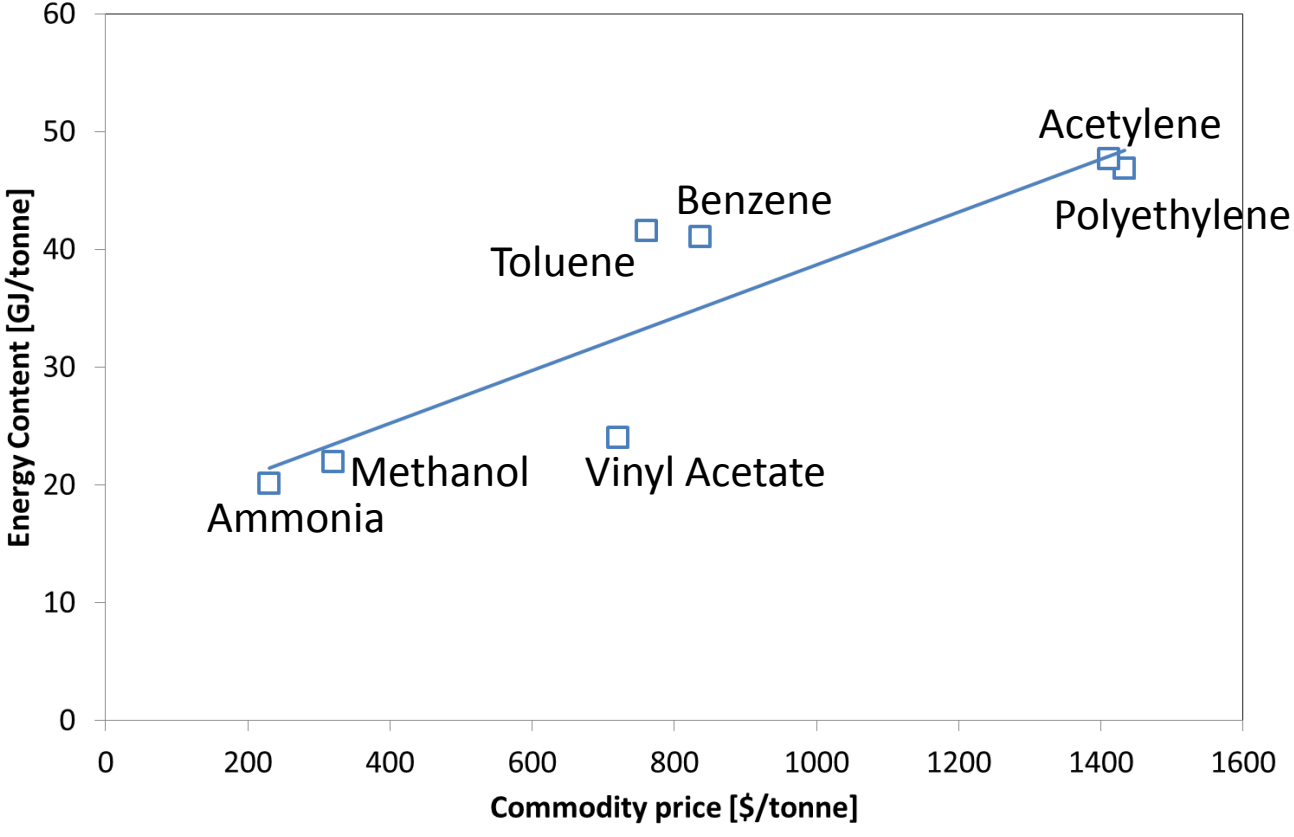
ECN's approach to the Iron & Steel industry

Smart decisions now: Smart choice for the future

Zaandam
19th April 2017

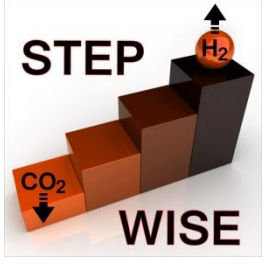
www.ecn.nl

Energy Cost and Price



When making commodities, energy content and ease of separation are primary drivers

ECN's current involvement in decarbonisation of the Iron & Steel industry



Decarbonisation of blast furnace gas (BFG) for the iron & steel industry power plant

FReSMe

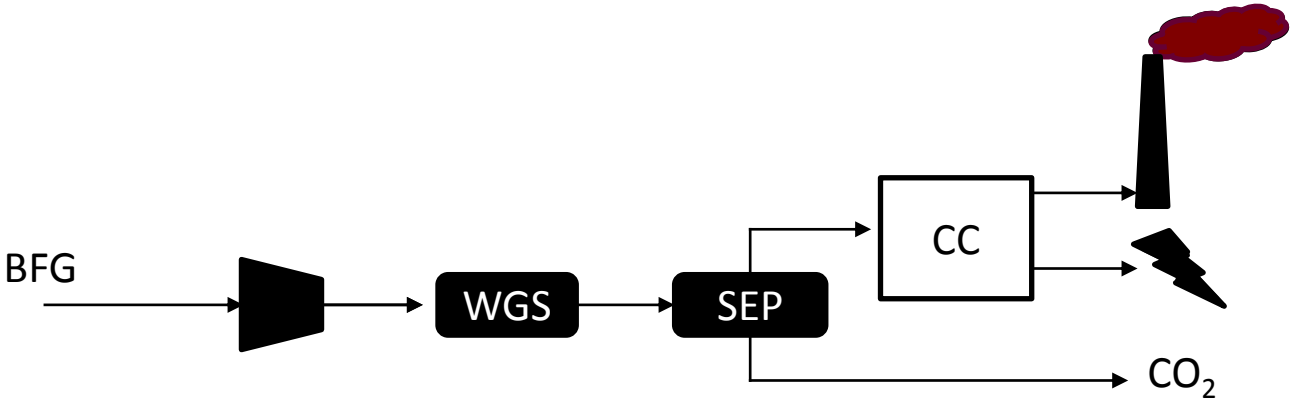
Utilization of the energy content of the residual steel gases for production of methanol from CO_2

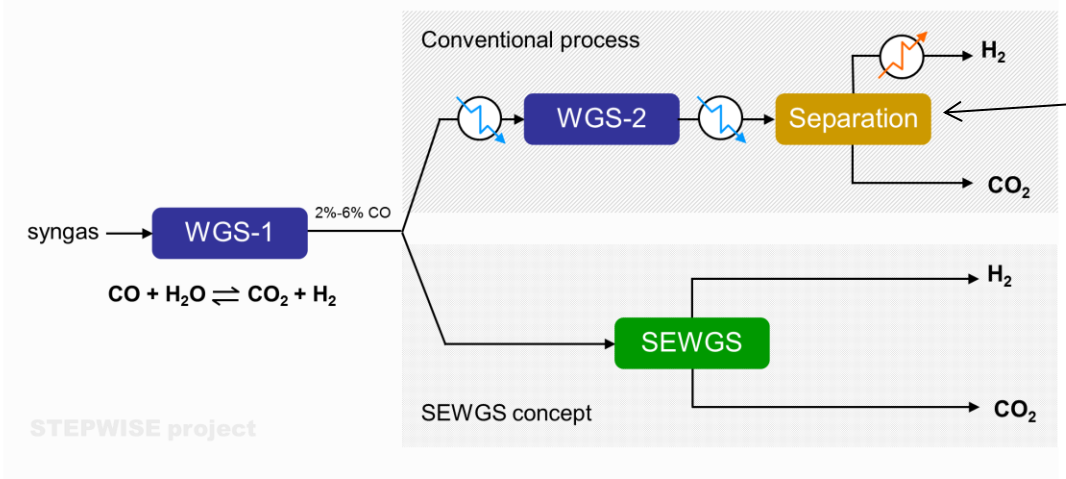
H2FUTURE
Green Hydrogen

Use timely power price opportunities, in order to provide affordable H_2 for current uses in the steel making processes

STEPWISE Project Introduction

Stepwise pilot approach

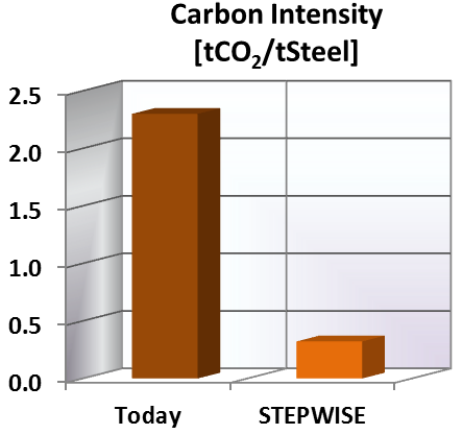




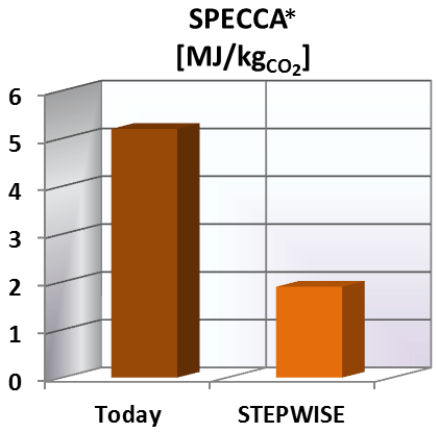
>10 GJ/tonne CO_2
Heat exchange

- Hot separation
- Pre-shift ↓

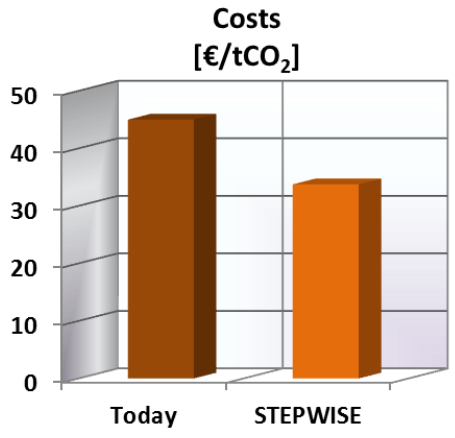
STEPWISE: Demonstration goals



85% reduction



60% reduction



25% reduction

Climb to TRL6 with 2 campaigns of 3 months

*) Specific Primary Energy Consumption per CO_2 avoided

FReSMe Project Introduction

FReSMe

FROM RESIDUAL STEEL GASES TO METHANOL.

Methanol from CO_2 Blast Furnace Gases to be used as ship transportation fuel.

FReSMe

FReSMe Project

- **FReSMe** is a Research and Innovation Action funded by H2020 Programme
- **Project data**: 11 European partners - 11,4 M€ - 48 months
- **Objective**:

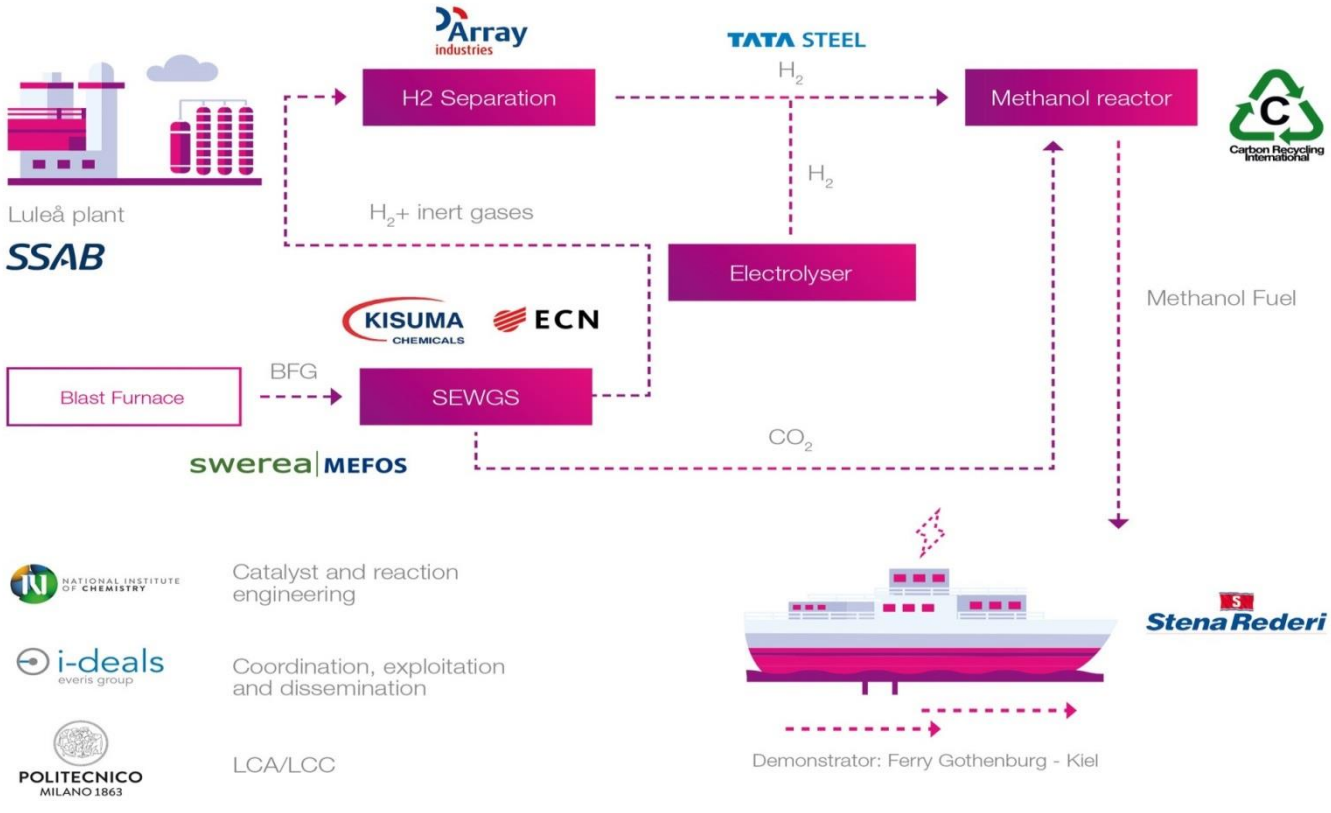
  To demonstrate feasibility of valorising CO_2 and H_2 capture from blast furnace gases (BFG) by turning into a versatile platform chemical and renewable fuel such as Methanol (MeOH)
- **Benefits**:
  - Add value to CO_2 capture
  - Increase competitiveness of the steel industry
  - Reduce the European dependency from fossil fuels

FROM RESIDUAL STEEL GASES TO METHANOL.

Methanol from CO_2 Blast Furnace Gases to be used as ship transportation fuel.

FReSMe

Project implementation



Demonstrate TRL6 with 3 campaigns of 1 month, 800m³/hr BFG, 50 kg/hr Methanol

What is the SEWGS separation technology?

Sorption Enhanced Water-Gas Shift

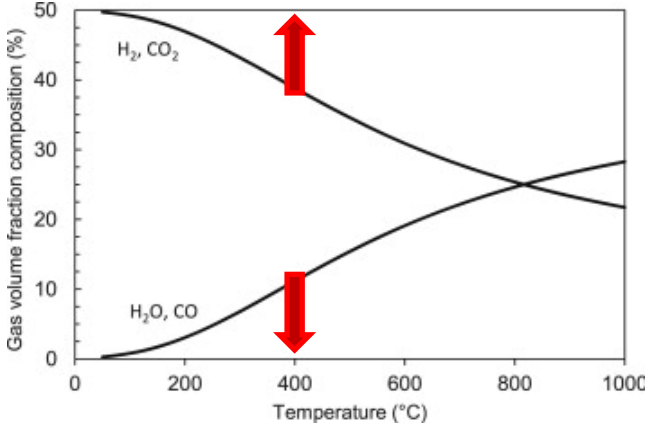
- **Platform Technology for Syngas Treatment**
  - Upgrade Blast Furnace Gas: remove CO_2, convert CO to H_2
  - Valorization of H_2 in CO_2/CO containing syngas streams
- **Technology**
  - High CCR at low steam use ($H_2O/CO_2 < 1.0$)
  - Co-capture of H_2S with CO_2
  - SEWGS technology is PSA system
  - Process intensification
  - Highest efficiencies for short-to-medium term developments
- **Most cost effective CCS solution in IGCC and BFG**
  - For IGCC, costs per ton CO_2 avoided estimated to be 35% lower than state of the art
  - For BFG, costs per ton CO_2 avoided estimated to be 25% lower than state of the art

SEWGS

- Sorption-Enhanced Water-Gas Shift (SEWGS)
  - CO_2 capture using a WGS active solid adsorbent

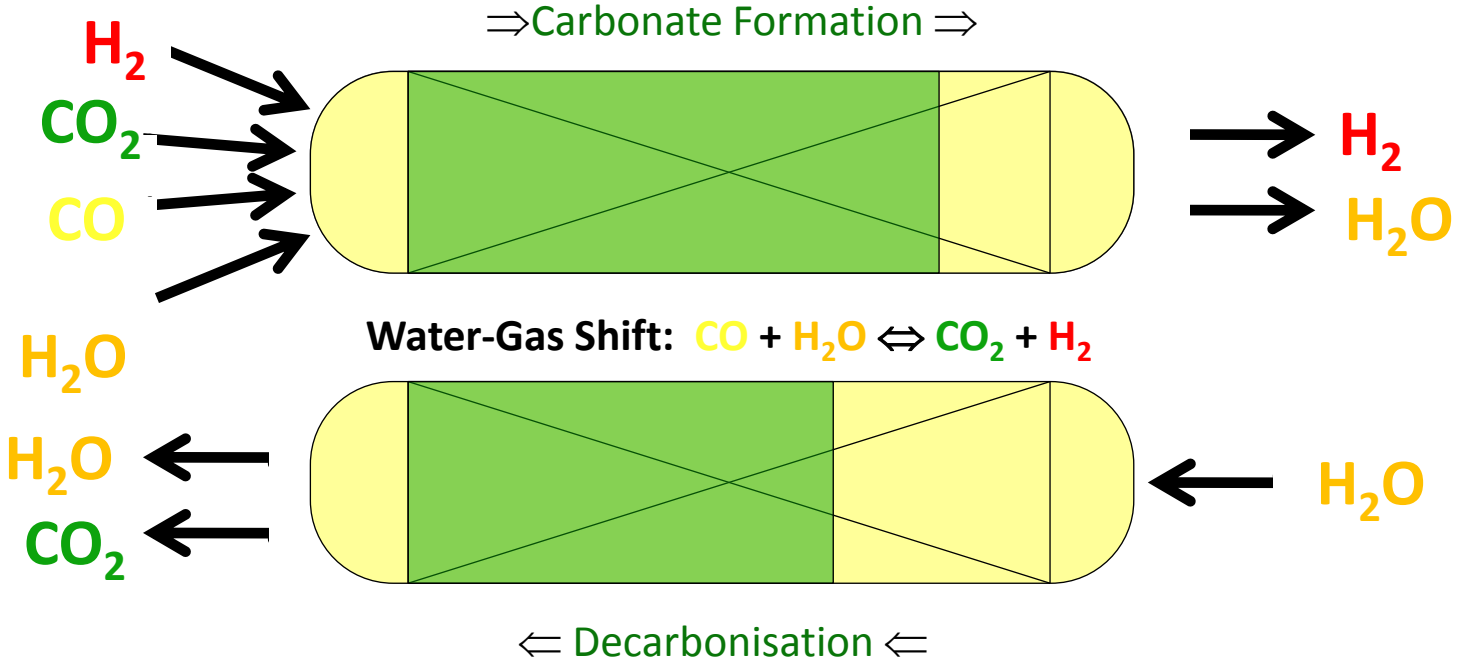
$$CO + H_2O \leftrightarrows \boxed{CO_2} + H_2 \qquad \Delta H = -41 \text{ kJ/mol}$$

In situ removal of carbon dioxide



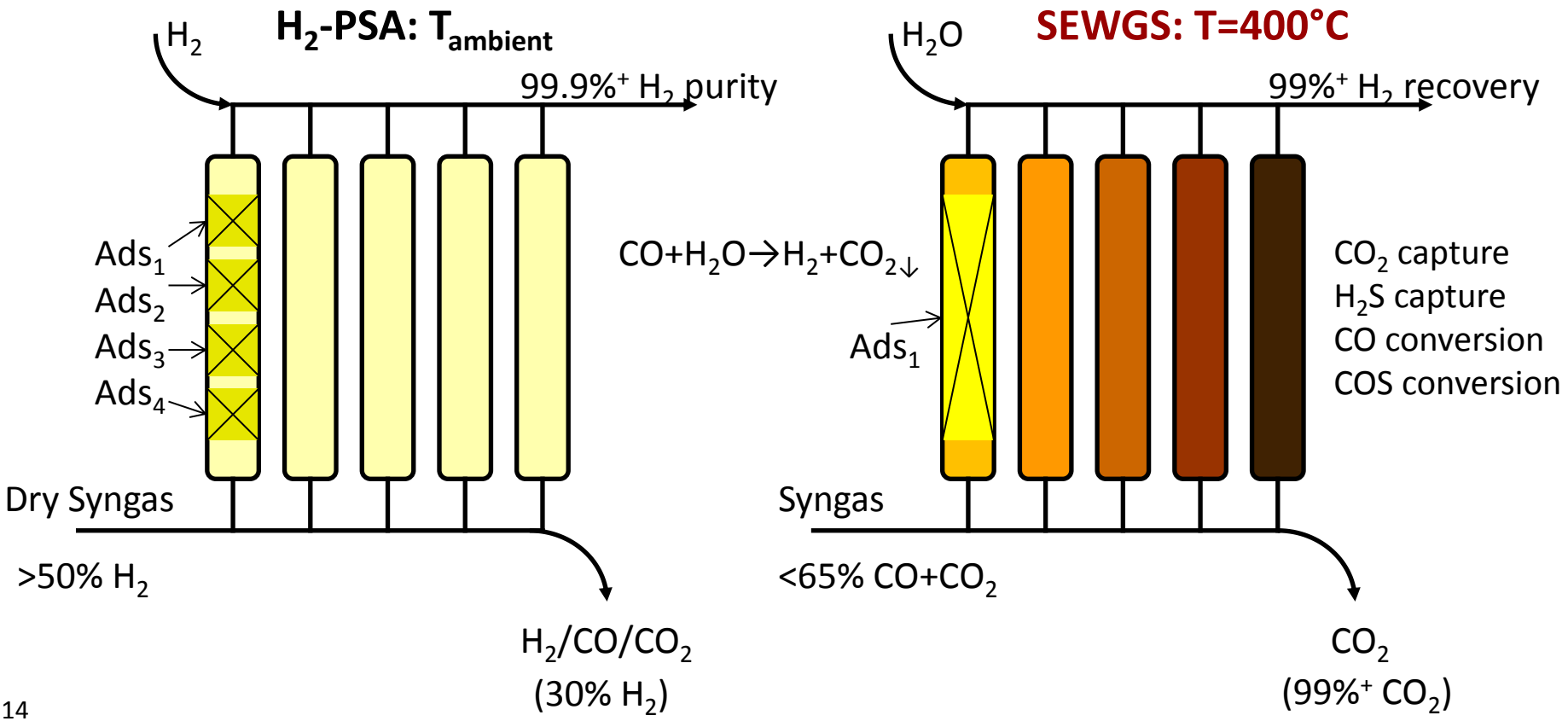
The Intensification Step

- Combines the Water-Gas-Shift reaction with sorbent material to simultaneously produce H_2 at high temperature whilst also capturing CO_2



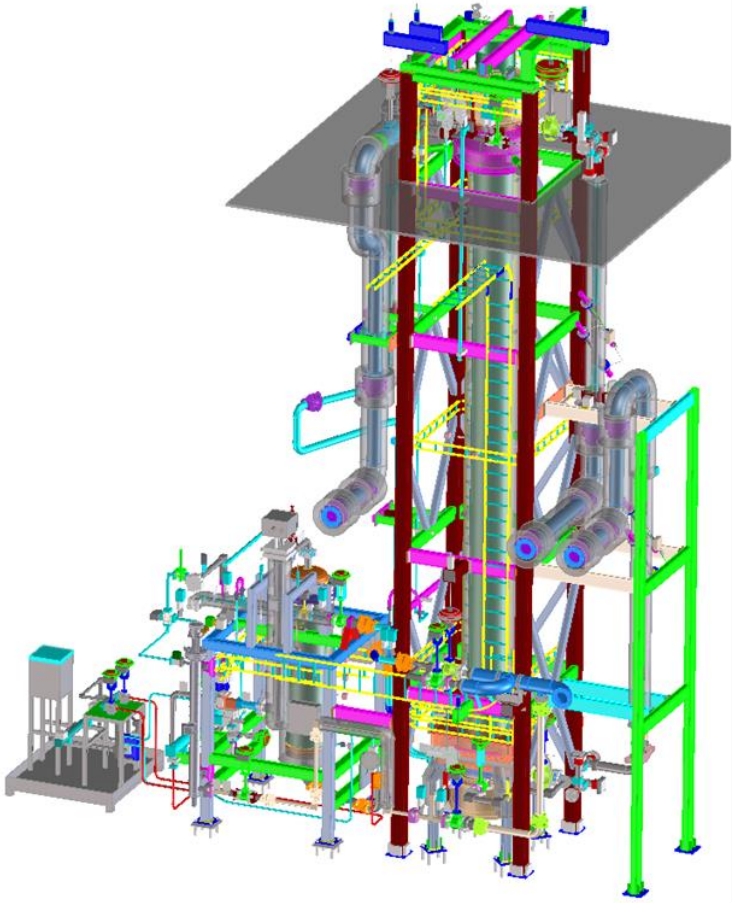
*SEWGS technology is protected by several patents

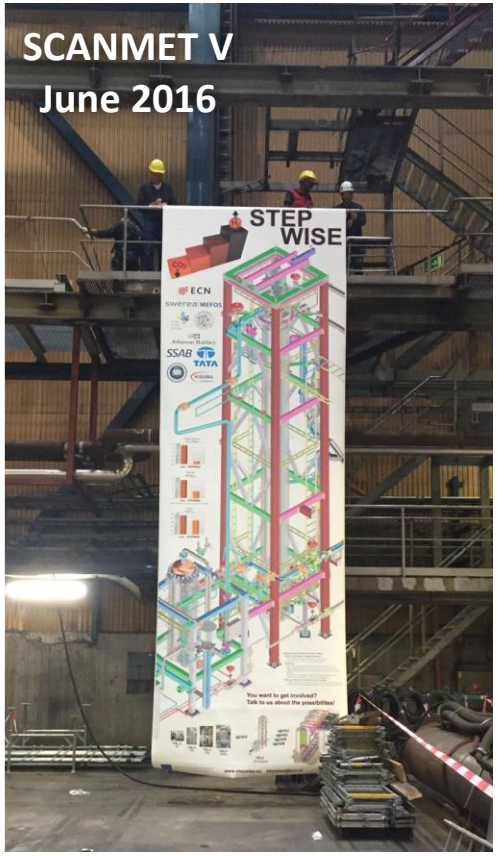
SEWGS principle



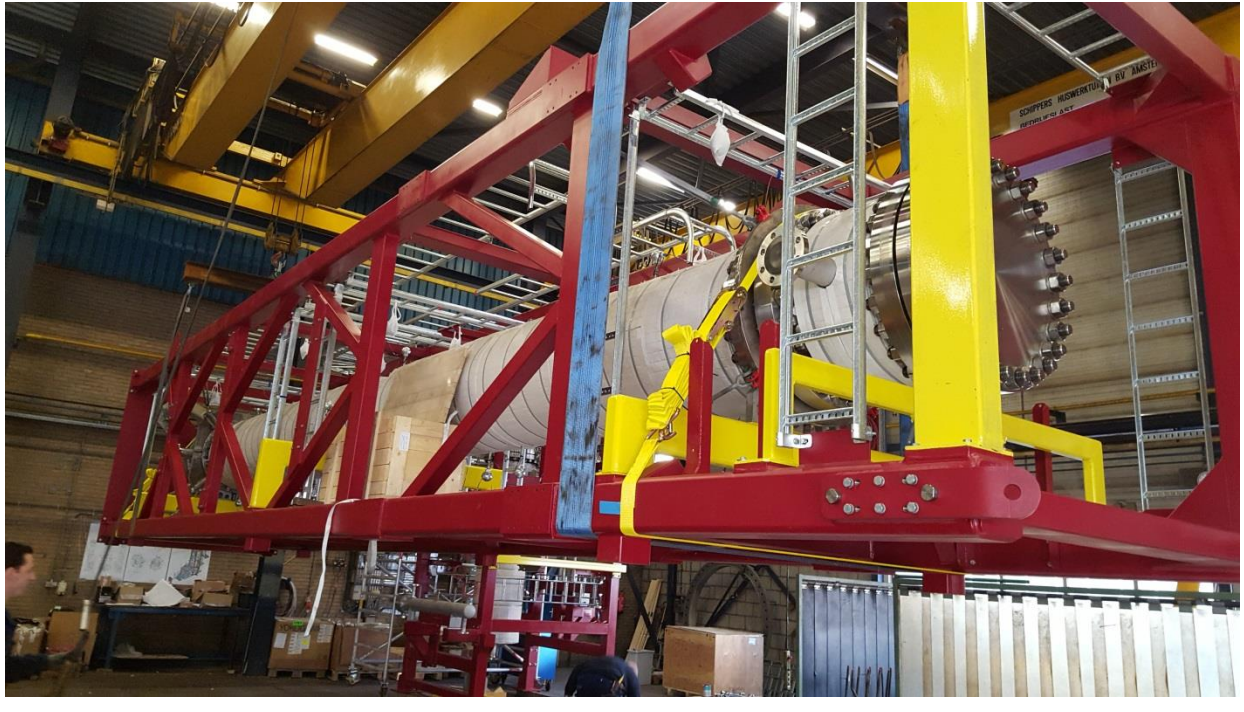
Progress on SEWGS reactor system for use in the STEPWISE and FReSMe projects, realised within STEPWISE

Pilot design and construction



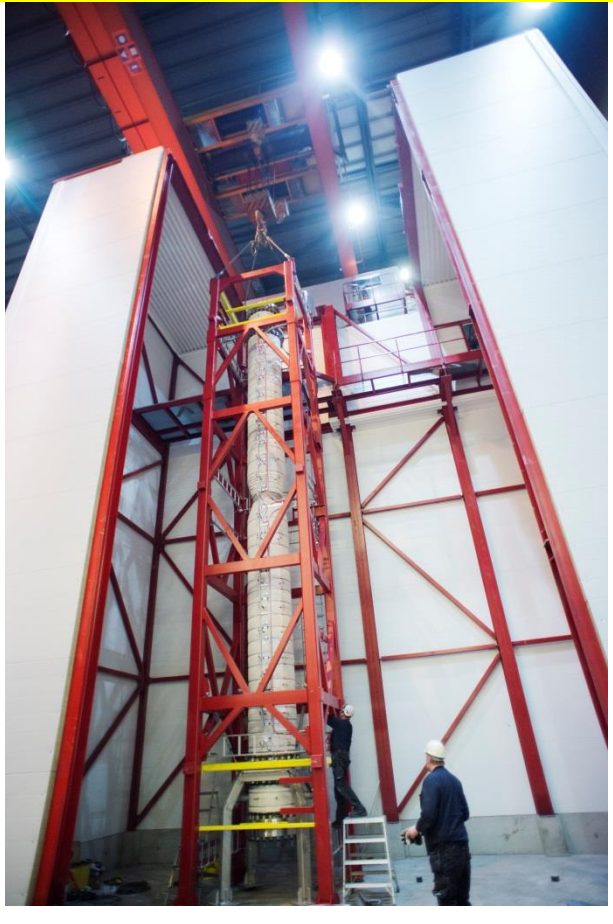


WGS & SEWGS construction



WGS & SEWGS construction

WGS & SEWGS construction

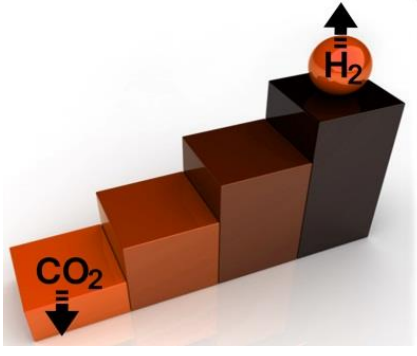


7th High Temperature Solid Looping Cycles Network Meeting

- 4-5th September 2017
- Luleå, Northern Sweden

swerea | MEFOS

ieaghg



STEP WISE

a H2020 Project

Pilot Grand Opening

The ECN approach towards decarbonisation of the steel industry

Realisation

- Fuel costs and energy are almost synonymous
- After energy content, separation is the main driver for efficient operation
- A more efficient separation of CO_2 from residual steel gases leads directly to more energy for commodity production

Implementation

- Develop low energy separation technologies
- De-risk upscaling through a tailored TRL approach
- Build the right consortium for the job
- Writing good proposals leads to valorisation of your ideas

ECN

You want to get involved?
Talk to us about the possibilites!

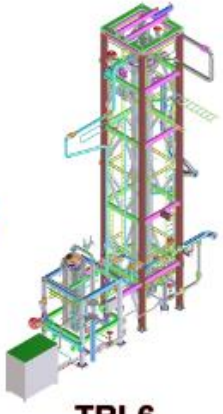
TRL 2
2g

TRL3
10g

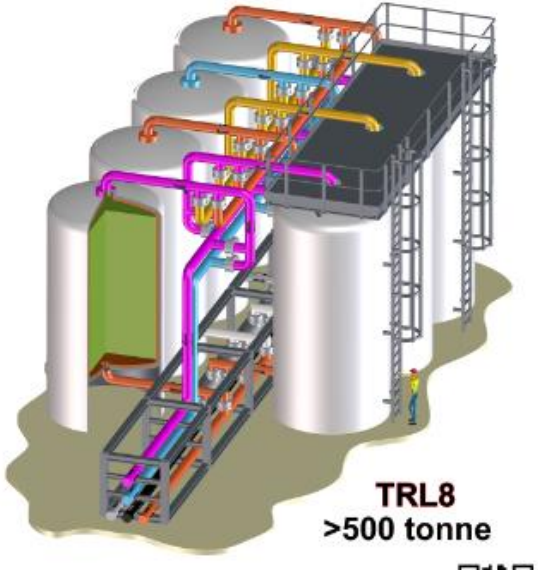
TRL4
2kg

TRL5
100kg

STEP WISE



TRL6
2.5 tonne



TRL8
>500 tonne

STEP WISE

This presentation is part of the STEPWISE project that has received funding from the European Union's Horizon 2020 research and Innovation programme under grant agreement No. 640769

FReSMe

This presentation is part of the FReSMe project that has received funding from the European Union's Horizon 2020 research and Innovation programme under grant agreement No. 727504

H2FUTURE
Green Hydrogen

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