



VTT

Power-to-X for Industrial Decarbonization: From Green Hydrogen to E-fuels

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Pohang International Hydrogen Fuel Cell
Forum 2026

VTT – beyond the obvious

What is VTT?

VTT Technical Research Centre of Finland Ltd

- VTT is a visionary research, development and innovation partner for companies and society.
- One of the leading technical research organisations in Europe.
- Staff (> 2300) : 87% has a university degree & 60 nationalities
- Government owned and non-profit organization
- 30% financing from state and 70% from open market
- Starting point for over 50 spin-off companies
- Close to 500 patent families



VTT in numbers

309 M€

operating income

2,350

employees

488

patent families

51 %

of the net turnover
from abroad

1,085

customers

646

scientific articles



VTT's impact is created with customers

Our customers gain unique expertise and new international business opportunities, and their RDI projects are accelerated.

96 %

of customers
said their
knowledge base
and competence
improved

73 %

felt that R&D
processes
improved

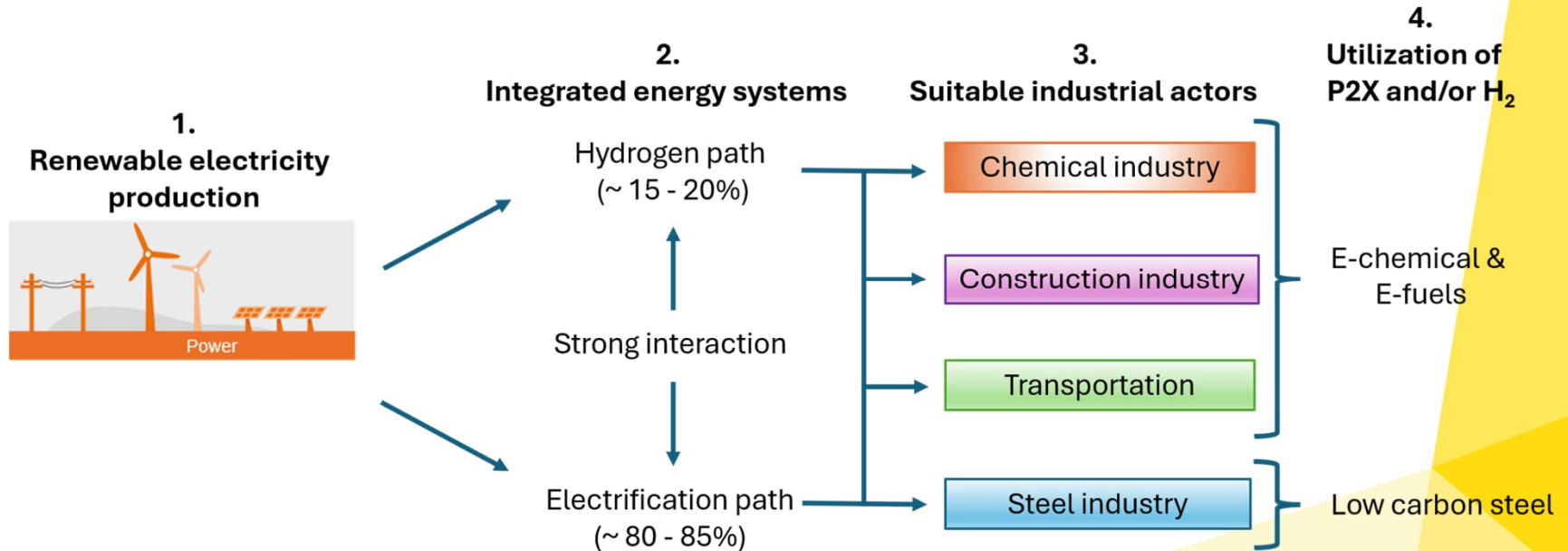
82 %

has utilised the
results or plans
to do so



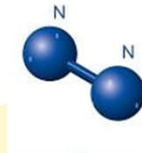
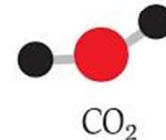
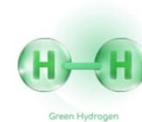
How decarbonization of industry can happen?

Decarbonization of industry

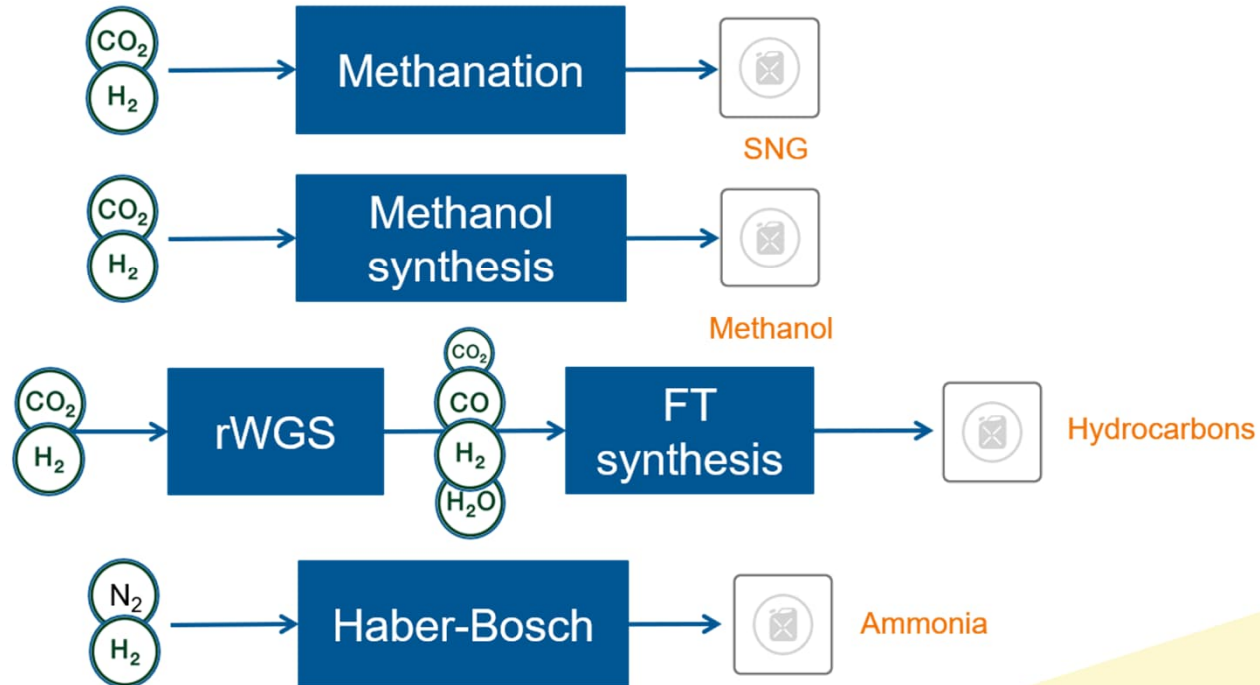


Green H₂, CO₂ and N₂ are essential for P2X

- Green hydrogen is produced through the electrolysis by using renewable electricity
 - Close to zero greenhouse gas emissions
 - There are four types of electrolyzers: Alkaline (AEL), Polymer electrolyte membrane (PEMEL), Anion exchange membrane (AEMEL) and solid oxide (SOEC)
 - Challenges are cost, efficiency and degradation of electrolyzers and availability of renewable electricity
-
- Carbon dioxide (CO₂) is a raw material for a variety of products and processes.
 - The cost of CCS varies greatly by CO₂ source but usually it is quite expensive process
 - Power plants, cement plants, and iron and steel plants produce lot of CO₂
 - Biogenic or fossil CO₂ → carbon footprint
-
- Nitrogen is produced on a large scale primarily by separating it from air using cryogenic or gas separation technologies
 - Price varies a lot but usually reasonable in industrial scale.



From CO₂, N₂ and green H₂ to E-fuels/chemicals



How do VTT deal with decarbonization?

VTT tools for decarbonisation

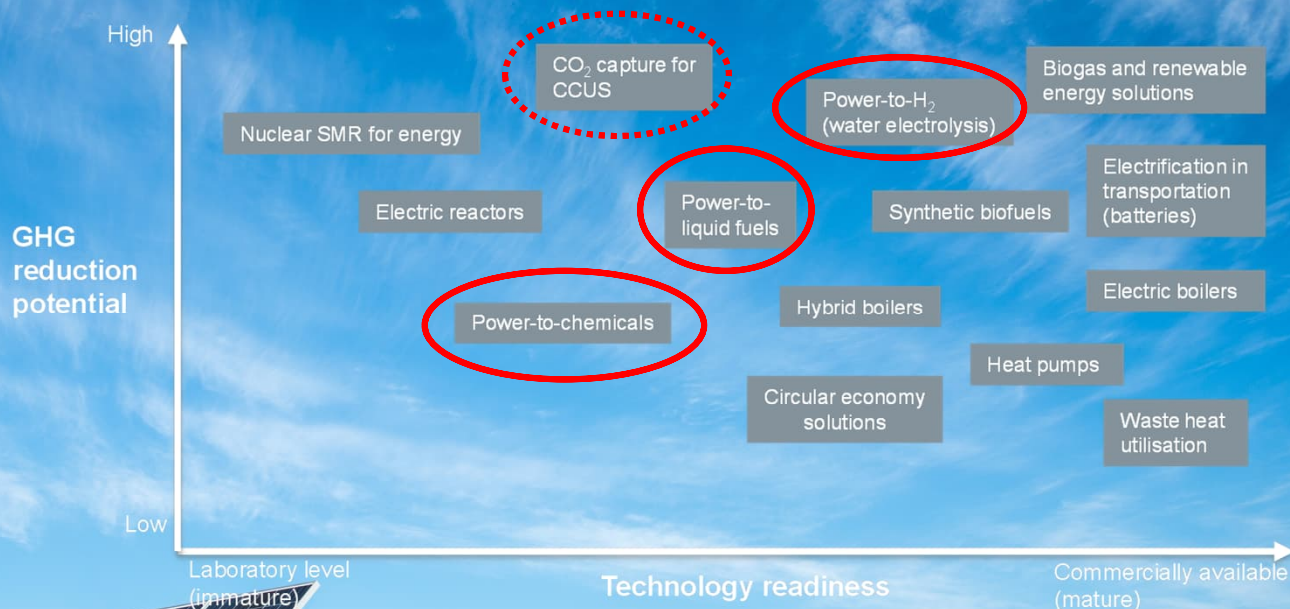
Industry



Transportation



Society



We work with

Customers

- Technology developers
- Hydrogen producers
- Hydrogen end-users

Including

- Industries
- Utilities
- Energy companies
- Materials producers
- Public authorities



Technologies

- Electrolyser systems and components
- Fuel cell power systems
- Direct industrial use (H₂)
- Transportation fuels (P2X)
- Hydrogen-derived chemicals (P2X)
- CCUS

Electrolyzer infra covers main technologies from lab to pilot scales



AEL

- Power range 6 kW – 10 kW (based on different stacks)
- Fully automated in-house developed system aimed at stack and Balance of Plant (BoP) characterization



PEM

- Power up to 50 kW
- Flexible, fully automated, highly instrumented cell and stack testing



SOE

- Stacks and modules up to 60 kW
- Versatile test platforms allowing also co-electrolysis, reversible operation and advanced operation strategies



AEM

- Two stacks, power up to 6 kW
- Liquid cooled, fully automated operation, mobile containerized system

Extensive lab and piloting infrastructure for fuel cells



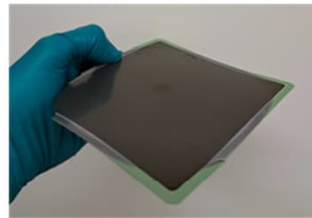
PEMFC materials, single cells and stacks

- Material compatibility with PEMFC (polymers, hoses, etc.)
- Effect of impurities and gas quality on PEMFC



PEMFC system testing

- Possibility to test PEMFC systems up to 1.5 MW
- Indoor and outdoor laboratories for complete systems



SOFC materials, single cells and stacks

- Continuous operation with marine fuels (CH_3OH , NH_3)
- Reliable testing infra allowing high-quality long-term operation (up to 25,000 h)



SOFC system testing

- Demonstration units with power up to 1.5 MW
- Flexible fuel options, including H_2 , CH_4 , and NH_3

Whole chain for Power-to-X (P2X)

Hydrogen production and carbon capture and utilization (CCU) processes & on-site testing and piloting



Mobile containers operated independently or with chosen combination:

Upstream options (examples)	Water electrolyser systems	Direct Air Capture (DAC) device	Adsorption/gas cleanup	CO ₂ capture from industrial processes
Processing options	Processing carbon dioxide on-site	Synthesis unit for producing hydrocarbons		Catalytic methanation unit

Testing platform for MW-scale fuel cells and electrolyser systems

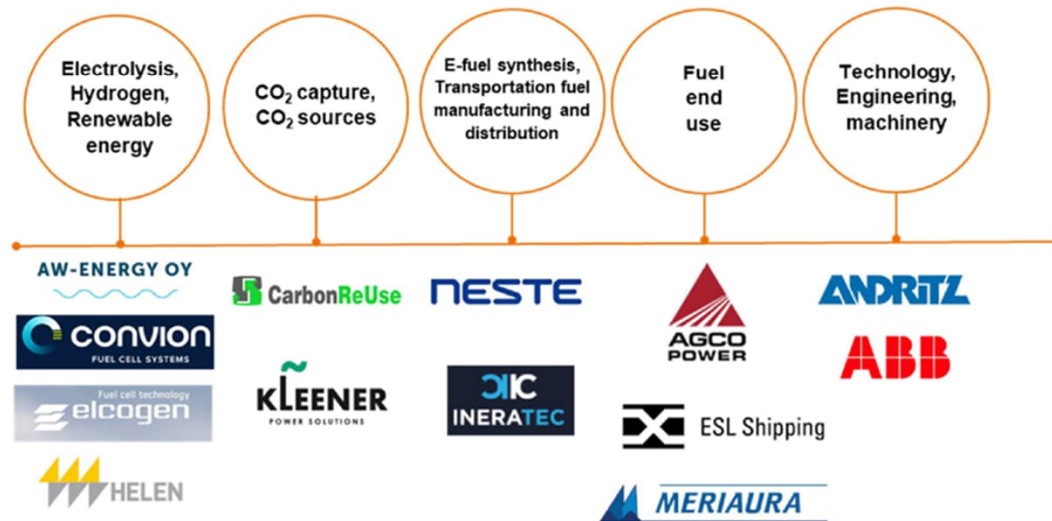
- **VTT has capability to characterize MW-scale fuel cell and electrolyser systems**
 - Laboratories testing in containerised systems
 - Outside testing area for fuel cell and electrolyser systems
- **Affordable, electrolyser-produced hydrogen**
- **Tailormade campaigns** from short commissioning tests to long-term testing



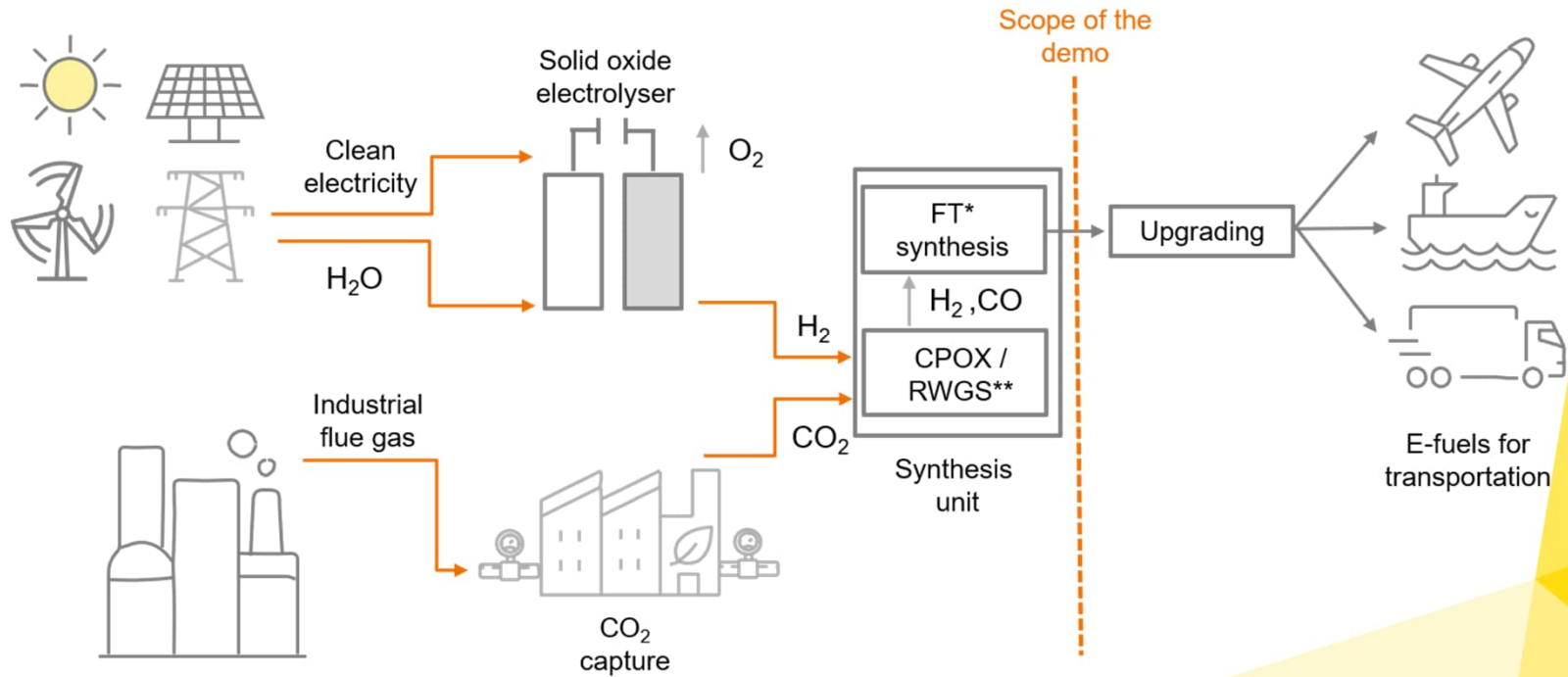
Some industrial related concrete decarbonization projects

E-fuel demonstration - Overview

- National project, mainly financed by Business FINLAND.
- Demonstrating production of *e-fuels*
- Combining and integrating steam electrolysis and Fischer-Tropsch synthesis
- Every step of value chain was occupied by the company



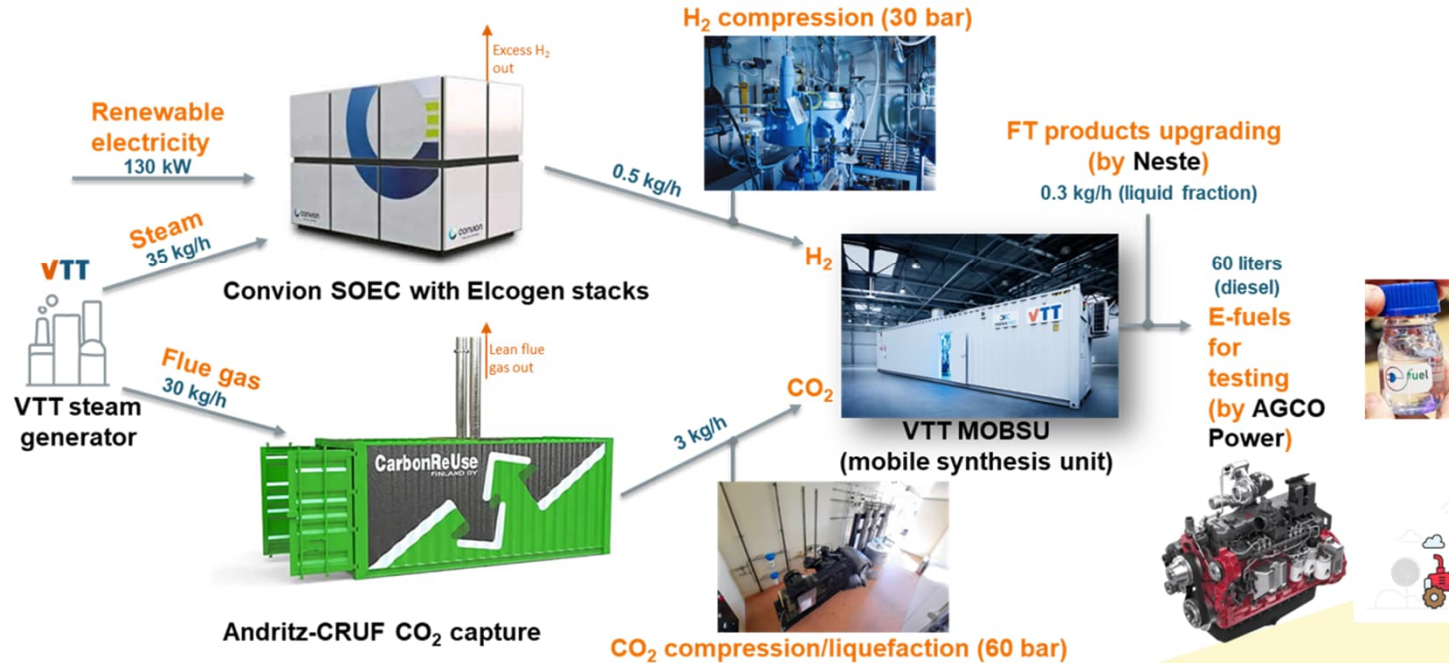
E-fuel Power-to-X concept



* Fischer-Tropsch

**Catalytic partial oxidation / Reverse water-gas shift

E-fuel demonstration – Integration of 6 units



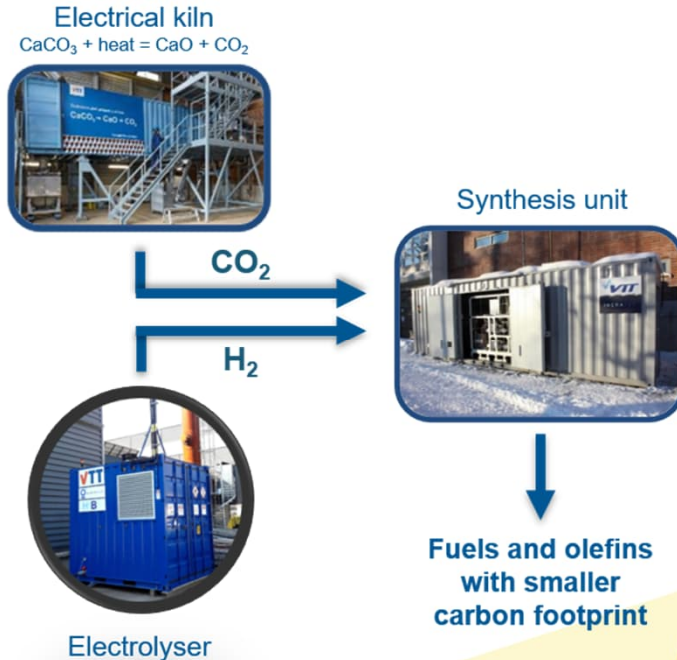
E-fuel demonstration - Results

- Production of 300 kg FT crude and 1000 h operation time
- A readiness to scale up the concept to a production scale of 10 000 ton/a.
- Cost estimates from 2400 €/ton e-Kerosene:
 - ✓ 1200 €/ton fossil kerosene
 - ✓ Cannot compete with fossil kerosine
- Possibilities to reduce the cost
 - ✓ Optimal dimensioning of the plant (electrolysers, H₂ storage, compressors etc.)
 - ✓ Optimal long-term contracting of renewable power
- Specific GHG-emissions 9-12 gCO₂eqv/MJ e-Kerosene
 - ✓ Fossil kerosene is ~94 gCO₂eqv/MJ
 - ✓ Reduction of 87-90% in GHG-emissions.
- Demonstration of the whole production chain was done successfully.
- E-kerosene was tested in a real field test with commercial tractor



DECARBONATE-project

- Decarbonization of cement production
- CaCO_3 based processes are globally big source of industrial CO_2 emissions (3.0 Gt from cement industry).
- Successful validation of electrically heated kiln with CO_2 capture and upgrading
- Using indirect electrical heating, ~50 % of CO_2 emissions can be reduced by substituting fossil fuels
- Pure CO_2 with H_2 stream could be used for e-Fuel and e-Chemical production
- Reduciner (<https://www.reduciner.com/>)



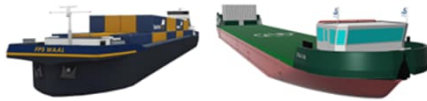
Decarbonization of marine sector

- VTT leads three MW-scale ship demonstration projects
- Inland waterway vessels (3 vessel types) for container and bulk goods
 - ✓ Hydrogen and fuel cells (Average power > MW)
- Commissioning and service operation vessel (CSOV) for wind-farm
 - ✓ Liquid organic hydrogen carrier and fuel cells (1 MW)



FLAGSHIPS

The FLAGSHIPS project will raise the readiness of zero-emission waterborne transport to an entirely new level by deploying two commercially operated hydrogen fuel cell vessels.



<https://flagships.eu/>

<https://rh2iwer.eu/>

<https://shipah2oy.eu/>

Conclusion

- Direct electrification of industry is most efficient way for decarbonization
- Electrification is not possible for everything → H₂ and P2X
- Integrated energy systems (combining e⁻ and H₂) are the future
- E-fuels and e-chemicals are still quite costly but are surely coming
- VTT has great number of tools for decarbonization
- VTT is looking for all kind of collaboration with industry and research globally

Thank you very much for your kind attention!

Any questions?

SAVE THE DATE EFCF 2028

18th European SOFC & SOE Forum

Solid oxide technologies: fuel cells (SOFC), electrolyzers (SOE) & membrane reactors (SOMR) — with CO₂ emission reduction & reuse

4 – 7 July 2028

KKL Lucerne, Switzerland · with Exhibition & FCH/EIS Tutorials · SSD & GSM 2028 alongside



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