Low-Carbon Steel Production

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NIM Industry Insights Series – Carbon Shift: Redefining Industry Through CCUS

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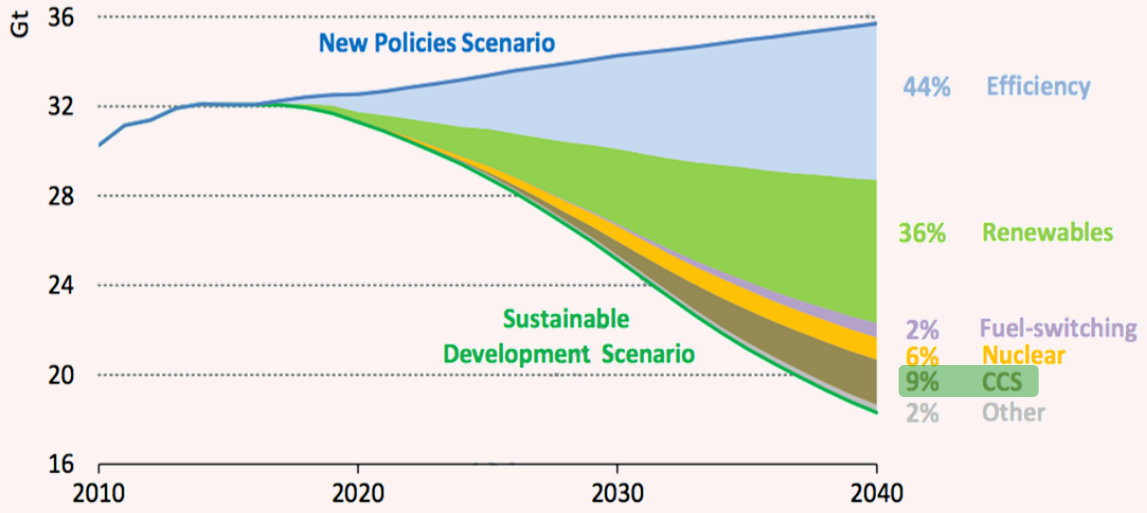
Why CCS and CCU in Iron and Steel ?

IN ALL SCENARIOS RELATED TO THE PARIS GOALS, CCS AND CCU PLAY A ROLE

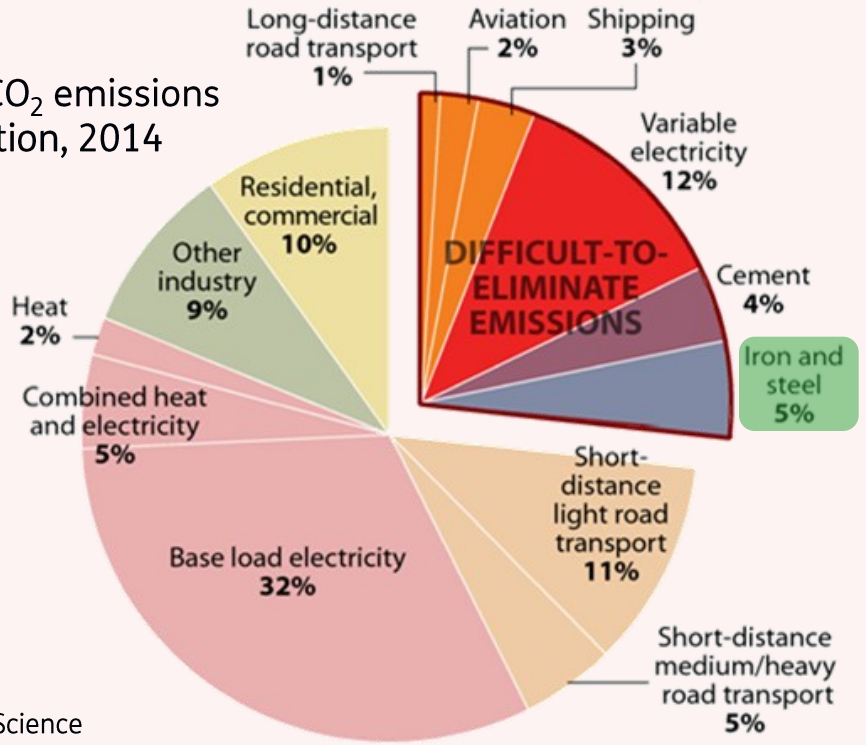
Global CO_2 emissions reductions in the New Policies and Sustainable Development Scenarios



2017 IEA - World Energy Outlook

AN IMPORTANT REASON FOR THIS IS THAT OVER 25% OF CO_2 EMISSIONS ARE DIFFICULT TO AVOID WITH OTHER MEASURES

Global CO_2 emissions distribution, 2014



Davis et al, Science

Challenge for Iron and Steel

Facts

- Iron & Steel: 3.0 $GtCO_2/yr$ = 7% of the worldwide CO_2 industrial emissions
  1.7 - 1.9 ton of CO_2 per ton steel (typical European values)
  360,000 employees in EU

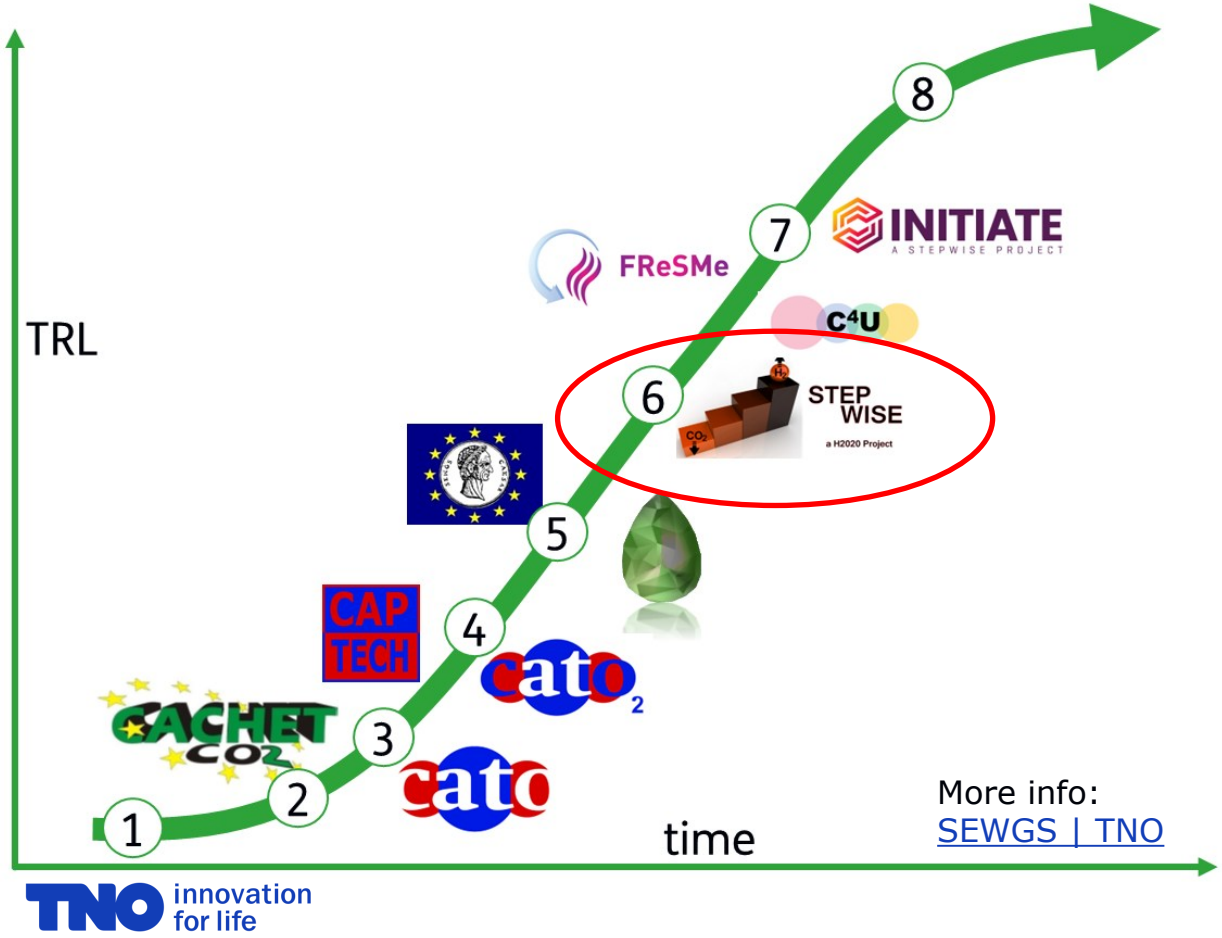
Reduce CO_2-footprint

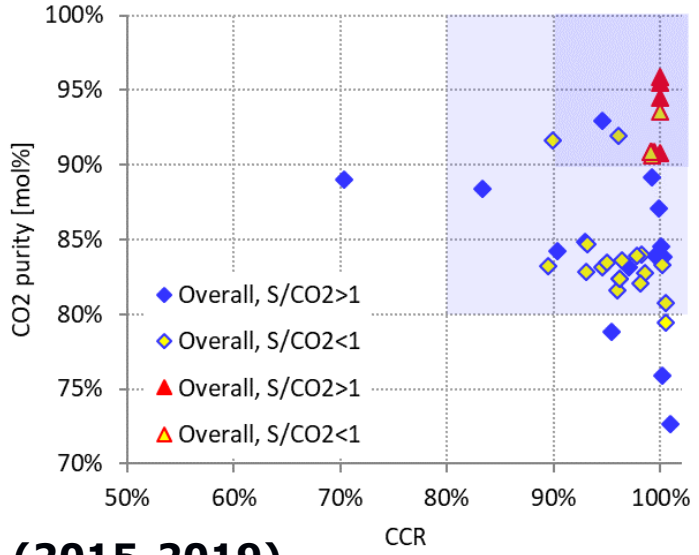
- Recycle more scrap
- Improve efficiency of iron making e.g. Hisarna
- Switch reductants e.g. H_2, electrical routes
- Capture CO_2 and permanent sequestrate

← GreenSmith

STEPWISE Technology applying Sorption Enhanced Water-Gas Shift (SEWGS)

STEPWISE technology





STEPWISE (2015-2019)

CO_2 capture from residual steel-off gases for power generation

High efficient capture performance

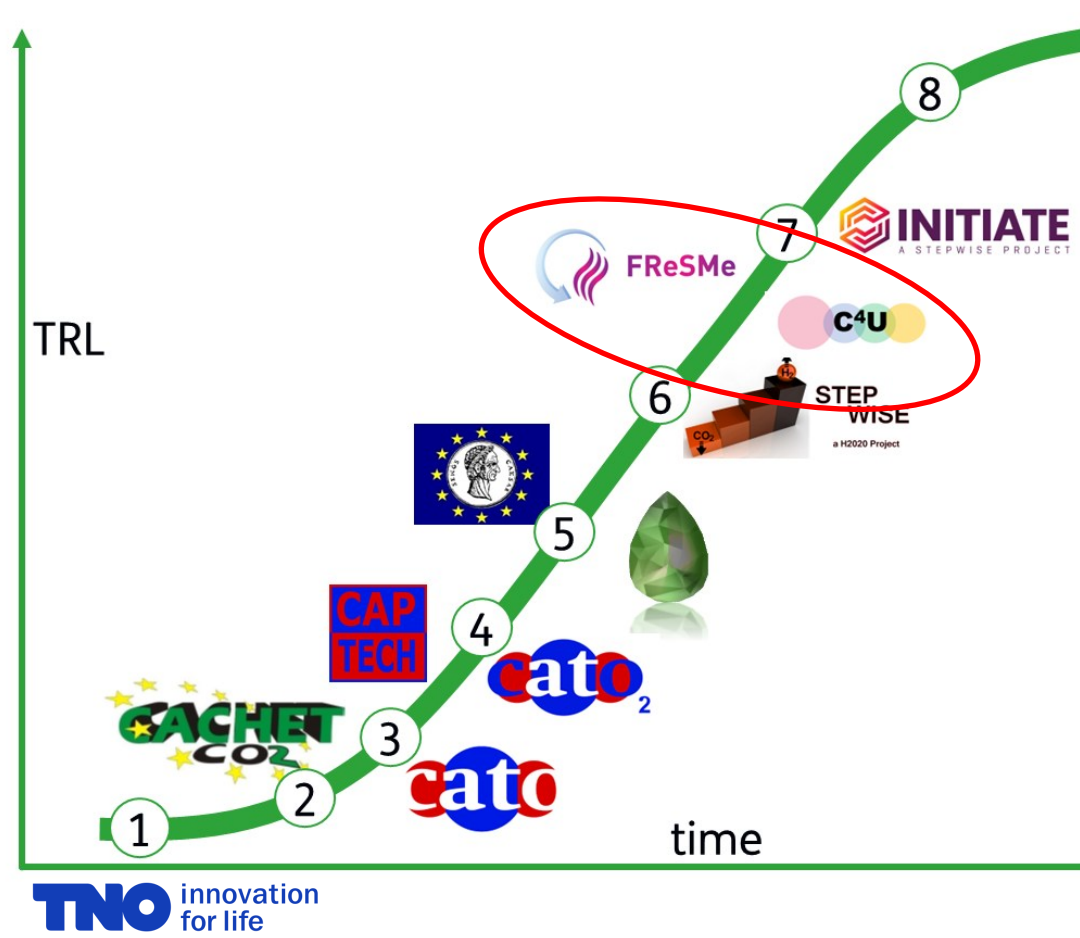
A SPECCA of less than 2 MJ/kg

Up to 35% cost advantage compared to state-of–the–art capture solutions

Lower impact on all LCA factors relative to amine scrubbing technologies

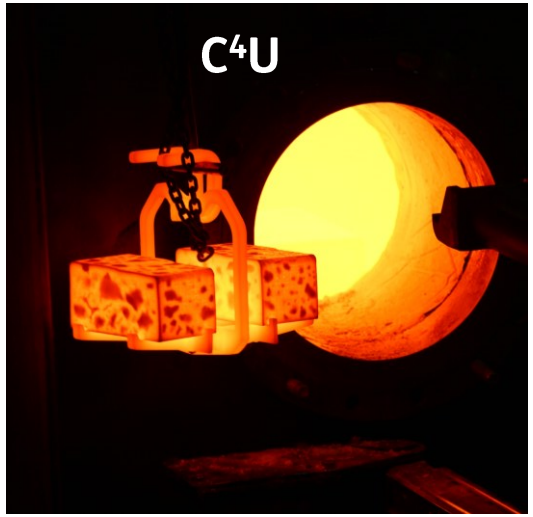
Publications:
https://doi.org/10.3390/su11071825
https://doi.org/10.1016/j.egypro.2017.03.1764
https://doi.org/10.1016/j.ijggc.2019.102935

STEPWISE technology



C⁴U (ongoing, start 2020)
Full decarbonisation of traditional steel mills

First time demonstration of decarbonised blast furnace gas as fuel for reheating furnaces

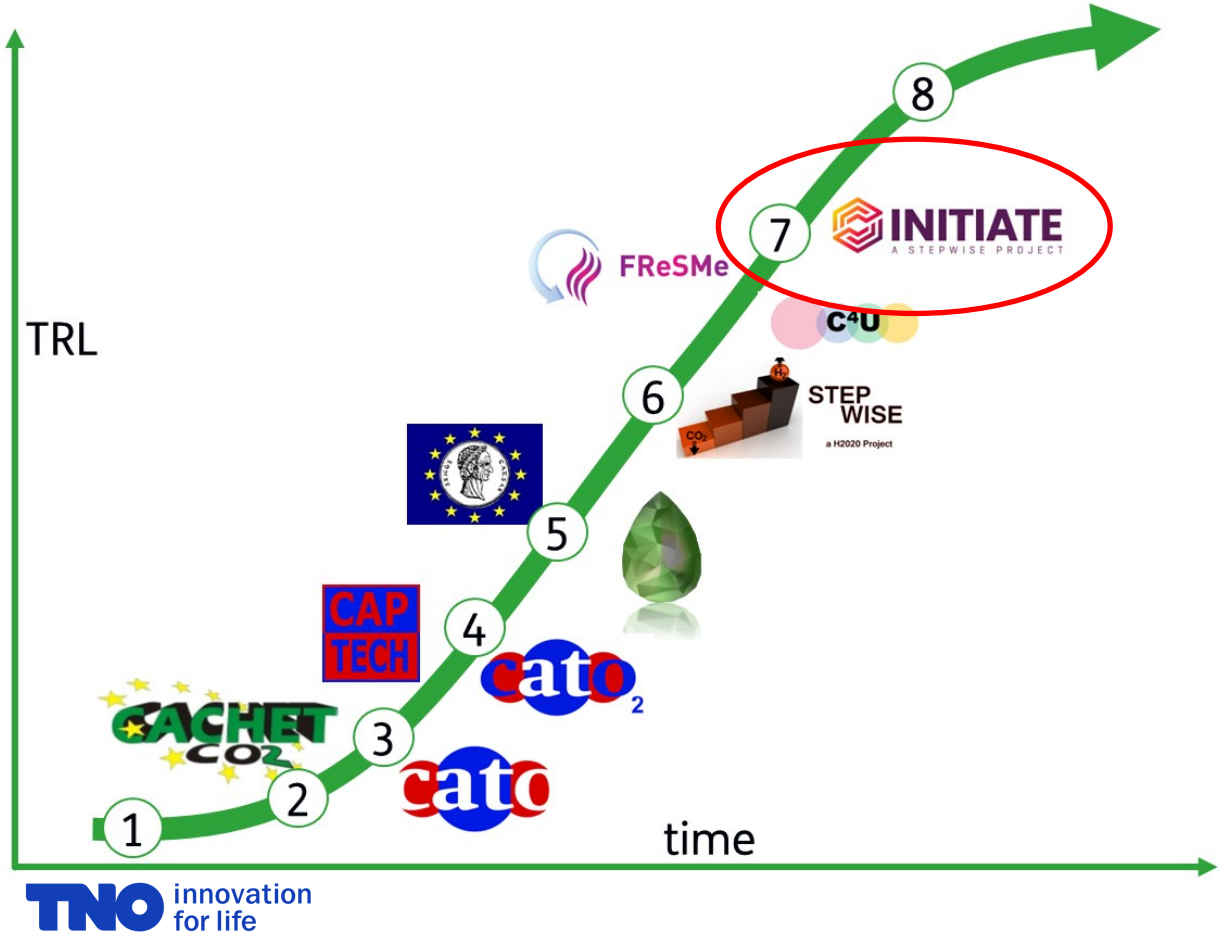


FReSMe (2016-2021)
Methanol production from residual steel residual gases

Demonstration of full production chain from steel residual gases to methanol used on STENA ferry

Positive business case for valorising energy content of the residual gases for MeOH production

STEPWISE technology

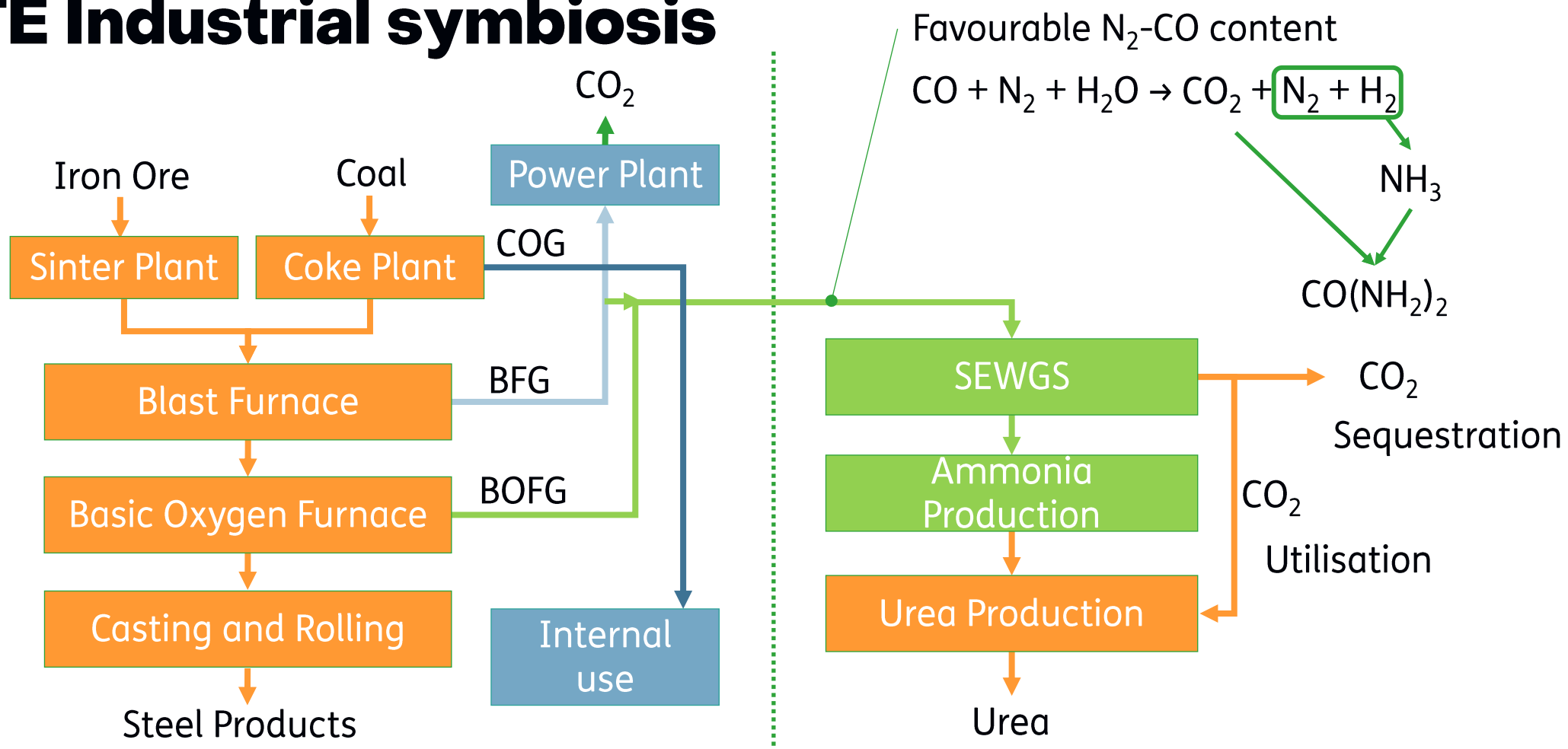


INITIATE (ongoing, start 2020)

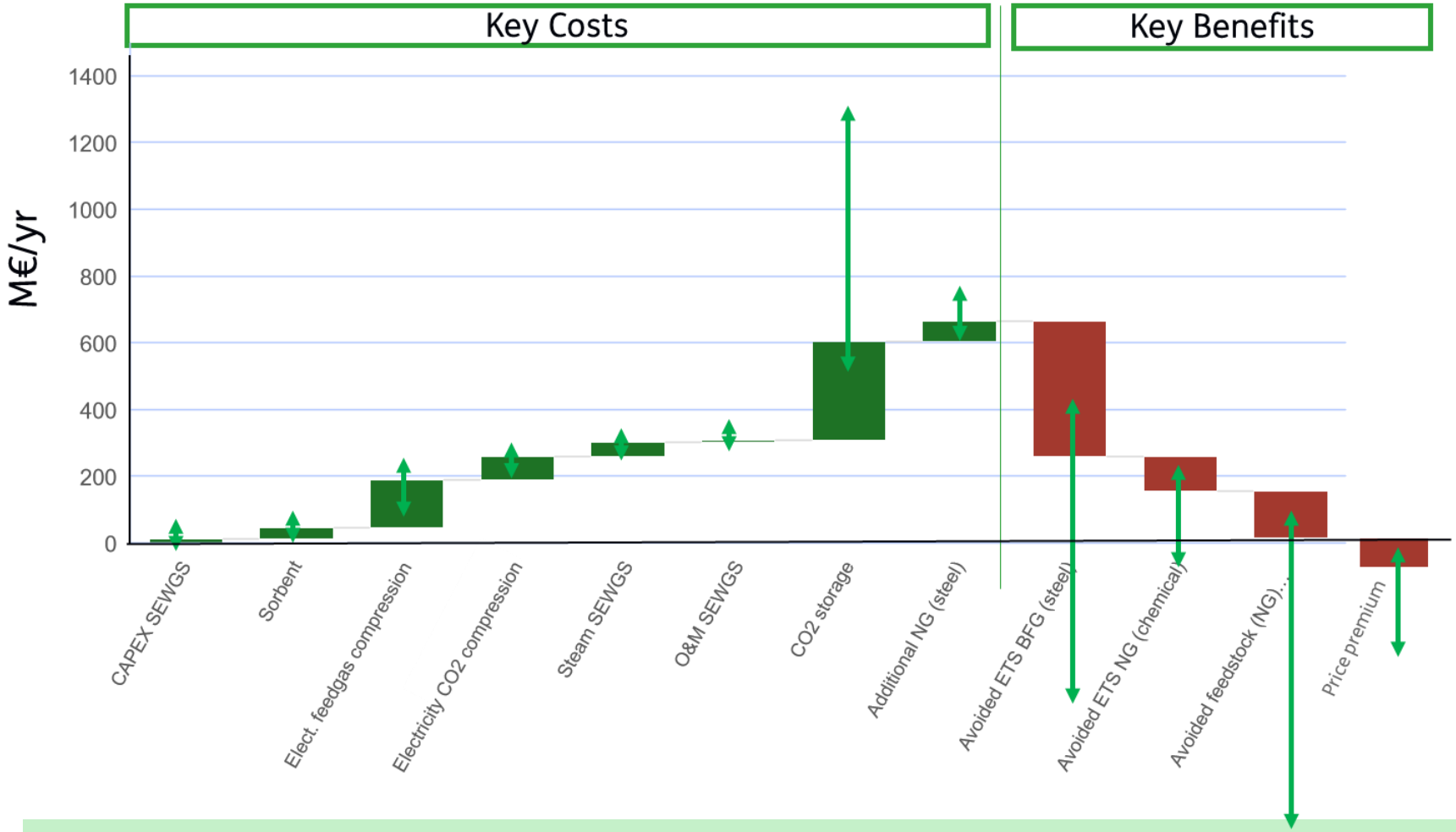
Industrial Symbiosis between the Iron & Steel and NH_3 & Urea industries

https://www.initiate-project.eu/

INITIATE Industrial symbiosis



INITIATE – Key cost drivers and uncertainties



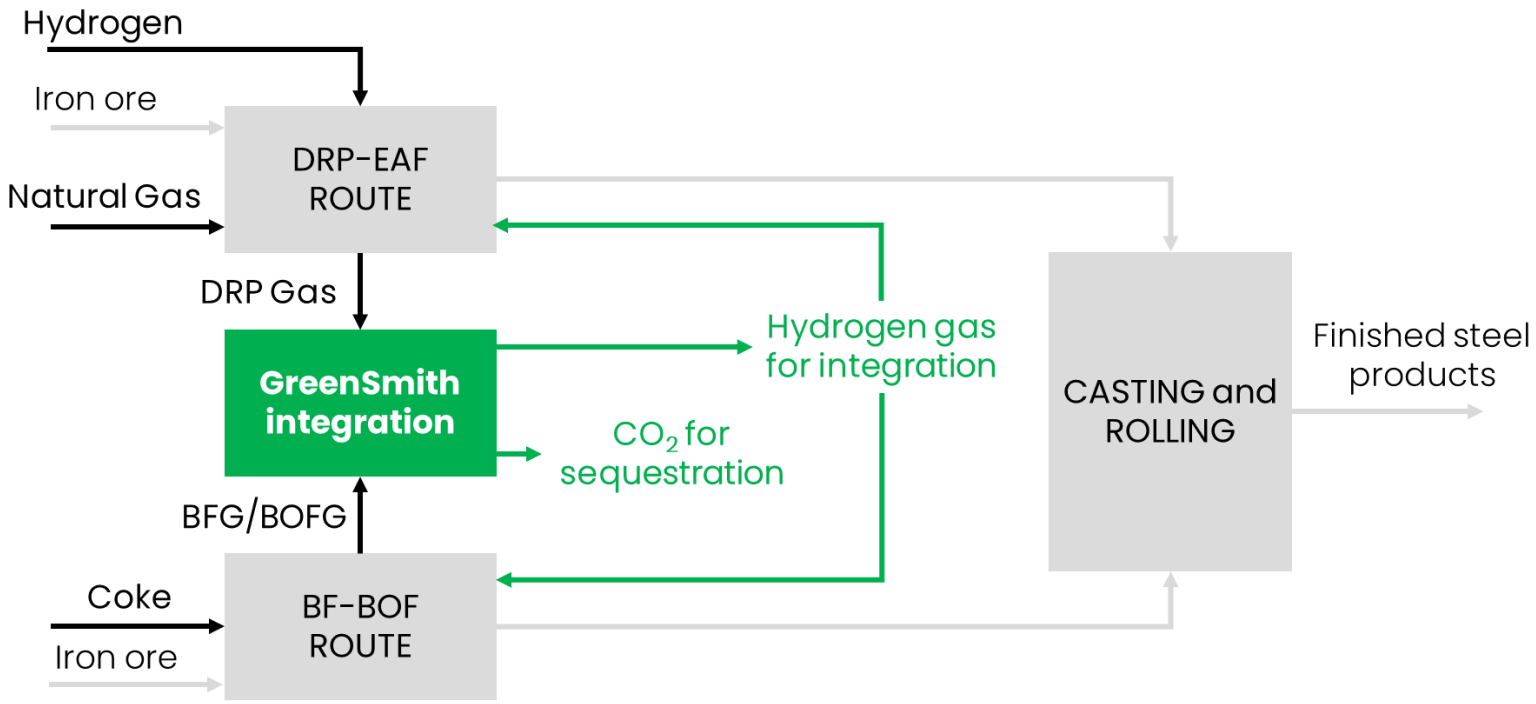
Summary key uncertainties

Level	Key drivers and uncertainties
EU	• ETS price • CBAM / free allowances • RED3 fuels/chemicals
EU + local	• Legal • Extra price/value products • Subsidies
Local	• CO_2 storage costs, specs, availability • Market volume products • Green electricity / natural gas costs & availability • H_2 costs & availability
Internal (consortium)	• SEWGS OPEX • Production at scale • Chemical plant availability (CAPEX)

Positive business case, but some large uncertainties remain - mainly on benefit side

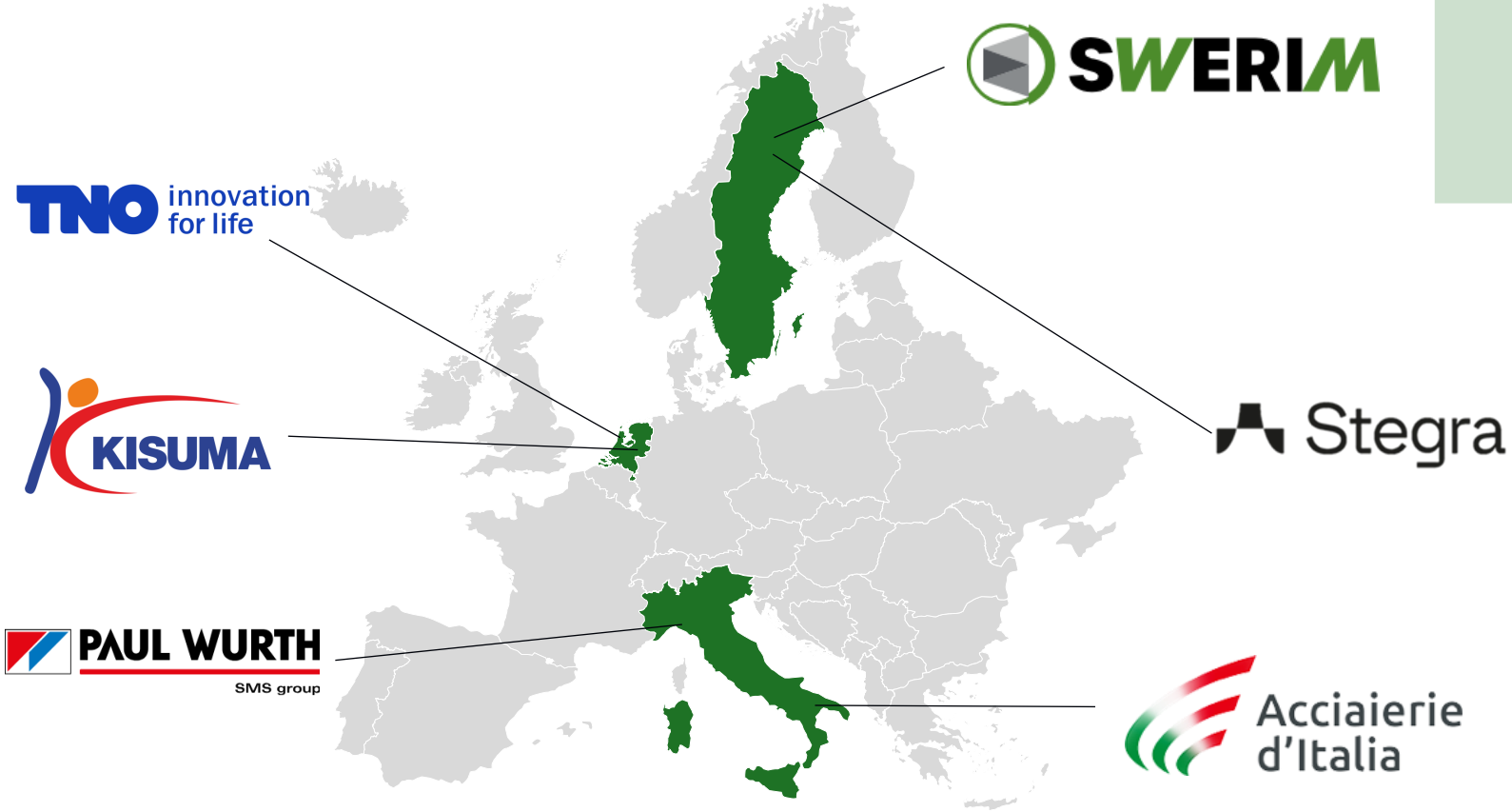
The GreenSmith Project

Demonstration of hydrogen/CO recovery from various integration routes of BF and DRP:



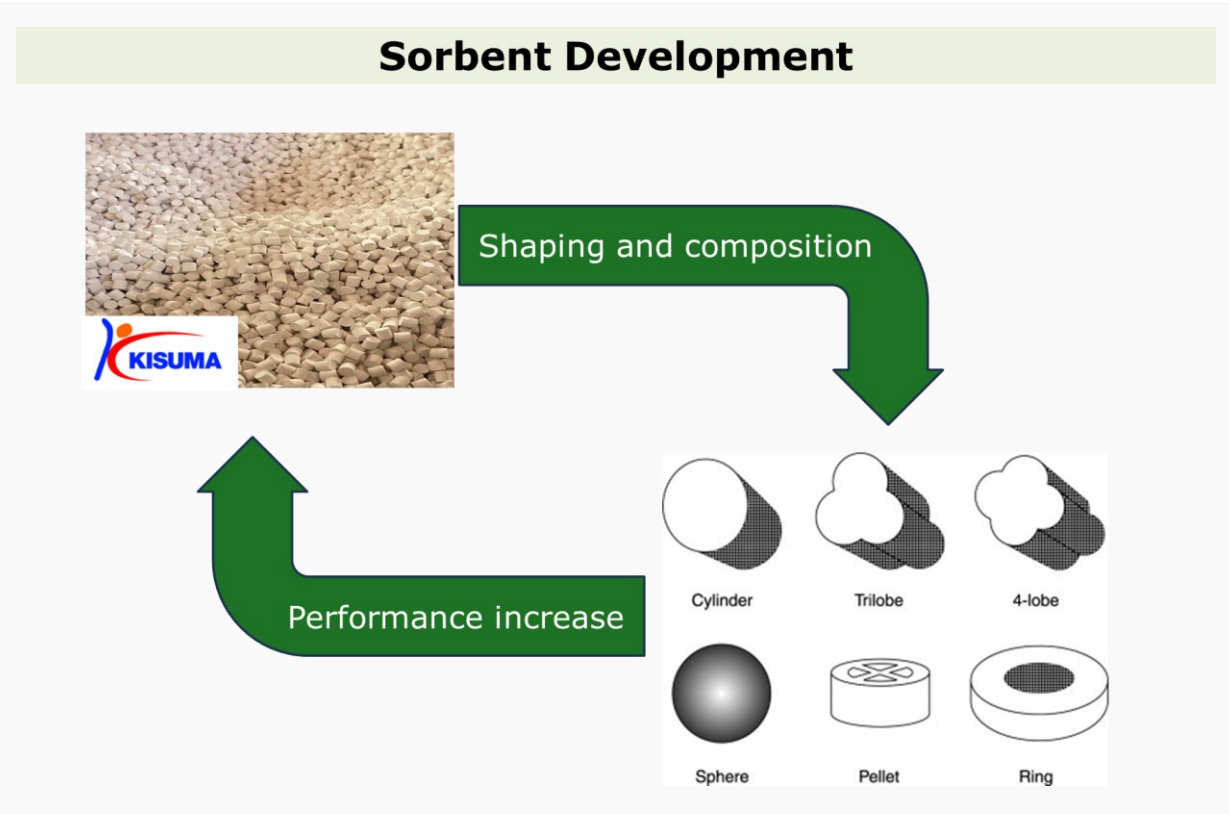
GreenSmith - Partners

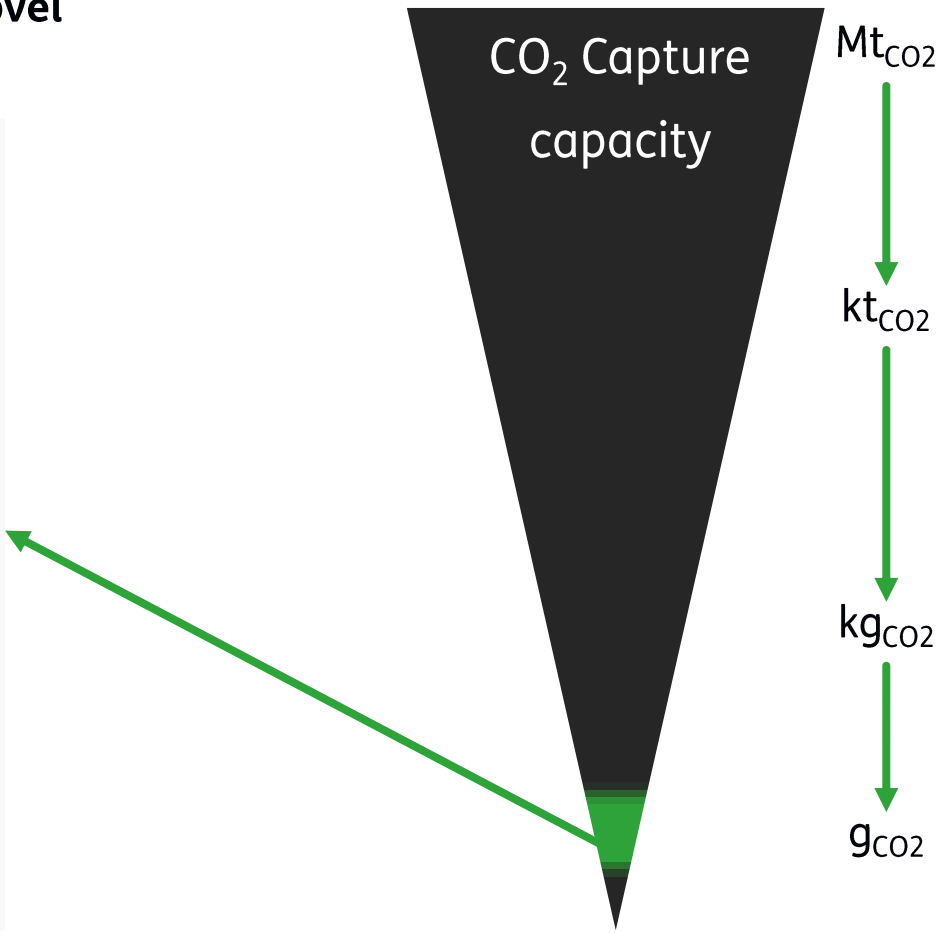
Project Passport	
Duration	July 2024- Sept 2026
Budget	2.8 M€
Consortium	Full Value Chain covered: • End-Users • Technology Suppliers • Research organisations



The Green Smith Project : Goals and Outcomes

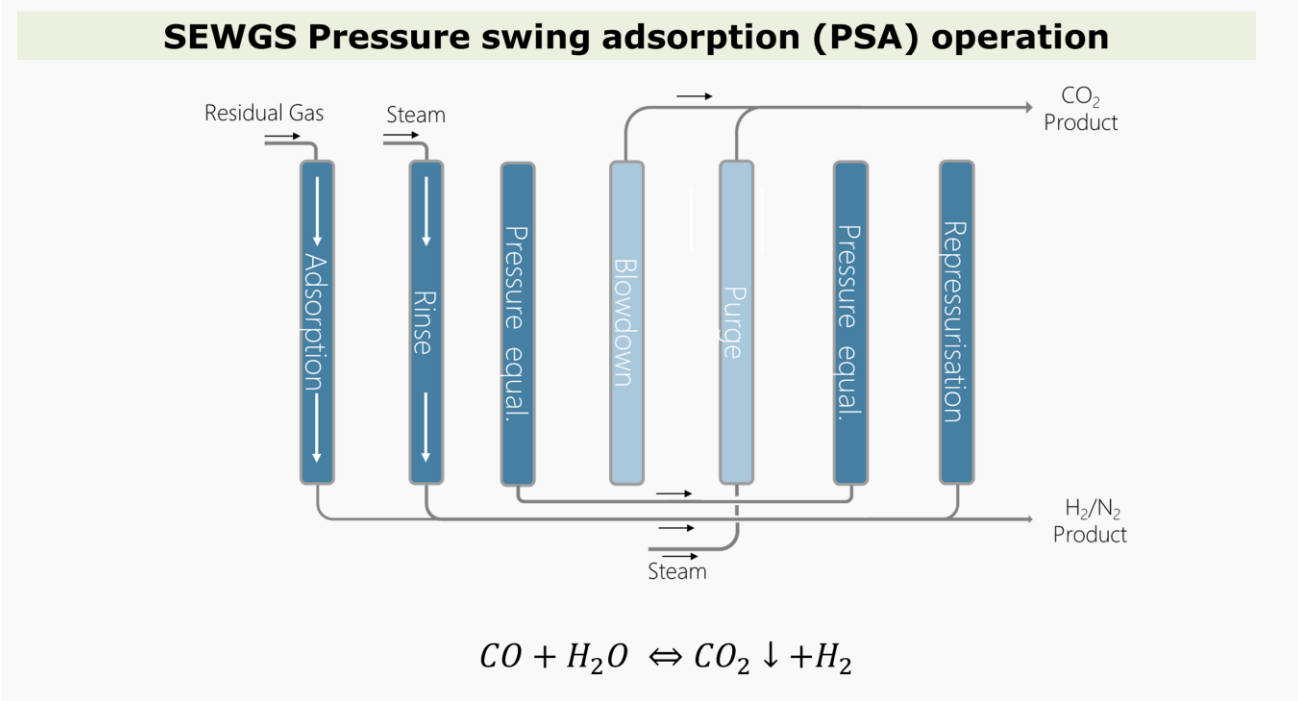
- Demonstrating a two-fold increase of SEWGS productivity by utilising **novel Himago™ adsorbents** crafted with advanced shaping techniques;

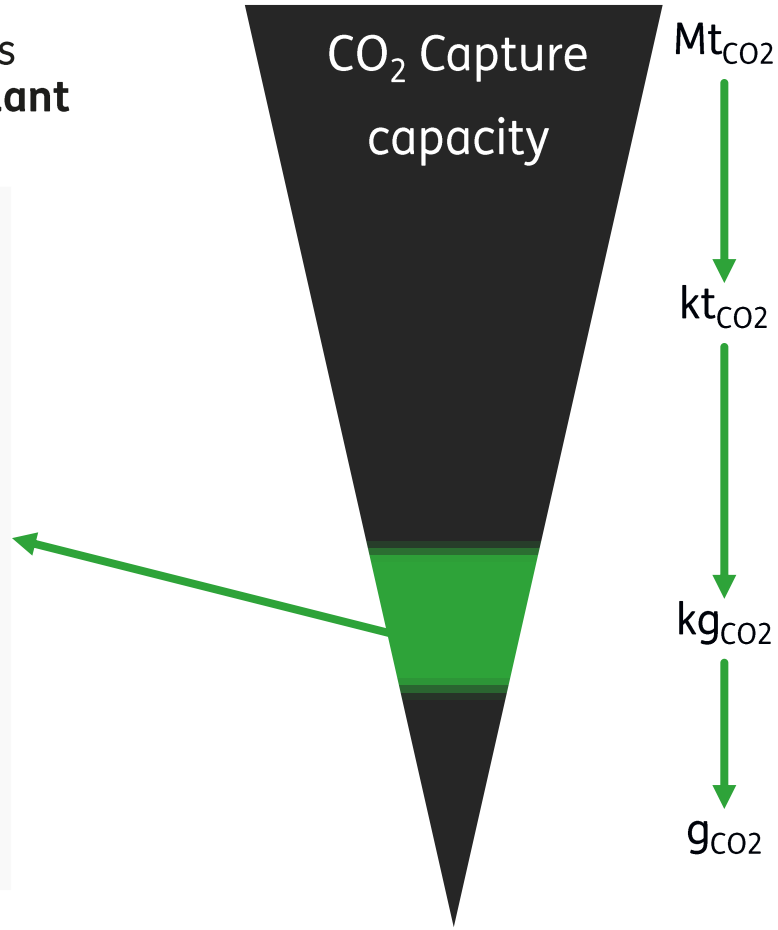




The Green Smith Project : Goals and Outcomes

- **Achieving TRL5 demonstration** of H_2-rich product streams recovery by **SEWGS** (Sorption Enhanced Water-Gas Shift) from relevant mixtures of residual steel gas from **Blast-Furnace (BF)** route and novel CH_4- and H_2-based **Direct Reduction Plant (DRP)** route

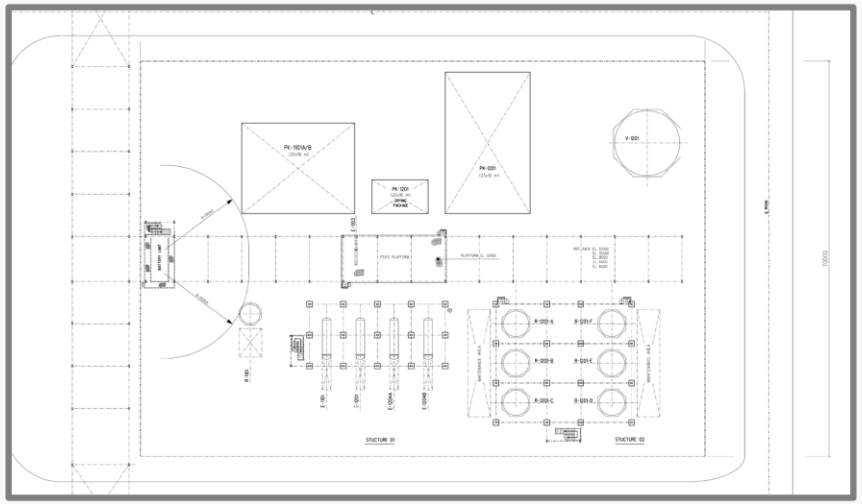




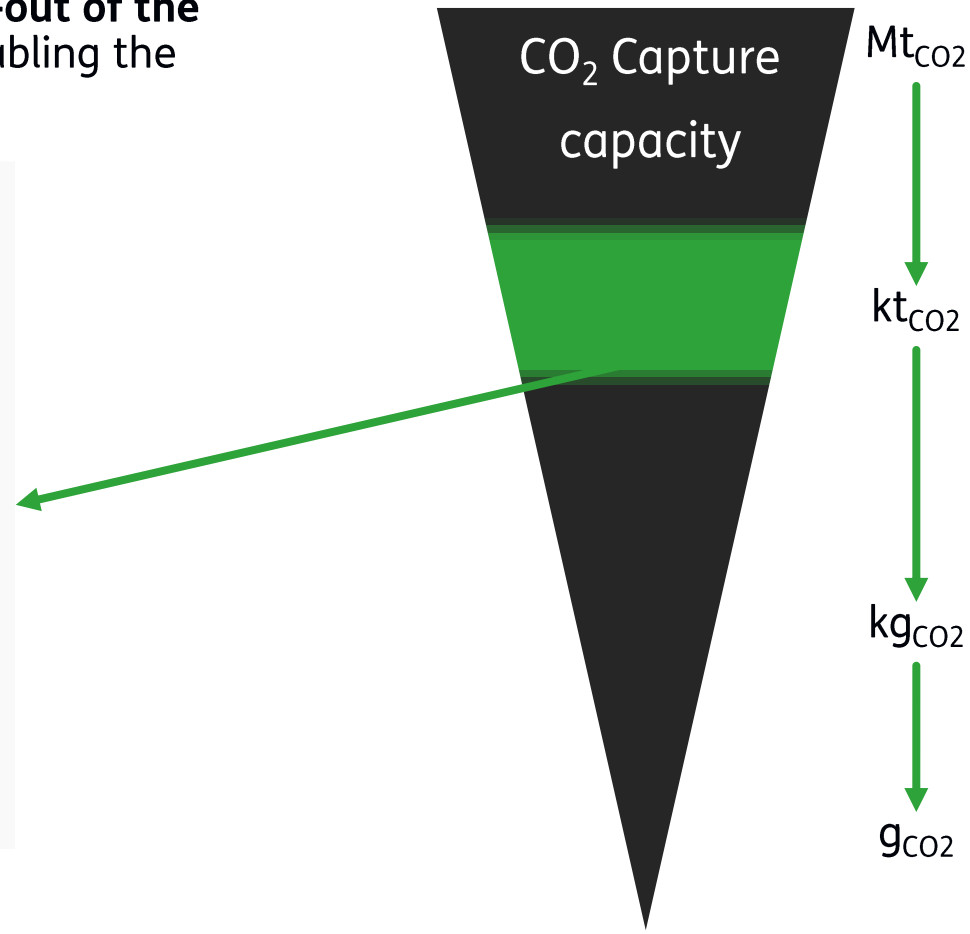
The Green Smith Project : Goals and Outcomes

- Establish a generic **Basic Engineering Design Package for a TRL8 roll-out of the technology** (50 ktonCO2/y from BFG at ADI's site in Taranto, Italy), enabling the replication potential and market diffusion.

Basic Engineering for TRL8 Plant



Example of a plot plan from project STEPWISE



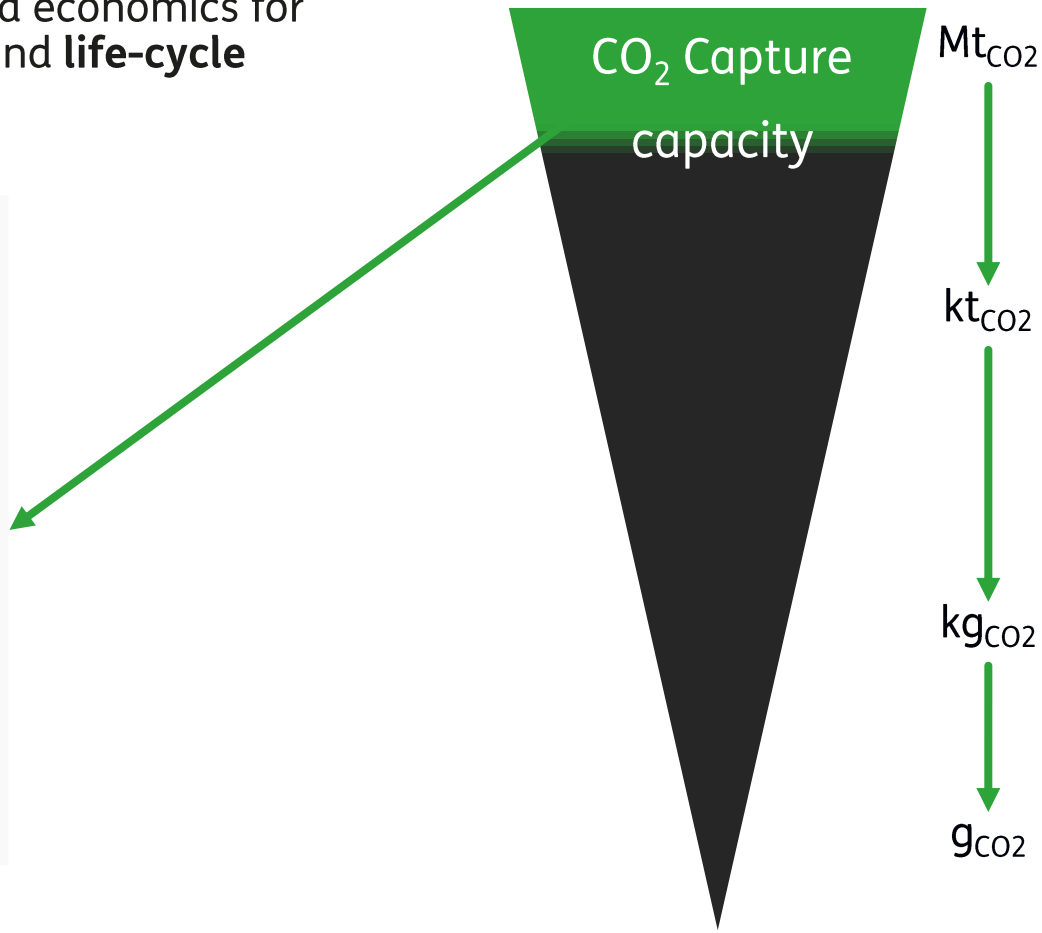
The Green Smith Project : Goals and Outcomes

- Showcasing competitive performance in terms of sustainability and economics for two implementation cases through **full scale techno-economics** and **life-cycle analysis**

Analysis of large-scale application

AdI's Taranto Site

Stegra's Boden Site



NET-ZERO INDUSTRIES MISSION

Green Smith

Partnership

More info at: greensmith-cetp.eu

Acciaierie d'Italia

PAUL WURTH SMS group

TNO innovation for life

Stegra

KISUMA

SWERIM

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Partnership

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