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Electrolyse à Haute Température – Une technologie à haut rendement pour la transition énergétique

Patrice Tochon, R&D Manager

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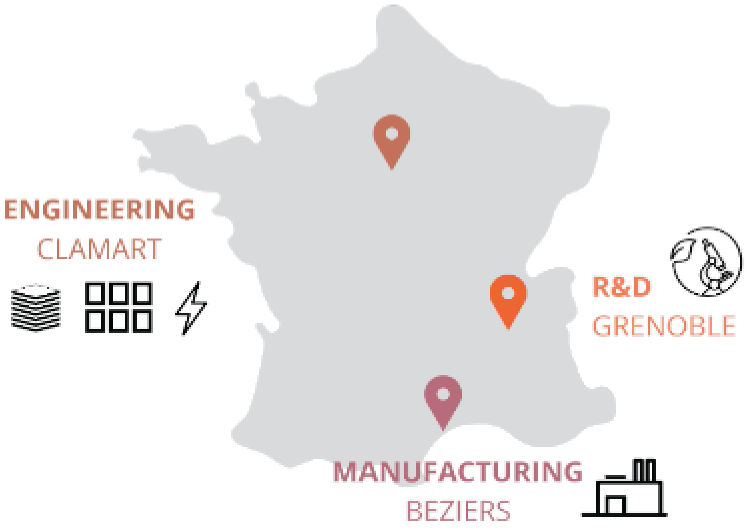
- Established 1 March 2021, based on 40 patents and 15 years of R&D
- Today more than 100 employees
- Maturing, industrialising and developing industry solutions with Solid Oxide Technology



slb
cea
VINCI
VICAT
ARIS Occitanie




Contextual Situation of Electrolysis

Hydrogen Production by Water / Steam Electrolysis

Function of temperature

Liquid water:
Low temperature electrolysis

- Alkaline Electrolysis (AEL)
- PEM Water electrolysis (PEMWE)

Steam:
High temperature electrolysis

High temperature steam electrolysis (SOEL)

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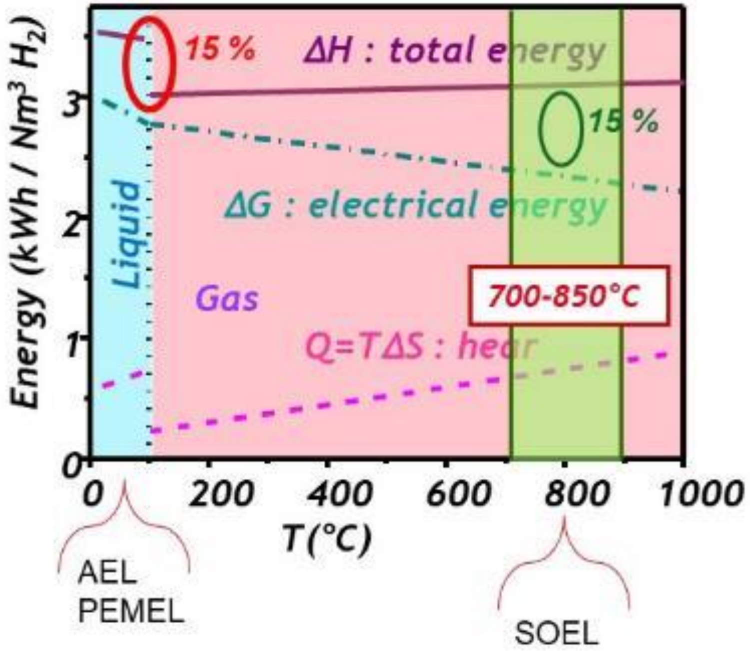
Interest of High Temperature Electrolysis

Why High temperature Steam Electrolysis (HTSE - SOEL)?

HIGH EFFICIENCY TECHNOLOGY



H_2O (g) → H_2 (g) + ½ O_2 (g)

ΔH Working in gas/liquid mode **saves 15% in Energy**

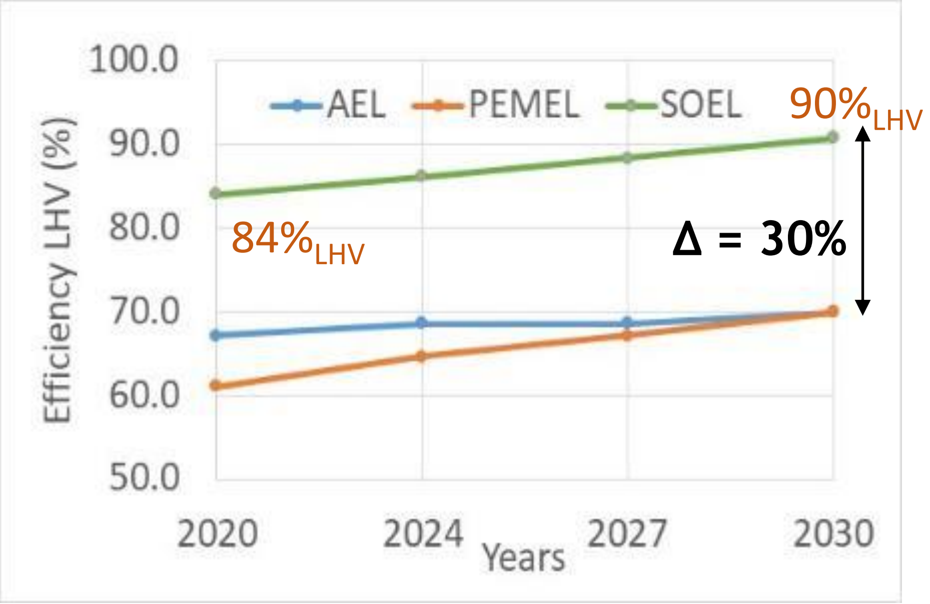
ΔG : Rising in T saves **15% additional electricity**

➡ **30% gain for high temperature steam electrolysis**

When coupled to a heat source (~ 150°C) to produce steam

➡ SOEL operating range = 700-850°C

EFFICIENCIES



Source : Strategic Research and Innovation Agenda, Clean H2 partnership, Feb 2022

30% gain in high temperature water vapor electrolysis

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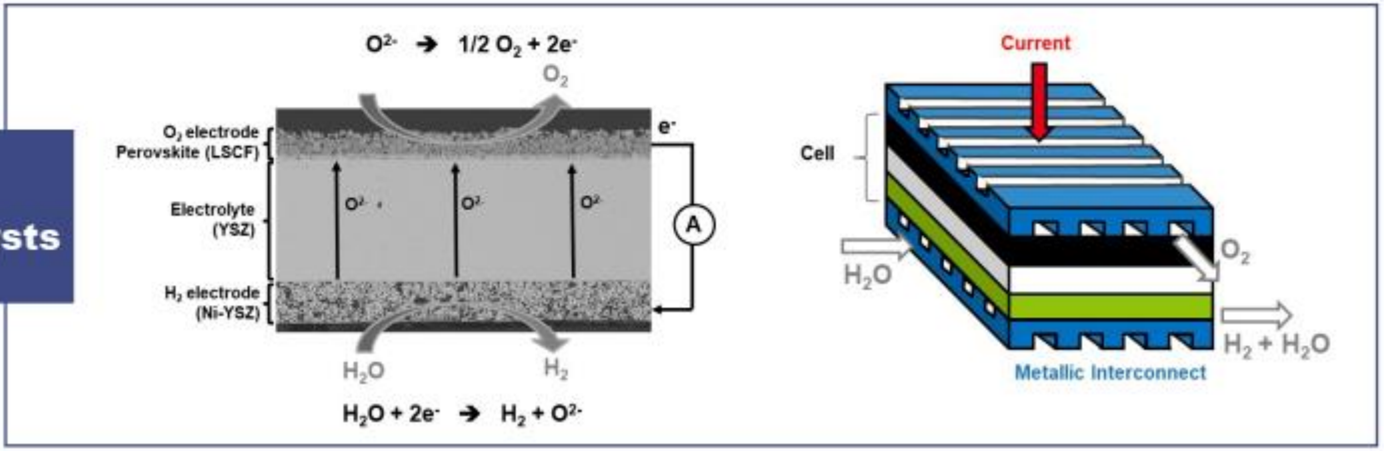
High temperature steam electrolysis - SOEL

The key components of the different technologies

Technology with no expensive noble catalysts



Modular technology

Electrolysis cell composed of:

- 2 electrodes (anode and cathode)
- One electrolyte
- Need of electricity (and heat)

Stacking of several electrolysis cells to increase the power

Integration of stacks into a **module** including 1st level Balance of Plant components

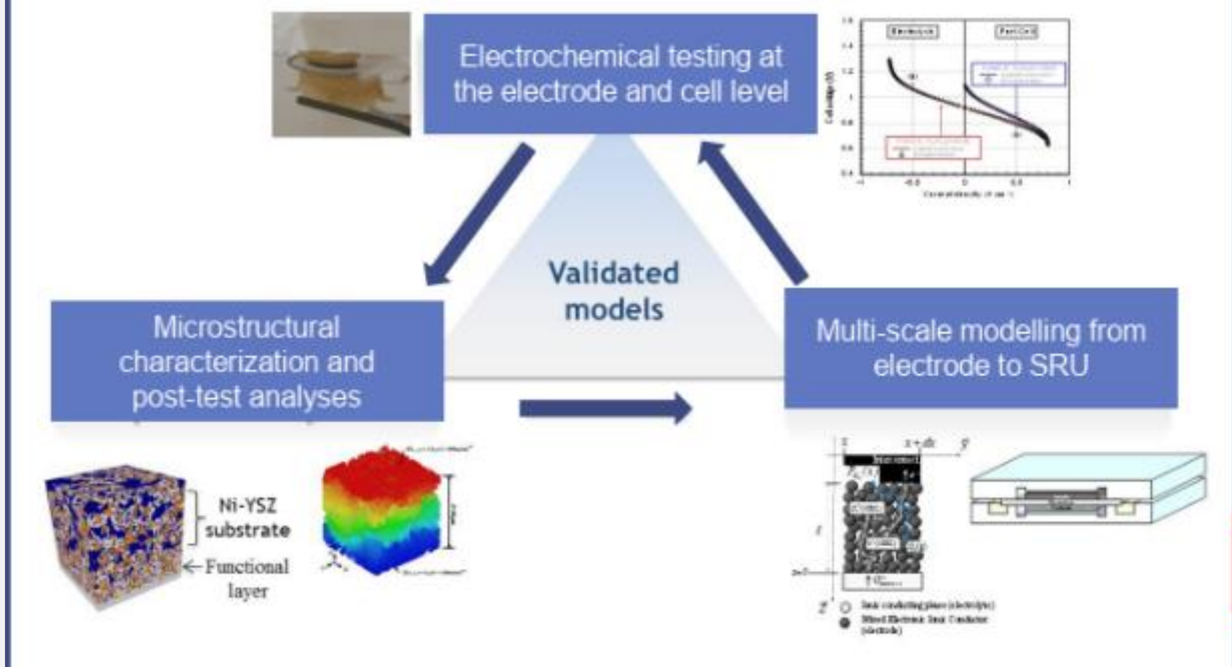
Can/will include several stacks into a module

Integration of modules into an **electrolysis system/plant** including all Balance of Plant components **= electrolyser**

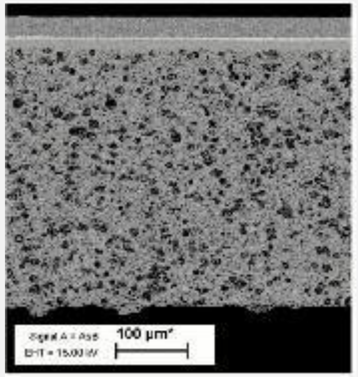
Can/will include several modules into the electrolysis system/plant

Scientific and Technologic Developments

Cell optimization to reach the best combination of performance/durability



Source: Monaco et al., J. Electrochem. Soc. 166 (15), (2019) F1229-F1242



Electrode Oxygen Mixed oxide LSCF	$(La_{0.60}Sr_{0.40})_{0.95}Co_{0.20}Fe_{0.80}O_{3-}$
Diffusion barrier Mixed oxide CGO	$(Ce_{0.90}Gd_{0.10})O_{1.95}$
Electrolyte Doped zirconia	$(Y_2O_3)_{0.08}(ZrO_2)_{0.92}$
Electrode H2 cermet Ni – YSZ	$Ni - (Y_2O_3)_{0.08}(ZrO_2)_{0.92}$
Mechanical Support Cermet Ni/YSZ	$Ni - (Y_2O_3)_{0.03}(ZrO_2)_{0.97}$
Current collector Nickel	Ni

A complex multi-layer architecture combining specific mixed oxides :

- Conductivity Ionic & Electronic
- Microstructure control Porous vs. Dense
- High Temperature 700-800°C

- **New active materials compositions**
- **New cell architecture**
- **New Processes**

> Scientific and Technologic Developments

Stack Development

Performance: optimize pressure drops and electrical contact layers

Stacking: increase number of SRU to increase power/stack

Manufacturability and **Integration in module**: Design devices to handle and transport the stack

Sealing : No leakages

Lifetime & Performance: Improve cell performance and durability

Cost

→ Co-Current Engineering and Model-Based Design

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Scientific and Technologic Developments

System Development

- **Performance**: Overall Efficiency
- **Lifetime**: Same behaviour for all the modules/stack
- **Manufacturability**: Automatized process of assembly
- **Cost:** Toward Giga factory in 2030

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TWO STREAMS FOR OUR PRODUCT DEVELOPMENT

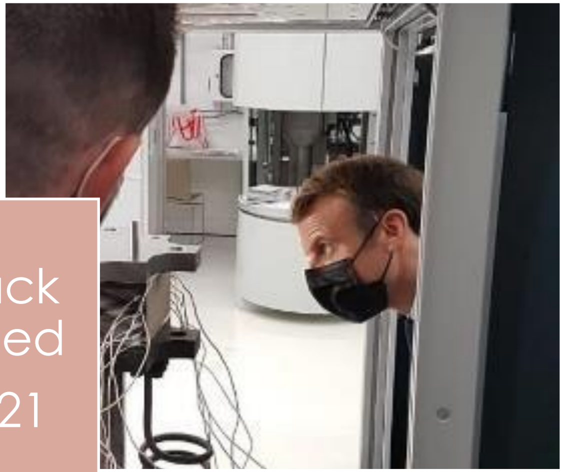
Building benchmark and experience with the SOEL200 EXP in 2023

Delivering performance with a new design, the H-Pod Desing frozen in 2026

GENVIA FIRST STEPS

Genvia founded
Q1 2021

Electrolyser workshop delivered
Q3 2021



First Stack produced
Q4 2021

Genvia Beziers Team
Q1 2022

Genvia
with main CO2 emissions industries
at Elysée

Q4 2022

Genvia
(and a Stack)
represents France 2030 technologies
at Elysée

Q3 2023

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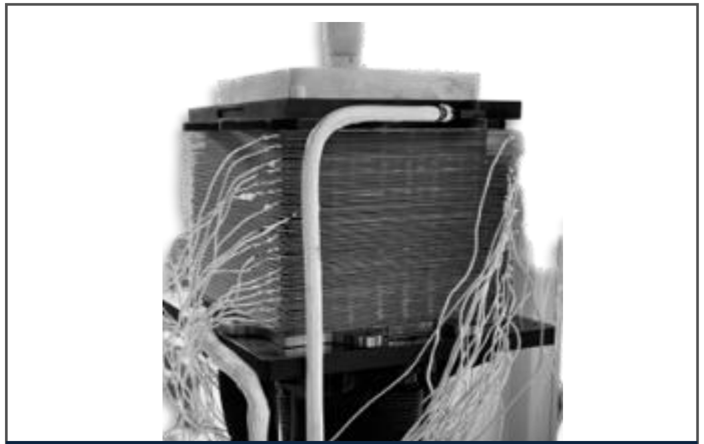
GENVIA KEY ACHIEVEMENTS AND NEXT STEPS



Stack prototyping

- 7000+ hours of test
- Successful performance tests

Next step:
Improve stack longevity and reliability

System Engineering

- Detail application engineering for prototype completed
- Launch production of prototype

Next step:
Scale to designing applications for all demonstrator use cases

Stack manufacturing

- Pilot line completed

Next step:
Increase throughput, improve quality and design automation for gigafactory

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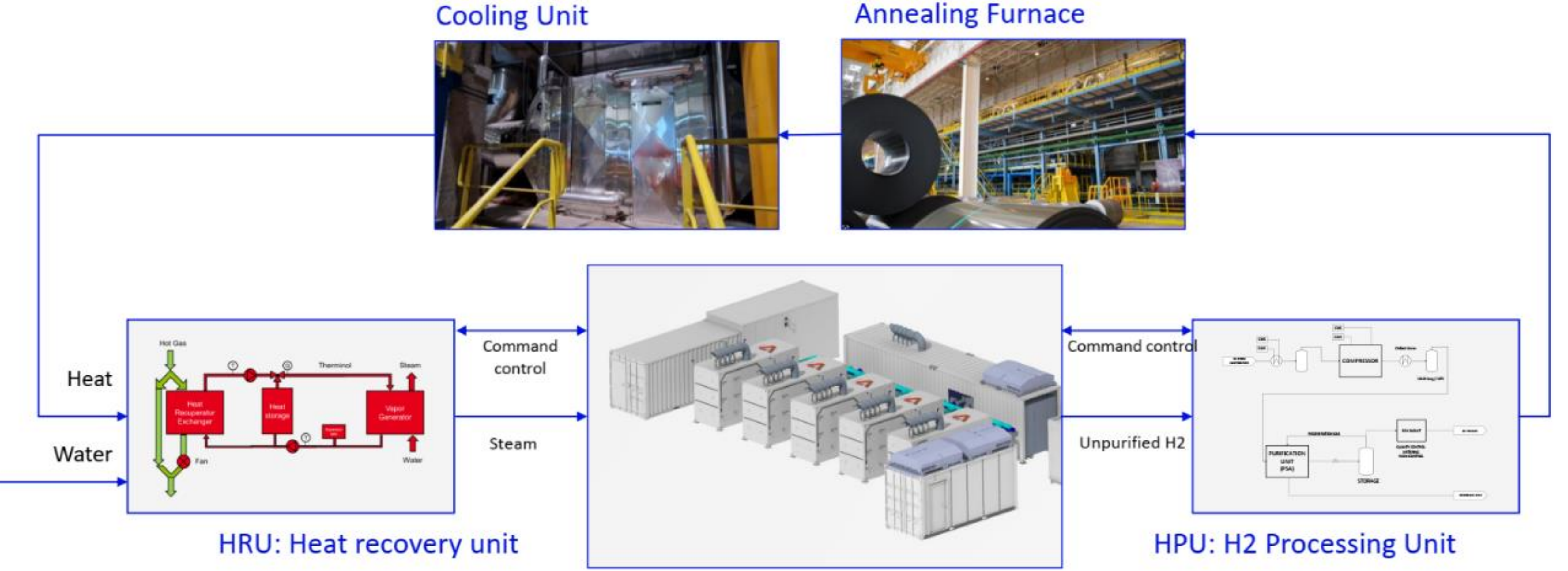
Example of SOEL applications

Industrial Coupling : Steel Industry



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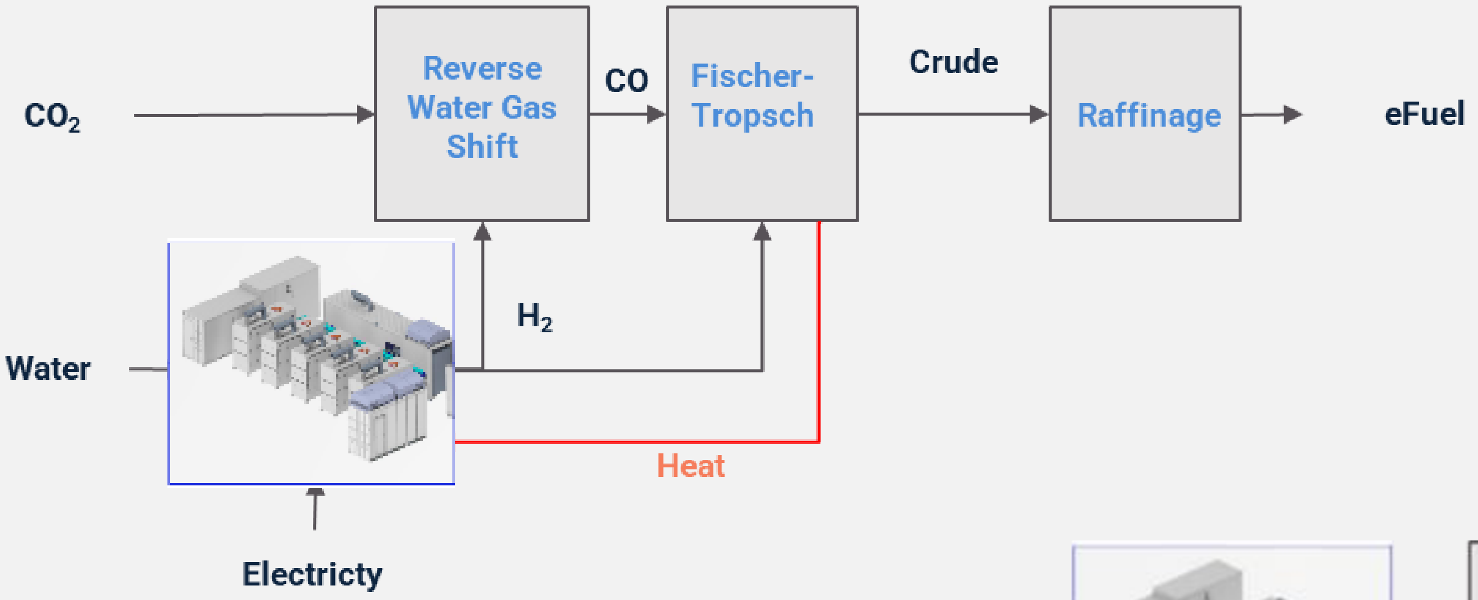
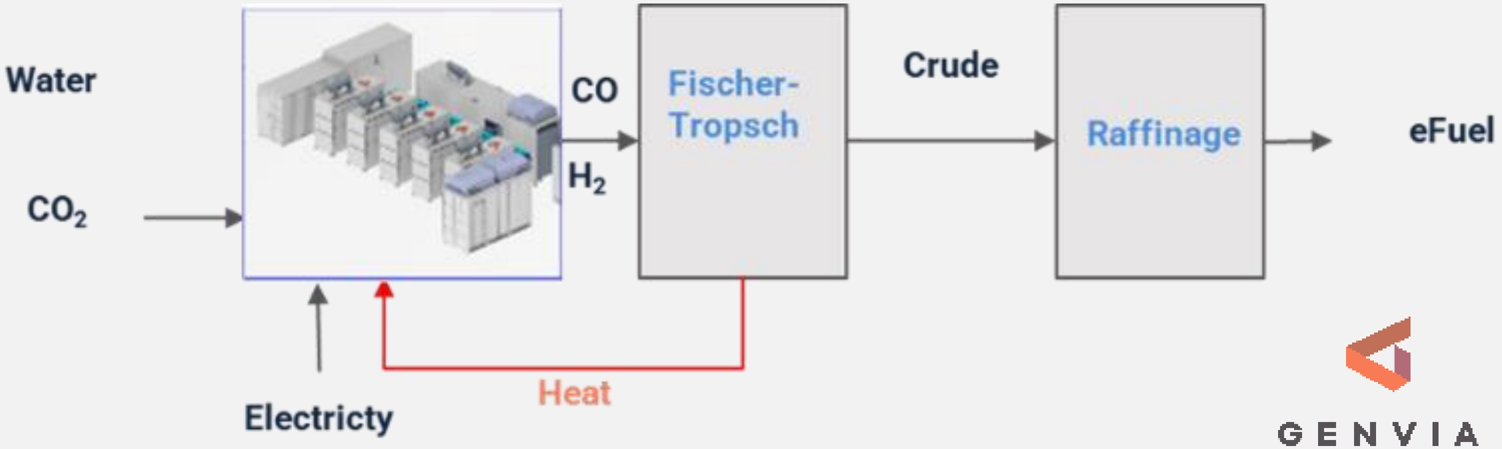
Industrial Coupling : CCUS (SOEC vs. Co-SOEC)





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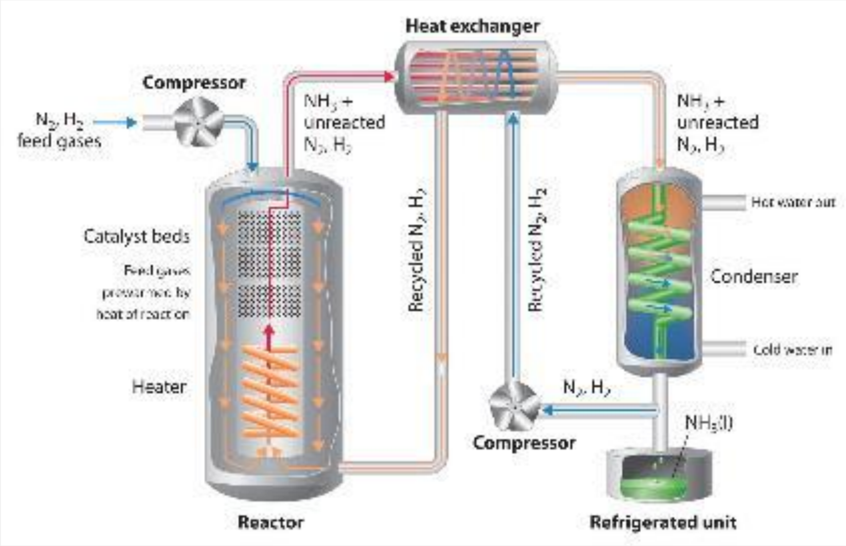
Industrial Coupling : Haber-Bosch



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Nuclear Coupling

Present nuclear Reactors :

- Electrical coupling + thermal network

New EPR nuclear Reactors :

- Low temperature coupling (<150°C)

Small Modular Reactors

- Low, Medium to high temperature coupling (from 150°C, to 550°C and 800°C)

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