INDUSTRIAL SYMBIOSIS OF STEEL AND FERTILIZER INDUSTRY

STAMICARBON'S ROLE IN CO2 NEUTRALITY THROUGH AMMONIA & UREA PRODUCTION USING STEEL INDUSTRY OFF-GASES

"INITIATE PROJECT"

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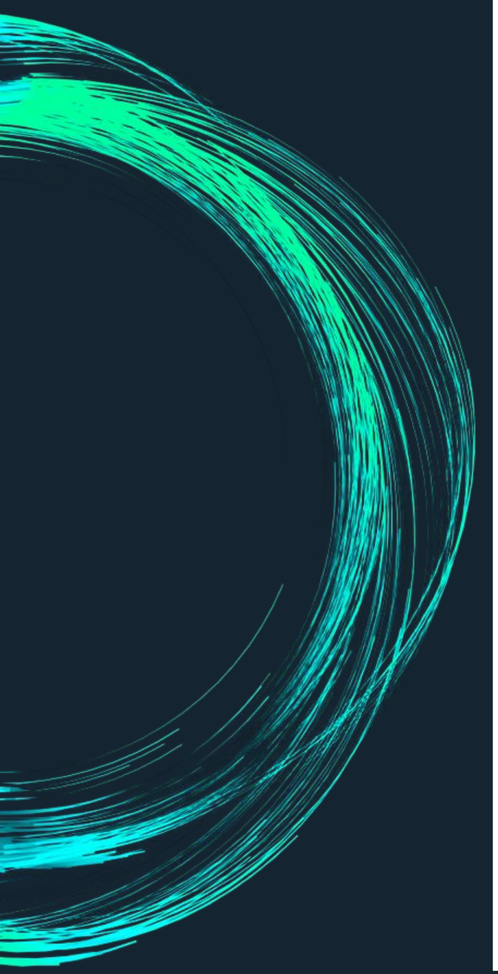
CBAM IMPLIMENTATIONS TIMELINE



October 2023

Transitional period

Importers only have reporting obligations, without financial obligations.

January 2026

Payment start

Importers start to face financial obligations which will ramp up progressively.

By 2030

Extension

EU aims to extend the CBAM to all sectors covered by the blocs Emissions Trading System

2034

Full implementations

The CBAM will reach full effect by 2034 in the initial sectors

Initial sectors covered

Electricity
Hydrogen
Cement
Fertilizers
Aluminum
Iron & steel

Sectors covered by 2030

Oil refining
Upstream
Aluminum
All metals
Pulp & paper
Aviation
Glasses & ceramics
Acids & organic chemicals
Iron & steel
Maritime

[Carbon Border Adjustment Mechanism - European Commission (europa.eu)]

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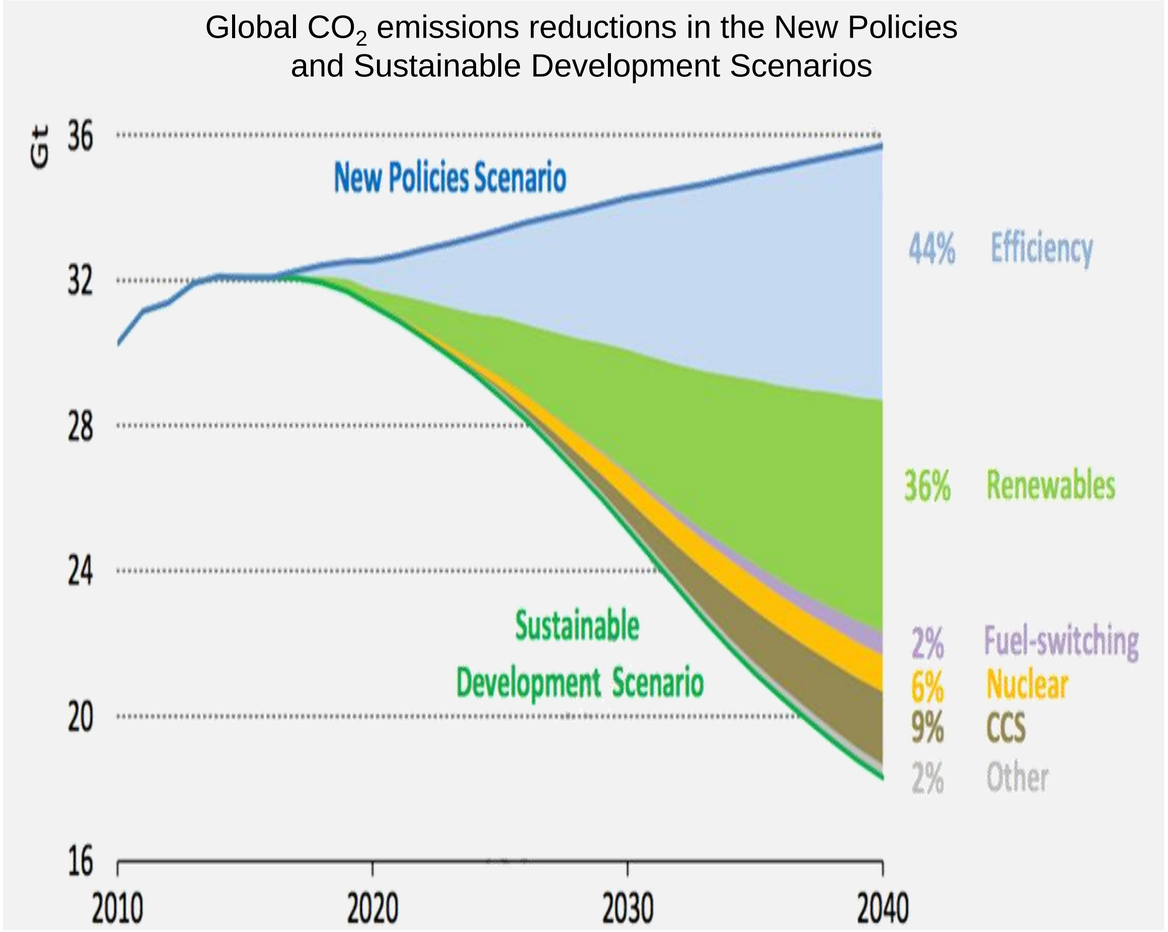
WHY CCUS IN IRON AND STEEL

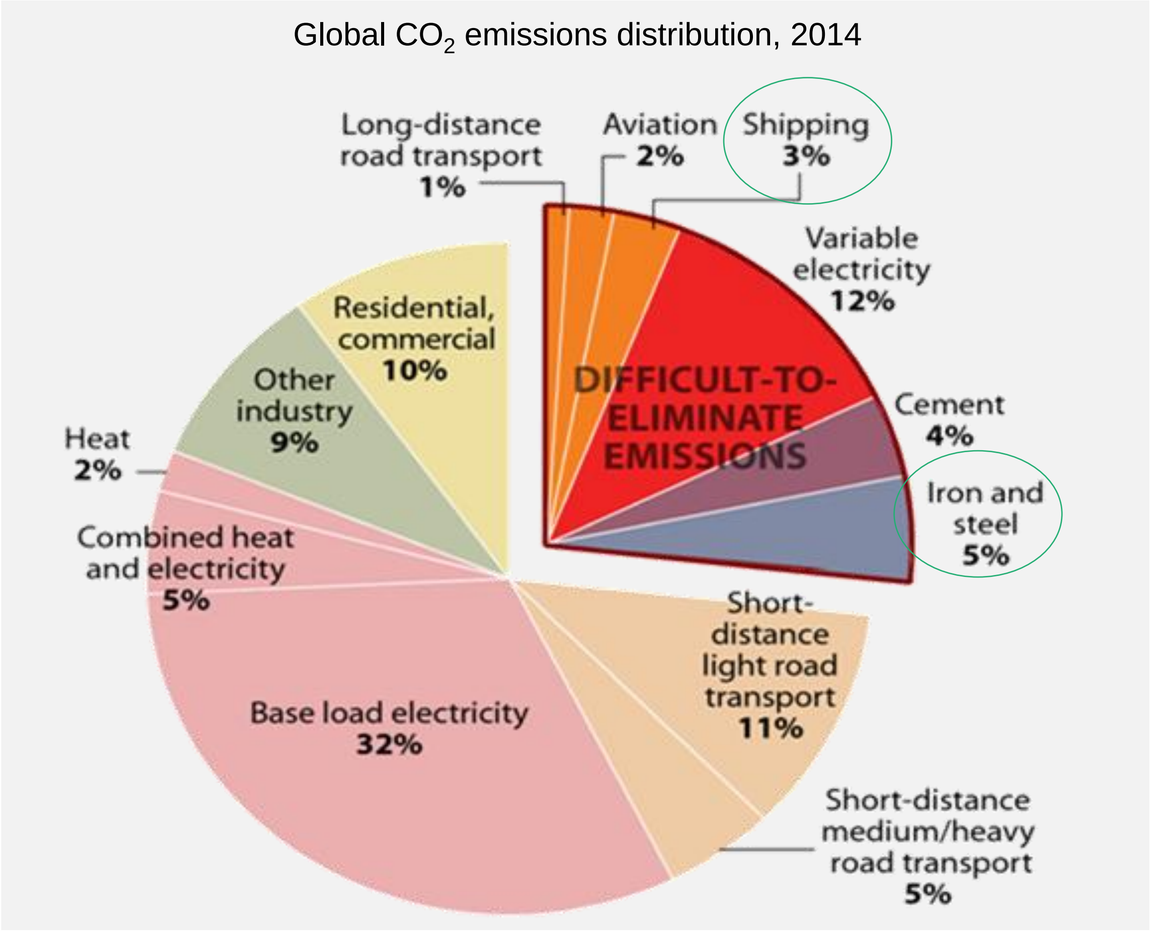
IN ALL SCENARIOS RELATED TO THE Paris goals, CCS AND CCU PLAY a role

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



An important reason for this is that over 25% of CO2 emissions are difficult to avoid with other measures

Global CO_2 emissions distribution, 2014



Source: Maire

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INITIATE IN A NUTSHELL

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CONCEPT

- EU Horizon 2020 Program: Nov. 2020 – Nov. 2025
- 21.3 M€ EU funding
- Focus is to provide decarbonization solutions to hard-to-abate (H2A) industries.
- Industrial symbiosis between iron and steel sector and fertilizer and fuel sector by ammonia and/or urea production.

VISION

- Create bankable case for a first commercial size demonstrator at a scale of 50 kt/y urea production capacity on the basis of Basic Oxygen Furnace Gas (BOFG) directly from the steel mill.

ROUTE

- Demonstration of continues production of decarbonized NH_3 from BOFG at 1.3 t_{NH3}/d scale
- Site identification
- Business plan development, IP&R, ownership, collaboration.

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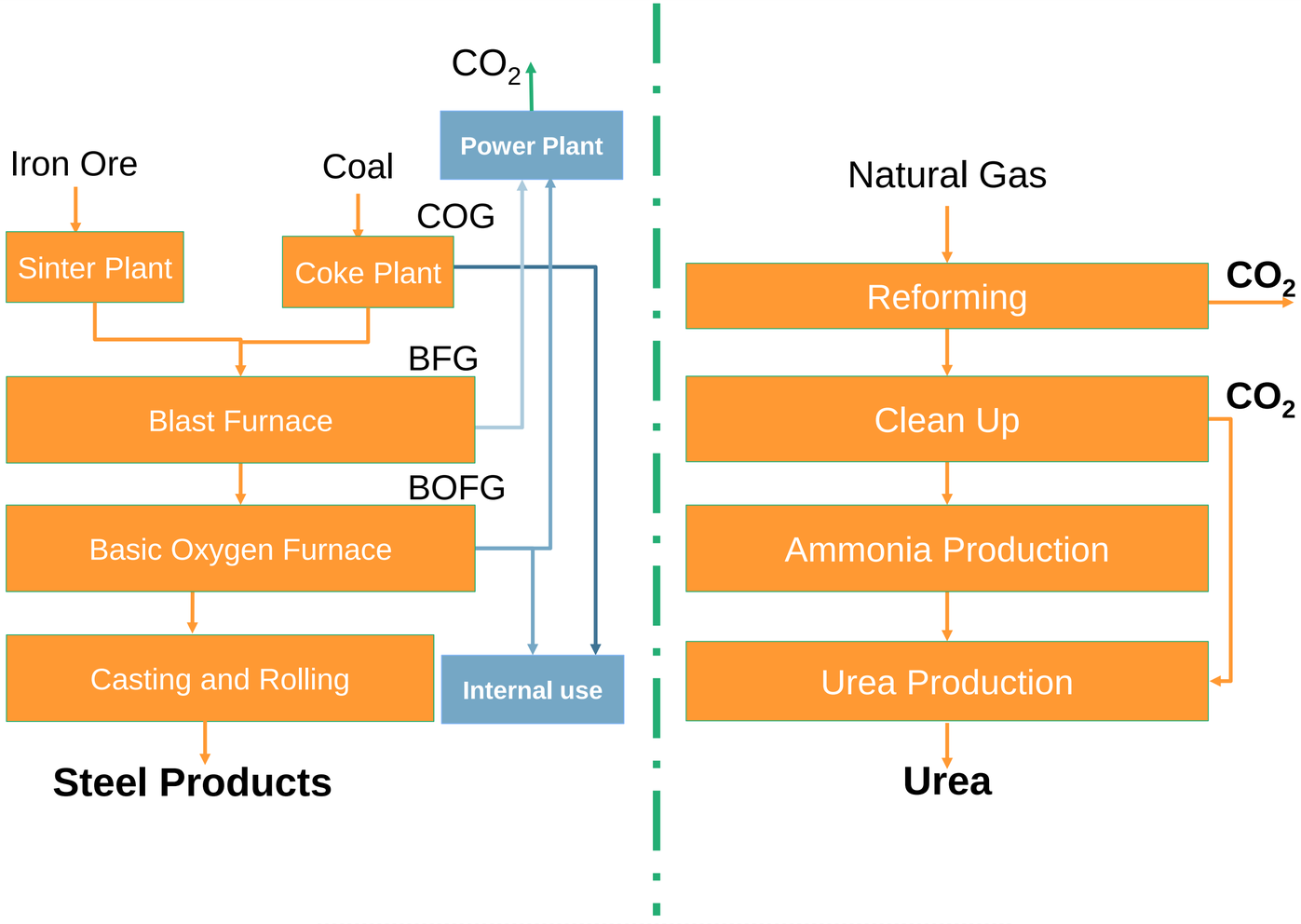
MULTIPLE ROUTES TOWARDS CO_2 NEUTRALITY

2 t_{CO2}/t_{HRC}

- Coal → NG, H_2
- CO_2 capture
- More scrap
- Efficiency



1.8 t_{CO2}/t_{NH3}

- CO_2 capture
- Green H_2

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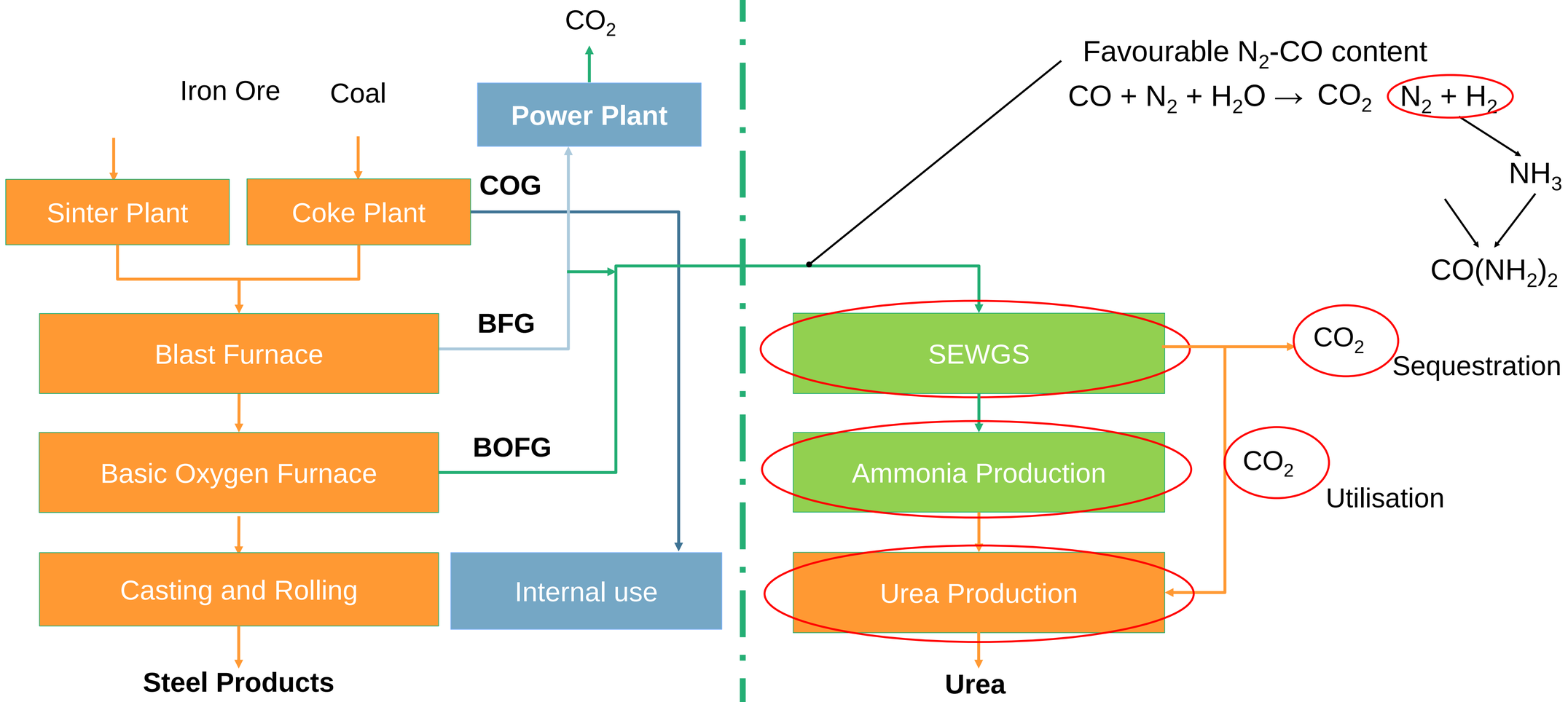
INITIATE INDUSTRIAL SYMBIOSIS



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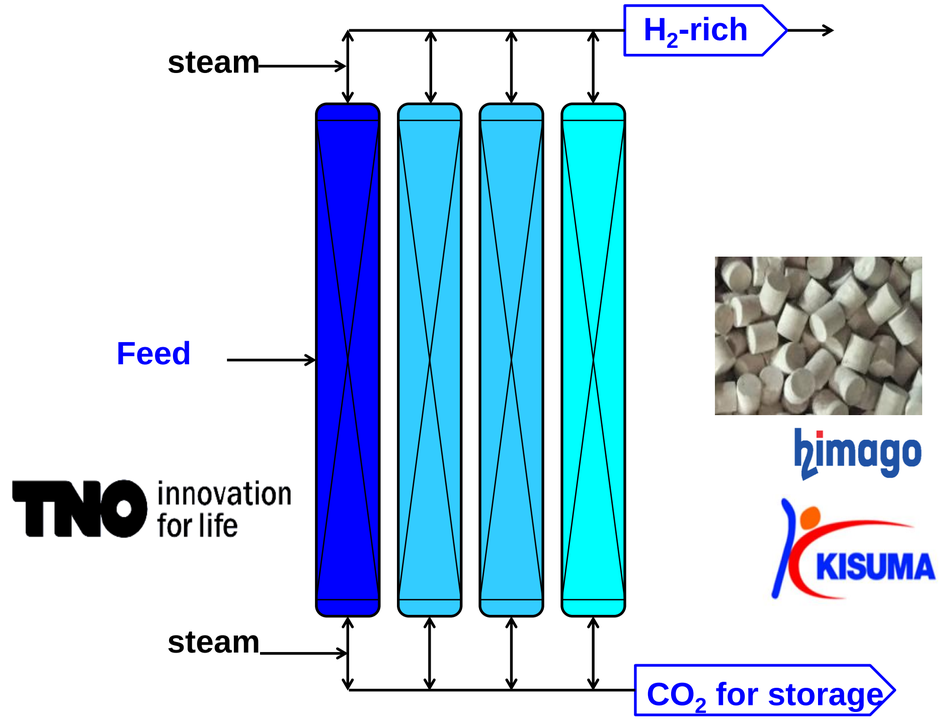
ENABLING TECHNOLOGIES

SORPTION ENHANCED WATER GAS SHIFT - SEWGS

- Combining CO_2 separation with WGS reaction
- Kisuma industrially sourced solid adsorbent
- Optimizing N_2/N_2 while removing CO_2
- Minimization of energy requirement



SUB-STOICHIOMETRIC NH_3 SYNTHESIS

- Stami Green Ammonia converter – 5 mtpd
- Suitable for variable H_2/N_2 ratio
- Simplification of knock-out and recycle
- Suitable for dynamics

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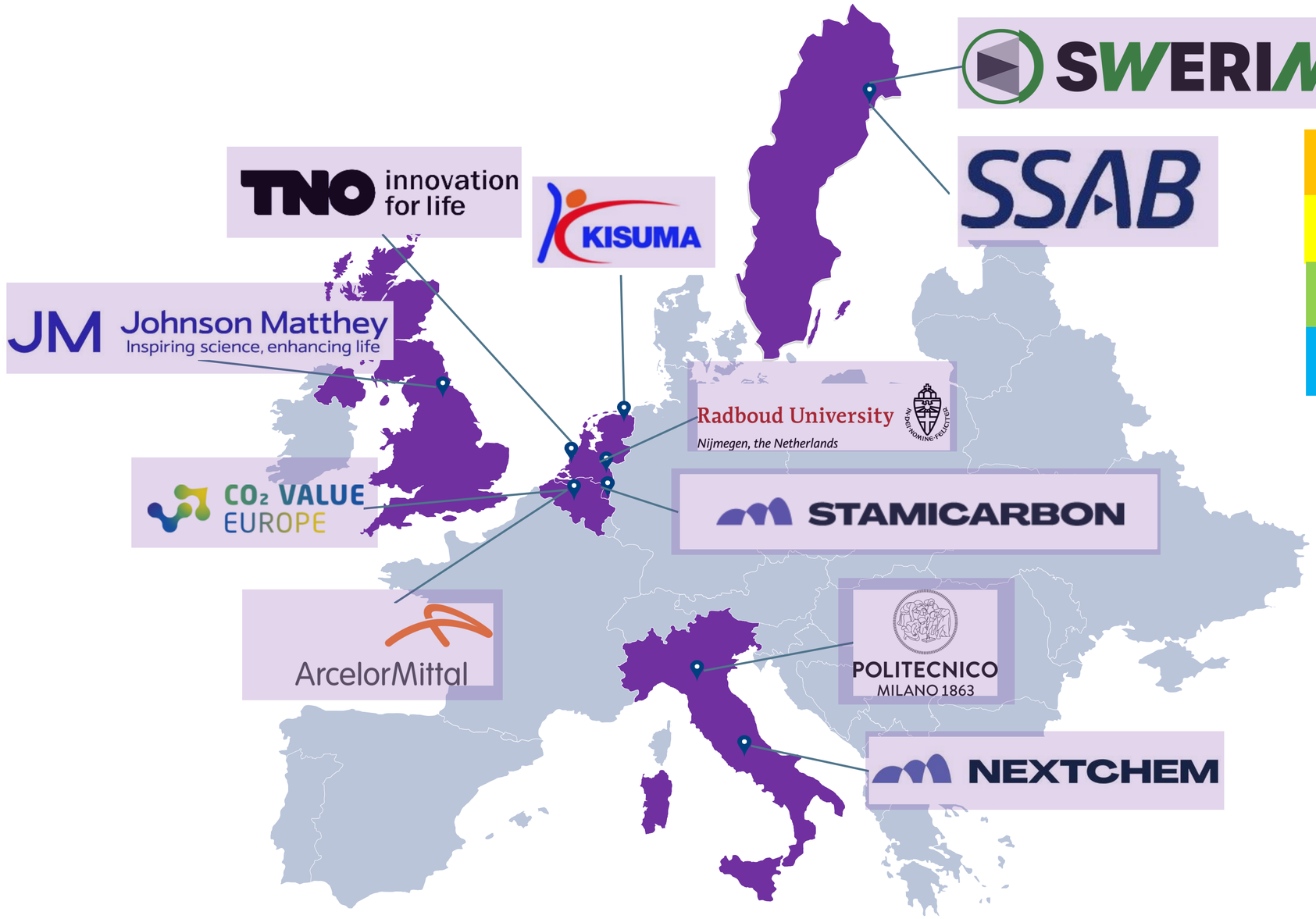
INITIATE- PARTNERSHIP



Materials and equipment

Technology licensors

End-users

Knowledge support

5 years
Nov. 2020 – Nov. 2025

21.3 M€ EU funding

958318
H2020-LCCI-2020-EASME
A.SPIRE

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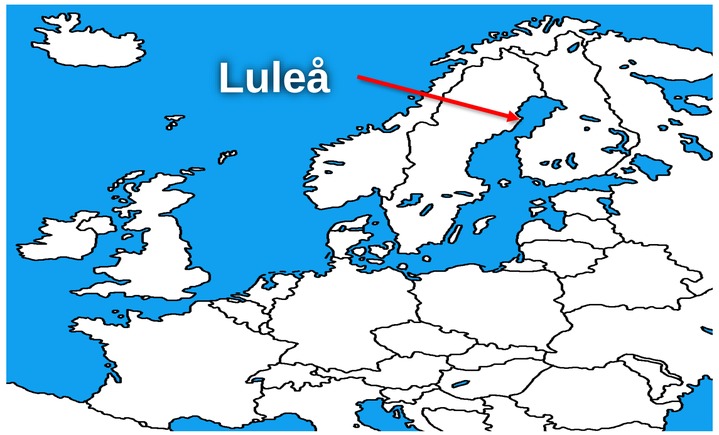
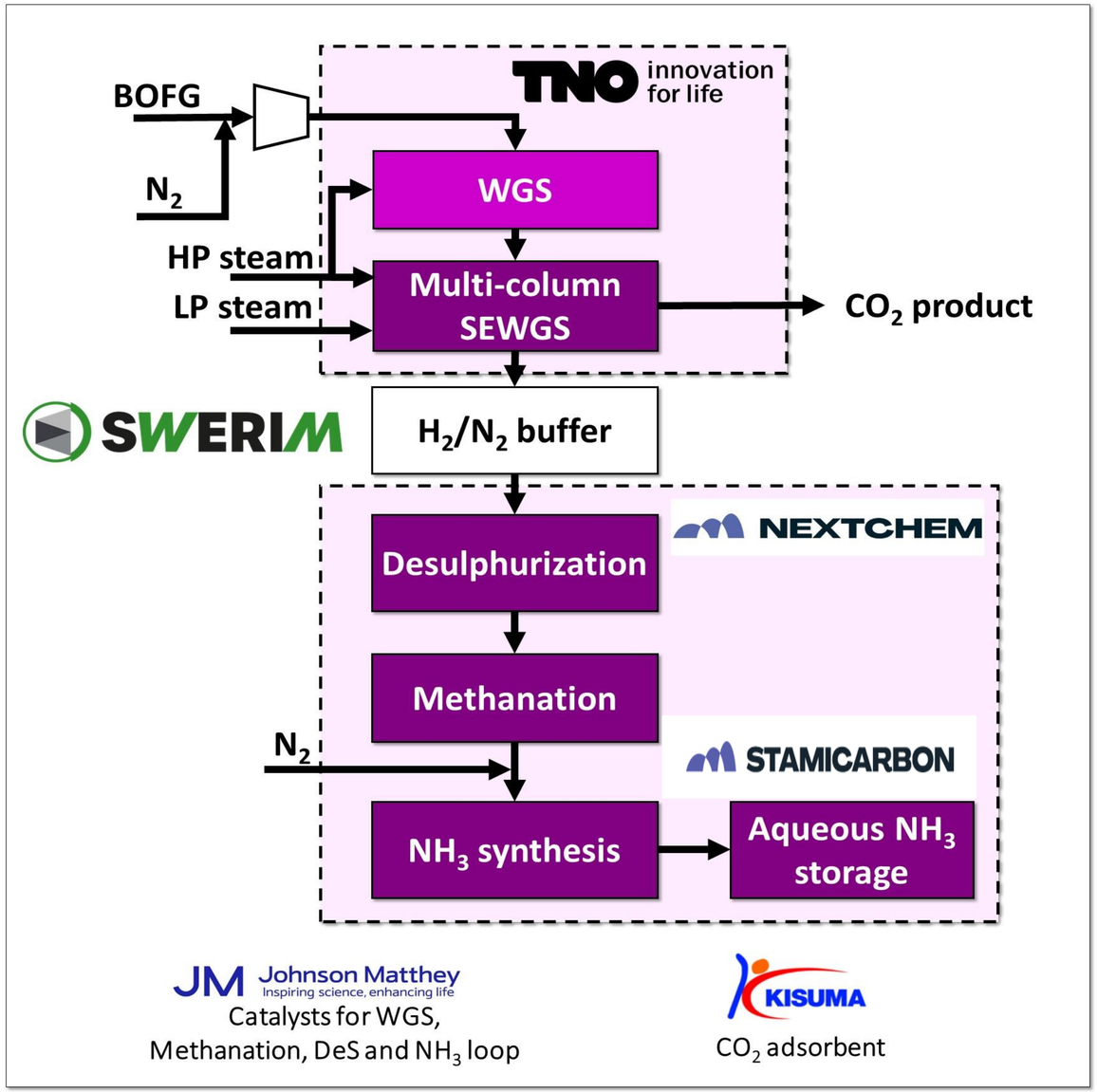
PROCUREMENT & CONSTRUCTION





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PROCUREMENT & CONSTRUCTION

Pilot capacity

400 Nm^3/h BOFG
2.8 t_{NH3}/d (1.3 t_{NH3}/d demonstration)
8.3 t_{co2}/d

Hoisting the WGS reactor into place

Positioning of SEWGS reactor 1

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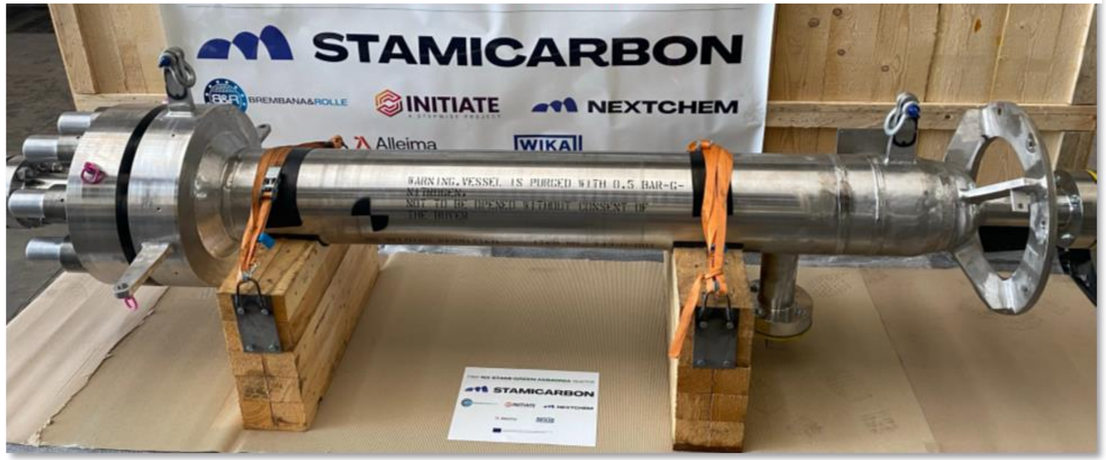
THIS IS WHAT IT SHOULD LOOK LIKE

Utility rooms installation

BOFG filtration & sampling station and pipeline

BOFG compressor upgrade



NH_3 reactor

Functional materials in production and delivery

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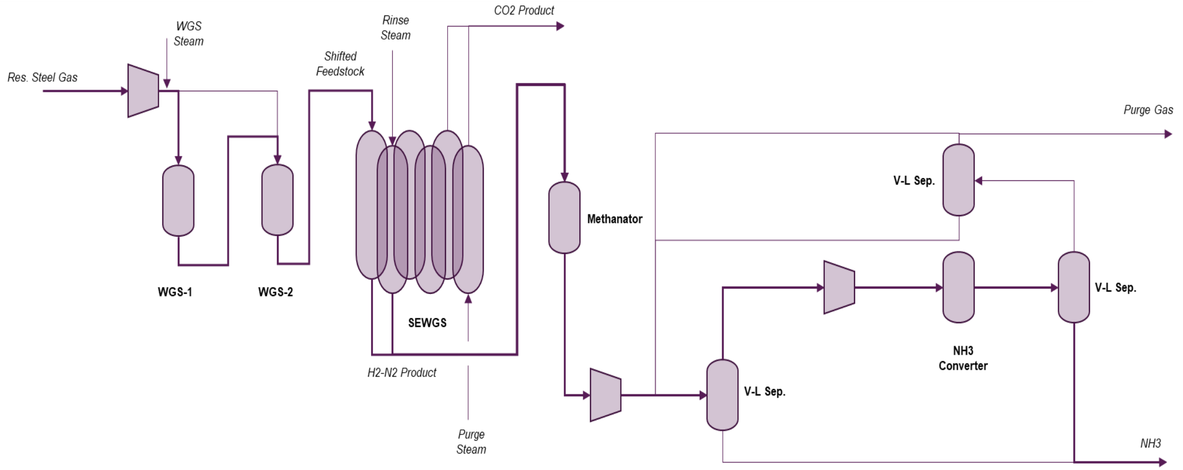
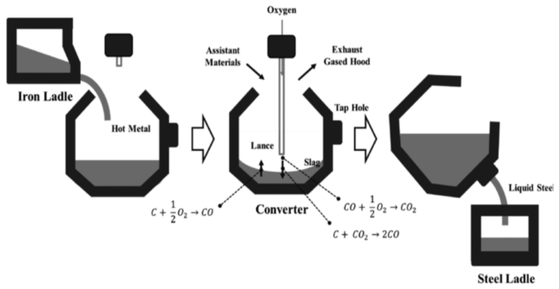
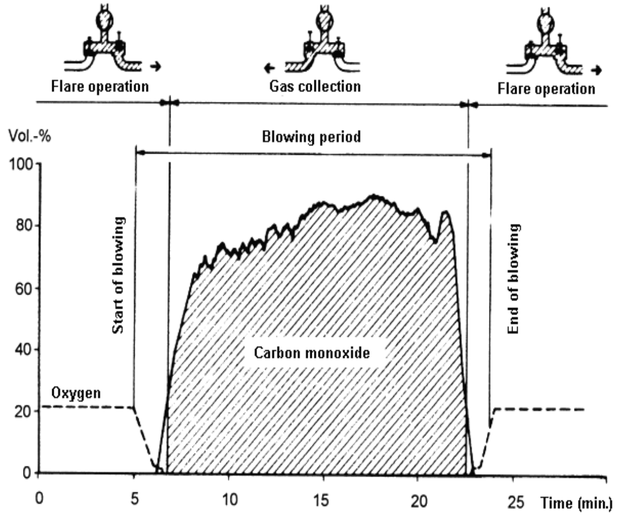
CHALLENGE: BOFG DYNAMICS

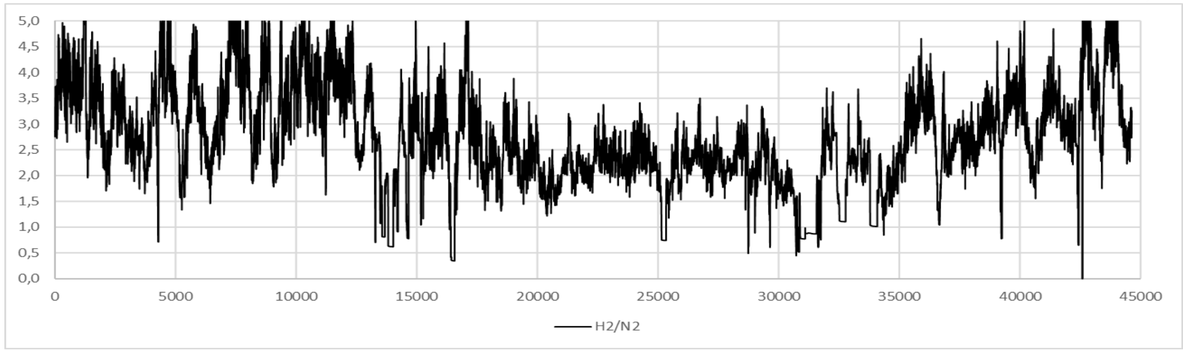
ADVANCED CONTROL

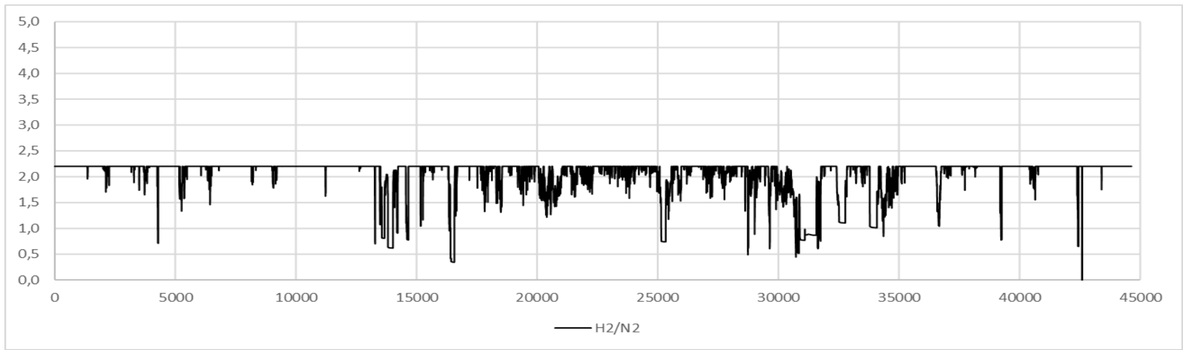
- Creation of digital twin for advanced control strategies
- Quantification through piloting and TEA











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TECHNO ECONOMIC ANALYSIS

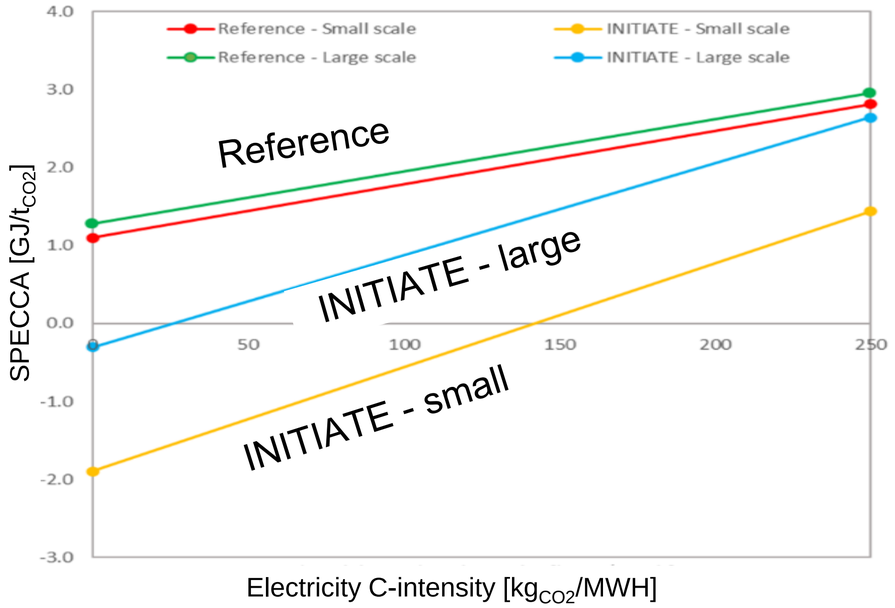
COMPARISON OF CASES

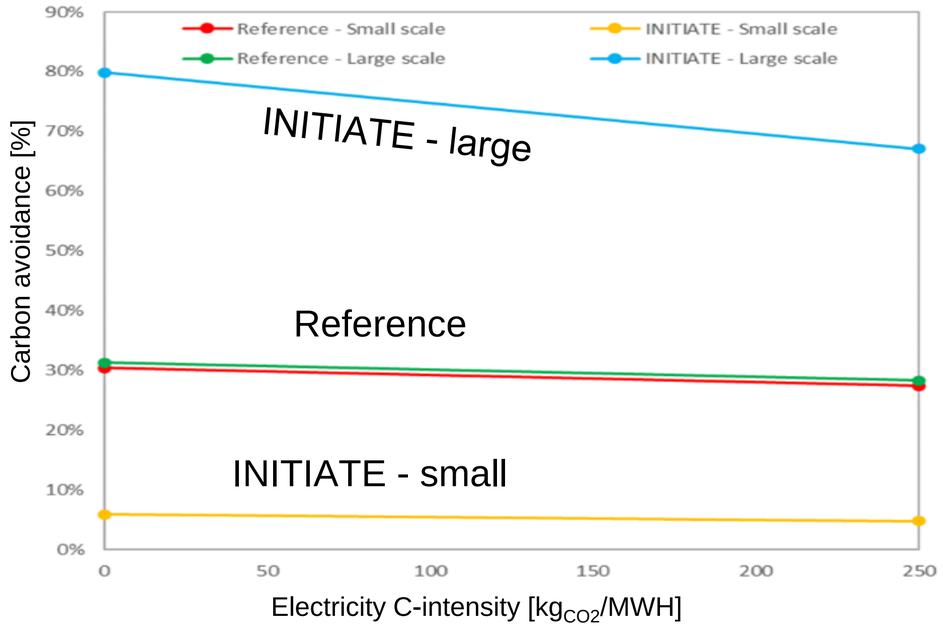
- Base — Stand-alone Steel and NH_3/Urea
- Reference — Stand alone Steel and NH_3/Urea with amine-based CCS
- INITIATE — Integrated Steel and NH_3/Urea with CC-S&U

small: BOFG
large: BFG+BOFG

Primary energy intensity can be significantly reduced

Carbon footprint reduction up to 80%





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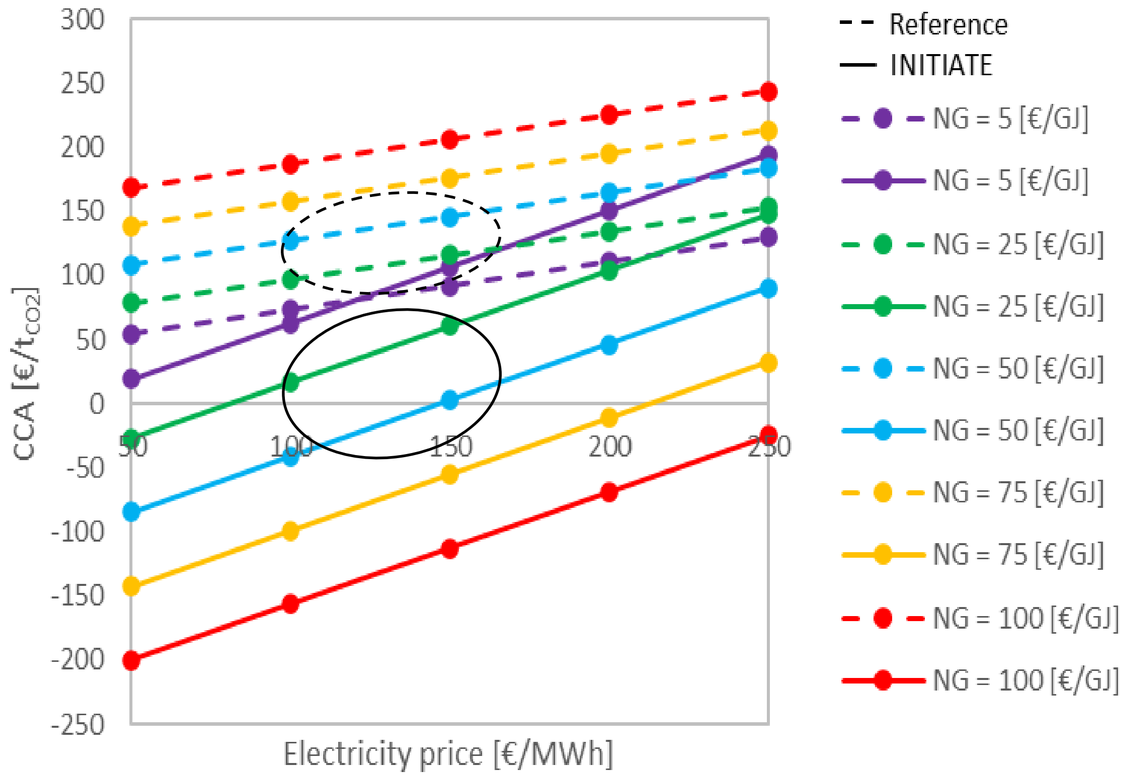
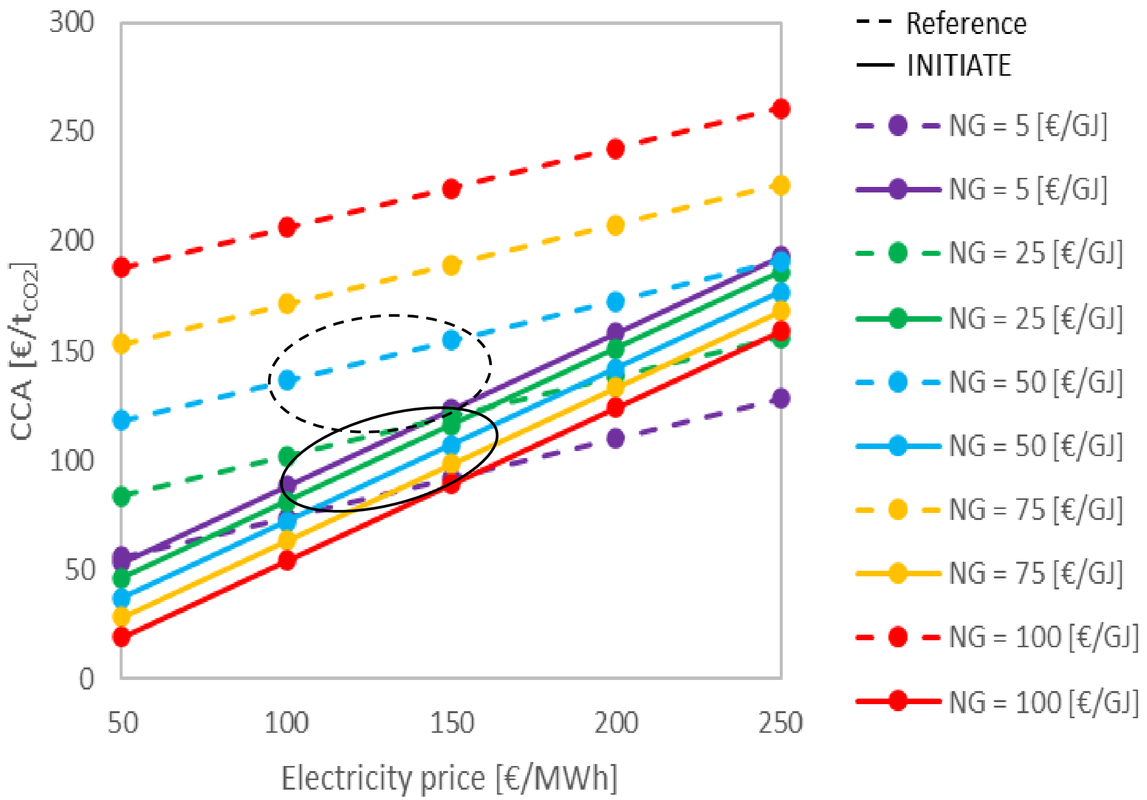
TECHNO ECONOMIC ANALYSIS

Small scale - BOFG



Large scale - BFG+BOFG



UREA production cost can be significantly reduced and negative cost of CO_2 avoided achieved

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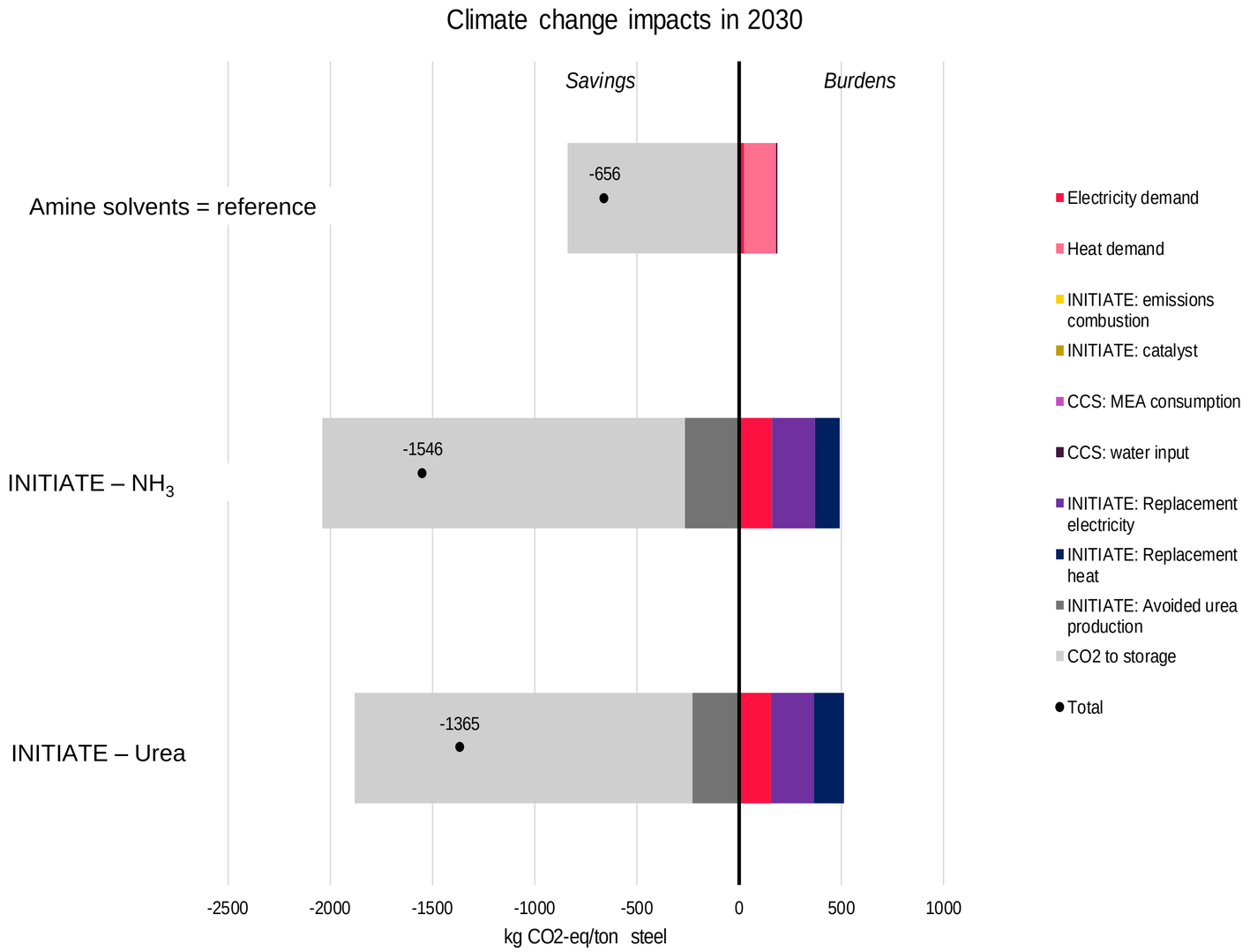
LIFE CYCLE ANALYSIS

Reference case and INITIATE cases relative to the base case

Base	=	Current industries
Reference	=	Stand alone Steel and NH_3/Urea with amine-based CCS
INITIATE	=	Integrated Steel and NH_3/Urea with CC-S&U



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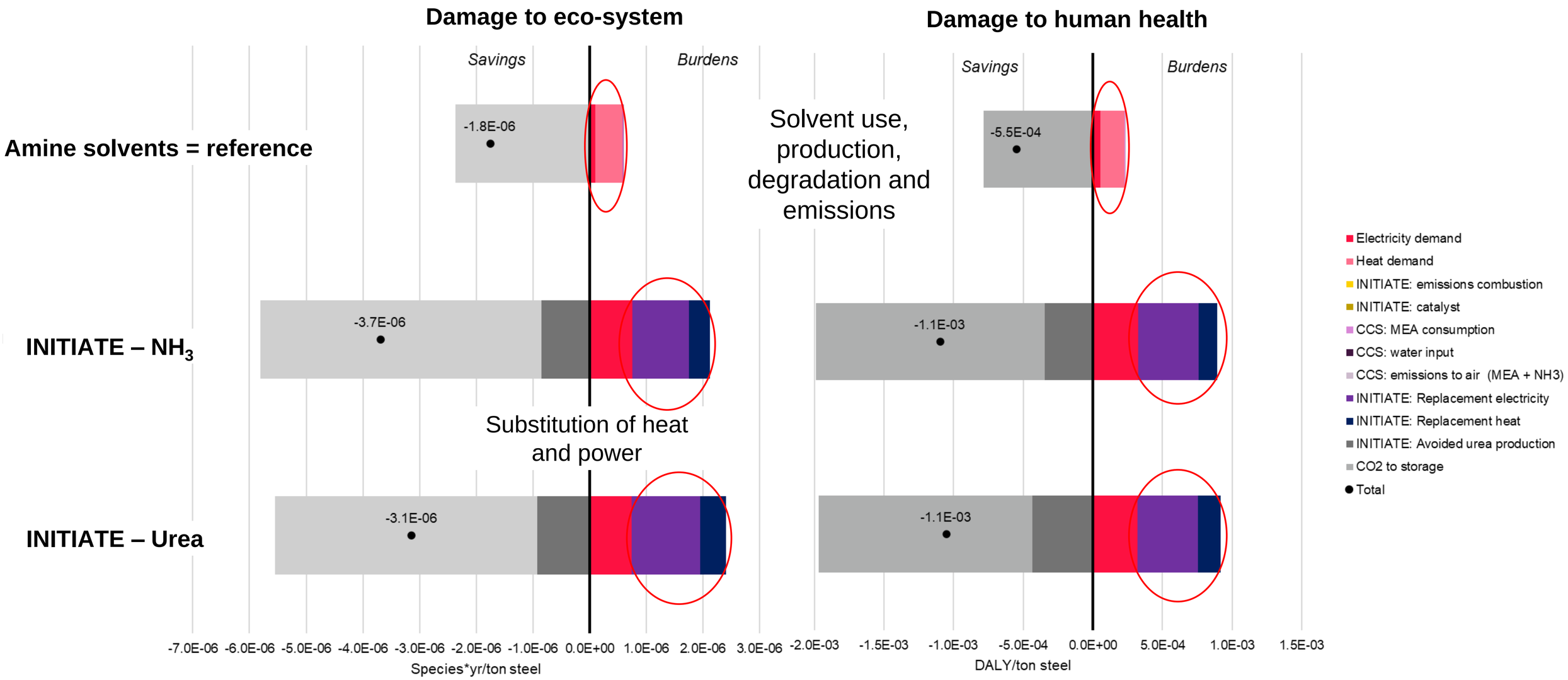

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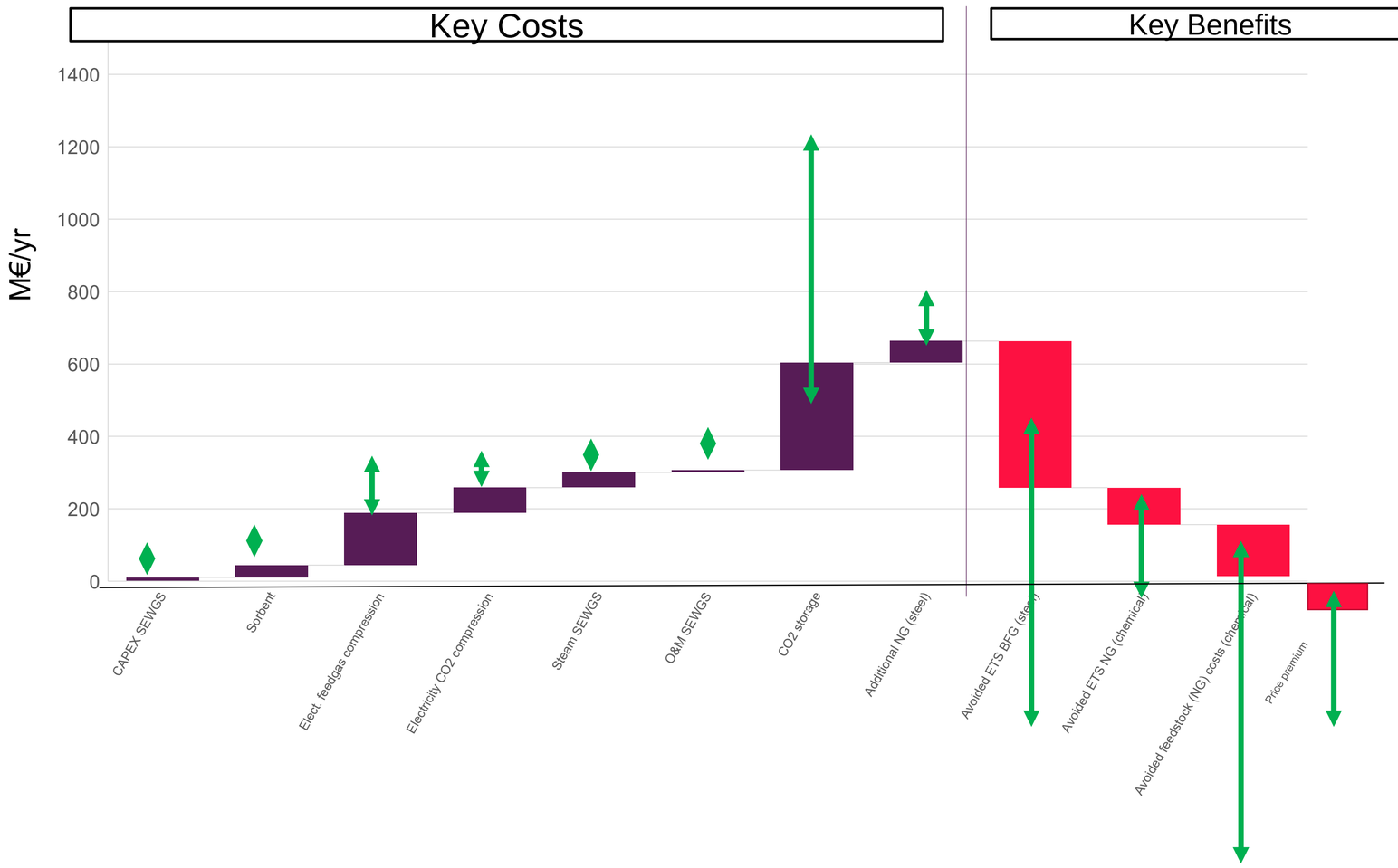
KEY COSTS DRIVERS & UNCERTAINTIES



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)

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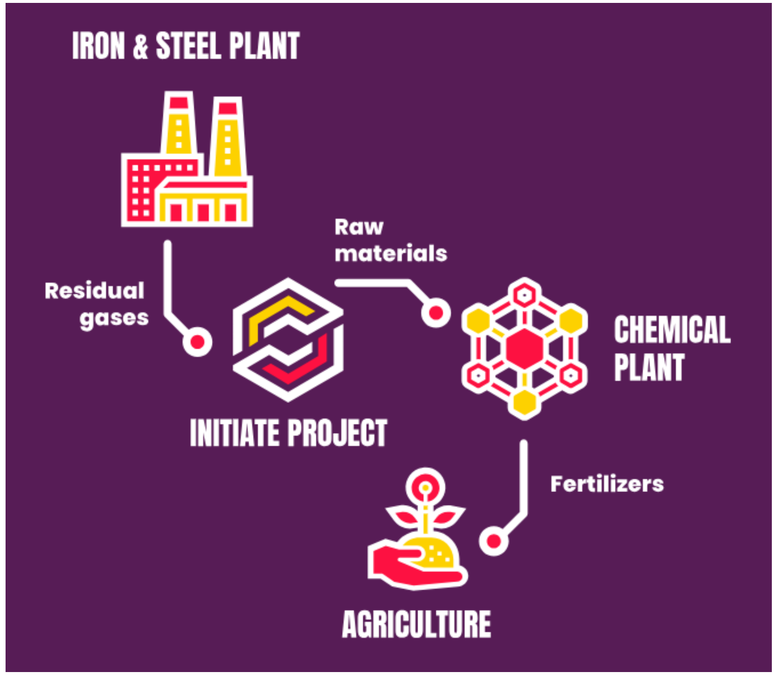
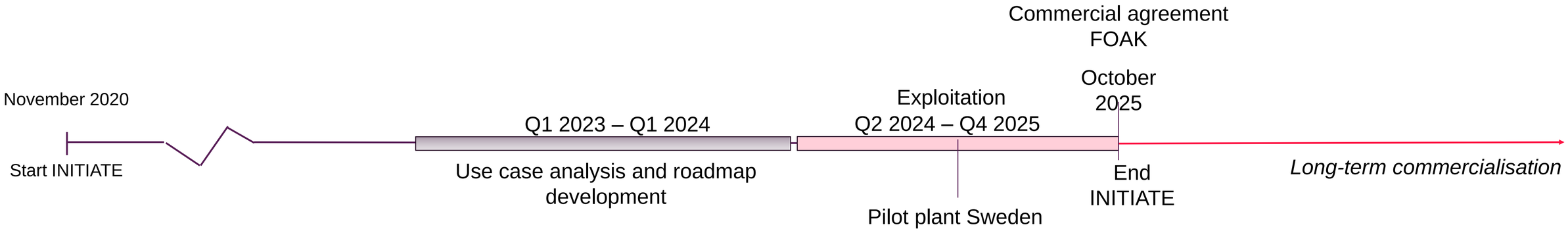
COMMERCIAL IMPLIMENTATION PLAN



Focus: long-term implementation plan including a collaborative strategy to align stakeholders' needs

Through the definition of the FOAK and the long-term vision



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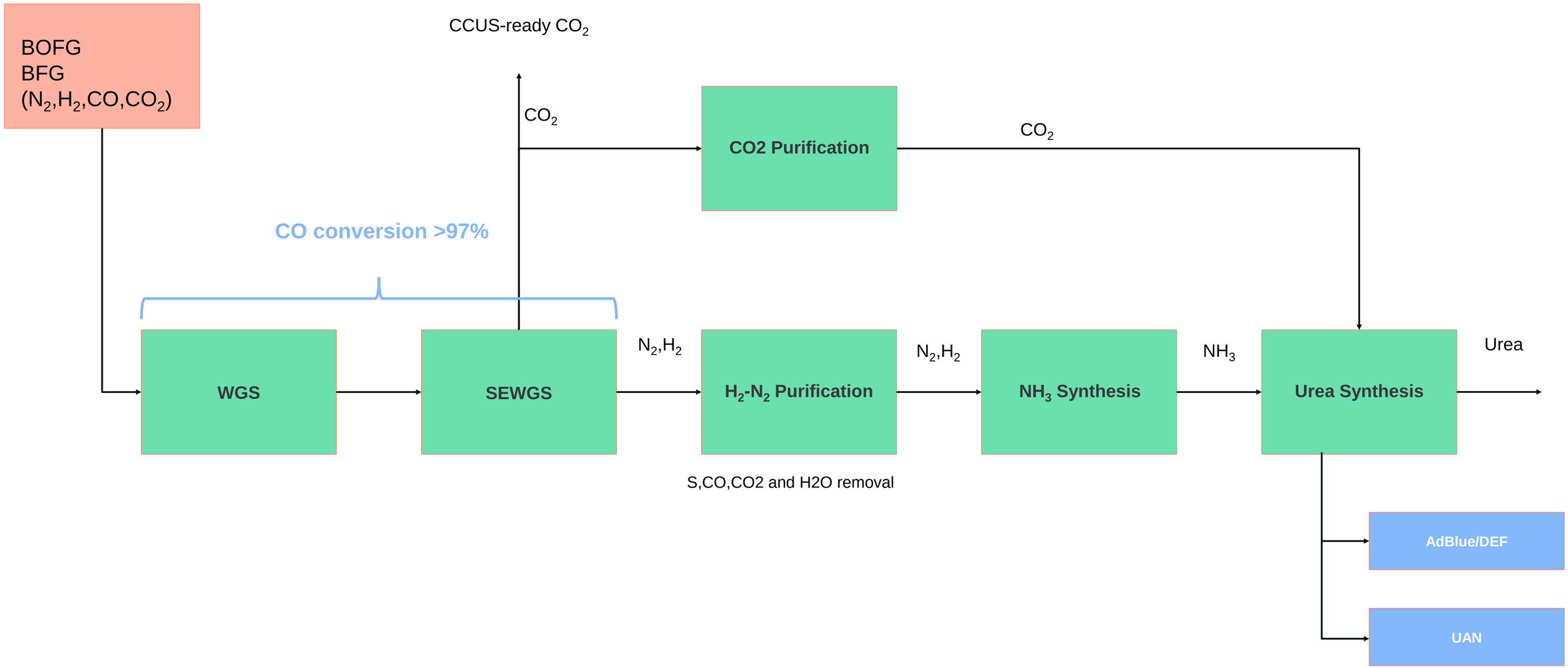

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