HIGH PRESSURE HYDROGEN VALUE CHAIN

HYGHER THROUGH ENERGY EFFICIENCY AND CIRCULARITY

UNIVERSITY OF LJUBLJANA, 17.04.2026, ONLINE

Clean Hydrogen Partnership

Co-funded by the European Union

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

AGENDA

- ***About HYGHER project***
- ***Energy efficiency in HYGHER***
- ***Circularity in HYGHER***

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HYGHER PROJECT

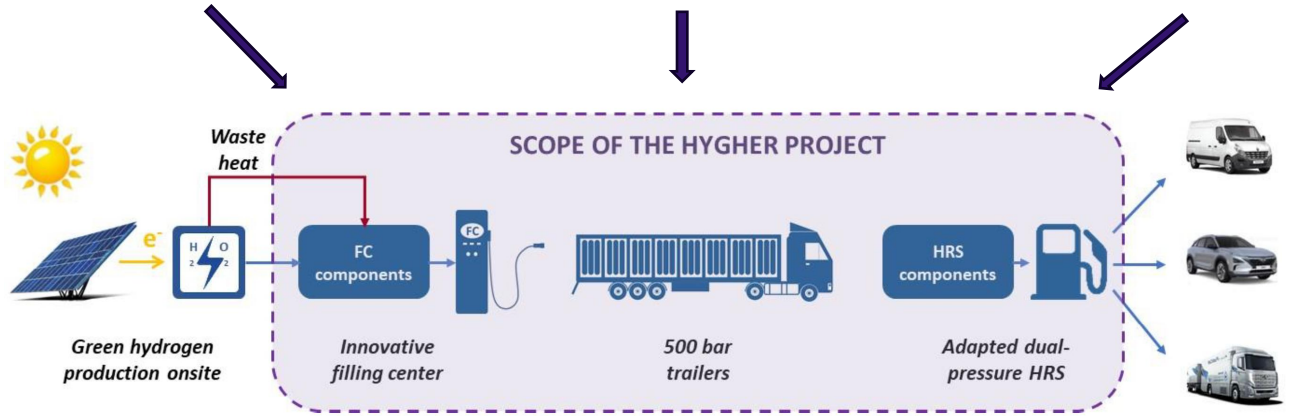
HYGHER project aims to demonstrate the feasibility of an **innovative, cost-efficient, safe and reliable high-pressure hydrogen value chain** for large scale deployment.

Its ultimate goals are:

- Transition to clean energy sources for hydrogen compression and distribution
- Increase of energy efficiency and reduction of environmental impacts while following strict safety requirements

The improvements are achieved through

Advanced hydrogen compression | **High-capacity tube trailers** | **Comprehensive value chain integration**



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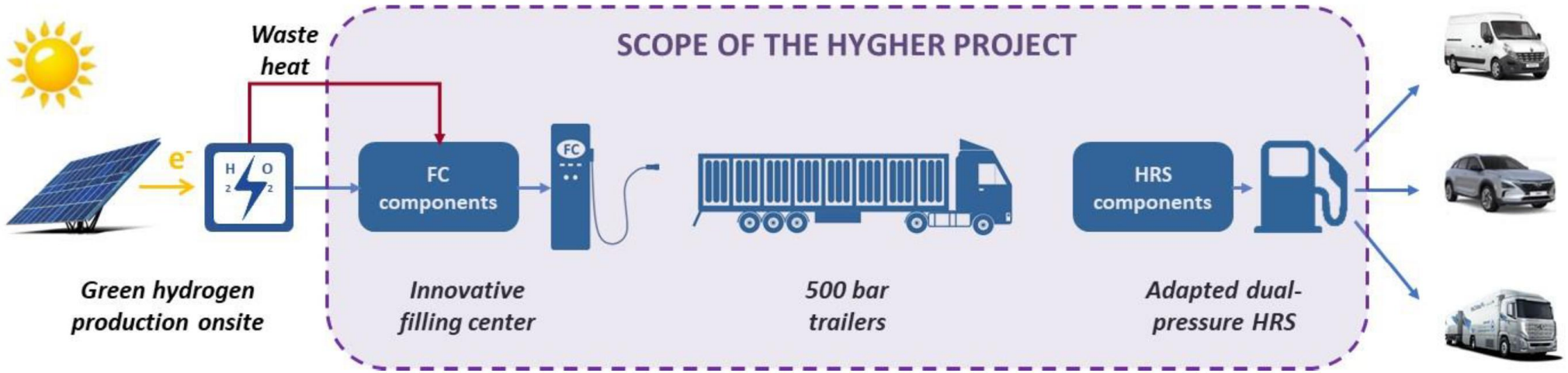
SUSTAINABILITY - TWO VIEWS ONE GOAL

Energy efficiency

- Waste heat utilisation
- Increased transport capacity
- Optimized cascading system

Circularity and material efficiency

- Metal hydride compressor
- TYPE IV pressure vessels
- Tube trailer



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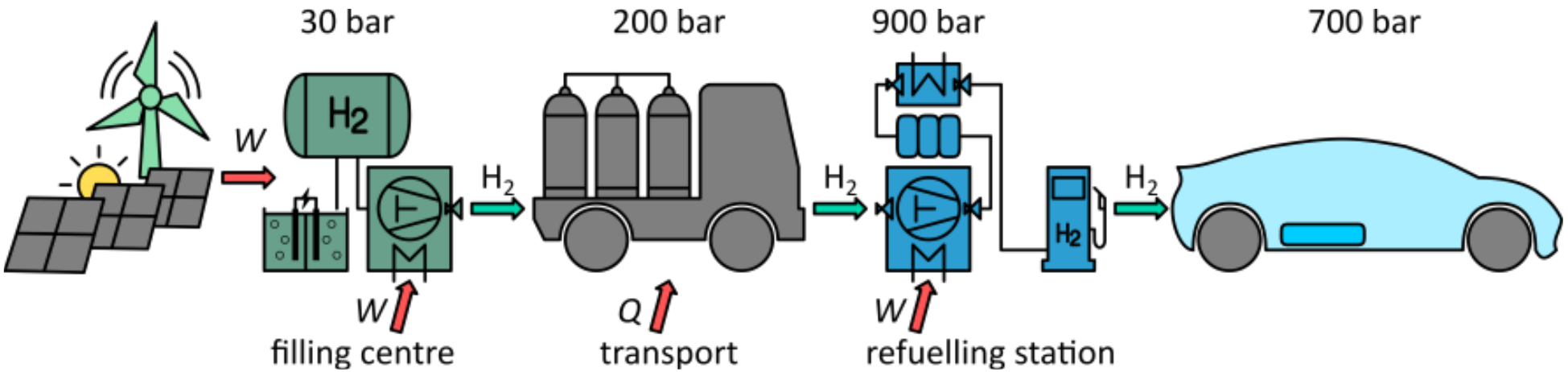
ENERGY EFFICIENCY



500 bar supply chain innovations

Metal Hydride Compressors (MHC)
Utilize waste heat from on-site H_2 production for compression

Type IV Composite Trailers
Carrying 3× more hydrogen than traditional steel vessels

Optimized Cascading Storage
Enabling direct H_2 transfer from trailers to vehicles without intermediate storage

Hojkar et al. (2025), Improving energy efficiency and environmental footprint of hydrogen supply chain by upgrading to 500 bar technology

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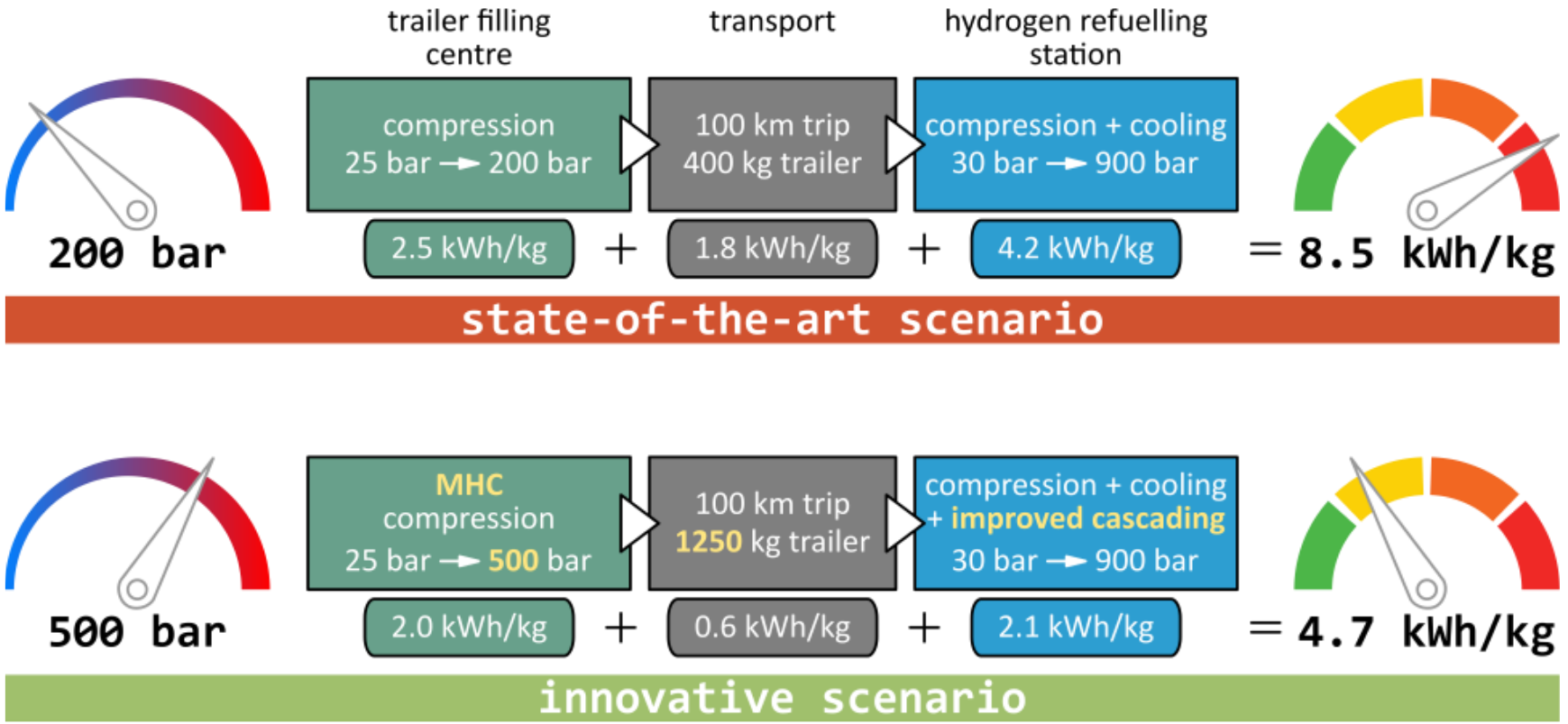
ENERGY EFFICIENCY



= 2,31 CO_2 eq./kg H_2

- 46%

= 1,24 CO_2 eq./kg H_2

Hojkar et al. (2025), Improving energy efficiency and environmental footprint of hydrogen supply chain by upgrading to 500 bar technology

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CIRCULARITY AND MATERIAL EFFICIENCY

What is circularity?

Circularity is a principle where **materials, products, and resources are kept in use for as long as possible.**

→ It uses strategies like **reuse, repair, remanufacturing, and recycling** ✓

→ Replaces the traditional **linear model** of ***take*** → ***make*** → ***waste***. ✗

Main concepts:

- Reducing the need for virgin resource extraction
- Using Ecodesign to decrease the amount of:
  - needed materials
  - generated waste
- Keep the materials circulating at their highest value for as long as possible (through reuse and recycling)

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CIRCULARITY - SELECTED SUBSYSTEMS

Subsystem 1 (S1)

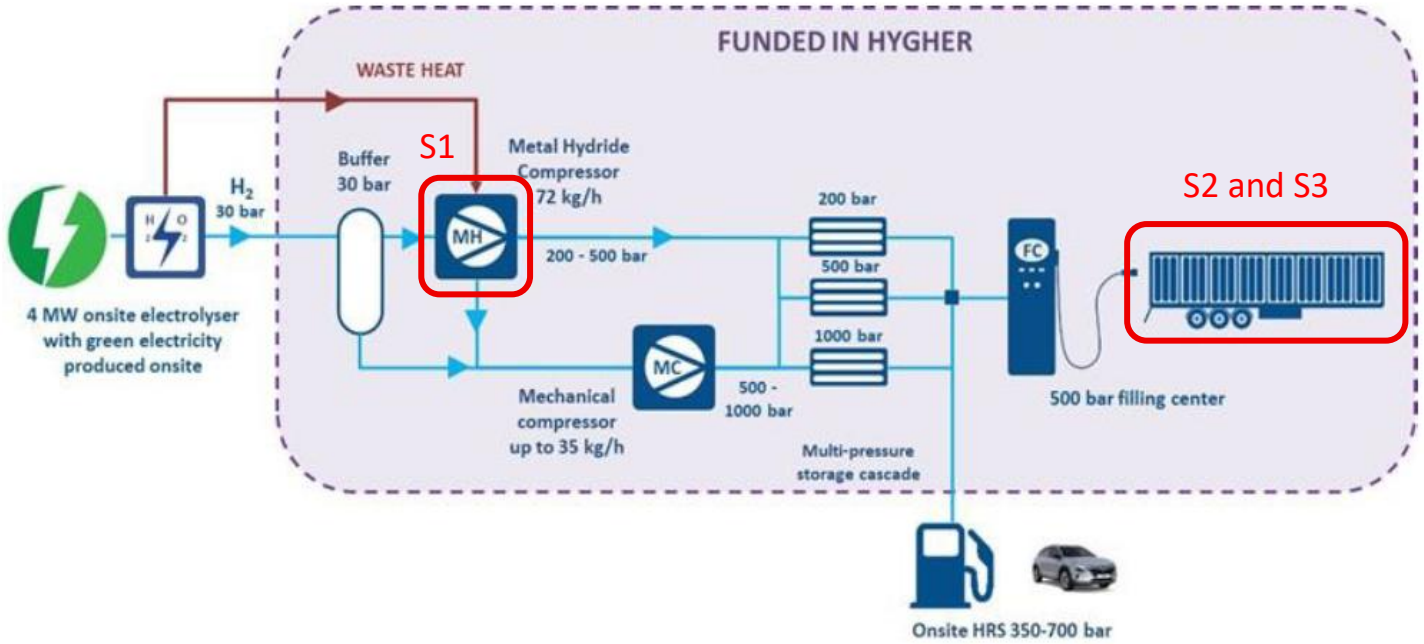
Metal hydride compressor

Subsystem 2 (S2)

Type IV pressure vessels

Subsystem 3 (S3)

Tube trailer



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CIRCULARITY – MAIN OUTCOMES

Subsystem 1 (S1)

Metal hydride compressor

- Metal hydrides:
  - Regeneration is desirable
  - No rare earth materials
- Waste heat utilisation is highly desirable, especially if combined with an on-site electroliser
- Modular design:
  - Easy maintenance
  - Easier disassembly -> easier to recycle

Subsystem 2 (S2)

Type IV pressure vessels

- Commercial recycling -> downcycling
- Experimental recycling technologies offer high retention of properties
- Reuse through recertification
  - Weakend by safety concerns and economic reasons

Subsystem 3 (S3)

Tube trailer

- The most common reuse option is stationary storage application
- Majority of the trailer (chasis, tyres, container) can be reused although more likely scenario is recycling

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QUESTIONS?

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THANK YOU FOR YOU ATTENTION!

For further information and to follow our project progress visit www.hygher.eu

Connect with us on LinkedIn: HYGHER-Project

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