- ***PL4: Ultrasonicate (US) assisted PL reactor for the production of NL*** to obtain stable colloidal suspensions of NL particles in the range of 10 to 50 nm by physical treatment
- ***PL8: Pyrolysis and carbonization of biomass up to 850°C,*** *producing porous solid carbons, liquids rich in phenolic compounds, and combustible gases.*
- ***PL13: Mechanical treatment to produce NFC and / or CNC*** *using a grinder and also a surface modification of nanocellulose to enhance its dispersion in polymers, coatings and /or inks will be carried out*

Final Products

- ***PL9: Continuous Reactive Extrusion*** *for non-isocyanate thermoplastic polyurethanes (TPU) production*
- ***PL11: Reactive extrusion*** *of LA for PLA and PLA copolymers synthesis as well as PLA-based nanocomposites*
- ***PL12: Resins Pilot Line for biobased polyesters and PU (UV curing applications)*** *using monomers from PL3, such as succinic acid, glycerol, EG, 1,2-PDO as starting materials for biobased polyester and polyurethane resins.*
- ***PL14 Nano based coatings and inks*** *will be used for Coating Formulations (printed electronics)*
- ***PL15: Additive manufacturing*** *(AM) using 3D printing technologies for biobased materials processing. Fused Filament Fabrication (FFF) for thermoplastic TPU (PL9) polymers and photopolymerization (SPP & MPP) for biobased resins (PL12).*
- ***PL16: Printed electronics*** *using biobased TPU and PU resins and several inks based on CNC / NFC*
- ***PL17: R2R Nanopatterning and thermoforming*** *of PLA films formed micro/nano textured surfaces with complex and highly curved 3D shapes.*

Test Cases (TeCs)



TeC1 – Automotive

TeC2 – Agriculture

TeC3 – Food packaging

TeC4 – Construction

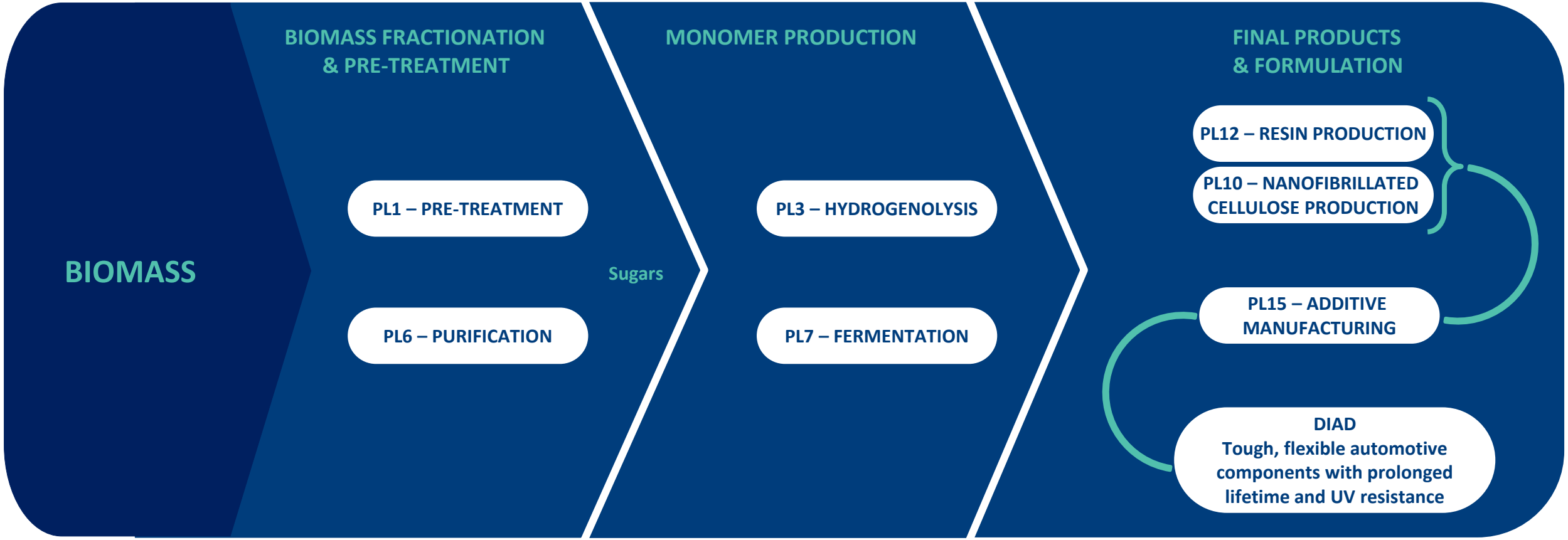
TeC5 – Printed electronics

Test Case 1: Automotive

- Biobased resins reinforced with NBMs will be used in the fabrication of interior car parts and components for the automotive industry.

- These will be succinate-based polyesters and isocyanate-free polyurethane resins with exceptional physical properties including toughness, flexibility, and resistance to abrasion and temperature.

TC1 Flow scheme



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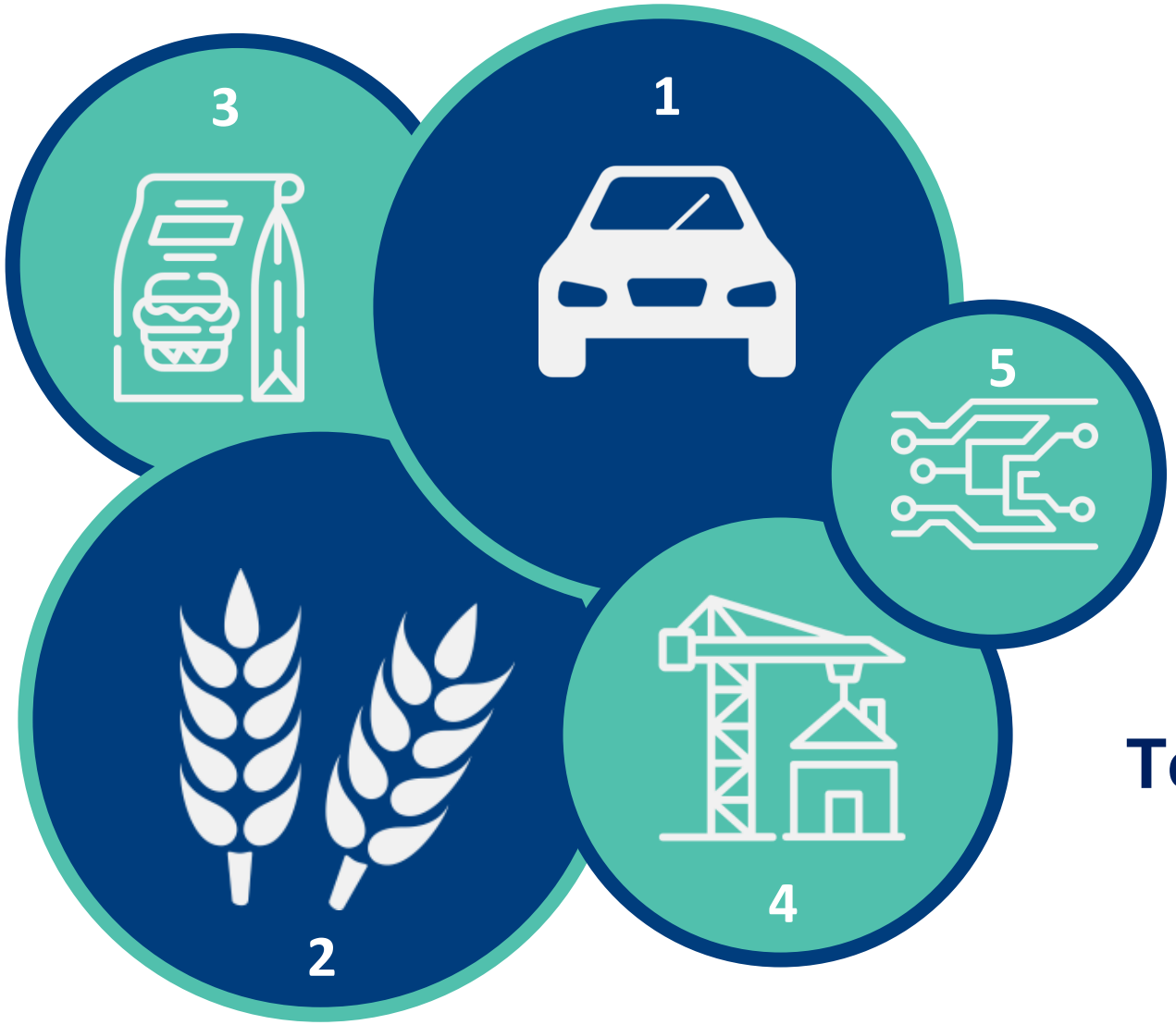

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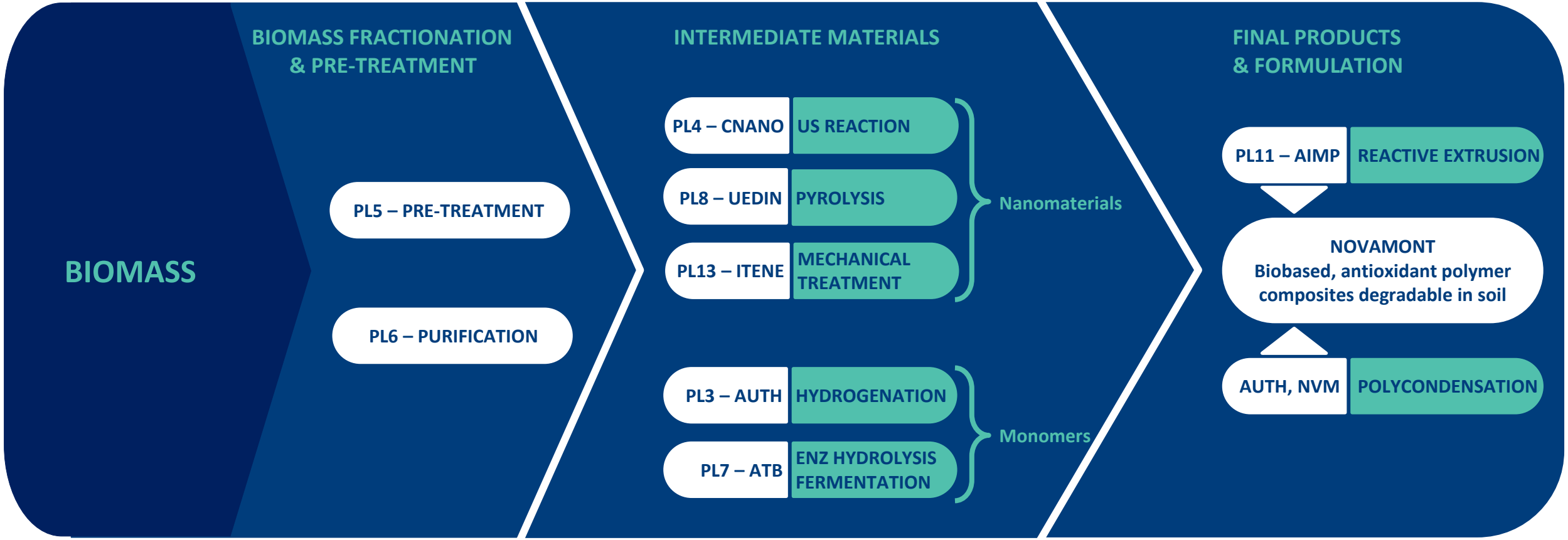
Test Case 2: Agricultural applications

- Biomass, succinic acid will be used as a monomer of the development of biopolymers.
- This will be used to nano-reinforce PLA and create a material with enhanced optical properties and UV/thermal resistance to be used in agriculture.
- Biopolymers and nano-additives will contribute to soil amendment and remediation after biodegradation of bioplastics in soil, thus increasing soil health and quality.

TC2 Flow scheme



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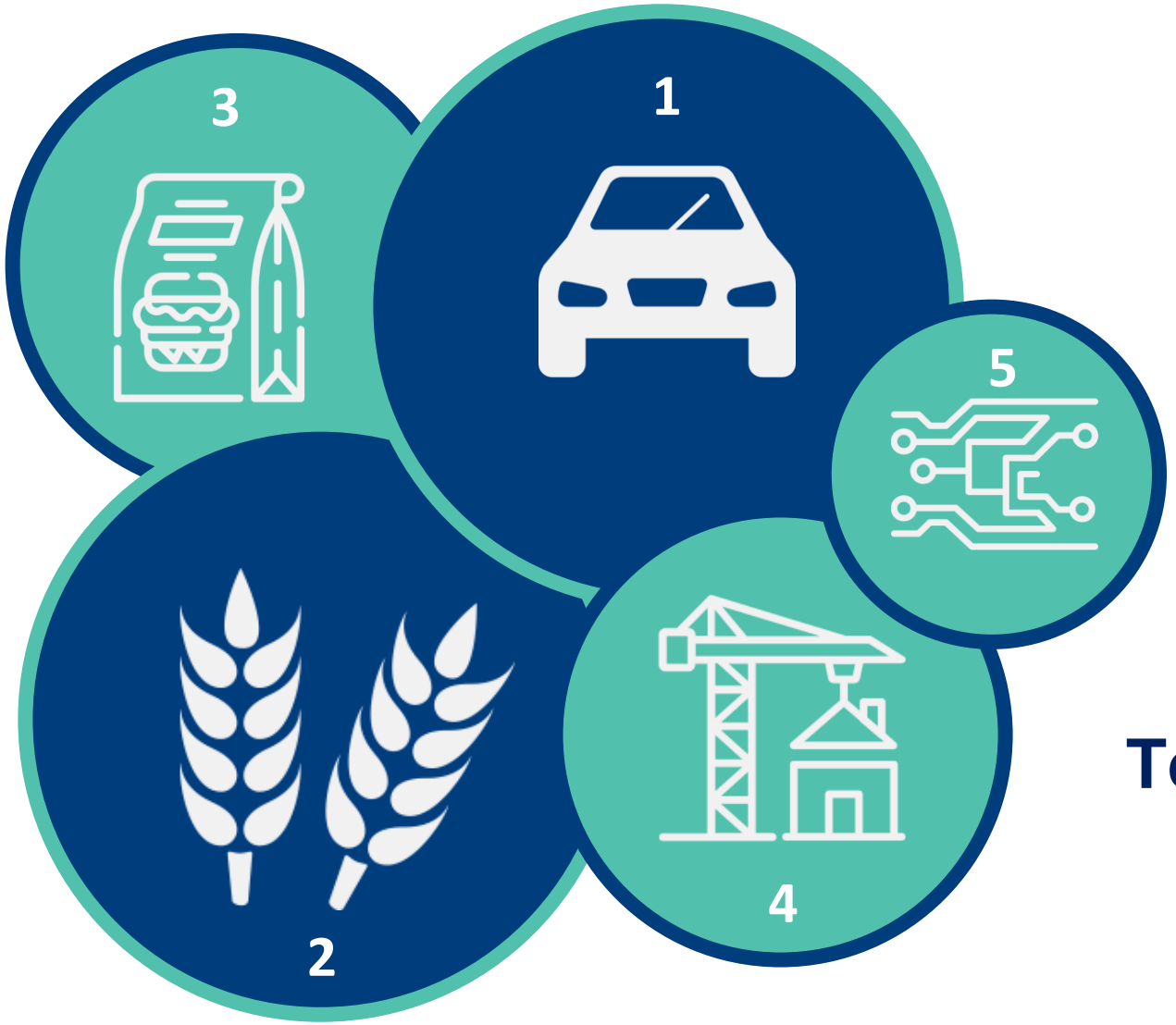

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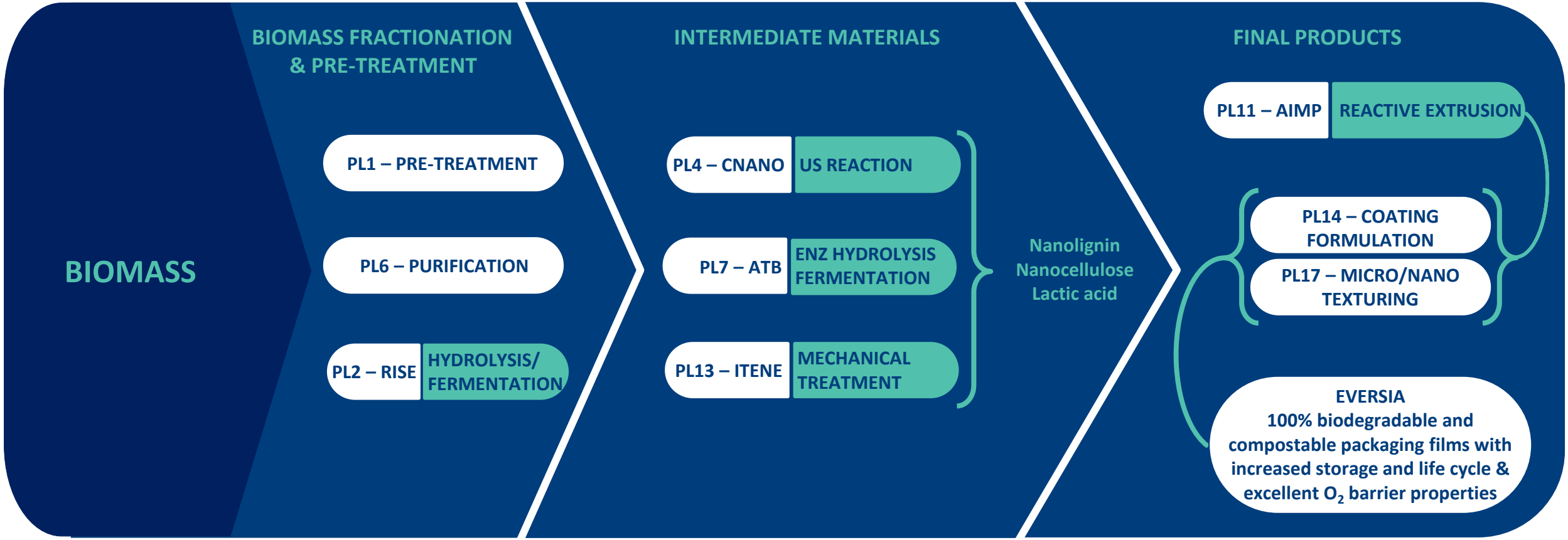
Test Case 3: Food packaging

- Vacuum thermoforming will be post-utilized to produce biocompostable and biodegradable food containers, using biobased PLA foils.
- These will be reinforced with nano-additives to enhance the mechanical and antibacterial properties of flexible packaging materials.
- By further improvements, the antimicrobial and antifungal properties of the film surface will be enhanced, leading to improved food maintenance/conservation and safety.

TC3 Flow scheme



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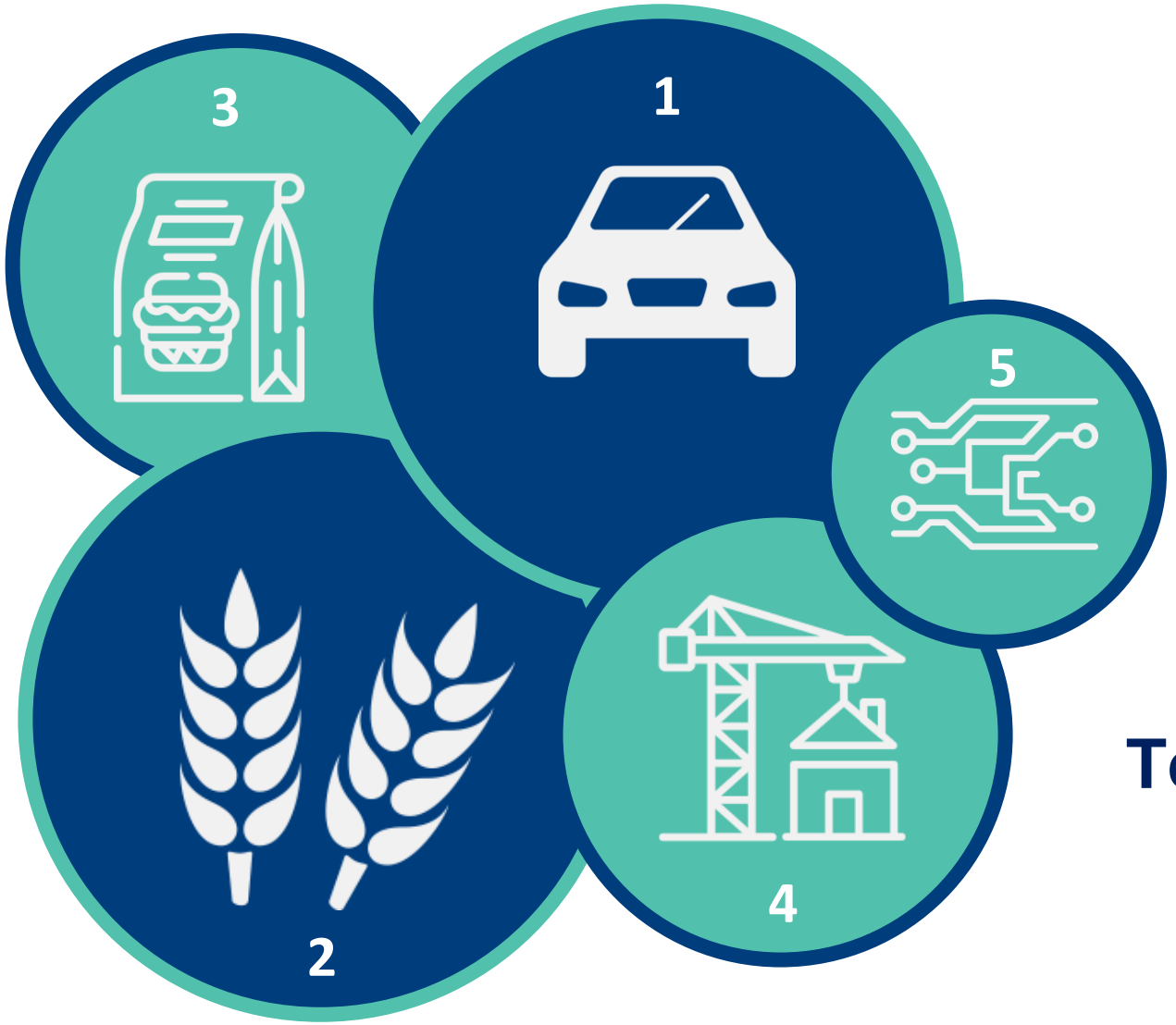

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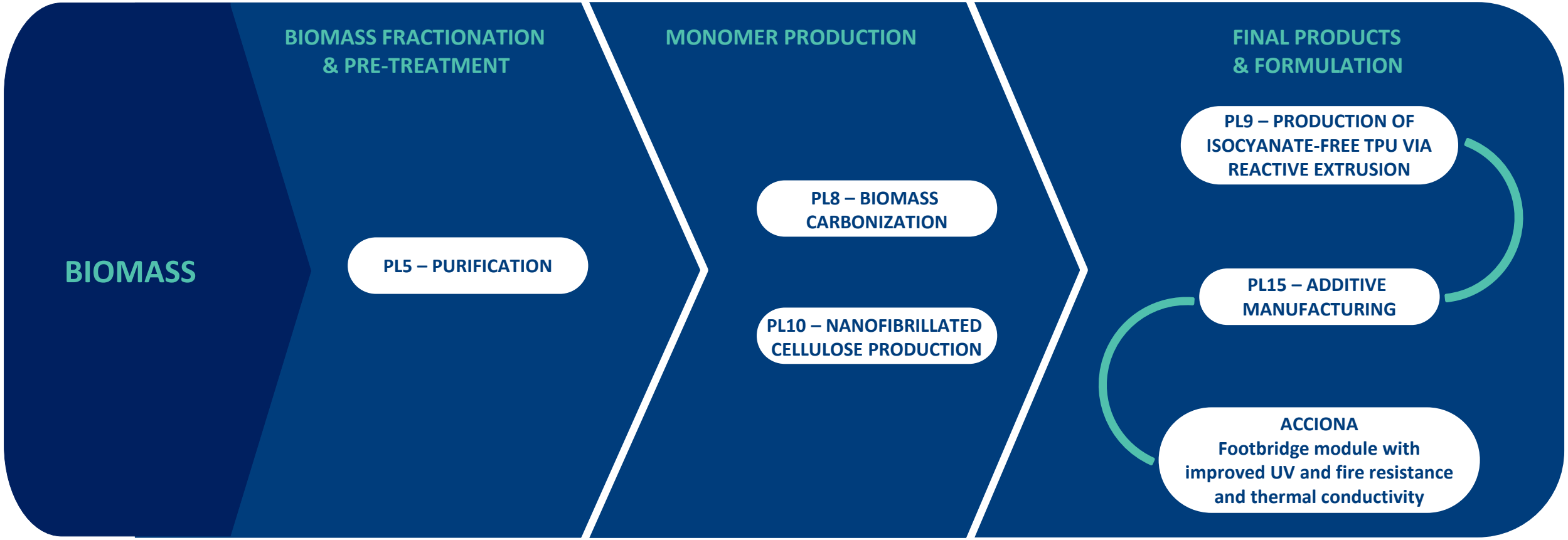
Test Case 4: Construction

- Bio-nanocomposites will be tested in the construction industry.
- A footbridge module made by biopolymers reinforced with nanolignin, biochar and nanofibrillated cellulose will be constructed with 3D printing technology.
- Fused filament fabrication (FFF) filaments prepared by melt extrusion will be used, and simple printing tests of the bio-filament will be performed using conventional fused deposition modelling equipment.
- The final product is expected to have high UV and fire resistance >80 °C, anti-fouling & easy-cleaning capability.

TC4 Flow scheme



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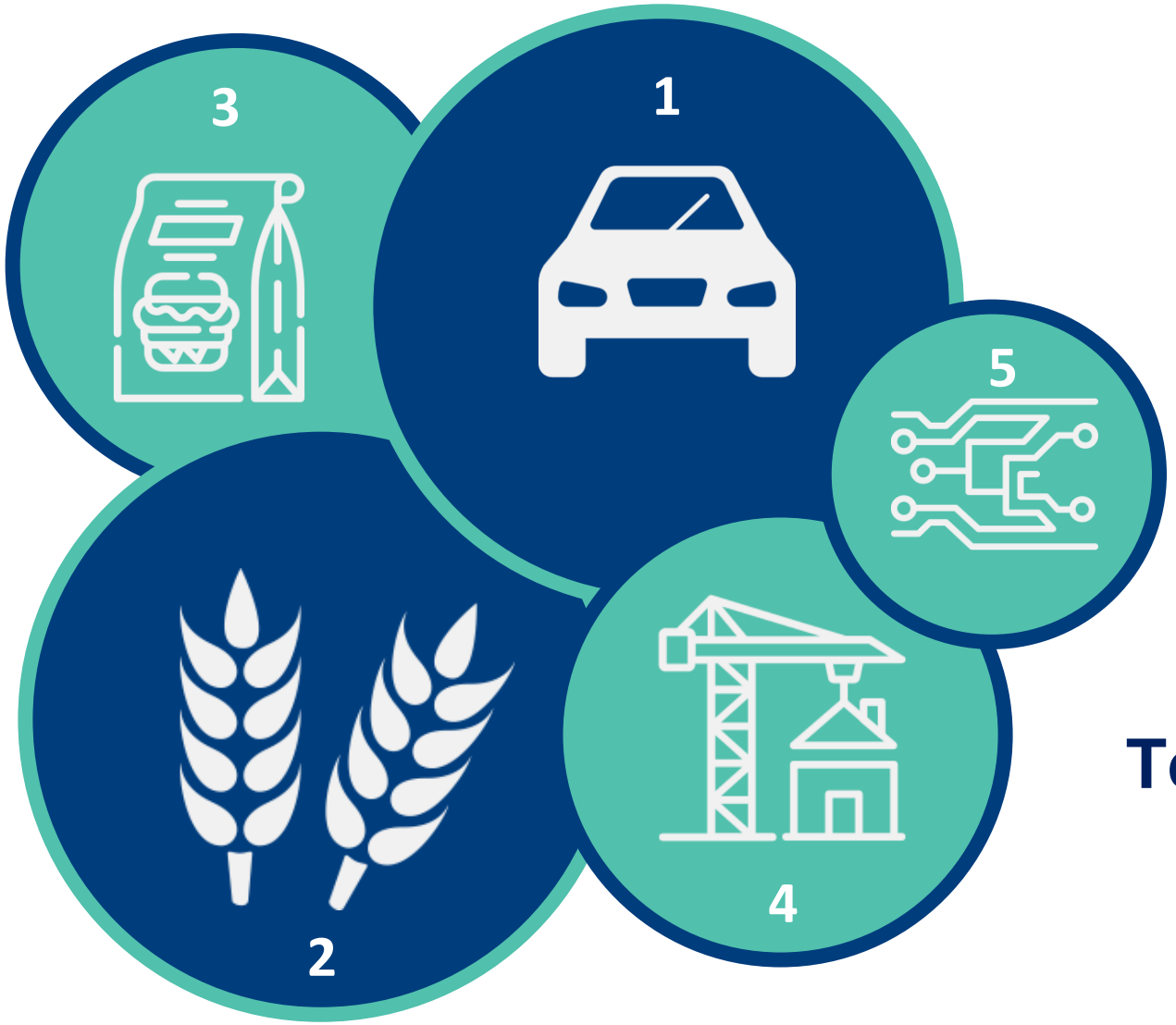

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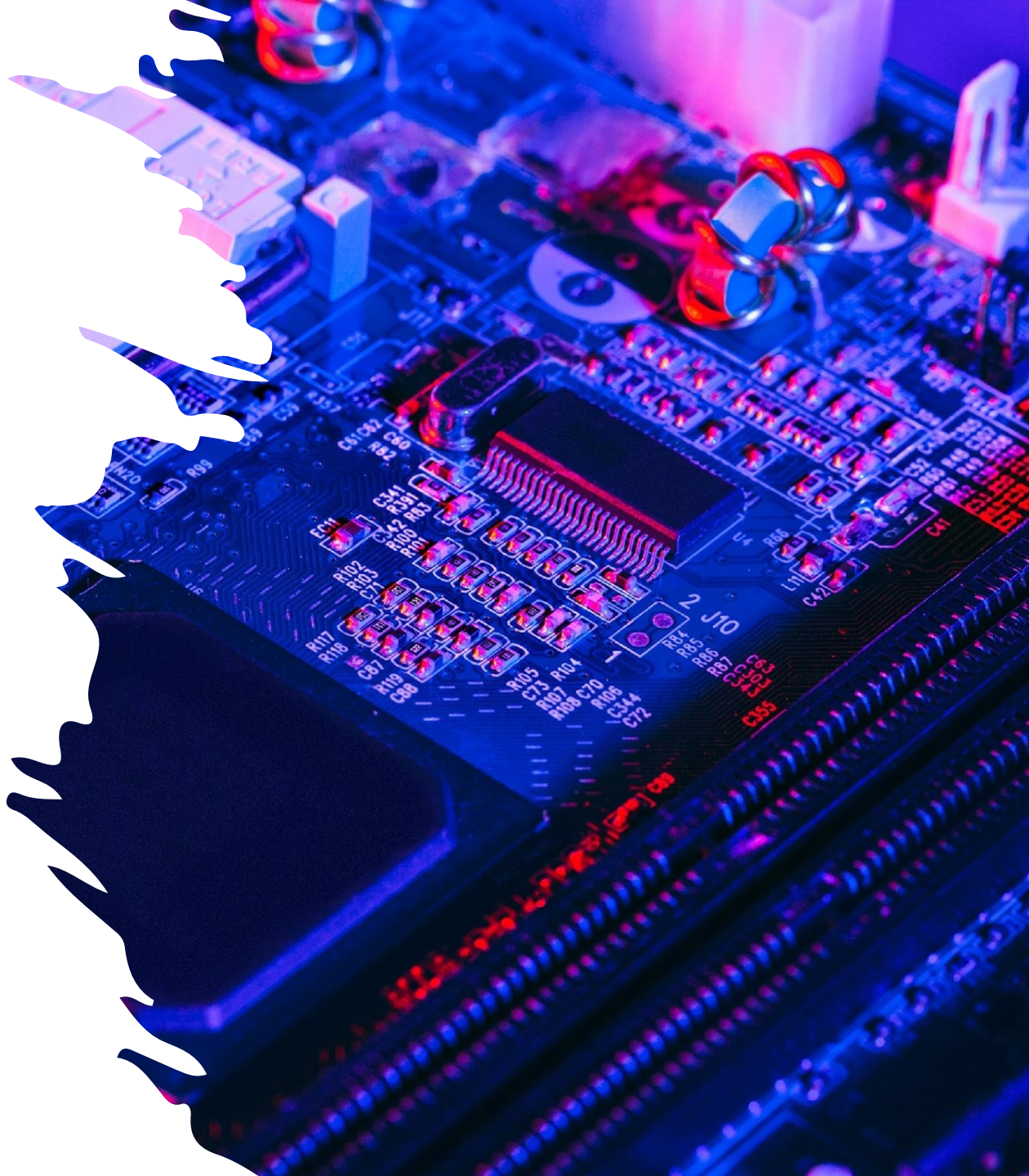
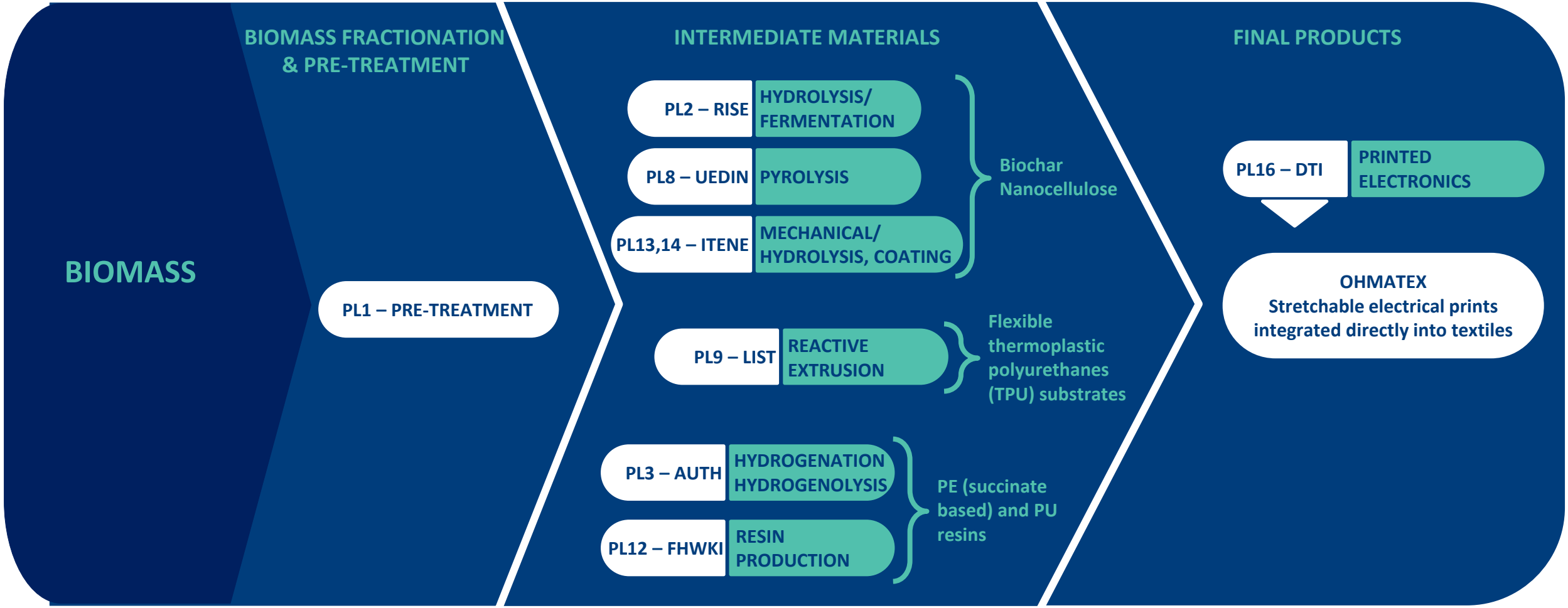
TeC5 – Printed electronics

Test Case 5: Printed Electronics

- Develop stretchable conductive layers embedded into textiles (sock with integrated conductors) using a biobased stretchable substrate, an ink and adhesives with printed electronic processes.
- To achieve this, nano-biochar will be modified by nano-copper and silver to enhance their electrical conductivity.
- TPU produced by reactive extrusion and biobased succinate polyesters will be used as flexible substrates, and nano-copper for stretchable electrical prints will be integrated directly into textiles as stretchable circuitry between sensors and electronics.



TC5 Flow scheme



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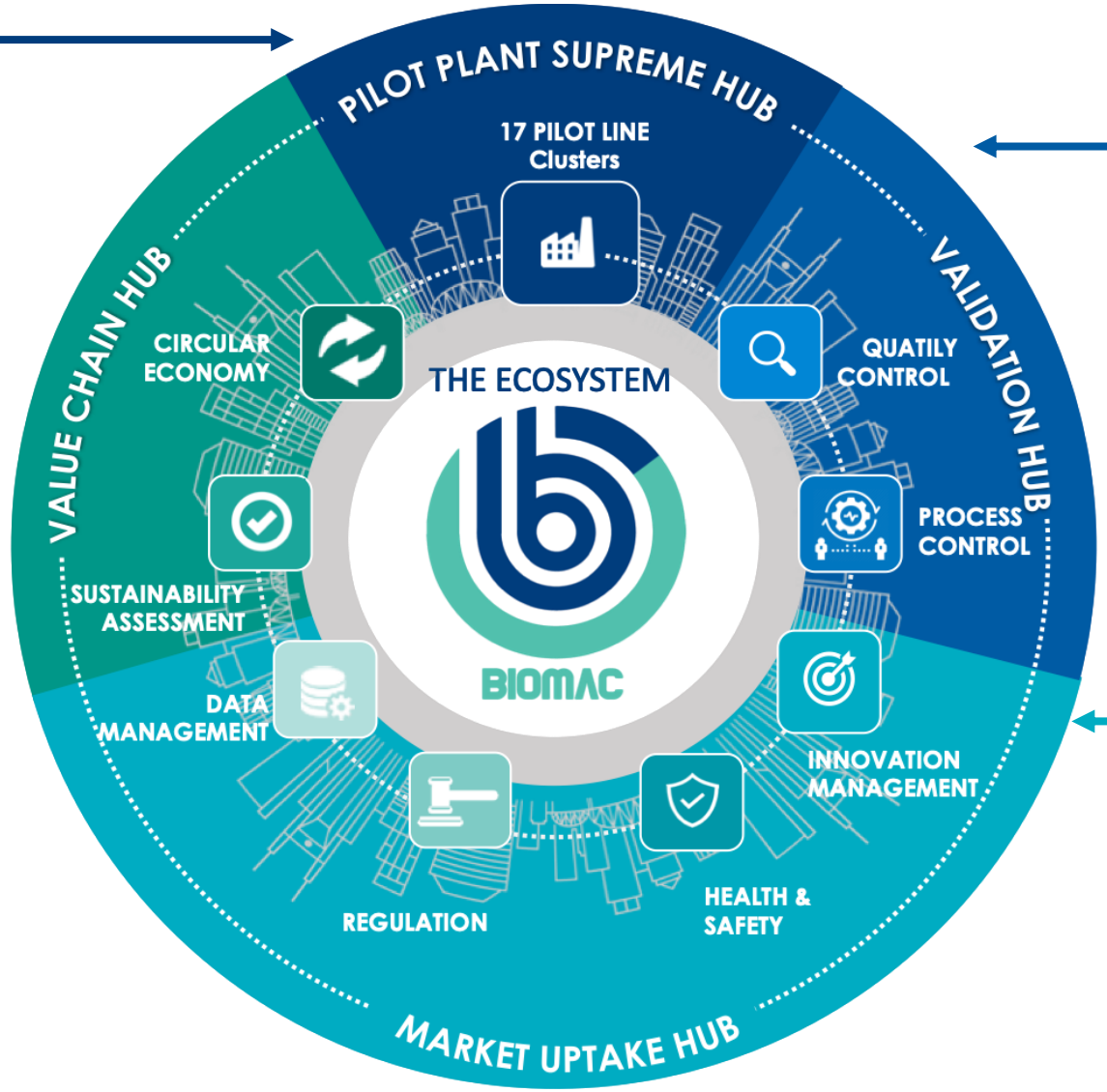

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Validation Services Hub

The **Validation Services Hub (VSH)** will provide in-detail characterization, performed under international standard procedure guidelines, of starting materials, raw materials and final products in terms of their physical, structure and morphological properties thanks to a wide range of analytical devices and setups. This group of services examines the feedstock, the technologies and the products from chemical, environmental, and economical perspective.

Quality control and characterization -> the aim is to promote the bridging of materials developments with end users and real market applications

Standardization

Process validation - modelling -> provide a model of the production lines

The Open Call

After the **TeCs validation phase**, SMEs and Research Centers will be granted access to the services and facilities of the BIOMAC ecosystem.

An **Open Call** targeted to end users will be launched here in **December 2022**, with the aim of selecting **5 additional TeCs (textiles, medical-biomedical, tissue engineering, single used items, etc.,)** utilizing biobased nanomaterials.

The Open Call will last for **6 months** until **May 2023**.

The Open Call

Applicants will liaise with BIOMAC's single entry point (SEP) constituted by **Industrielle Biotechnologie Bayern Netzwerk GmbH (BBI)**. A call for Innovation Concepts will be designed based on questionnaires filled in by the applicants. All the members of the OITB will participate to cover all aspects of innovation.

The main selection parameters will be the **proof of TRL 4-5** of the applicants' cases, the **feasibility study** and the c**omplexity** of the test cases. Another aspect is that **all 17 PLs** must be **utilized** during the implementation of the open call test cases.

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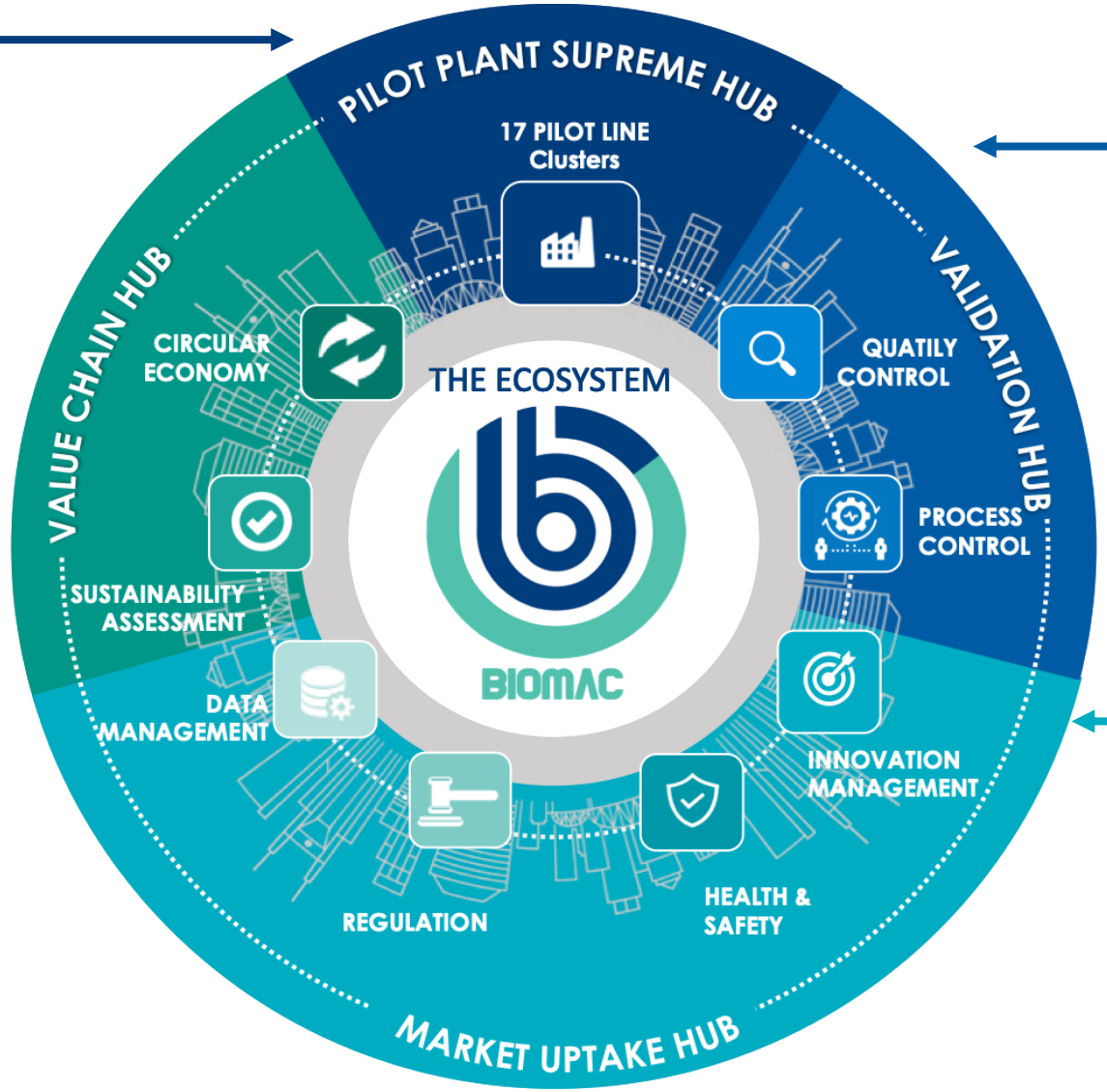

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Value Chain Hub: The services

- **Sustainability assessment** -> To demonstrate the final processes and products' environmental and economic sustainability, S-LCA, LCA and LCC will be performed, especially to highlight the environmental impact versus petroleum-based benchmarks.
- **Supply management** -> A Decision Support Tool (DST) will be developed to simultaneously assess the products against environmental and economic criteria; the DST will be then developed into an online user-friendly platform to secure general use
- **Circular economy** -> a circular overview of the value chain will be undertaken, allowing the development of efficient networks, identifying opportunities to foster the transition from linear to circular model, and evaluating the sustainability and economic feasibility

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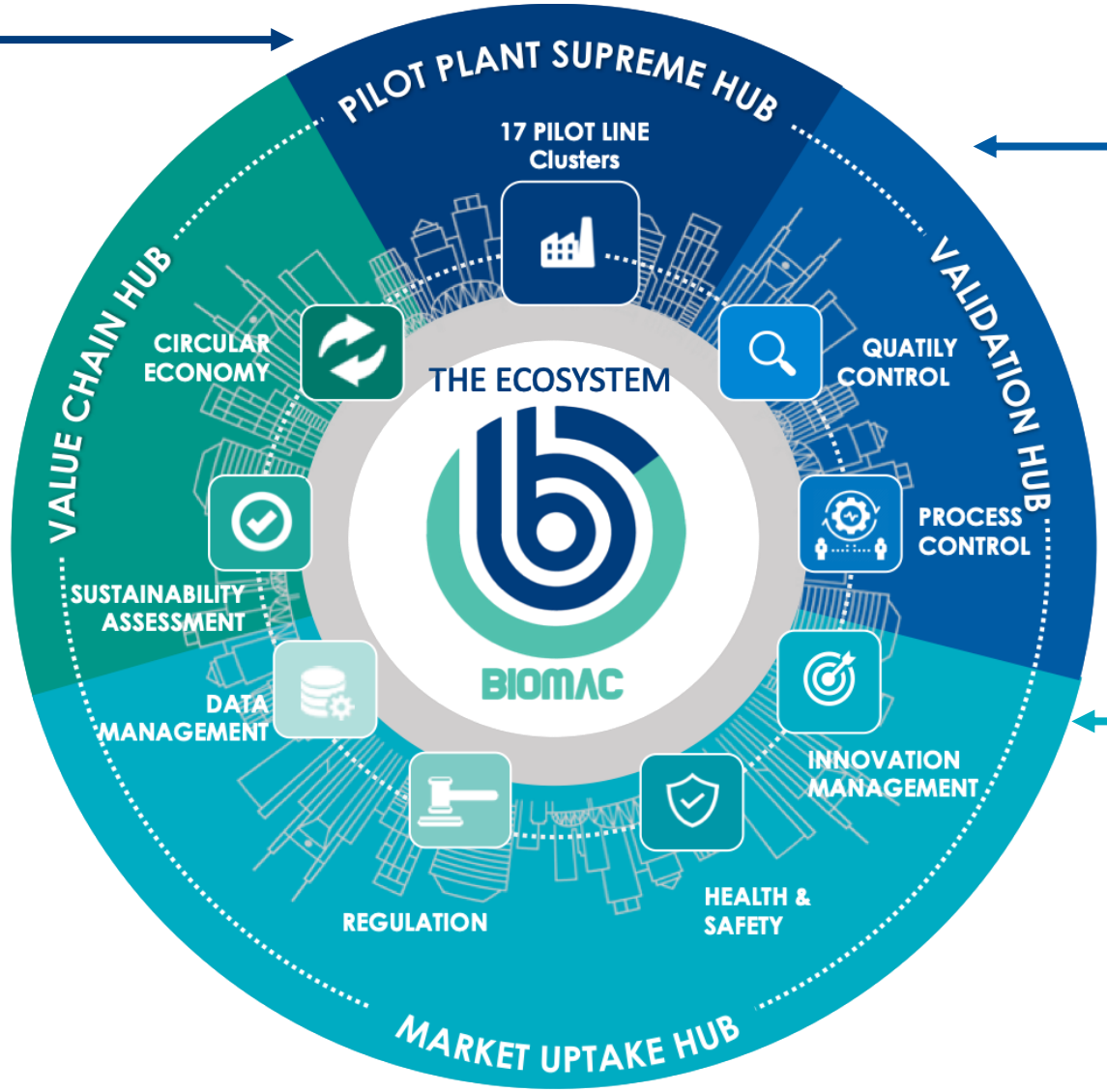

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Market Uptake Hub: The services

Innovation management (IM) -> the activities related to IM will ensure the effective deployment of the exploitation plan provided by the clients of the ecosystem and will indicate the customer segments and which value propositions they require/need

Health and safety -> a safe-by-design approach will be applied across the value chains to reduce potential health, safety and environmental risks at an early phase in the innovation process.

Regulation -> An assessment of regulation will be conducted to ensure partnering in the commercialization phase of a technologies, securing compatibility and reducing market uncertainties

BIOMAC

THANK YOU!

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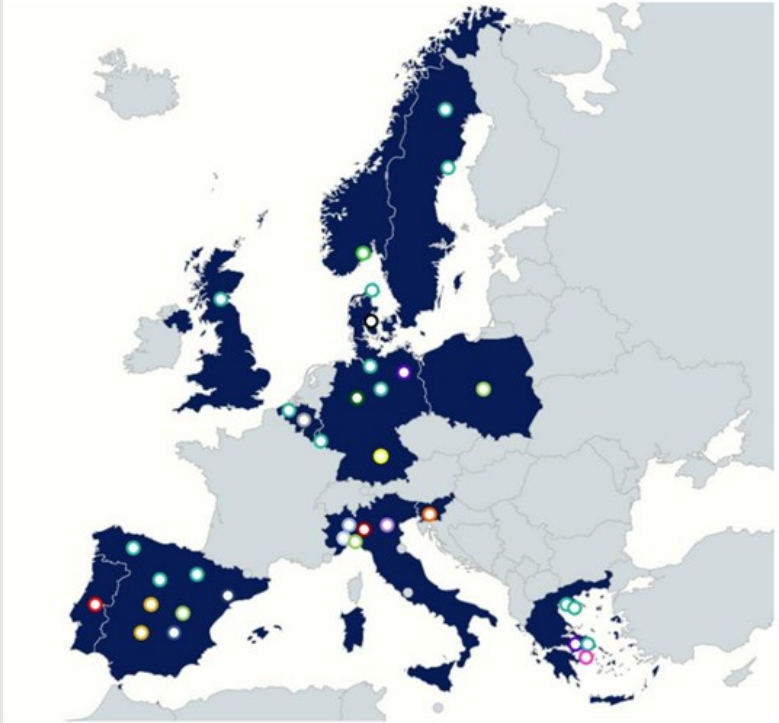
34 European Partners



- Pilots
- Characterization
- Modelling
- Monitoring
- Innovation
- IT Platform
- LCA, LCC
- Decision Support Tool
- Dissemination & Clustering
- Biomass Provider
- Business Development
- Standardization
- TeC1 Automotive
- TeC2 Agriculture
- TeC3 Food Packaging
- TeC4 Construction
- TeC5 Printed Electronics

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