KEMIJSKI INŠTITUT

Center for Development, Demonstration and Training for Carbon-Free Technologies

# *Testing and Scaling Hydrogen Technologies for Industrial Use*

## Vanguard Initiative Hydrogen Pilot Summit

26. November 2026, Brussels, Belgium

CENTER FOR DEVELOPMENT, DEMONSTRATION AND TRAINING FOR CARBON-FREE TECHNOLOGIES IN KISOVEC, SLOVENIA

ARIS Javna agencija za znanstvenoraziskovalno in inovacijsko dejavnost Republike Slovenije

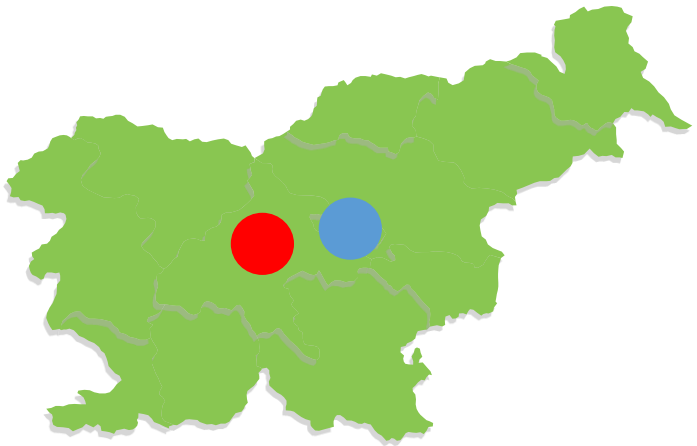
REPUBLIKA SLOVENIJA
MINISTRSTVO ZA IZOBRAŽEVANJE, ZNANOST IN MLADINO

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NATIONAL INSTITUTE OF CHEMISTRY

**National Institute of Chemistry (NIC)**
Ljubljana, Slovenia



Center for Development, Demonstration and Training for Carbon-Free Technologies

**Center for development, demonstration and training for carbon-free technologies**
Kisovec, Slovenia



**Undergoing full renovation**



**Fully operational in 2026, 32 mio EUR investment**

NATIONAL INSTITUTE OF CHEMISTRY

Center for Development, Demonstration and Training for Carbon-Free Technologies

# Structure

L51

Laboratory for the development and testing of batteries

L52

Laboratory for the demonstration of H2 and CO2 technologies





***> 2.000 m2 of stat-of-the-art research infrastructure***

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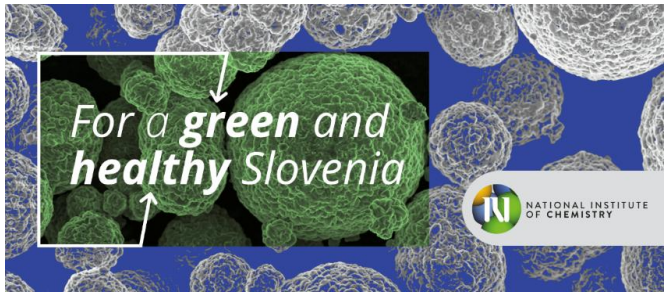
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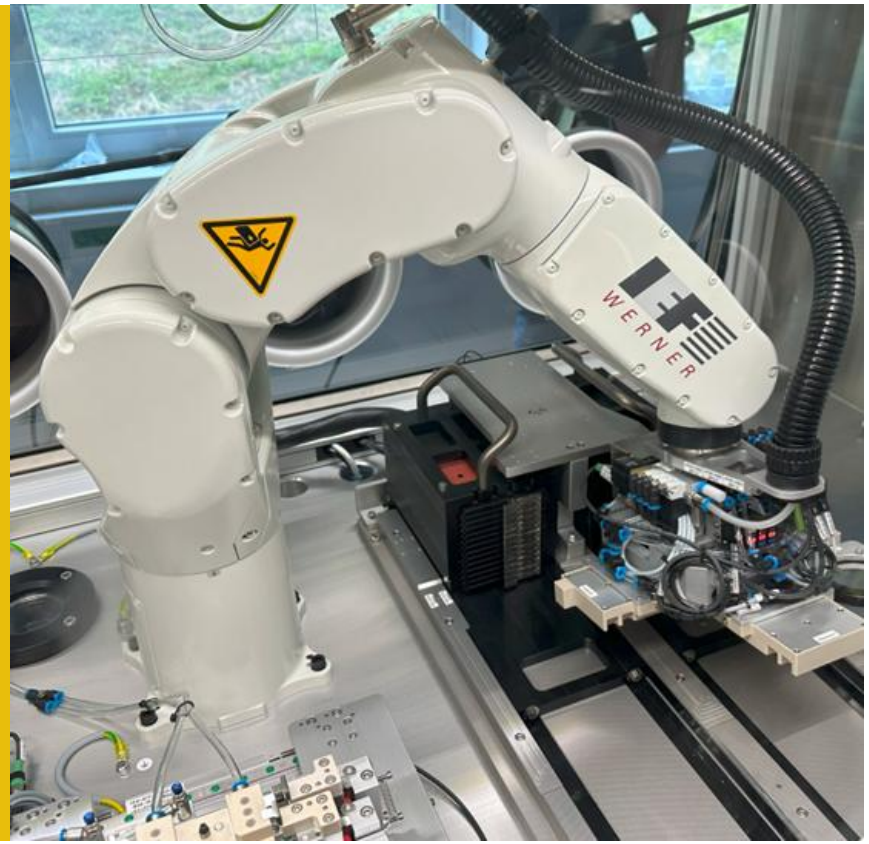
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# Objectives

- Work on higher TRLs that are closer to industrial needs,
- Education and training in carbon-neutral technologies,
- Extra-regional action to strengthen the Zasavje region,
- Bridge between research and industry
- Establishment of infrastructure that is not present in Slovenia or in the wider surroundings




**Faster transfer of knowledge from academic institutions to industry and to end users**

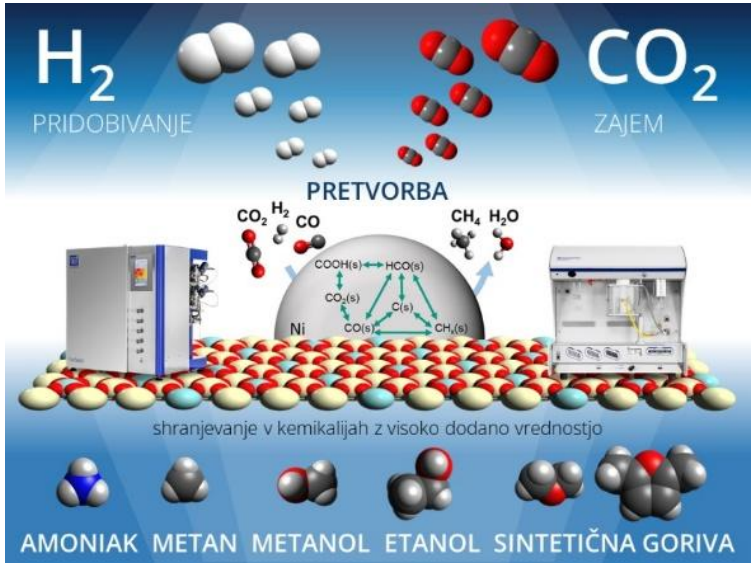



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# L52 Laboratory for Demonstration of $H_2$ and $CO_2$ Technologies

Head: Asst. prof. dr. Ilja Gasan Osojnik Črnivec, gasan.osojnik@ki.si



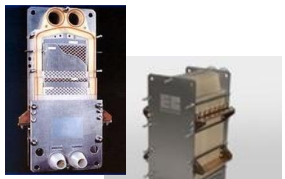

Pridobivanje in pretvorba vodika

kataliza in elektroliza

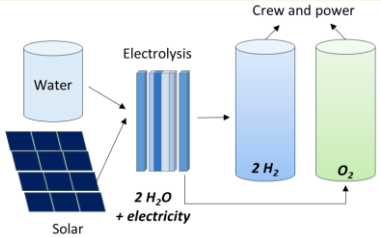
Zajem ogljikovega dioksida

trdni in tekoči sistemi

| | |
|---|---|
| **MATERIALS** | **catalysts, sorbents, electrodes, membranes** |
| **CATALYSIS** | **gas to gas, gas to liquid standard, HT, HP** |
| **ELECTROLYSIS** | **AEM, PEM, water, wastewater, hybrid …** |












*Including support to cross-cutting biological processes and waste utilisation challenges.*

*Chemical engineering for alternative energy, fine chemical production, decarbonization and energy intensive industries, at industrially relevant operating conditions.*

### *PILOT HALL*

*Modern design for safe reactor engineering and design:*

- *16x safe hydrogen handling stations*
- *12x reactor assembly stations*
- *2x electrolysis*
- *2x furnaces/heat treatment*
- *2x working with reagents stations*
- *2 ATEX chambers for hydrogen*
- *2 chambers for CO2 capture*
- *All metal parts grounded*
- *Antistatic grounded floor*
- *Hot membrane welding*
- *Polymer powder coating*
- *CNC machine*



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# L52 Laboratory for Demonstration of $H_2$ and $CO_2$ Technologies

Prof. Dr. Ilja Gasan Osojnik Črnivec, gasan.osojnik@ki.si

# Resilience and Energy Efficiency

## Opportunities in decarbonization

## Green Hydrogen

for sustainable industrial processes

**ENERGY CARRIER**: substitution of fossil energy carriers
*SI: glass ✓, ceramic, lime, metallurgic – aluminum, (steel)*
*long-haul transport: ships, trucks, …*

**HEAT RECOVERY**
utilization of high temperature industrial heat

**ELECTROLYSIS** and **BIOMETHANE REFORMING**
standalone production of hydrogen
*SI: glass and chemical industry*

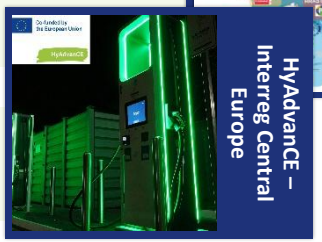
**FEEDSTOCK**
substitution of fossil hydrogen sources
methanol, ethanol, jet fuel, ammonia etc.



Center for Carbon-Free Technologies

HyBReED
SI $H_2$ and battery
RRI – TRL 3-6

H2GLASS
$H_2$ furnace



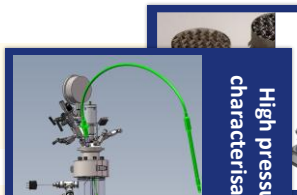
HyAdvanCE – Interreg Central Europe

## Carbon Capture

supporting $H_2$ technologies and biomass recovery

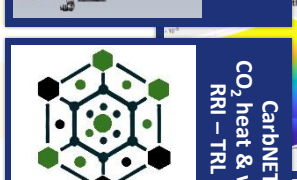
**NOVEL SORBENTS & TECH**
($CO_2$ composition, process heat, gas purity)

**FEEDSTOCK**
fuels, polymers, advanced ceramics/minerals



$CO_2$ capture piloting

High pressure characterisation



Breakthrough & regeneration

CarbNETs
$CO_2$ heat & water
RRI – TRL 3-6

## Water Security

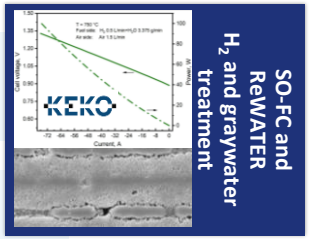
supporting decarbonization

**ELECTROLYSIS**
Water treatment and alternative water sources

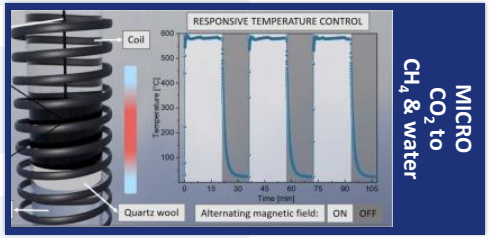
**BIOBASED MATERIALS**
Biobased sorbents for emerging pollutants and hazardous gasses removal

Biobased PFAS-free advanced coating and polymer adhesive alternatives

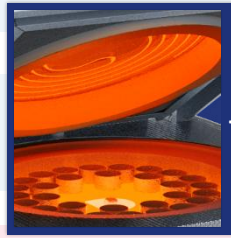
**NOVEL PROCESSES**
Residual water production
High pressure electrolysis



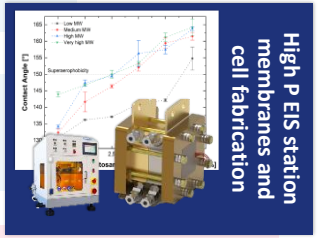

SO-FC and ReWATER
$H_2$ and graywater treatment




MICRO
$CO_2$ to $CH_4$ & water



Thermogravimetric tuning and sorbent development



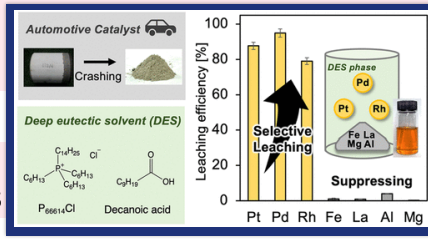
High P EIS station membranes and cell fabrication

## Critical Raw Materials

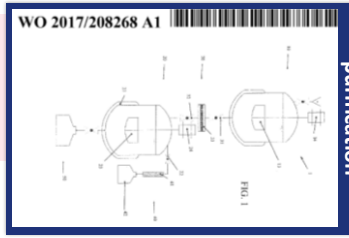
value chains for high added value materials

**ADVANCED NANOMATERIALS**: new technologies for selective recovery and/or separation of metals

**PHOSPHOROUS RECOVERY**: novel solvents and electrochemical extraction systems
SI value chain: sludges to technical agents, electrolytes, electrodes and absorbent producers.




Extraction solvent and process RRI



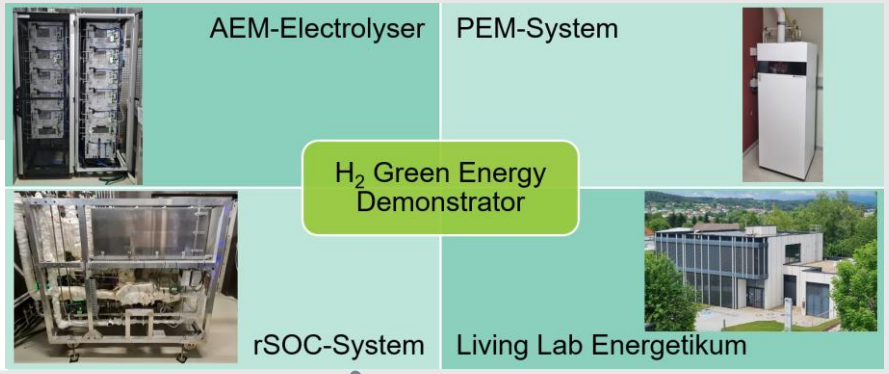

Phosphorous precipitation and purification

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# HYDROGEN PROJECTS TIMELINE

Interreg Co-funded by the European Union
Slovenia – Austria
H2GreenFUTURE




2023-2026




Institut Jožef Stefan
Center za energetsko učinkovitost
IJS-Lead partner, NIC-Partner

ACTION PLAN FOR THE DEVELOPMENT OF HYDROGEN TECHNOLOGY BY 2030 WITH A VISION TO 2040 (AN H2)

2025-2026

2020-2023




2024-2026

Center for Development, Demonstration and Training for Carbon-Free Technologies




2026-2028

ADVANCING HYDROGEN PLANNING IN CENTRAL EUROPE (HyAdvanCE)



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## Modular magnetic heating for added value products

**solar/RE, on demand, fast response**

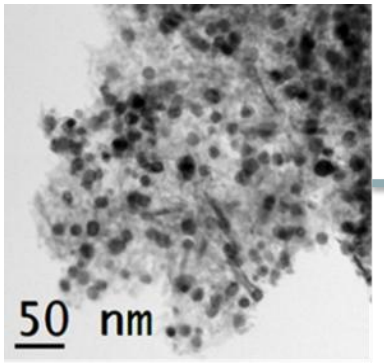
**Hydrogen and carbon based**
reversible green methanol …

**Hydrogen based**
reversible green ammonia …

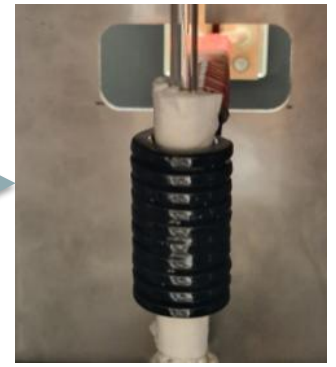
**Carbon based**
advanced nanostructured minerals …

ARIS CHRONOSTORE

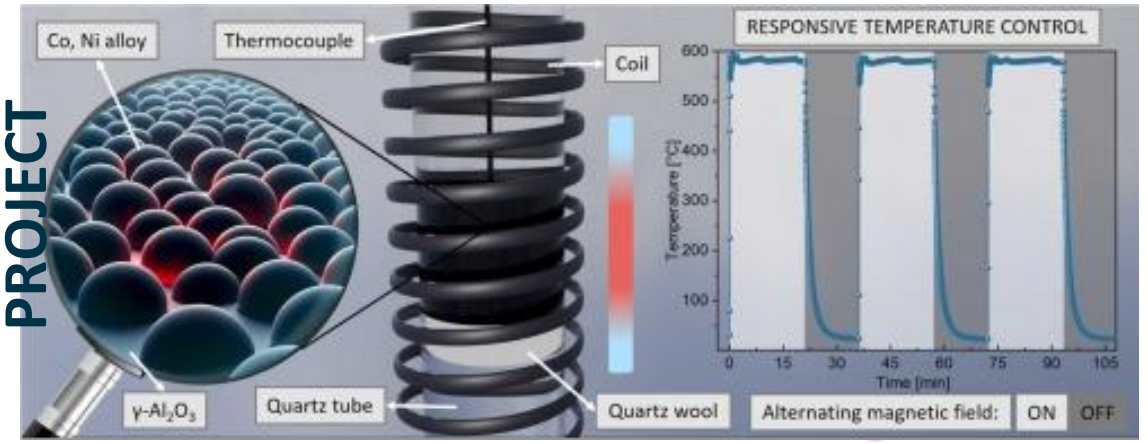
e-CODUCT





esa MICRO PROJECT




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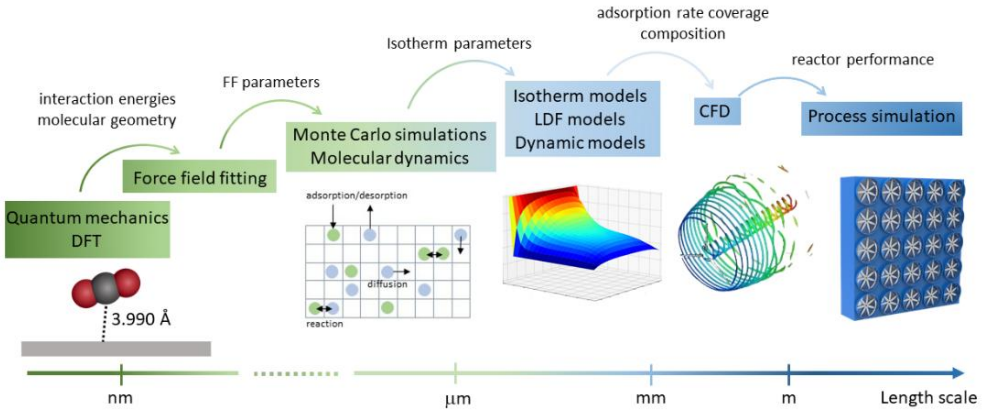
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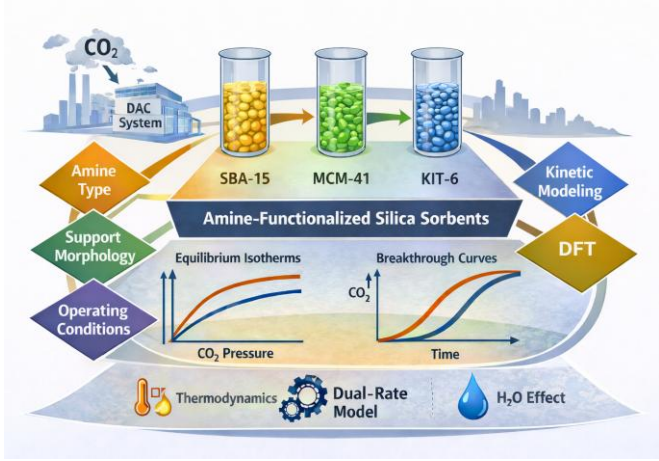
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## Carbon capture

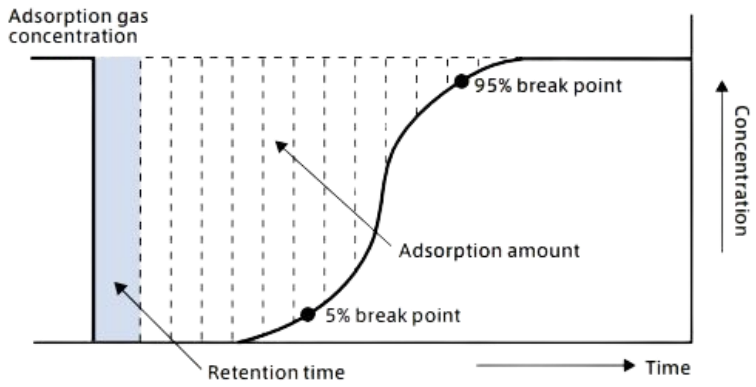
**Direct air capture**
sorbent design
process optimisation
pressure drop
multiscale modelling




## Flue gas capture and fermentation gas polishing

Slovenian CCU, heat and water utilization network CarbNETs TRL 3-6 programe

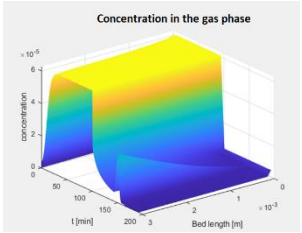





*Precise microstructural analysis*



*Breakthrough curves*




*Validation and theoretical simulation*

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*SUMMARY: Chemical engineering for alternative energy, fine chemical production, decarbonization and energy intensive industries, at industrially relevant operating conditions.*

- *Renewable and conventional **energy carriers***
- *Bio-based and conventional **reagents** and **feedstocks***
- *Conventional, green synthesis and circular recovery of **active materials***

## Looking for project & RRI partners in:

**Process development for $H_2$ vectors**
reversible green methanol
and green ammonia…

**Process development for resilient applications**
magnetic heating methanation
hydrogel templated porous catalysts and electrodes

**Biobased advanced materials**
fibrous and biochar based enhanced sorbents
carbon based electrodes and catalyst supports



## CONTACTS

Asst. prof. dr. Ilja Gasan Osojnik Črnivec: Gasan.Osojnik@ki.si
dr. Marko Soderžnik: Marko.Soderznik@ki.si
Tomaž Čebela: Tomaz.Cebela@ki.si

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