INITIATE
A STEPWISE PROJECT

BOFG to Urea in the INITIATE project: industrial symbiosis between the steel and chemical industry

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The INITIATE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 958318

PUBLIC

INITIATE project concept and vision

CONCEPT

- Industrial symbiosis between iron and steel sector and ammonia/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 BOFG

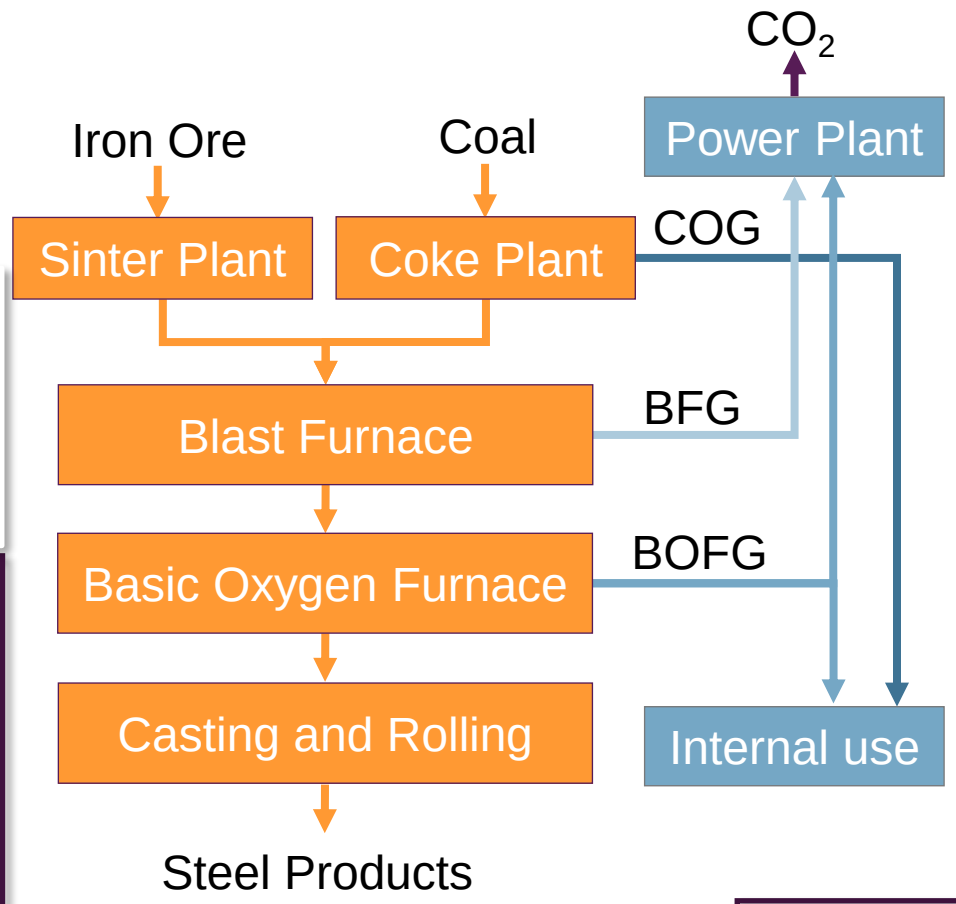
ROUTE

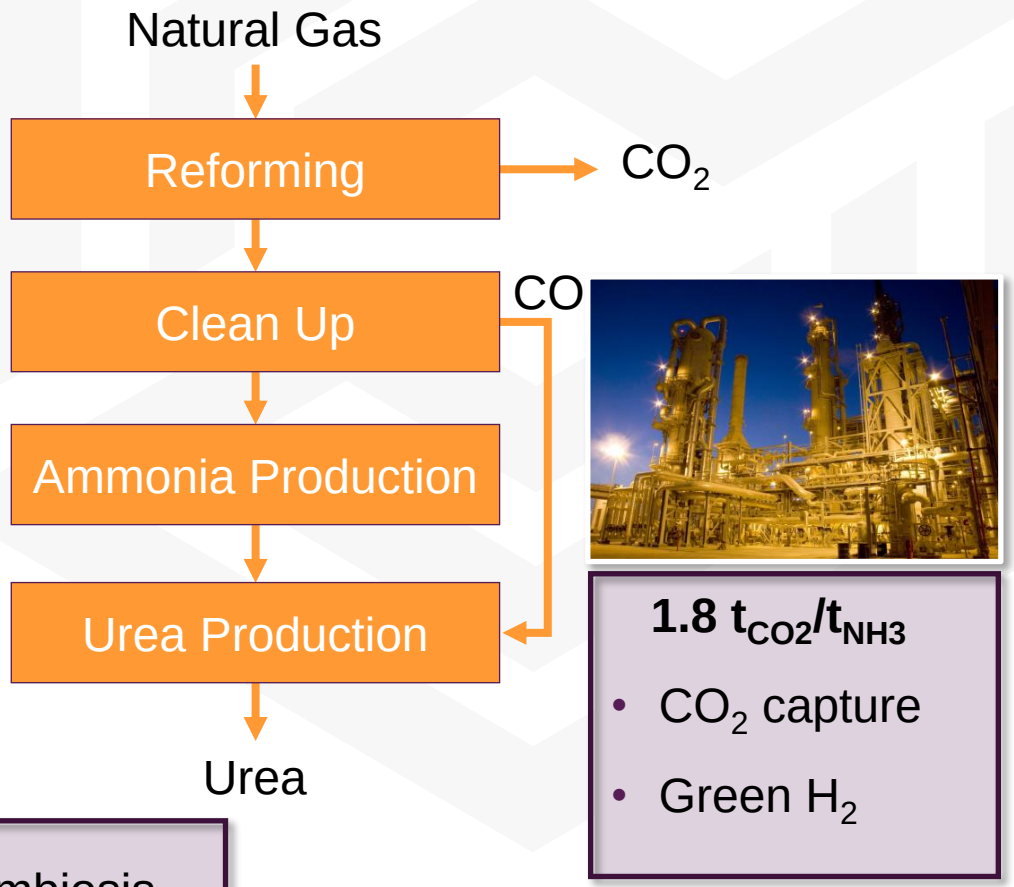
- The INITIATE project takes all the steps required to develop the FOAK plant
  - Demonstration of continues production of NH_3 from BOFG at 2.5 t_{NH3}/d scale
  - Site identification
  - Business plan development
  - IP&R, ownership, collaboration

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}

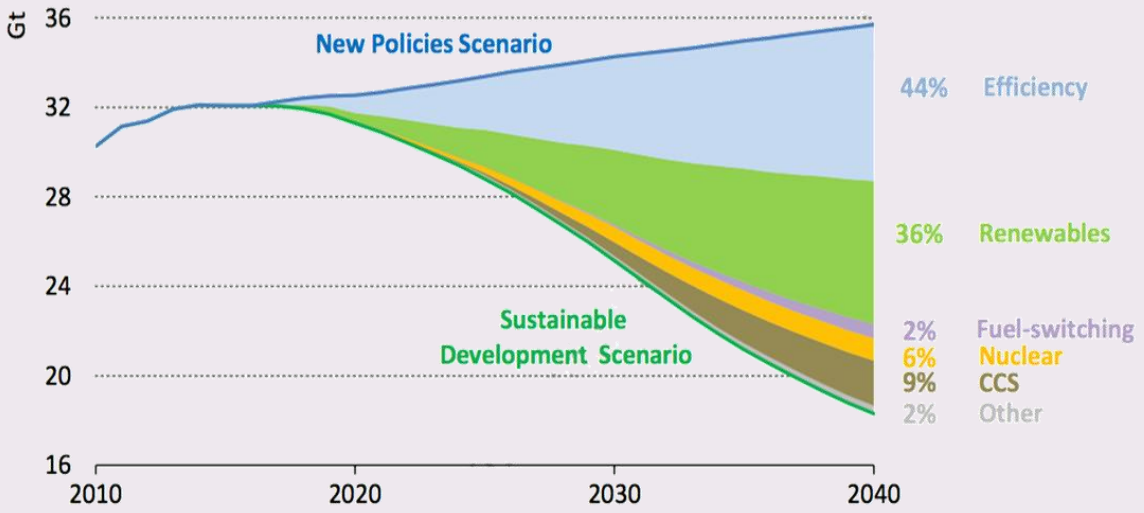
- CO_2 capture
- Green H_2

Industrial Symbiosis

Why CCS and CCU in Iron and Steel ?

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

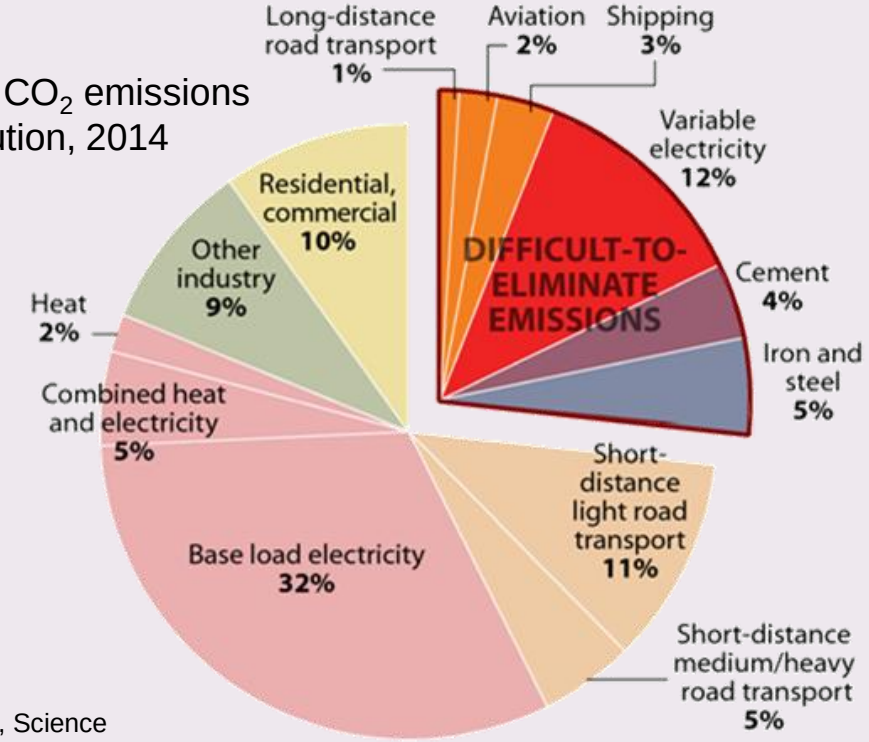
Global CO_2 emissions reductions in the New Policies and Sustainable Development Scenarios



2017 IEA - World Energy Outlook

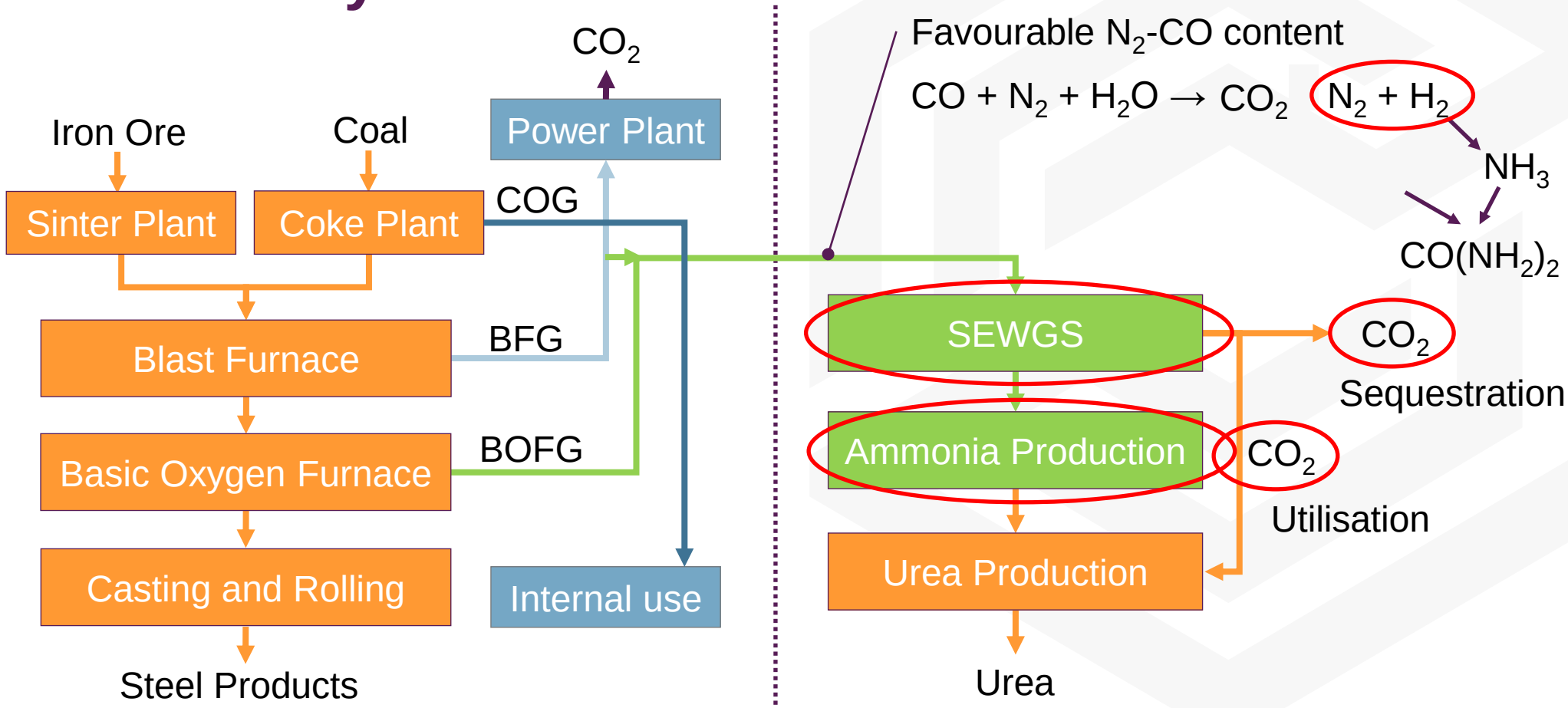
AN IMPORTANT REASON FOR THIS IS THAT OVER 25% OF CO_2 EMISSIONS ARE DIFFICULT TO AVOID WITH OTHER MEASURES

Global CO_2 emissions distribution, 2014



Davis et al, Science

INITIATE Industrial symbiosis



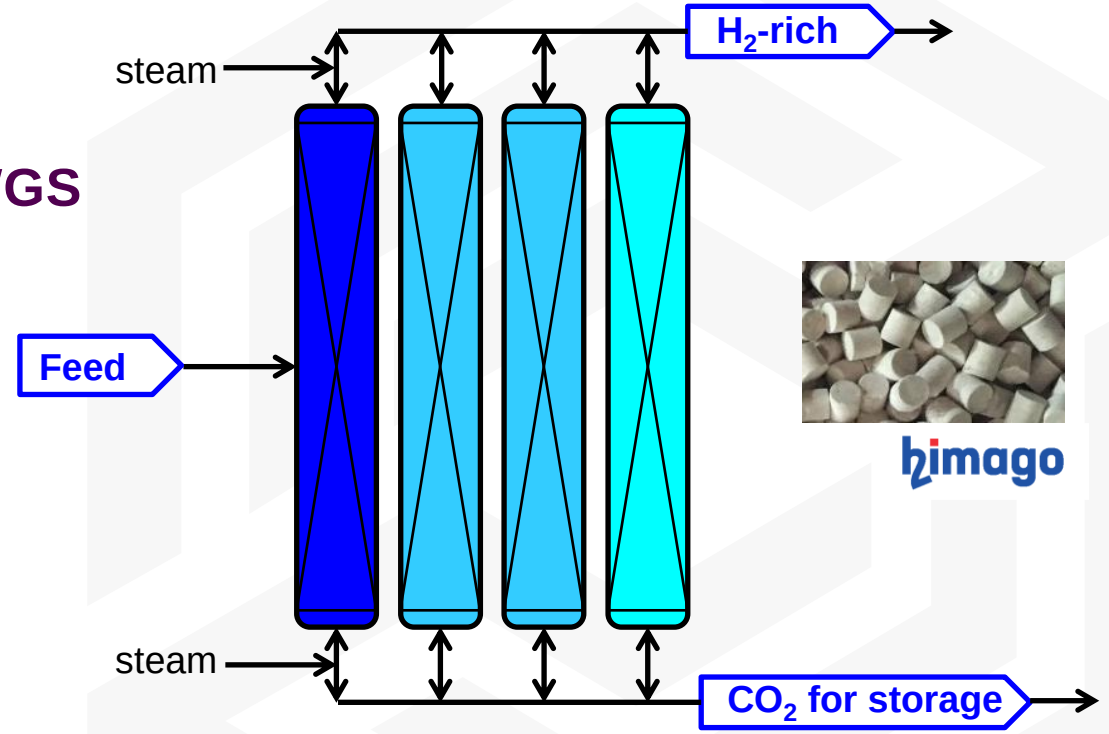
Enabling technologies

SORPTION ENHANCED WATER GAS SHIFT - SEWGS

- TNO development
- 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

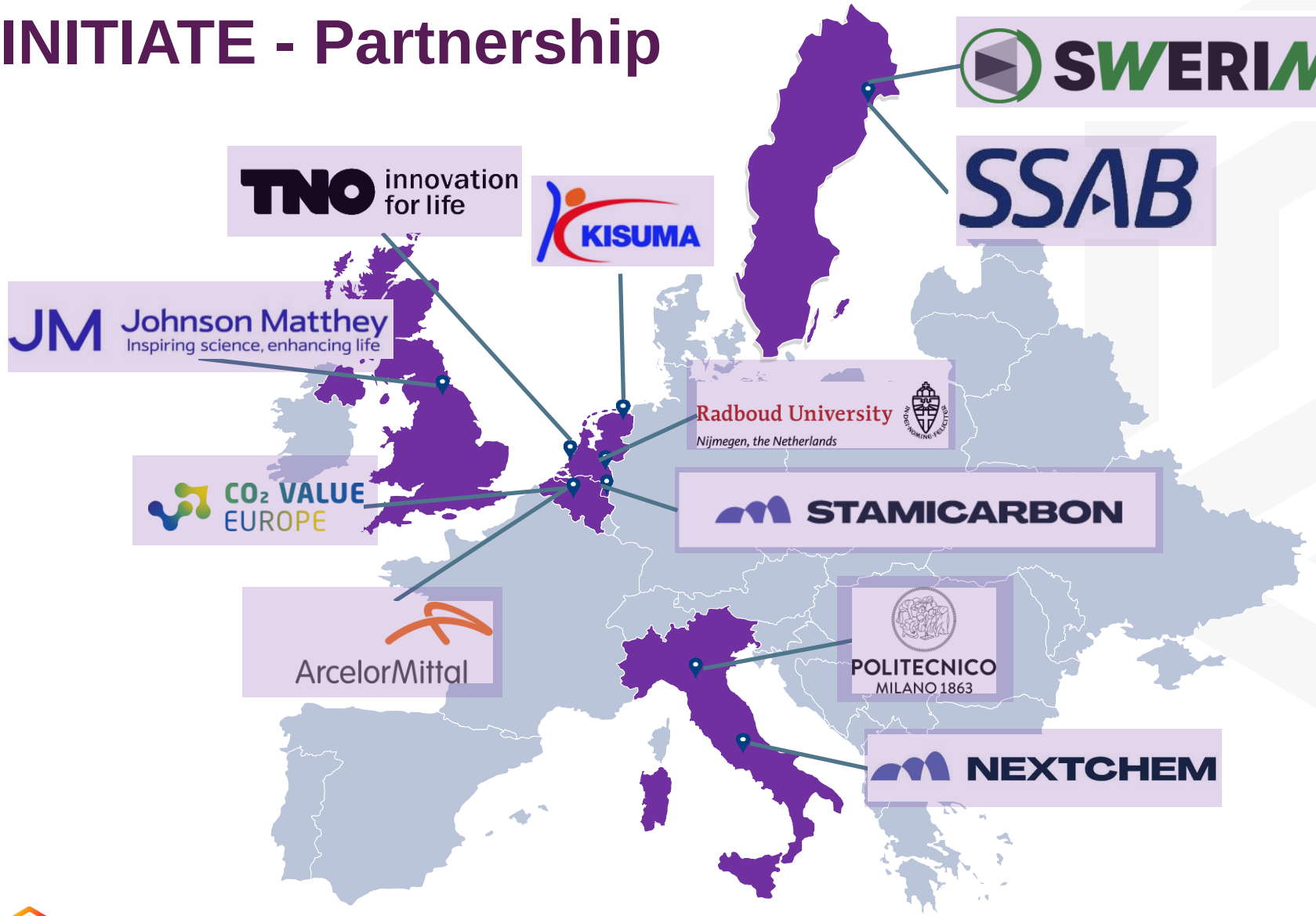
SUB-STOICHIOMETRIC NH_3 SYNTHESIS

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



himago

INITIATE - Partnership



Materials and equipment

Technology licensors

End-users

Knowledge support

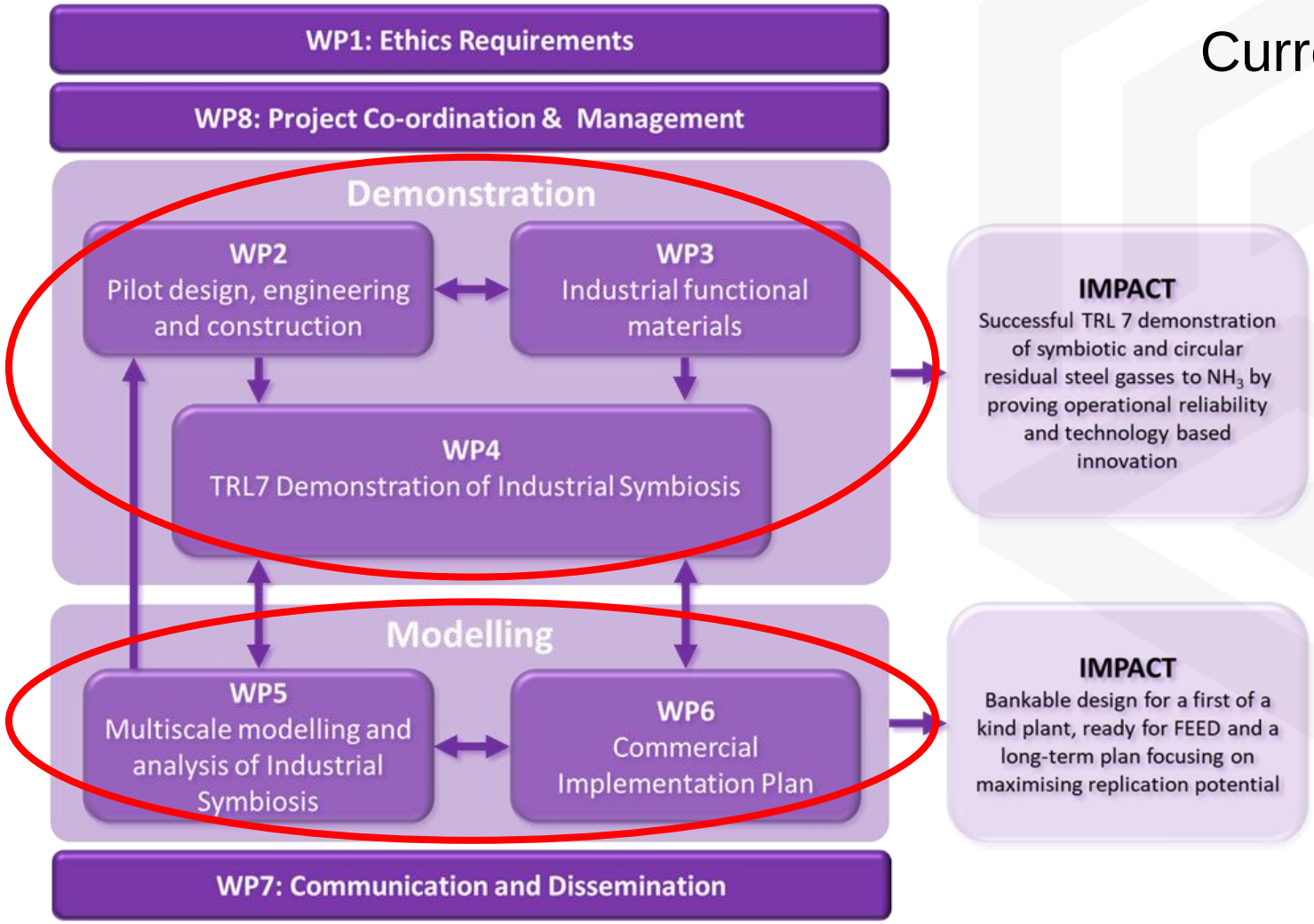
5 years
Nov. 2020 – Nov. 2025

21.3 M€ EU funding

958318
H2020-LCCI-2020-EASME
A.SPIRE

INITIATE – Project structure

Currently month 40/60



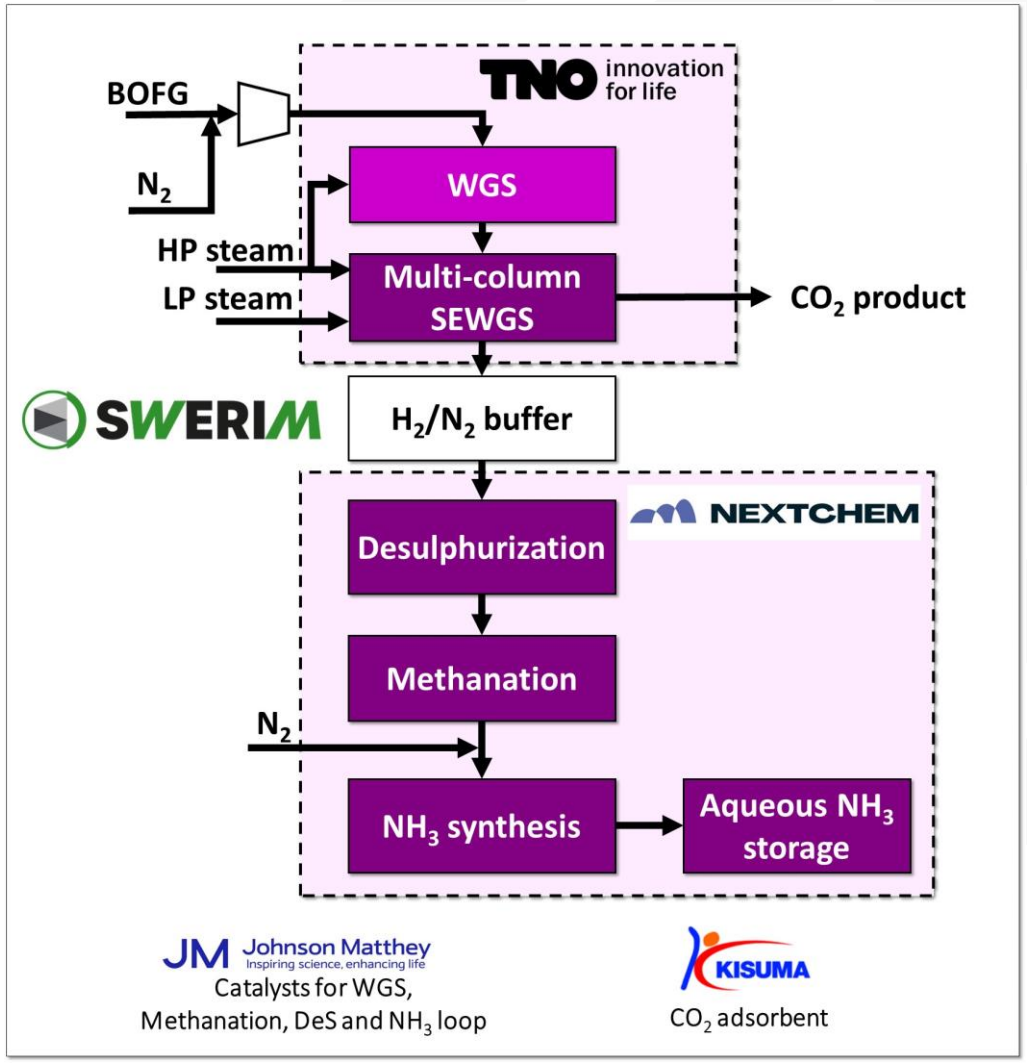
Technology demonstration

PILOT CONSTRUCTION

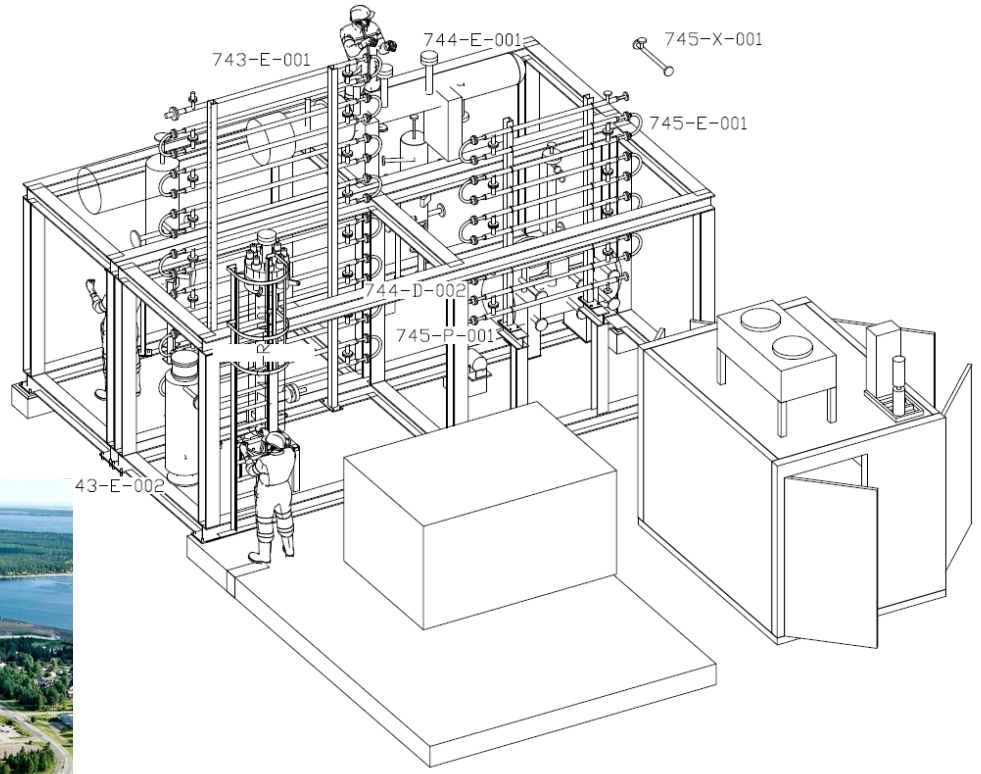
- Capacity 400 Nm^3/h BOFG for 2.6 t_{NH3}/d
- Design finalized
- Procurement and construction on-going

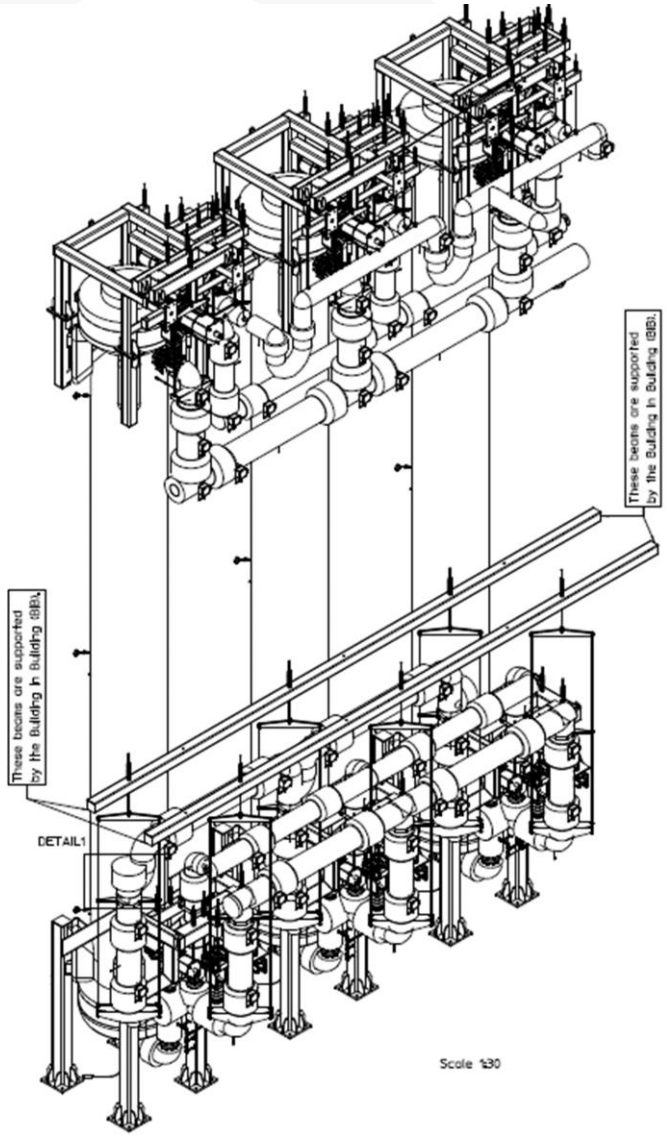
MAIN CHALLENGES

- Inflation driven cost increase
  - Scope reduction to 1.3 t_{NH3}/d



Procurement and construction

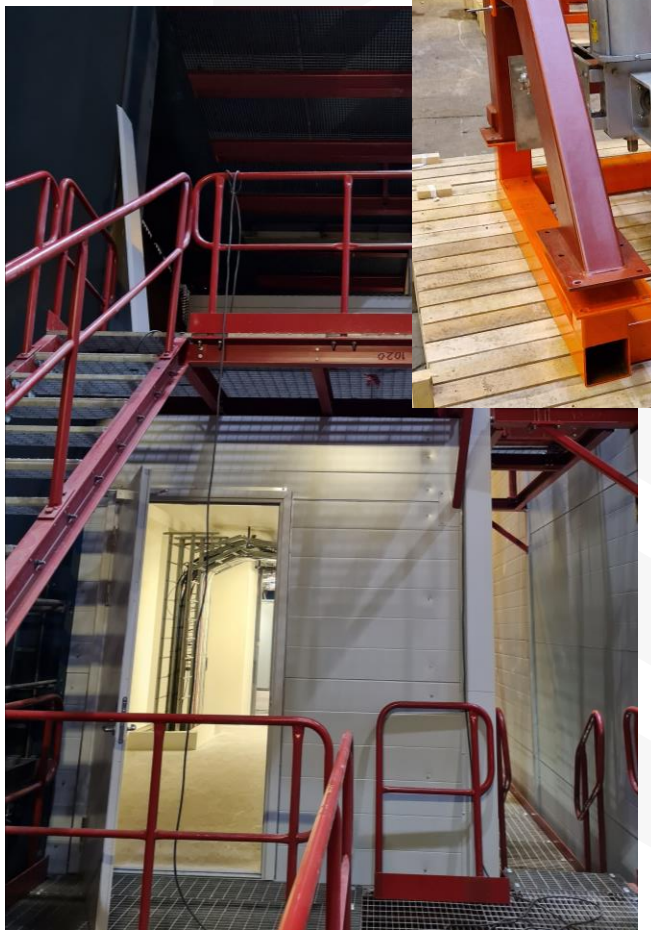




Procurement and construction

Hoisting the WGS reactor into place

Positioning of SEWGS reactor 1



Utility rooms installation

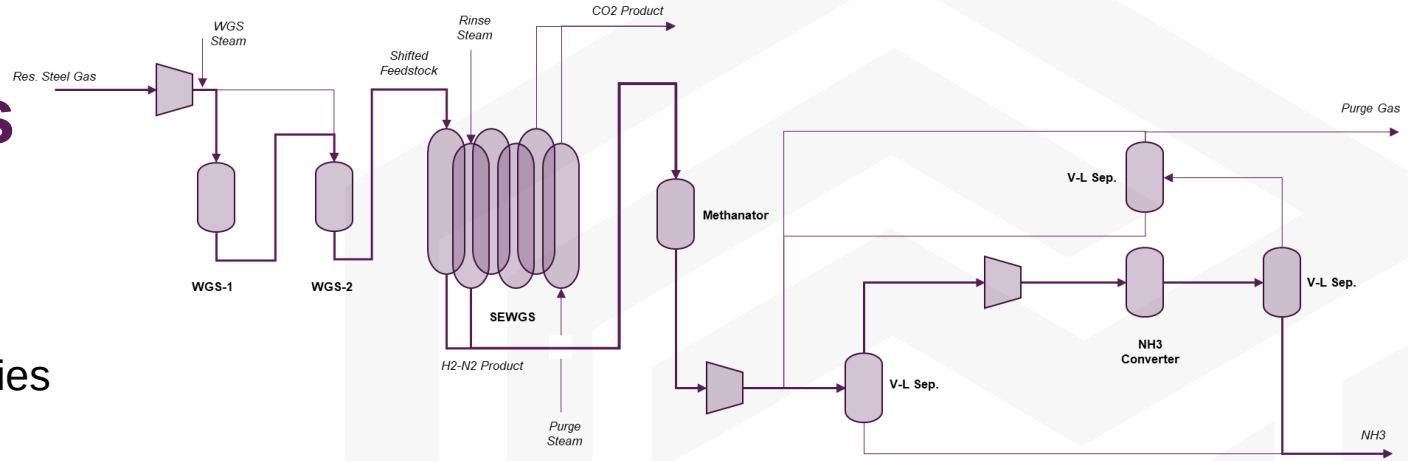
Valve block

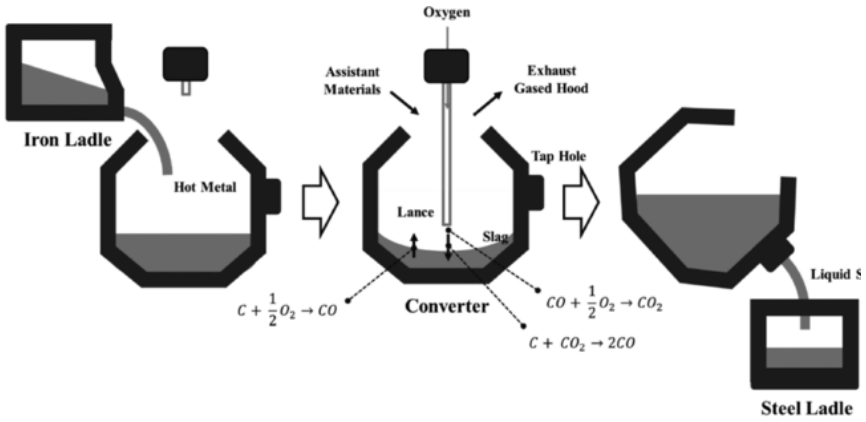
Functional materials selected and in production

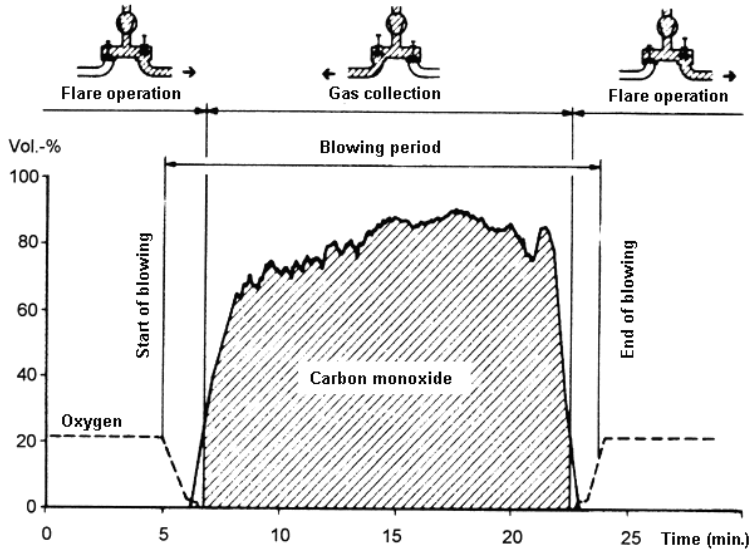
Challenge: BOFG dynamics

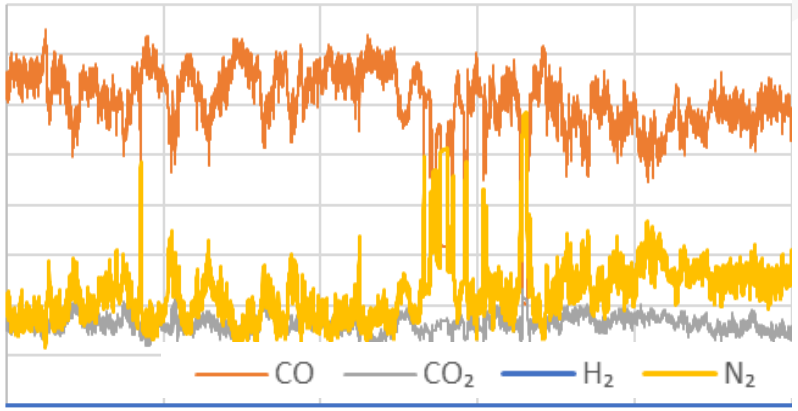
ADVANCED CONTROL

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









Techno economic analysis

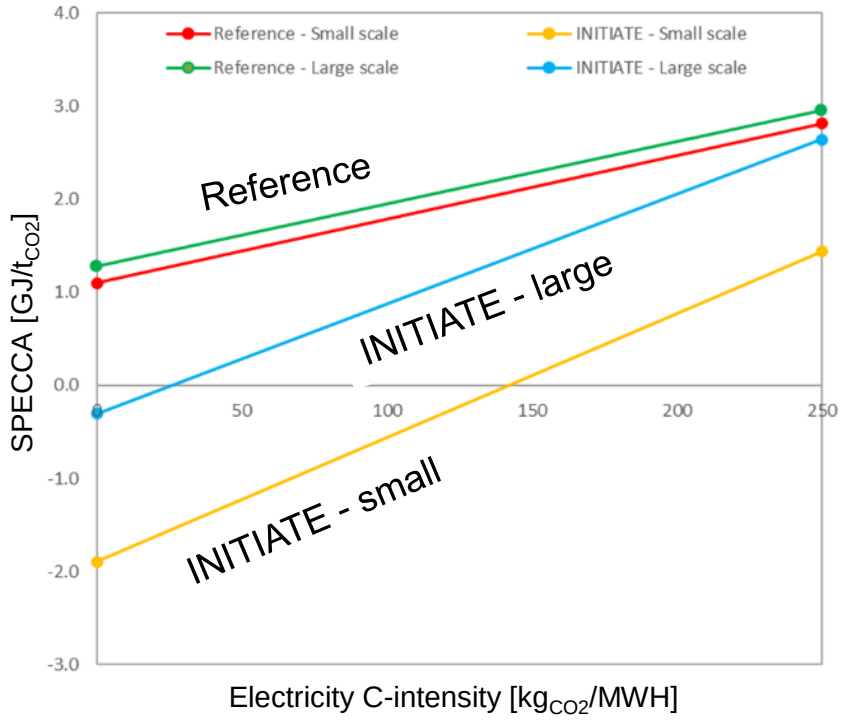
COMPARISON OF CASES

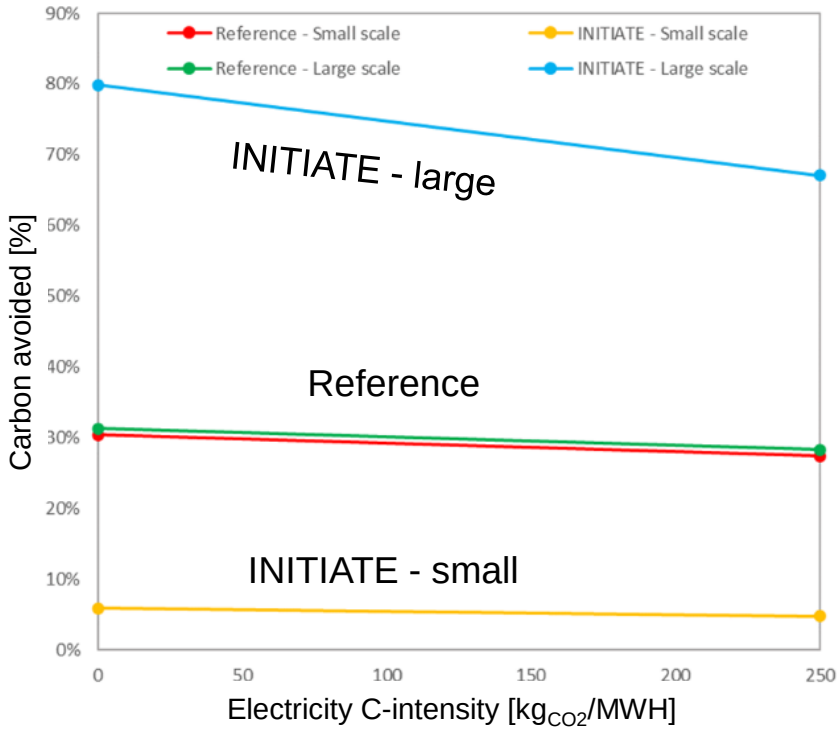
- Base — Stand alone Steel and NH_3/Urea
- Reference — Stand alone Steel and NH_3/Urea with CCS
- INITIATE — Integrated Steel and NH_3/Urea with CC-S&U

small: BOFG
large: BFG+BOFG

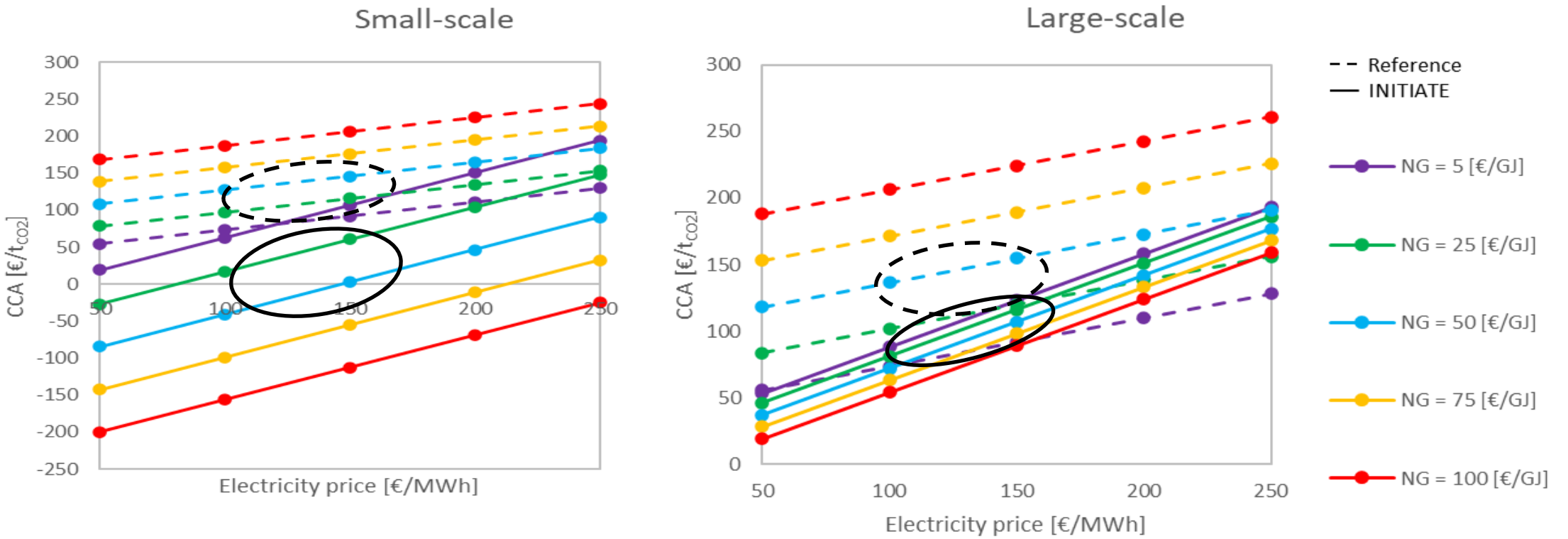
Primary energy intensity can be significantly reduced

Carbon footprint reduction up to 80%



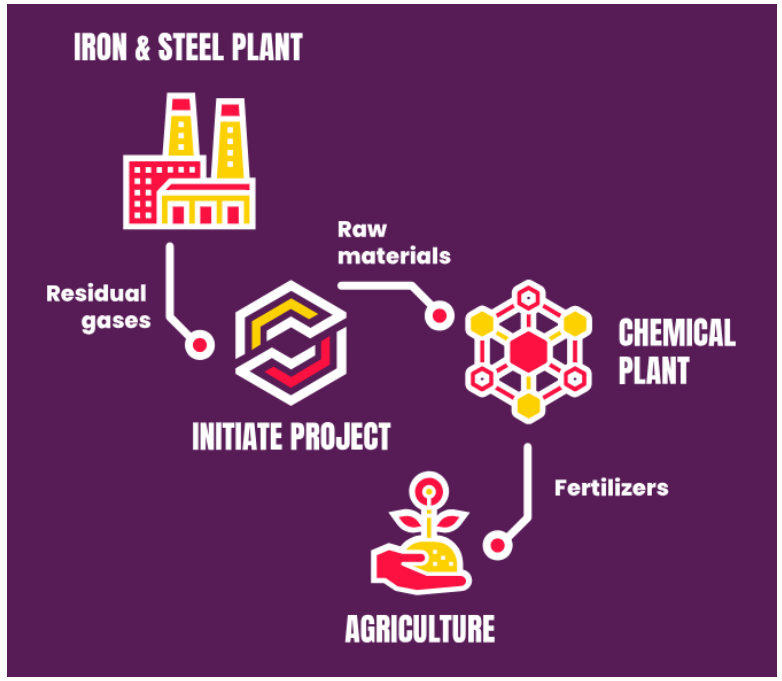


Techno economic analysis



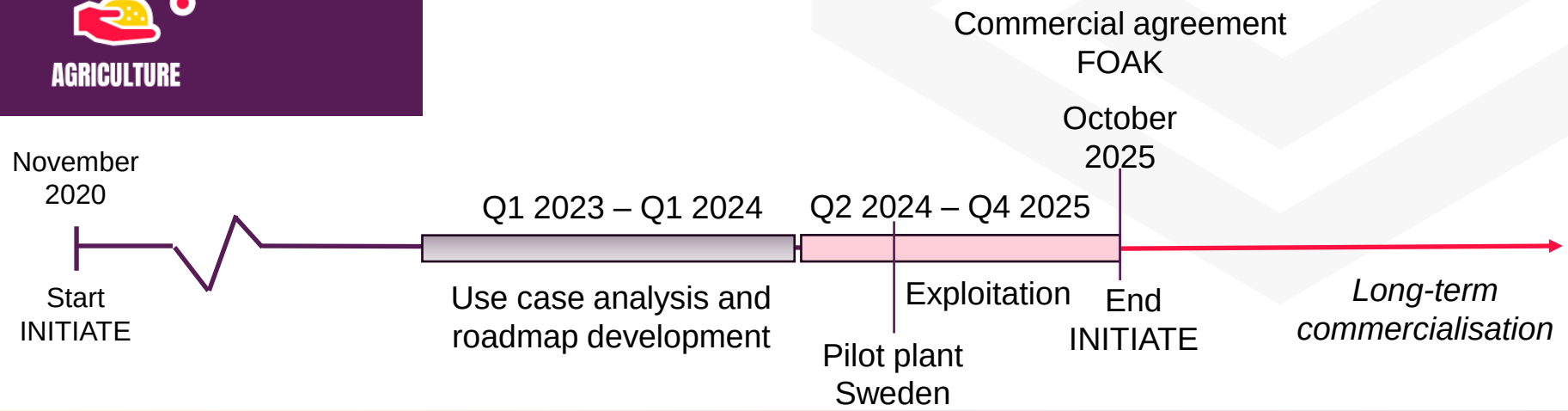
UREA production cost can be significantly reduced and negative cost of CO_2 avoided achieved

Commercial implementation 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



long-term implementation plan approach

PMC SELECTION

- Inventory of product-market combinations (PMCs)
- Assessment through KPIs

} **hydrogen, methanol, ammonia, urea**

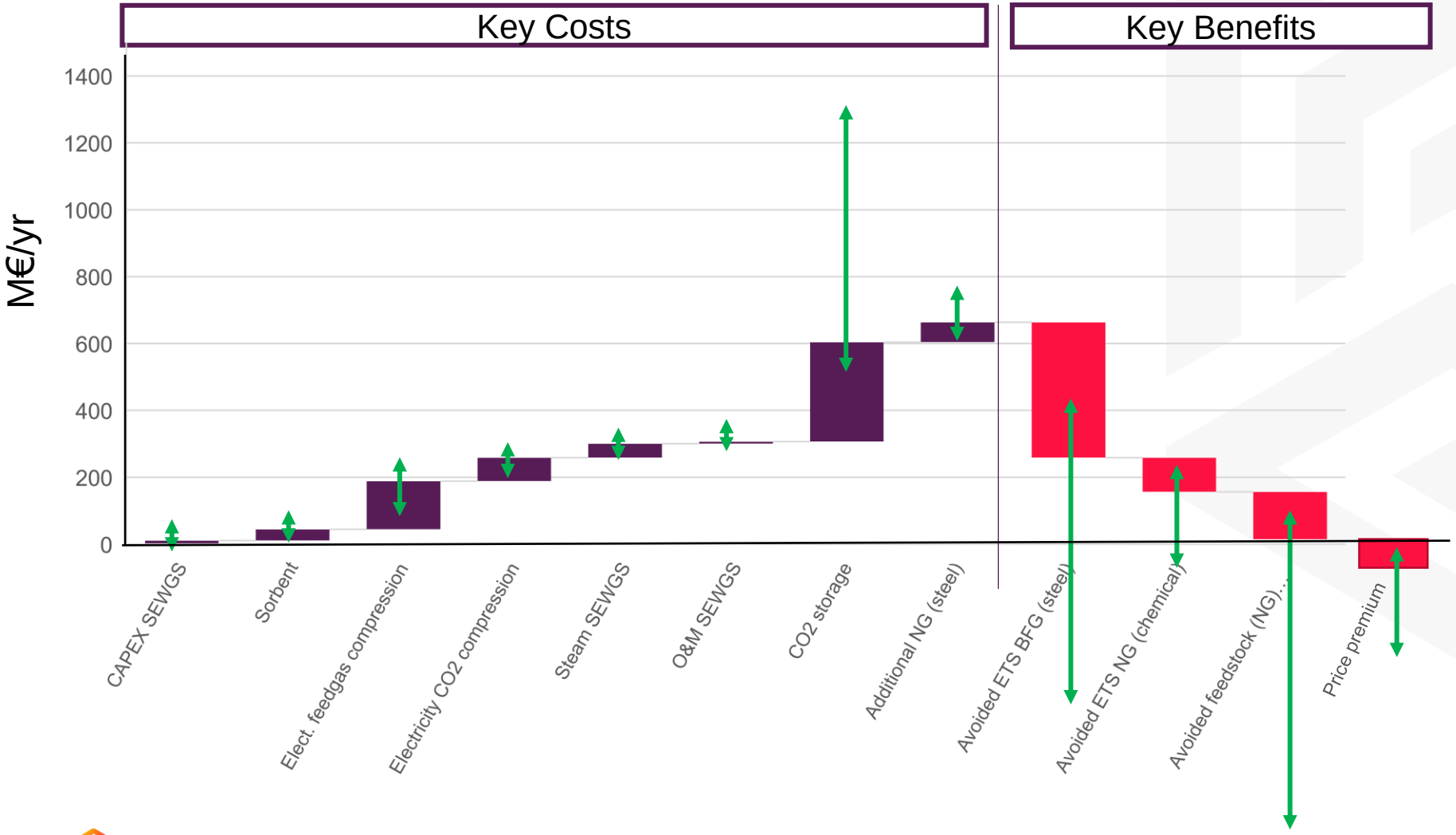
USE CASES

- Production of hydrogen and methanol – ArcelorMittal
- Production of ammonia and urea – Stamicarbon

REFERENCE CASE

- ArcelorMittal steel plant Ghent
  5 Mt steel / yr
  7.5 Mt BFG / yr available for CCU
  4.5 Mt CO_2 reduction / yr

Key cost drivers and uncertainties

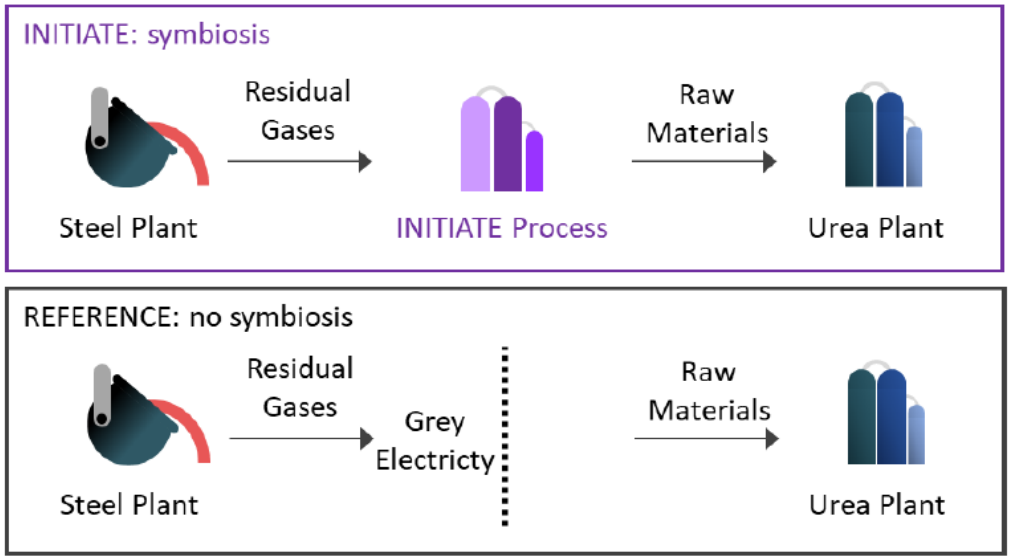


Summary key uncertainties

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)

Steps towards the First of a Kind plant

- **Demonstration** – pilot under construction
- **Site identification** – inventory finalized, discussion on-going
- **Business plan** – long term implementation plan
- **IP&R, ownership, collaboration** – exploitation of results



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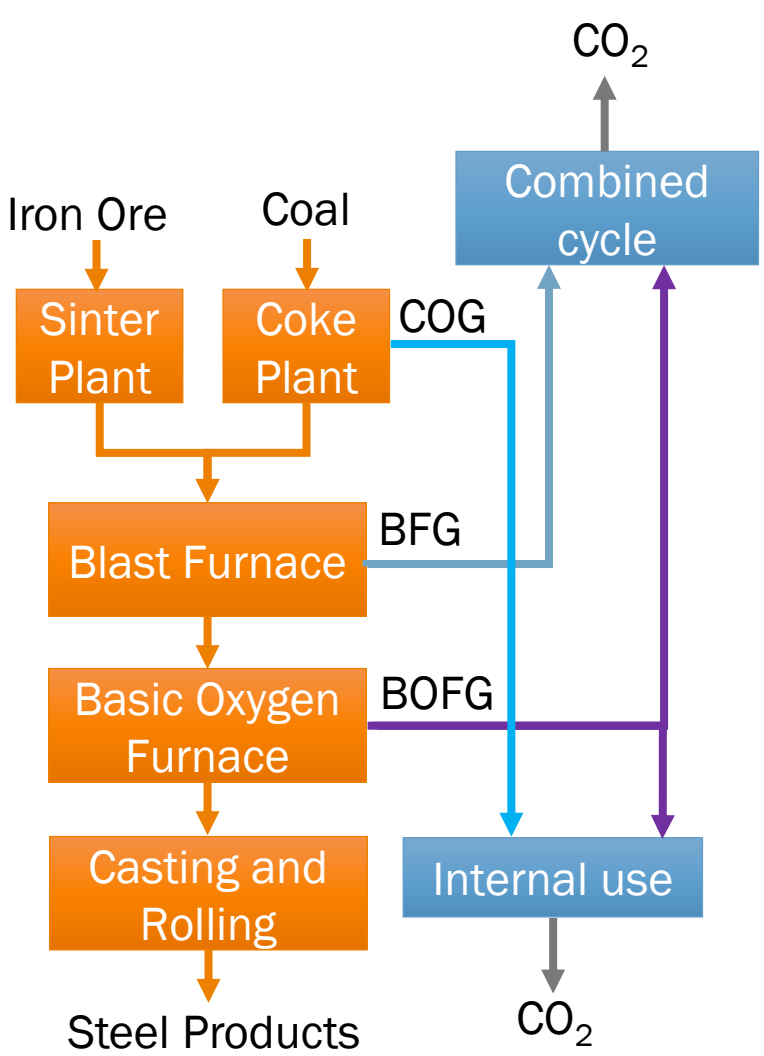
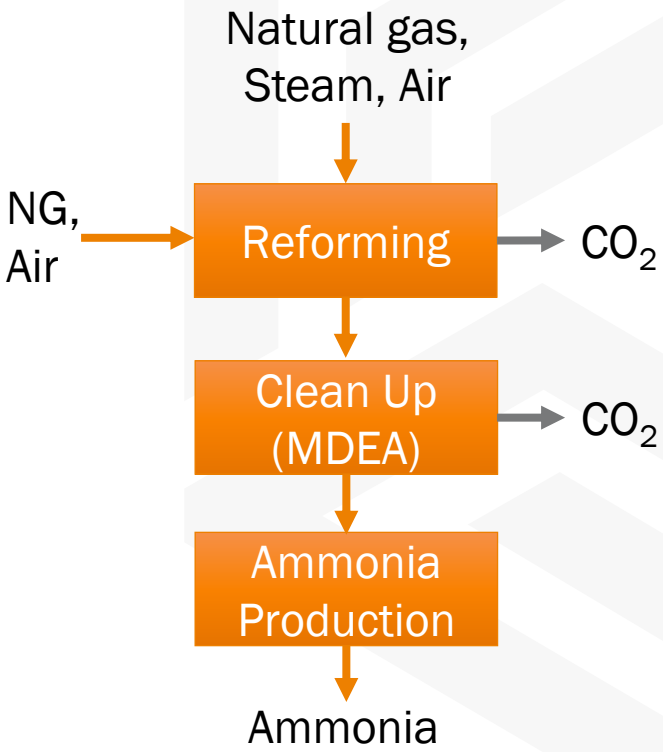
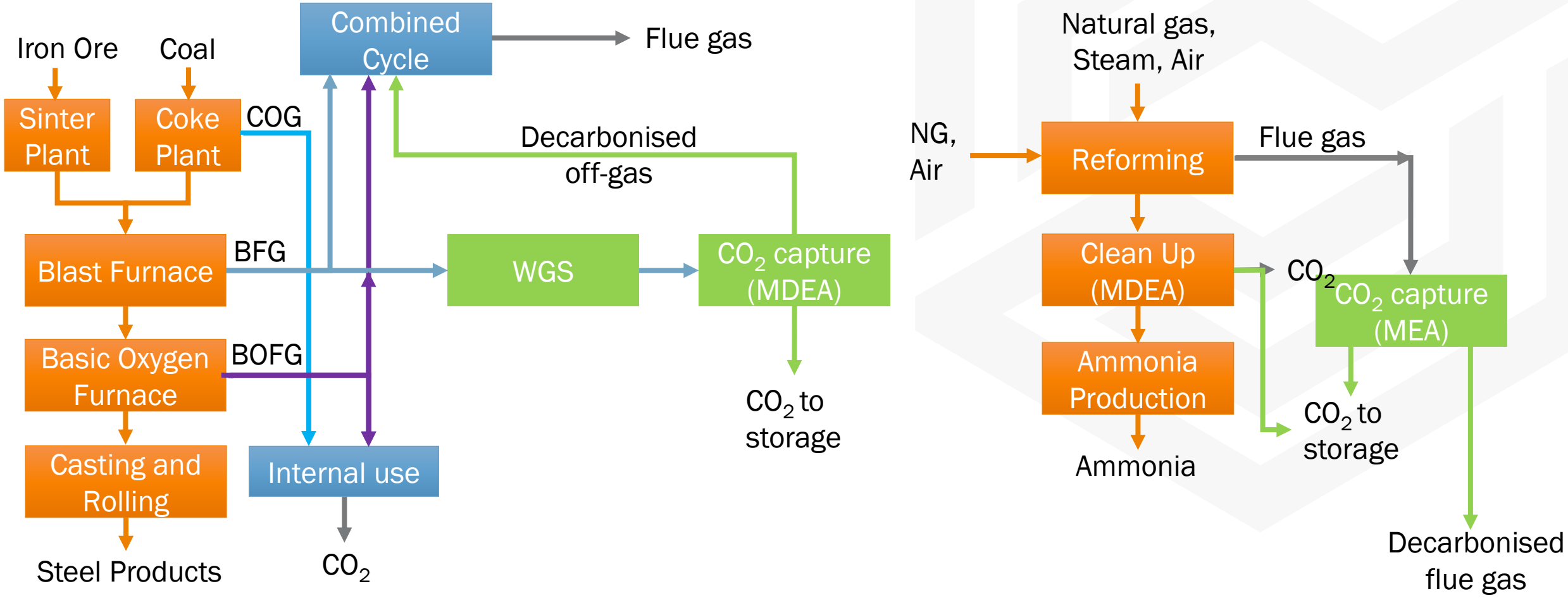
Back-up slides

Base Case – commercial plant lay-outs





Reference Case - State-of-the-art commercially available plants with CO_2 capture technologies



INITIATE Case – demonstrating symbiosis