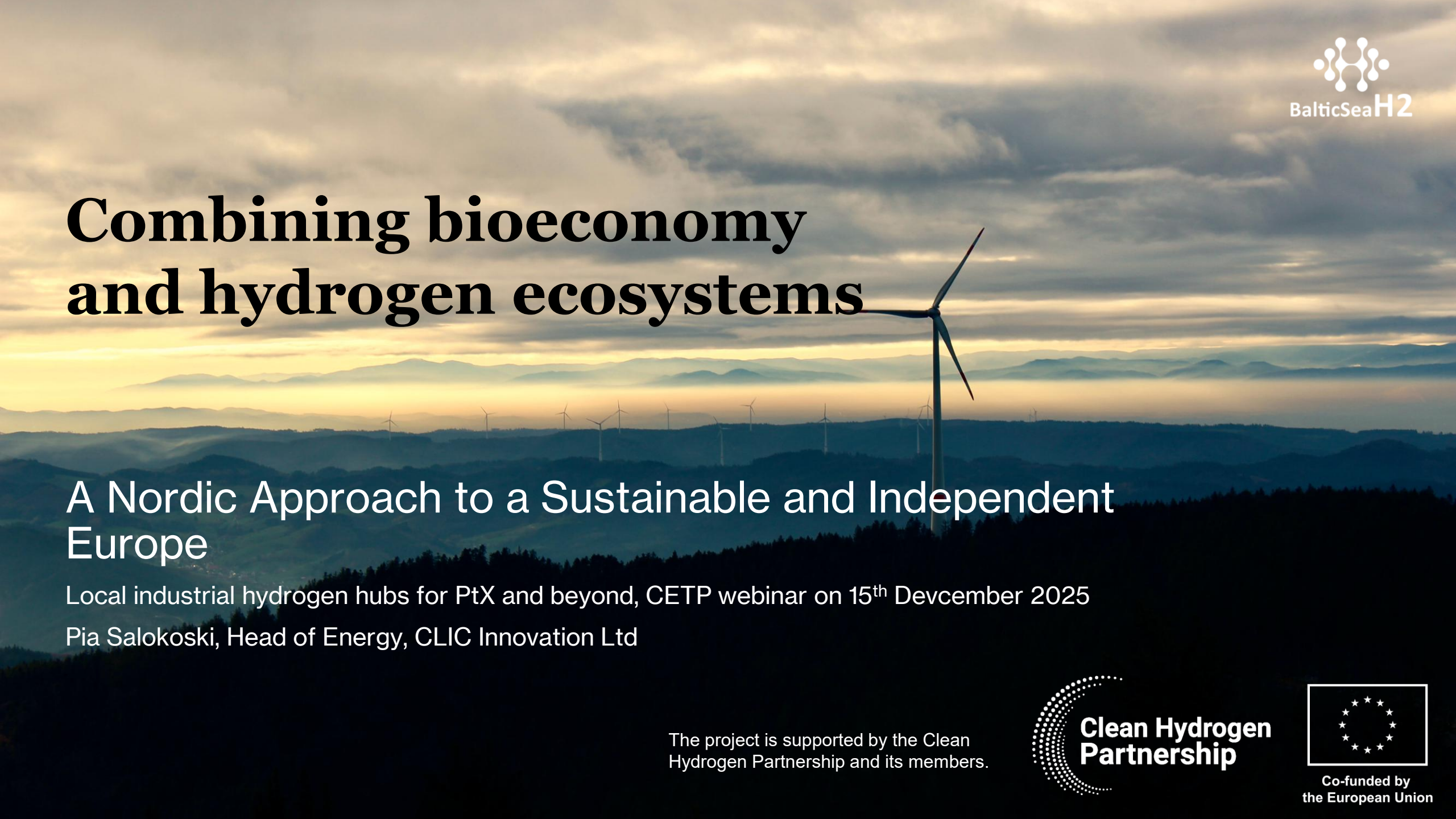

Combining bioeconomy and hydrogen ecosystems

A Nordic Approach to a Sustainable and Independent Europe

Local industrial hydrogen hubs for PtX and beyond, CETP webinar on 15th Devcember 2025

Pia Salokoski, Head of Energy, CLIC Innovation Ltd

The project is supported by the Clean Hydrogen Partnership and its members.

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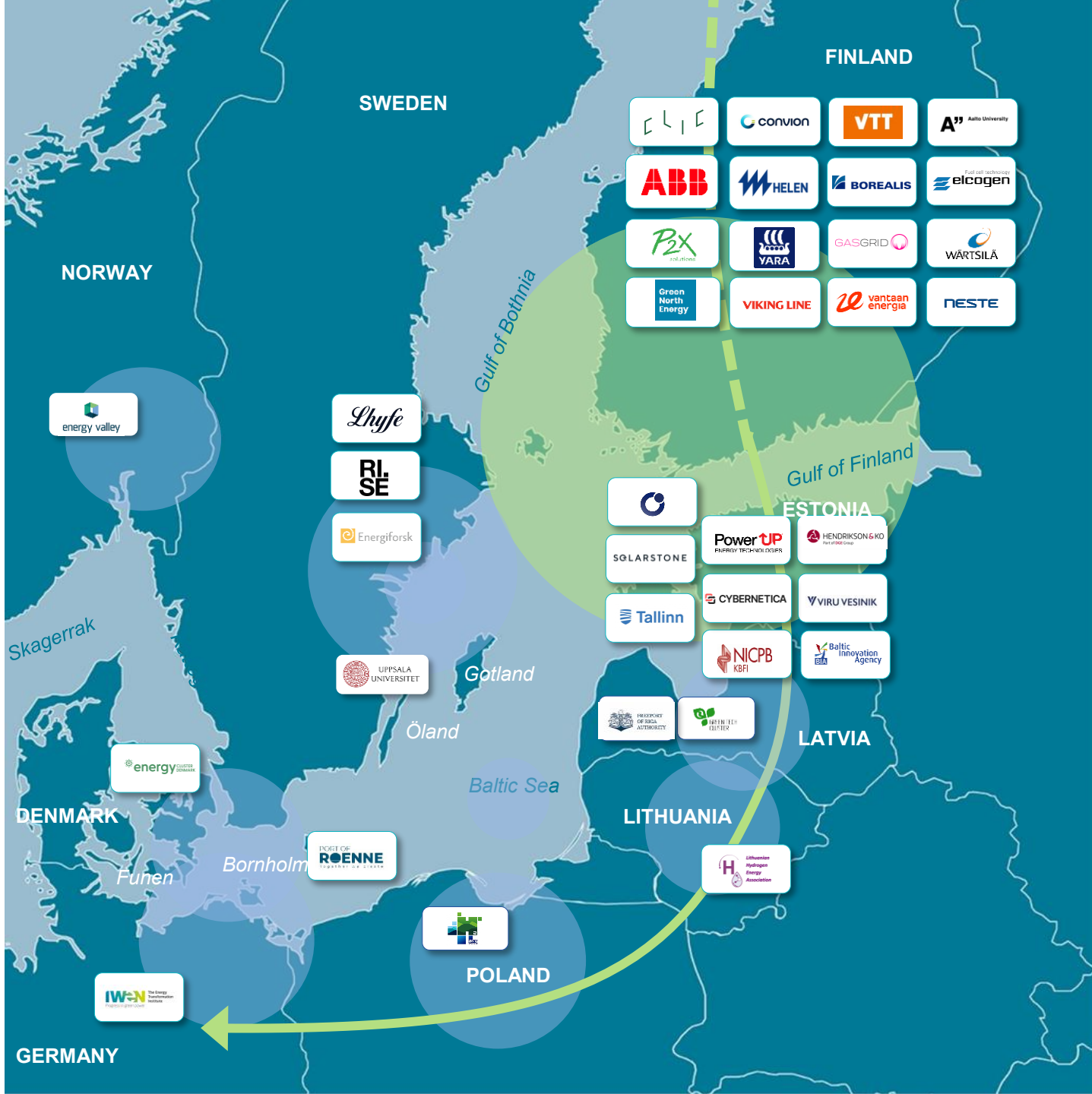
BalticSeaH2 – A pioneering initiative for a fully sector-coupled, interregional hydrogen economy

- Main Valley connecting Southern Finland and Estonia
- 7 Connected Valleys: Norway, Sweden, Denmark, Latvia, Lithuania, Poland and Northern Germany
- Total budget 33 M€, EU funding 25 M€
- Timeline: 2023-2028
- Co-coordinated by CLIC Innovation and Gasgrid Finland

BalticSeaH2 develops a Baltic Sea –wide Hydrogen Economy across country borders, industries, and energy sectors



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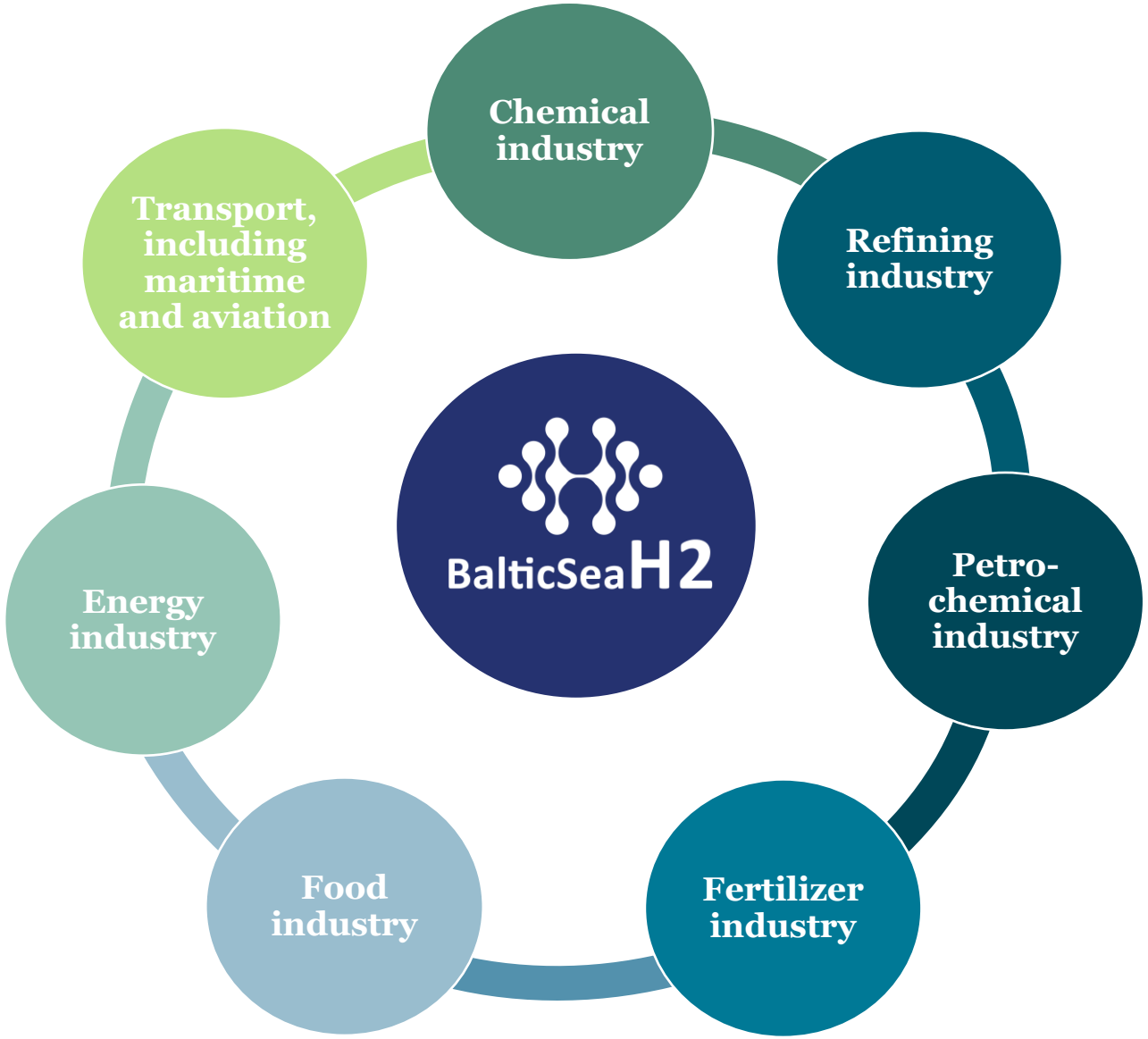
Use cases and industries involved in BalticSeaH2

‘Investment cases’ integrate multiple use cases from our collection of + 20 use cases to create the hydrogen value chain simultaneously.

Not all cases are published yet – follow the project to know first when our partners publish their investments!



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Our approach: Working on two parallel tracks

1. Valley implementation

2. Co-creation for shaping of the hydrogen economy

Co-funded by the European Union

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BalticSeaH2 Valley implementation plan by 2030

Renewable hydrogen production targets (tonH_2/year)

In production
Harjavalta 20 MW

FID made in 2024
3H2 pilot plant 3 MW

FID estimated H1/2026
Joensuu 30-40 MW

FEED
Naantali 280 MW

70000
60000
50000
40000
30000
20000
10000
0

Total ~60,000 ton/a

2024	2025	2026	2027	2028	2029	2030
	3,000 ton/a	500 ton/a		5,500 ton/a	36,000 ton/a	15,000 ton/a
	H2 & E-methane	H2 for refuelling		H2 & E-methanol	Green ammonia	
	Target sectors: Transport, Food industry, Storage	**Target sectors:** Transport, Industry, Storage		**Target sectors:** Transport, Energy, Industry	**Target sectors:** Maritime, Industry	**Target sectors:** Transport, Energy, Industry, Storage

Note: The plants that are already under construction have received investment financing from the Innovation Fund, IPCEI, RRF, or other funding from the Finnish ministry or the Finnish Climate Fund.

Co-funded by the European Union

Our approach: Working on two parallel tracks

1. Valley implementation

2. Co-creation for shaping of the hydrogen economy

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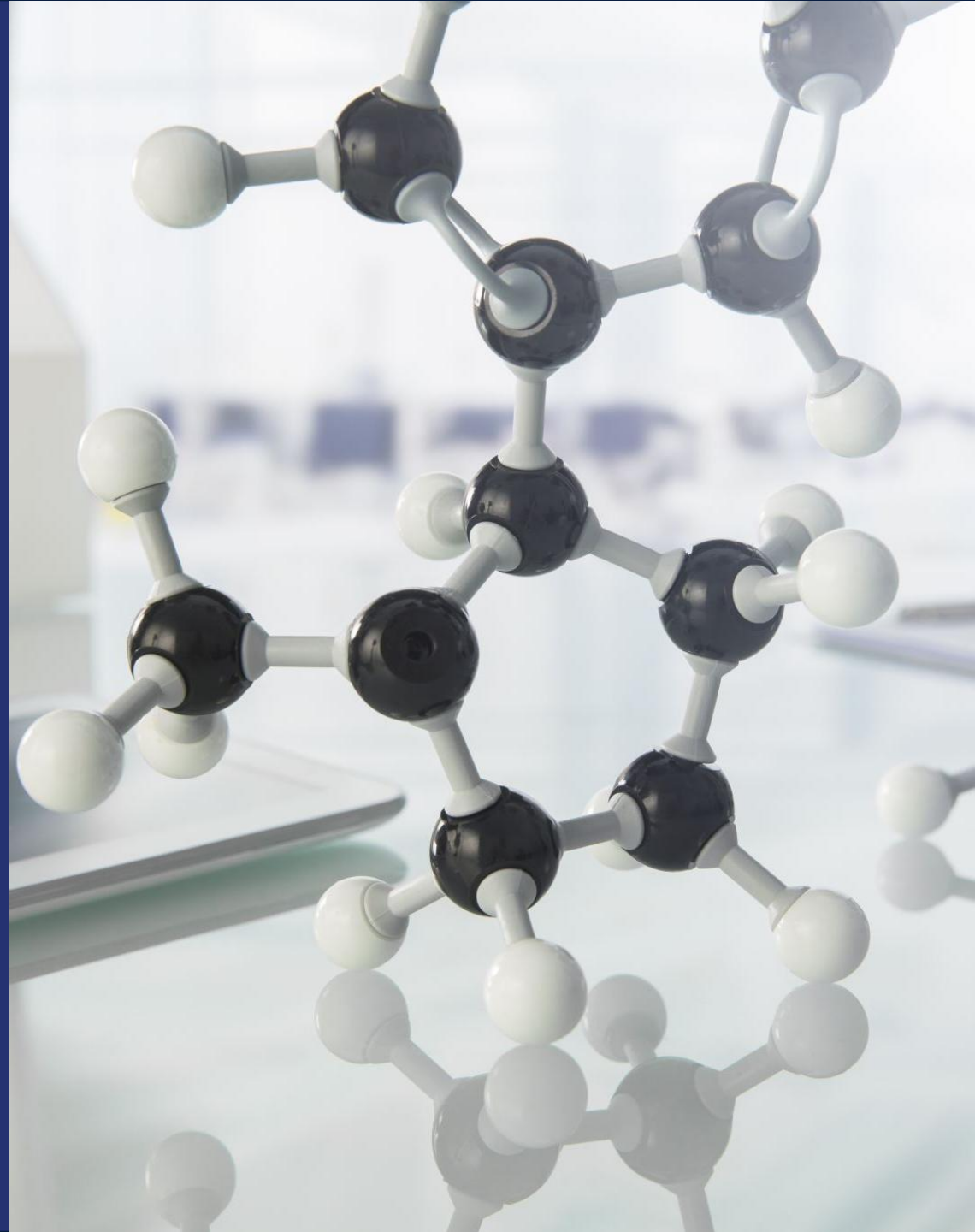
Our overarching goal: A sustainable supply system and security of supply for Europe

This means:

Resilient, climate-neutral and resource-efficient flows of energy, carbon and materials for European industry and society

- **Fossil-free and flexible energy** for industry and society, enabled by hydrogen
- Essential **green industrial chemistry**, delivered through clean hydrogen
- **Defossilised and circular carbon**, powered by clean hydrogen

Our goal is not a hydrogen economy in isolation.



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Clean Hydrogen Partnership

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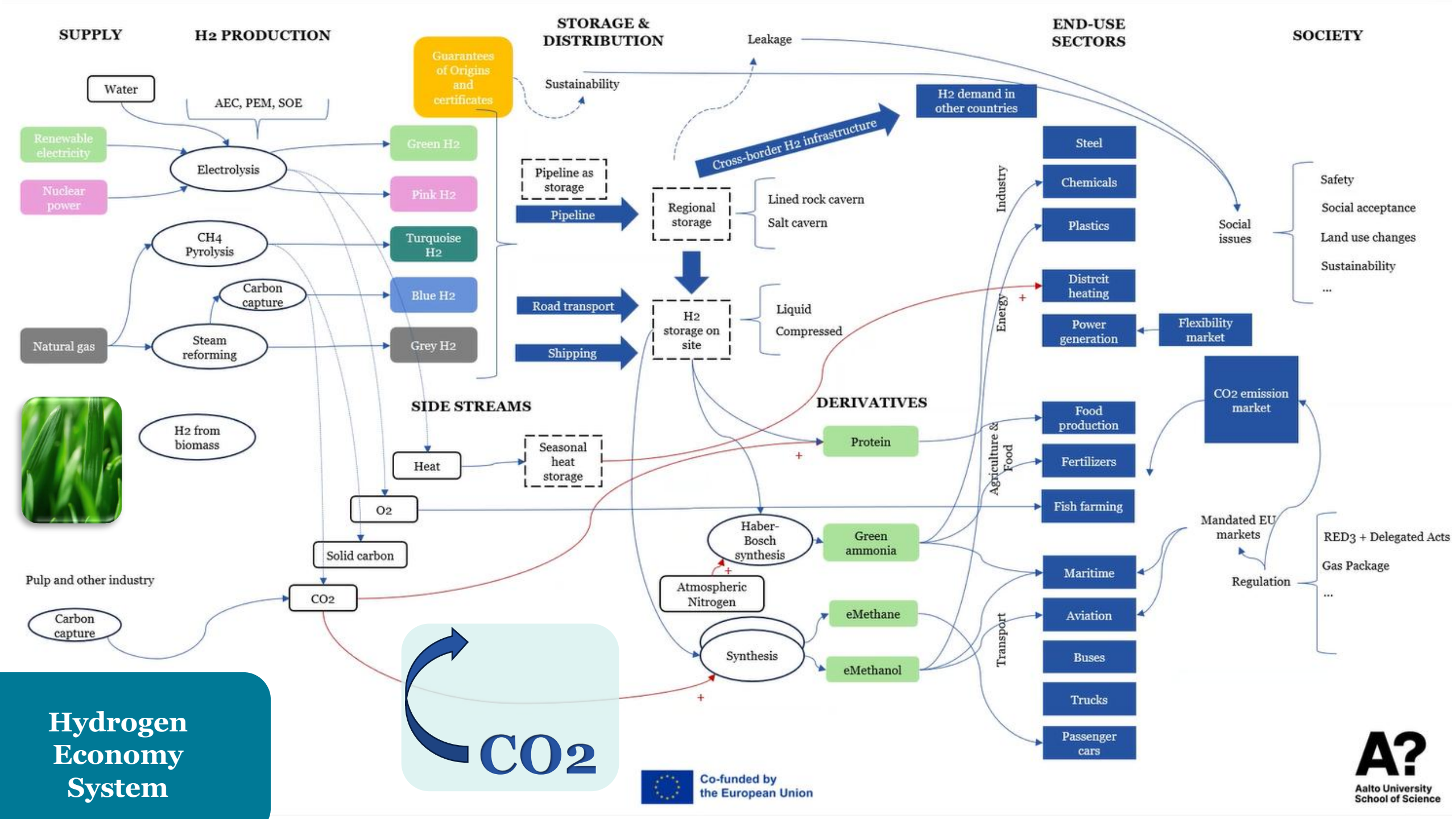

SUPPLY
H2 PRODUCTION
STORAGE & DISTRIBUTION
END-USE SECTORS
SOCIETY
Water
AEC, PEM, SOE
Guarantees of Origins and certificates
Leakage
Sustainability
H2 demand in other countries
Renewable electricity
Nuclear power
Electrolysis
Green H2
Pink H2
Turquoise H2
Blue H2
Grey H2
CH4 Pyrolysis
Carbon capture
Natural gas
Steam reforming
Pipeline as storage
Pipeline
Cross-border H2 infrastructure
Regional storage
Lined rock cavern
Salt cavern
Road transport
Shipping
H2 storage on site
Liquid
Compressed
Steel
Chemicals
Plastics
Industry
Distrcit heating
Energy
Power generation
Flexibility market
Social issues
Safety
Social acceptance
Land use changes
Sustainability
...
SIDE STREAMS
DERIVATIVES
H2 from biomass
Heat
Seasonal heat storage
O2
Solid carbon
CO2
Protein
Food production
Fertilizers
Agriculture & Food
Fish farming
CO2 emission market
Haber-Bosch synthesis
Green ammonia
Atmospheric Nitrogen
Pulp and other industry
Carbon capture
Synthesis
eMethane
eMethanol
Maritime
Aviation
Buses
Trucks
Passenger cars
Transport
Mandated EU markets
Regulation
RED3 + Delegated Acts
Gas Package
...
CO2
Hydrogen Economy System
Co-funded by the European Union
Aalto University
School of Science

The systems every essential sector of society depends on

Europe needs many supply systems – but two of them are **foundational:** *lifeline supply systems*

Bioeconomy provides Europe's sustainable biological supply

The bioeconomy covers **everything derived from living, biomass-based production**:

- **Food & feed** – the foundation of Europe's food security
- **Bio-based energy, materials & chemicals** – power and heat, wood, fibres, biomaterials and -chemicals
- **Ecosystem services** – carbon sinks, soil health, water cycles, biodiversity
- **Biomass residues & biogenic CO_2** – to be upgraded and circulated instead of wasted

👉 *Bioeconomy = Europe's biological primary production + a sustainable source of carbon and materials*

Clean hydrogen economy delivers Europe's clean energy and clean industrial chemistry

The hydrogen economy solves the parts that the bioeconomy cannot:

- **Clean energy carrier** for hard-to-electrify sectors (steel, chemicals, heavy transport)
- **System flexibility & storage** – balances the power system and stores energy for long periods
- **Clean industrial chemistry & upgrading** – hydrogen acts as a raw material and also converts biogenic CO_2 and biomass residues into fuels, fertilizers and green chemicals

👉 *Hydrogen economy = clean energy + industrial chemistry for a fossil-free system*

“Bioeconomy sustains life.

Clean hydrogen economy will sustain the systems that sustain life.”

Four fundamental linkages tie these systems into one circular European supply system

1. Hydrogen from biomass

Bioeconomy not only provides carbon and biogenic CO_2, but also **renewable hydrogen feedstock.**

👉 Bio-based green hydrogen

Co-funded by the European Union

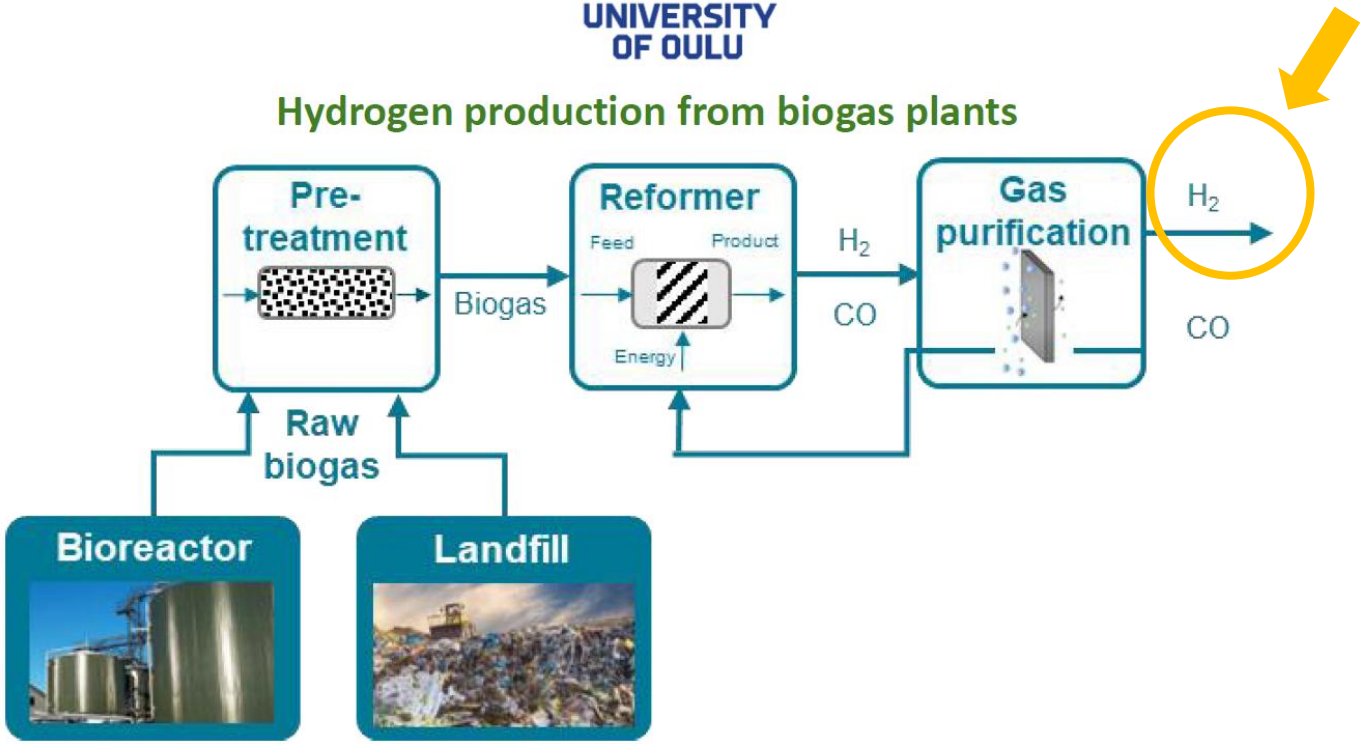
Linkage 1: Hydrogen from biomass – one route

H2 from biomass

UNIVERSITY OF OULU

BioCCU

Hydrogen production from biogas plants



Source: BioCCU project final report, 2024, University of Oulu

Four fundamental linkages tie these systems into one circular European supply system

1. Hydrogen from biomass

Bioeconomy not only provides carbon and biogenic CO_2, but also **renewable hydrogen feedstock.**

👉 Bio-based green hydrogen

2. Biogenic CO_2 + clean H_2 = circular carbon loop

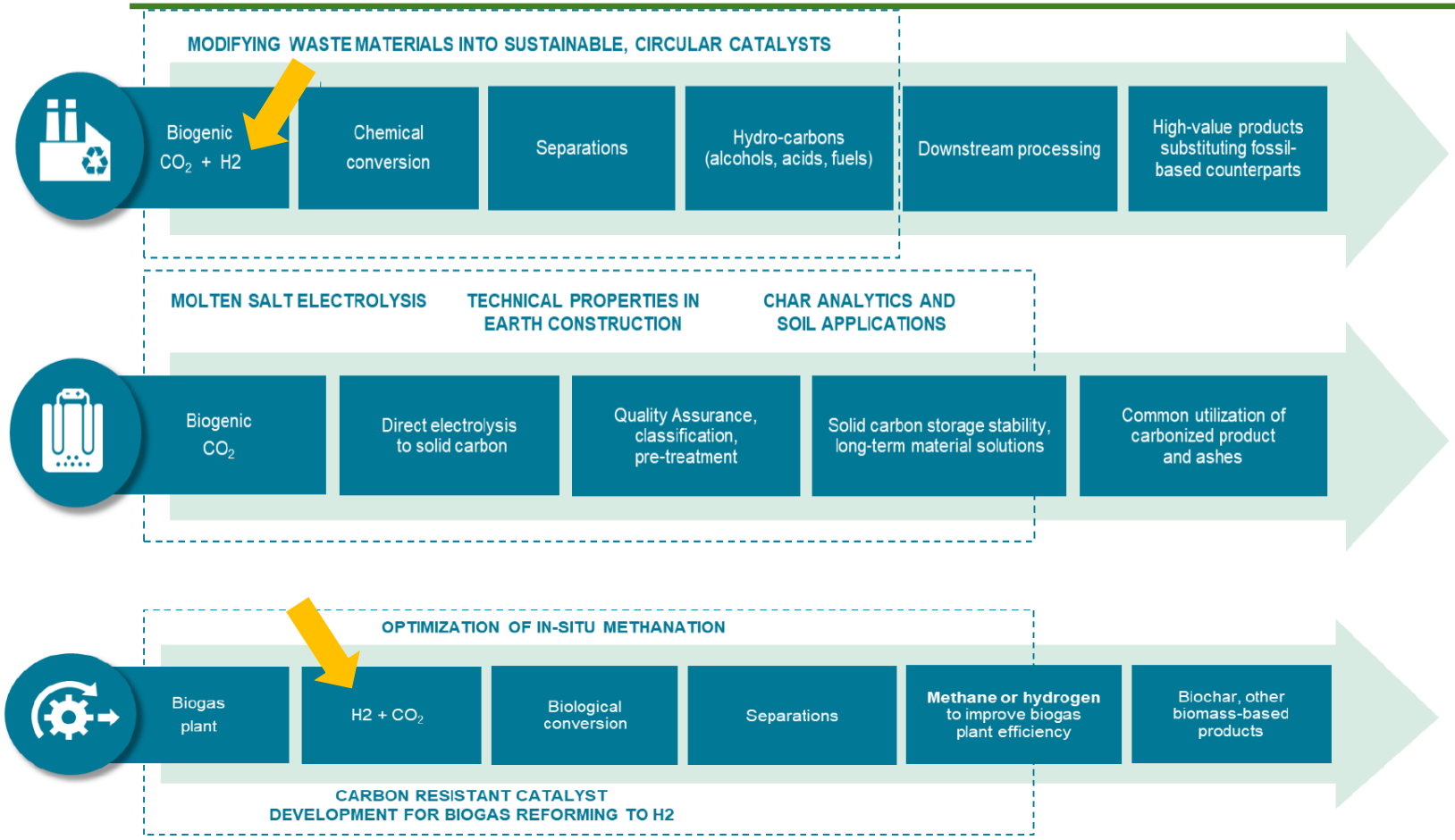
Hydrogen turns biogenic CO2 and residues **from waste into feedstock**, completing the carbon loop:

Bioeconomy produces sustainable carbon, hydrogen upgrades it.

👉 Circular fuels, chemicals and materials

Co-funded by the European Union

Linkage 2: Biogenic CO_2 can be converted in many ways



Biological conversion route (BioCCU)

TASK 3.5
INTEGRATION TO WP4 AND WP5 VALUE CHAINS
(Responsible leader: UOULU)

Solid carbon conversion (BioCCU)

Chemical conversion routes

- **Catalytic conversion (BioCCU)**
- **Fischer-Tropsch synthesis (ForestCUMP)**

Source: BioCCU project final report, 2024, University of Oulu

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👉 Circular fuels, chemicals and materials

3. Bioenergy ↔ Hydrogen: mutual energy system benefits

- Biomass (solid, liquid, biogas) provides **dispatchable renewable energy**
- Hydrogen provides **long-duration storage**

Together with hydropower, they provide Europe's **renewable backbone** that variable wind and solar alone cannot deliver.

👉 Energy system stability

4. Shared role in defossilising industrial value chains

Hydrogen and bioeconomy are **complementary feedstocks** for defossilising:

- **Steel** (H_2 reduction + biochar)
- **Chemicals** (bio-based intermediates + H_2 for synthesis)
- **Fertilizers** (bio-based nitrogen cycles + green ammonia)
- **Aviation and shipping fuels** (bio-feedstocks + H_2-derived e-fuels)

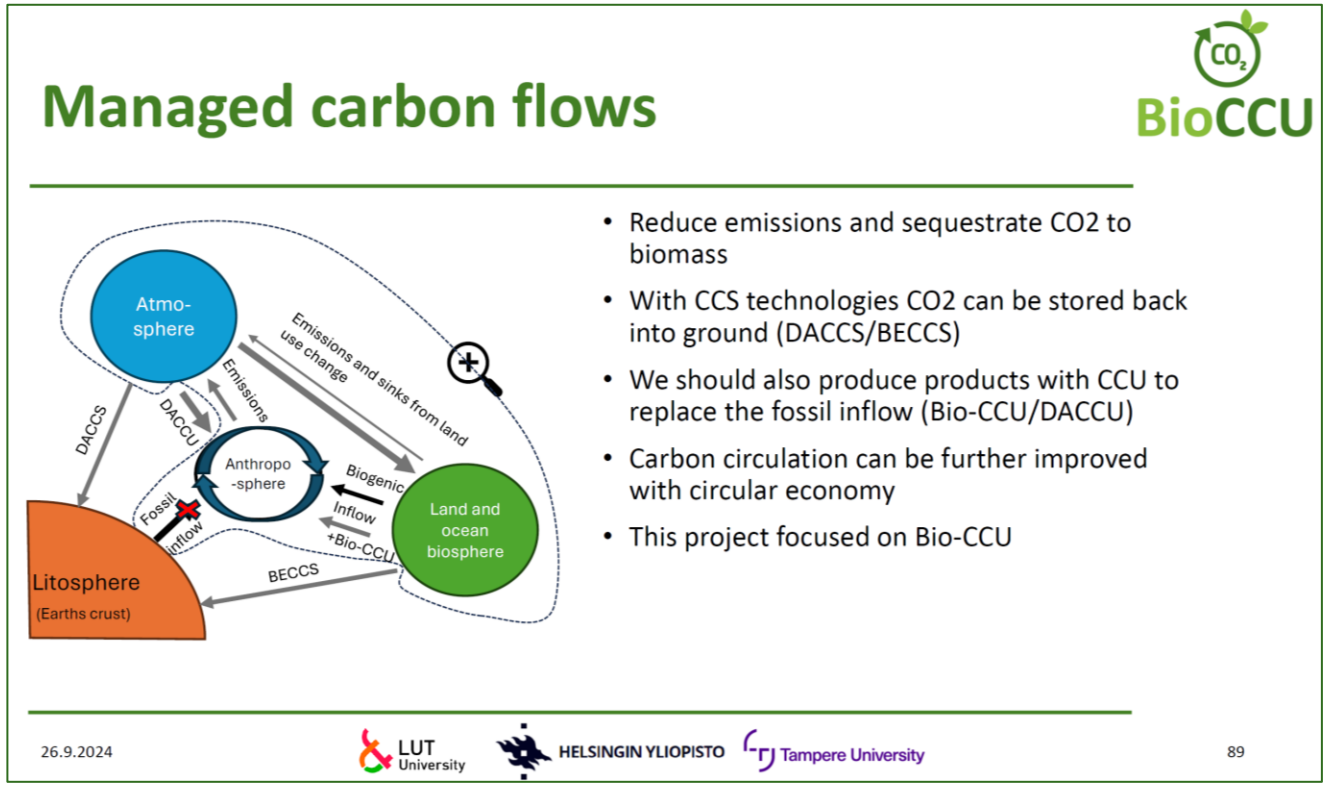
👉 Fossil-free molecules

From zero-carbon thinking to managed carbon flows

"Zero carbon" is not a viable concept — life depends on carbon, and circular value chains require it.

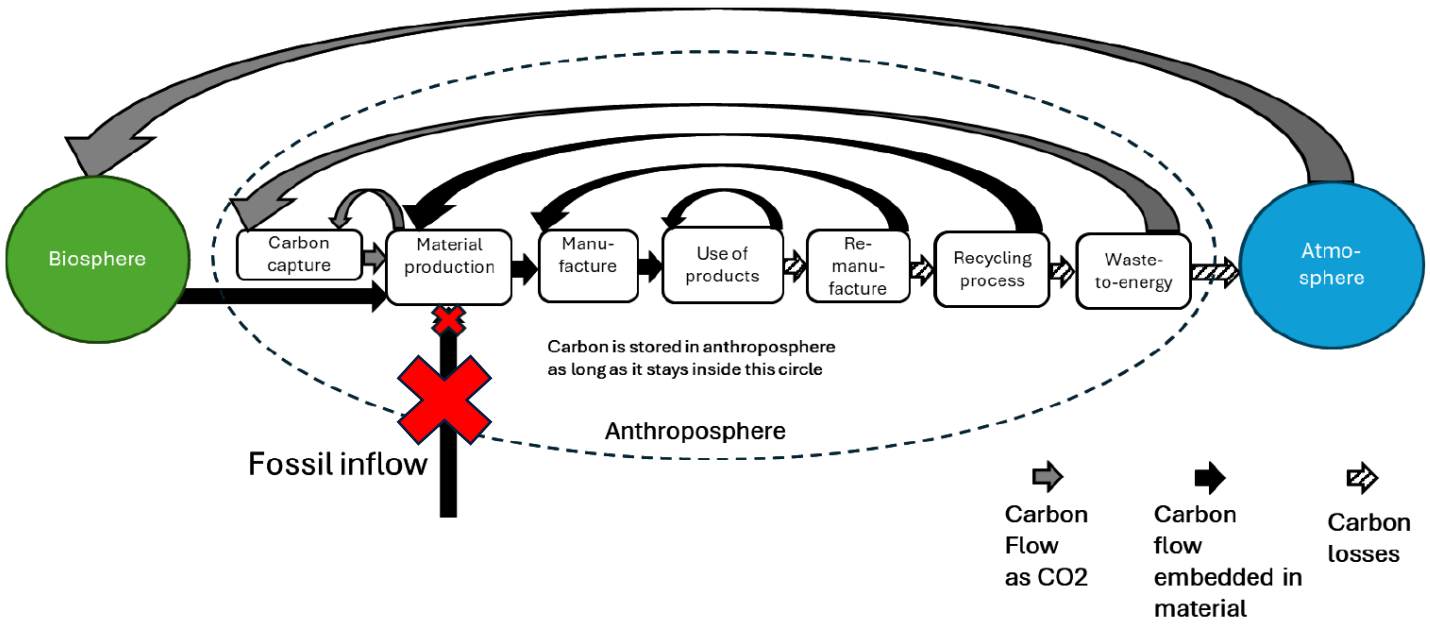
What we must **eliminate** is **fossil carbon**, not carbon itself.

By connecting circular bioeconomy with clean hydrogen, we can create defossilised fuels, materials and chemicals, and **close the carbon loop**.



This is how Europe reaches **true net-zero and independence**.

Carbon circulation in CCU value chain



- CCU can be used in both ends of a circular value chain to improve the circulation of carbon in the economic system
- This adds a new human controlled carbon cycle into the circular economy
- Replacing a fossil product with a CCU product can create climate benefits

The complex regulatory landscape is a barrier for large scale Bio-CCU implementation

Regulation: CCU value chains and lawscapes

BioCCU

1. **RED III**: biomass definition and sustainability criteria define which part of CO_2 is biogenic
2. **ETS Directive**: incentives to capture fossil CO_2 – not applicable to waste incineration (yet) , biogenic CO_2, or sources of predominantly biogenic CO_2.
3. **CRCF Regulation:** incentive to store biogenic CO_2 in products if storage at least 35 years
4. **Waste Framework Directive:** Waste hierarchy regulates source and availability of CO_2 . Whether CO_2 captured from waste incineration for utilization is classified as waste is uncertain.
5. **Plastics regulation:** does not recognize CCU-plastic – though recognizes many other types of plastics, e.g biogenic, compostable.
6. **GHG savings criteria and incentives** for synthetic fuels (RED III, ReFuel Aviation, FuelEU Maritime and ETS,
7. **Forest regulation** on carbon sink (LULUCF) and biodiversity (e.g. Nature Restoration Law) regulates the availability of sustainable biogenic CO_2.

Source: BioCCU project final report, 2024

Demand creation and connected value networks are the two keys we need

Challenge	Key Message	Proposed EU Action
1. Clean industry is key to security of supply and autonomy in Europe	To replace fossil carbon in industrial value chains, clean hydrogen must be paired with CO_2 — turning emissions into feedstock via CCU. Hydrogen and CCU together build **STRATEGIC RESILIENCE**.	• Support cross-border **H_2 and CO_2 infrastructure** • **Integrate** both into NZIA and REPowerEU • Fund regional **hydrogen–CCU clusters**
2. Clean innovators face cost pressure and export risks	**UNLOCKING PROFITABILITY!** Don't penalise first movers. Clean producers need support not just to produce cleanly but to compete cleanly globally.	• **Demand** pull for green H2 and its derivatives: ✓ Subsidies and mandates to end-users ✓ Smart market design in Europe (CfDs, CCfDs) ✓ RFNBO quotas ✓ Green content in procurement and tenders • **Export** competitiveness tools: ✓ Export credits for clean products ✓ CBAM expansion or equivalent trade mechanisms ✓ Bilateral recognition of green value (green trade corridors)
3. Regulatory uncertainty slows scale-up of hydrogen & CCU	**BREAKING REGULATORY BARRIERS!** EU regulation must strengthen its clean industrial base. Hydrogen and CCU must be integrated in EU climate, energy and industrial frameworks.	• **Fast-track** regulation and permitting • **Simplify** RFNBO rules, including additionality and temporal matching • Ensure regulatory **certainty** in RED III, ETS, and taxonomy • Establish **lifecycle** carbon accounting for CO_2 use • **Integrate** CCU in hydrogen valley frameworks and funding calls

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