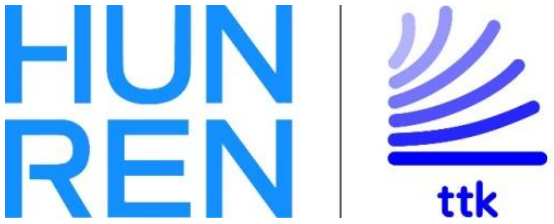
Development of an efficient LOHC technology



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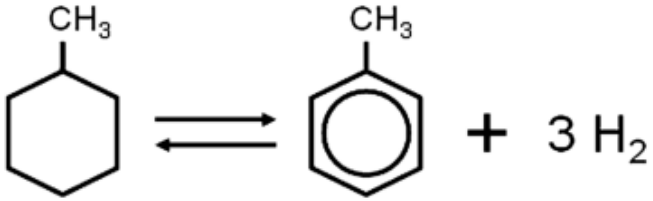
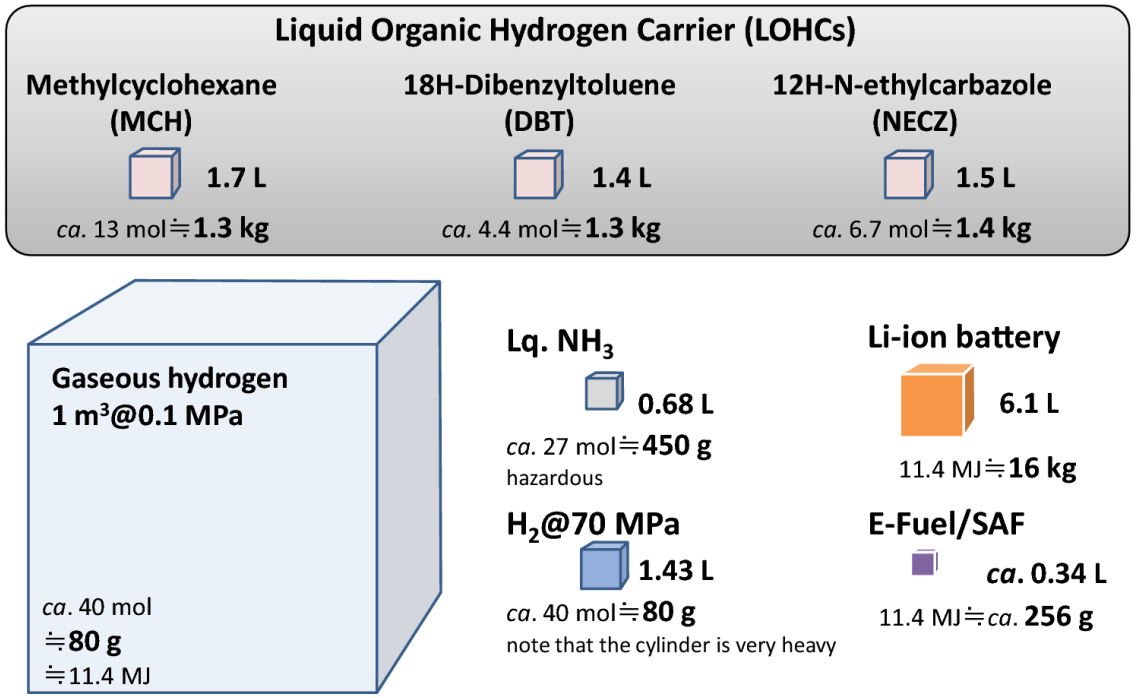
Presentation of the LOHC technology

- Liquid Organic Hydrogen Carriers: an example: methyl cyclohexane



Methyl cyclohexane Toluene

- Volumetric energy density and specific energy:
  - 1873 kWh/m^3
  - 2,43 kWh/kg
- Compared to gasoline:
  - 9500 kWh/m^3
  - 11,1 kWh/kg.
- A two-axle semi-trailer tanker transports 29 m^3 of MCH, which enables the delivery of 1366 kg of H_2, which can be used to refuel 273 fuel cell vehicles with 5 kg hydrogen tanks.



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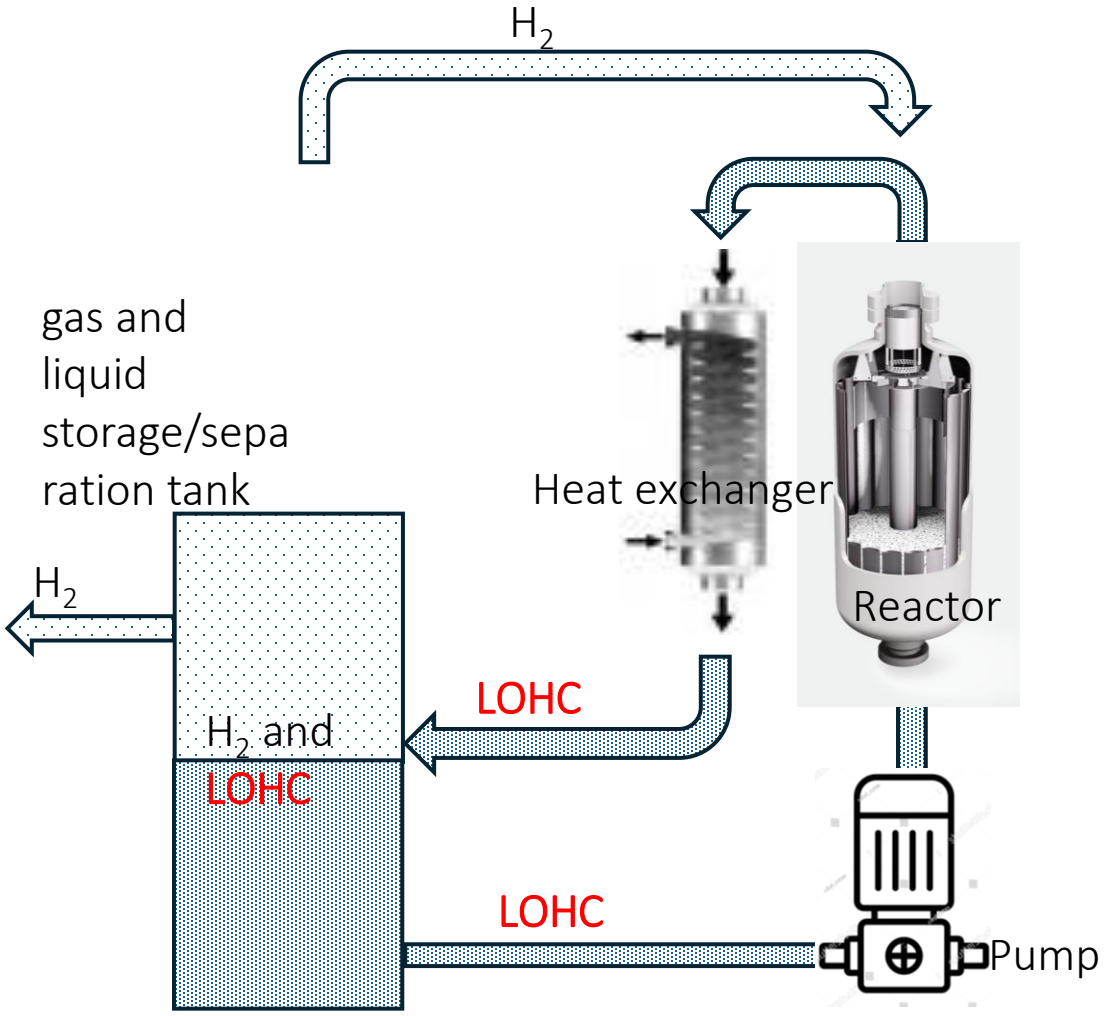
Our goals

- The creation of LOHC technology with higher energy efficiency than the known, LOHC-based, catalytic hydrogen storage/hydrogen release technologies **advanced heat management**: energy demand of **6 kWh/kg H_2**.
- **Catalytic technology in a loop reactor**.
  - Hydrogenation: at a temperature of 100 - 250 °C and a pressure of 30 - 40 bar H_2.
  - H_2 supply: the pressure is 3 - 7 bar, the temperature of the reactor > 250 °C.
- New, **non-noble metal-containing, validated catalyst** using wear-resistant ceramics with favorable mechanical properties: high fracture strength and wear resistance.



Reactor operation

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Partnership

- We offer
  - Research expertise and infrastructure in the field LOHC technologies
  - We are open both for research contracts and partnership in granted projects
- Research activities
  - Highly durable, selective catalysts with low Pt content for reversible LOHC conversion.
  - Development of the loop reactor.
- Our technical expertise
  - High throughput tests of catalysts in a 6-channel flow-through tubular reactor system.
  - Combination of optimization algorithms, with machine learning tools such as PLS and ANNs, RF, XGBoost
  - Research service in the field of design, preparation and testing of heterogeneous catalysts.
  - Characterization techniques (XRD, TG-DSC, FTIR, TPR and TPO, RAMAN, UV-VIS, particle size analyses, quantification of the number of acid and redox sites, SEM-EDX, TEM-EDX, XPS, electrochemical techniques)

- We need industrial partners
  - In the field of catalyst formulation
  - Scaling up catalyst production
  - Safety-related operational balance of plant components
  - Providing demonstration sites in EU for deployment of the technology

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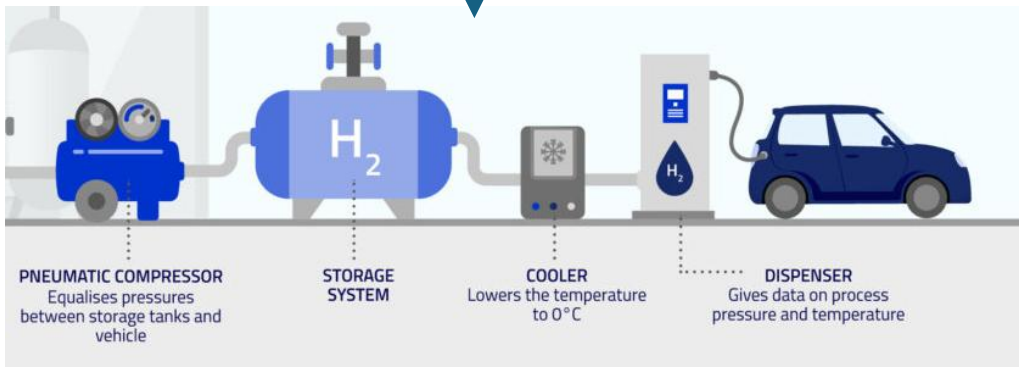
Market opportunities

LOHC container

LOHC reactor



- Connection to a hydrogen refueling station (HRS).
  - The LOHC liquid (MCH) is transported to the station by a two-axle semi-trailer tanker (29 m3 MCH) and fills the LOHC storage container
- Battery-like operation: balancing energy supply and demand of an energy community connected to renewables
  - In LOHC, energy can be stored in the long term without loss: periods of several days or weeks without sunlight can be bridged.

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Summary

- By implementing the heat management of the LOHC, we achieve the energy demand of 6 kWh/kg H_2.
- We are installing a TRL6 level reactor that operates autonomously in its application environment.
- We develop long-life technology (over 99% selectivity) and develop low-cost, noble metal-free and durable catalysts.

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