



INITIATE

Ammonia and urea from steel off-gases

Transforming the metal-making industry Workshop
Showcases for retrofitting and circularity

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September 26, 2023



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 continuous production of NH_3 from BOFG at $2.5 \text{ t}_{\text{NH}_3}/\text{d}$ scale
 - › Site identification
 - › Business plan development
 - › IP&R, ownership, collaboration

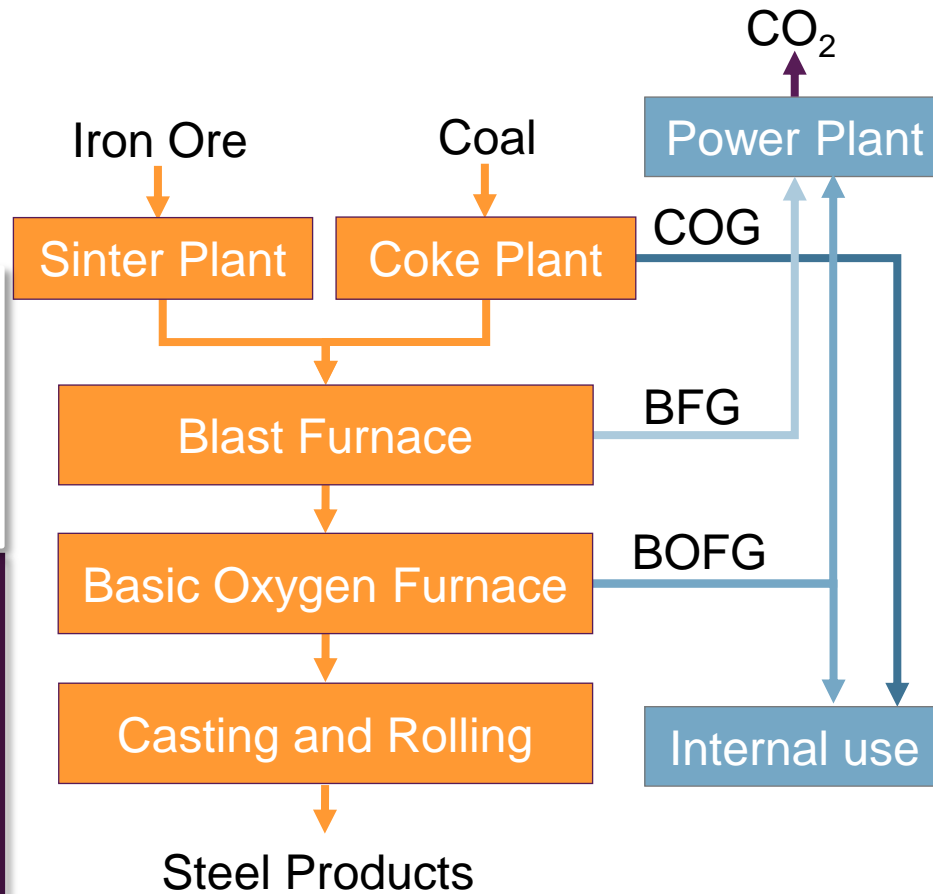


Multiple routes towards CO₂ neutrality

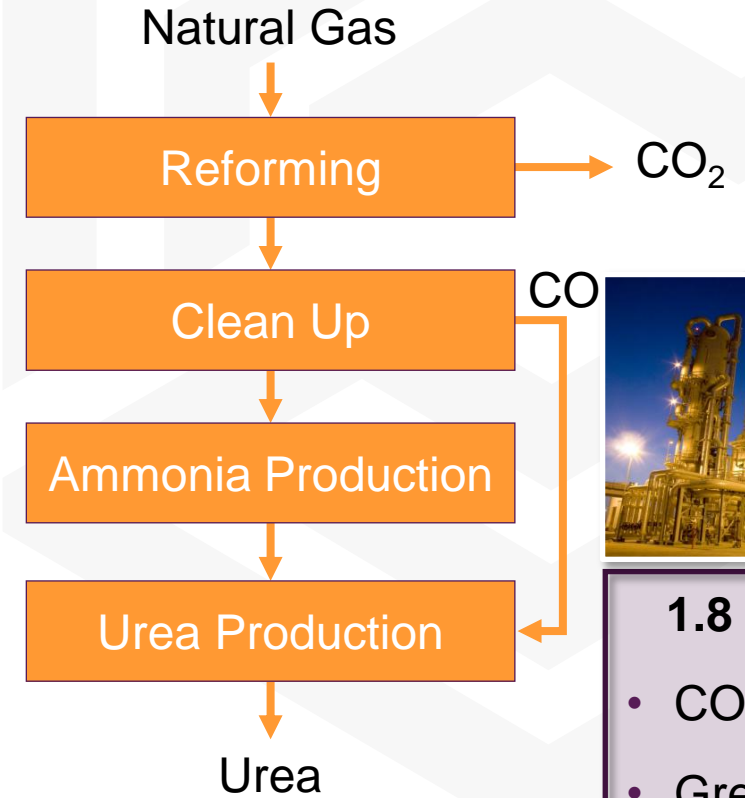


2 t_{CO2}/t_{HRC}

- Coal → NG, H₂
- CO₂ capture
- More scrap
- Efficiency



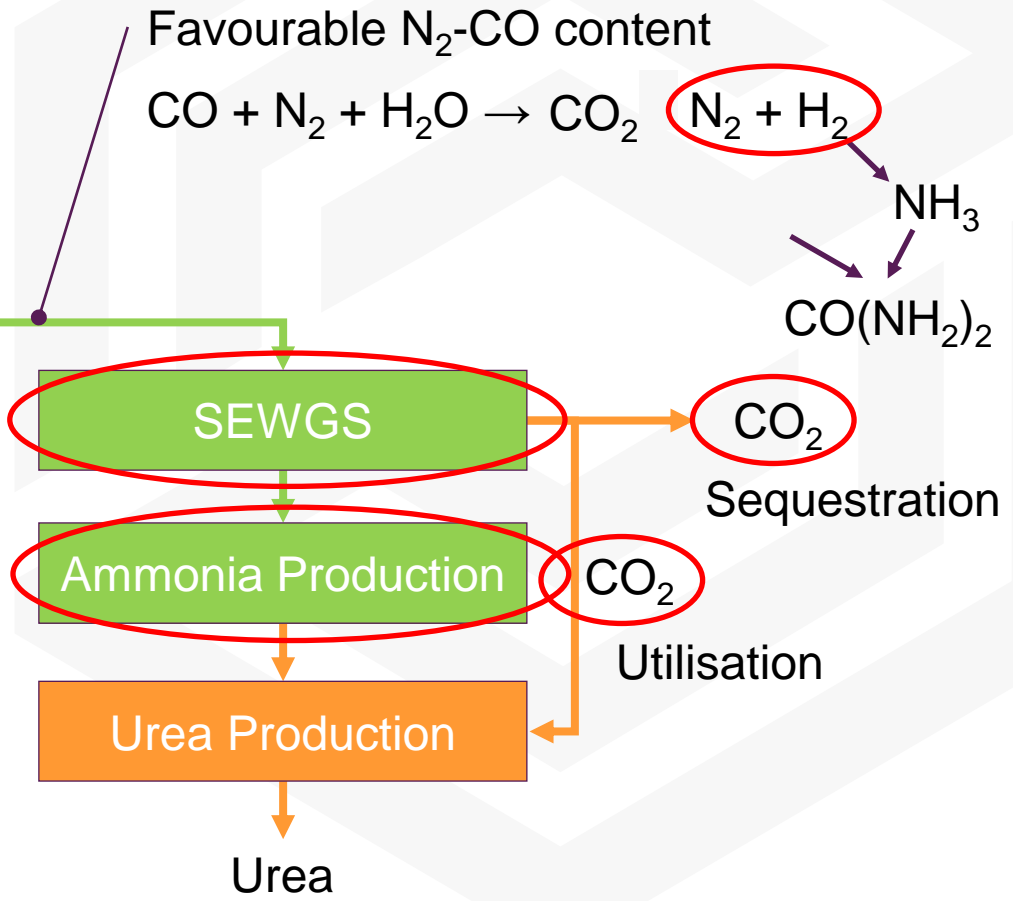
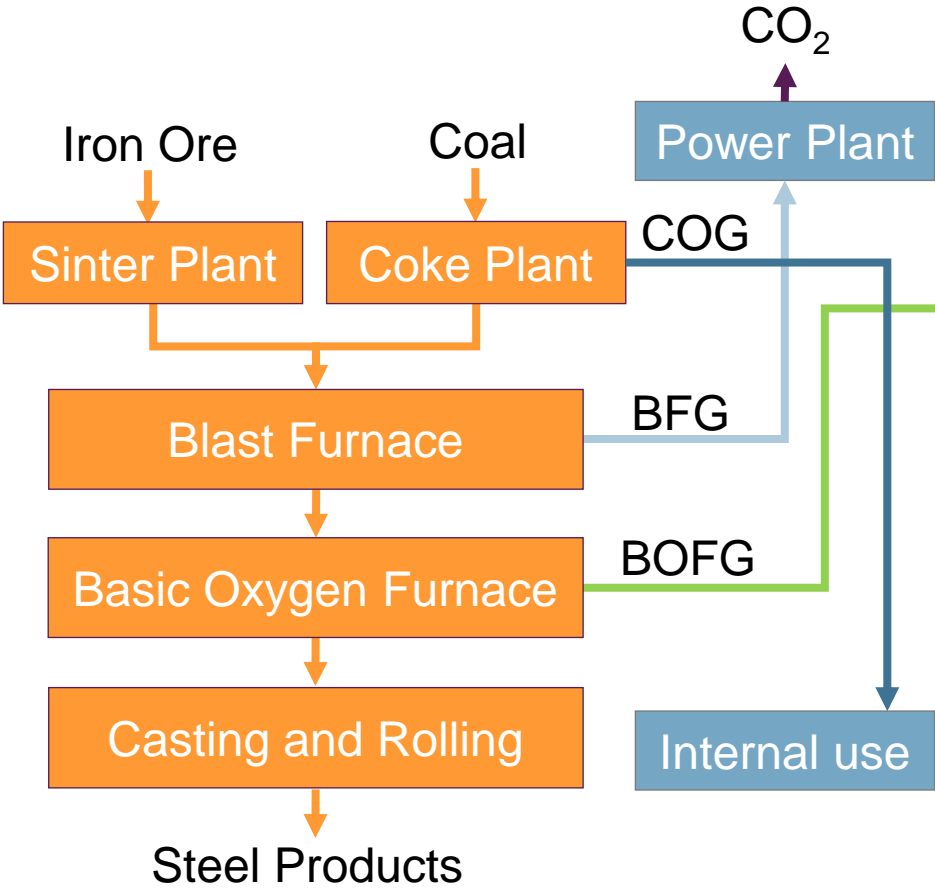
Industrial Symbiosis



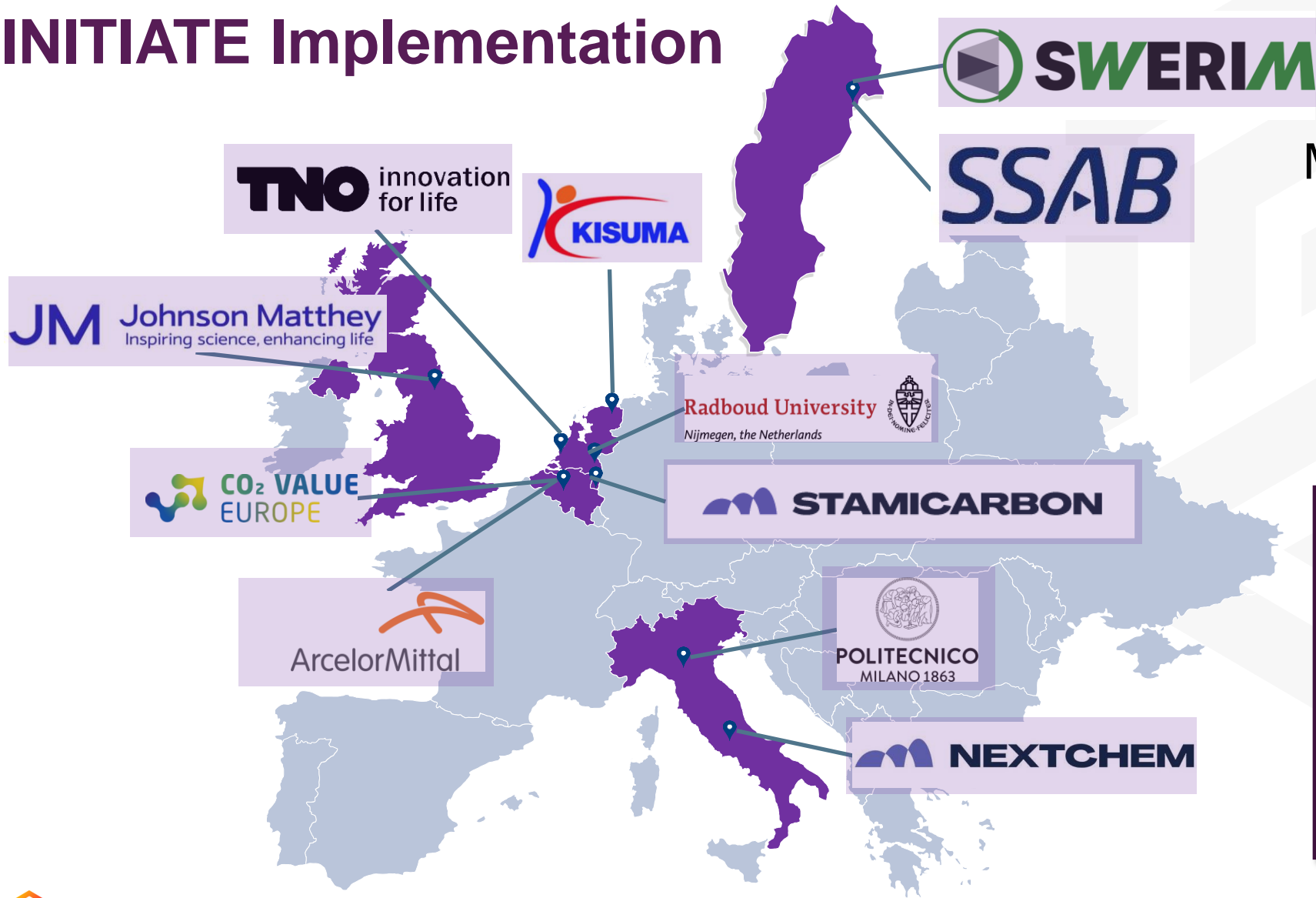
1.8 t_{CO2}/t_{NH3}

- CO₂ capture
- Green H₂

INITIATE Industrial symbiosis



INITIATE Implementation



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

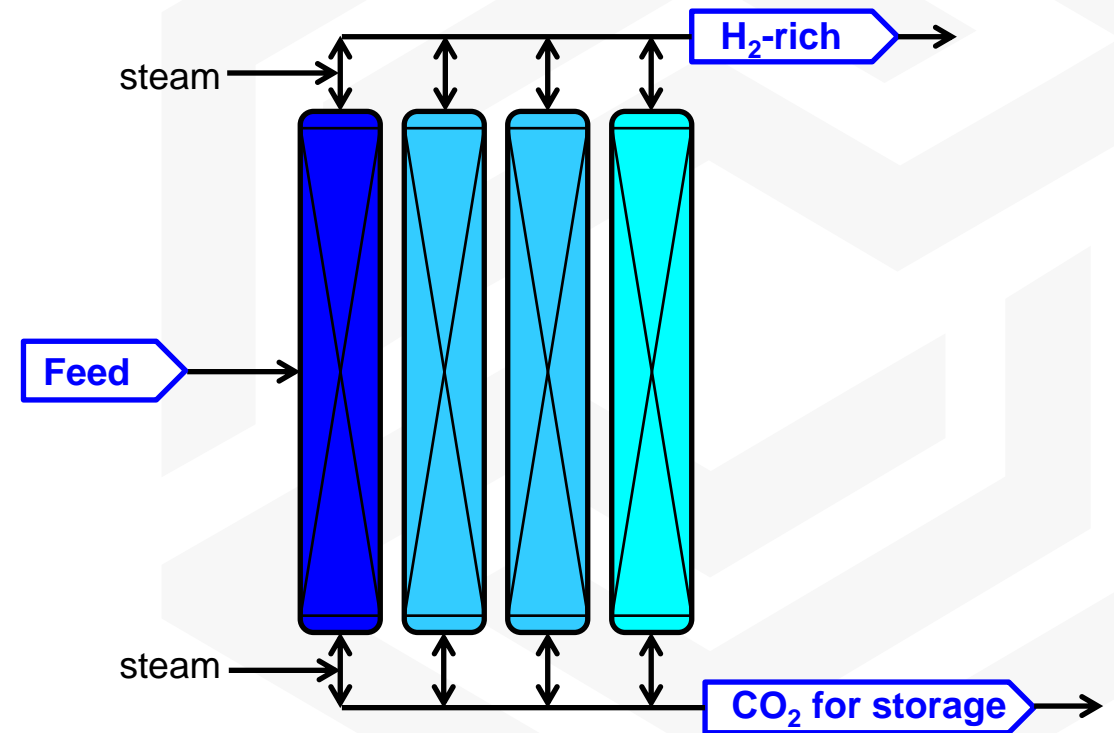
Enabling technologies

Sorption Enhanced Water Gas Shift - SEWGS

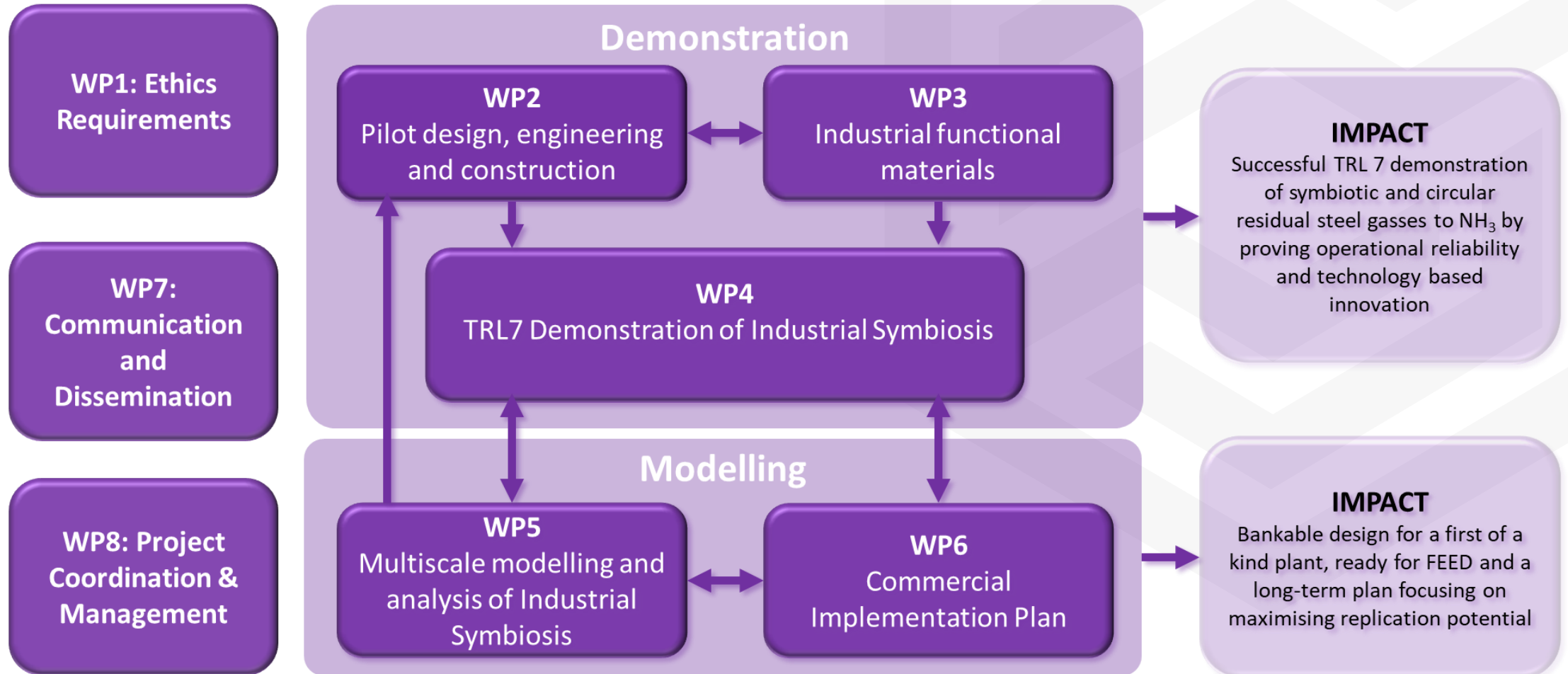
- TNO development
- Industrially sourced solid adsorbent
- Combining CO₂ separation with WGS reaction
- Optimizing N₂/N₂ while removing CO₂
- Minimization of energy requirement

Sub-stoichiometric NH₃ synthesis

- NextChem development
- Suitable for variable H₂/N₂ ratio
- Simplification of knock-out and recycle
- More suitable for dynamics



INITIATE Project Organisation



Pilot lay-out for 2.5 t_{NH₃}/d

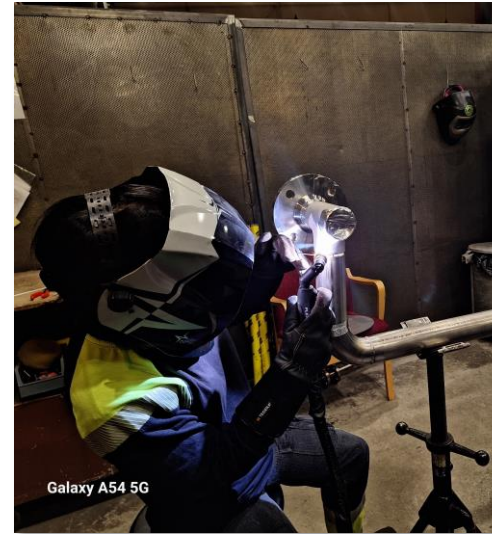
2017

Column arrival for
STEPWISE

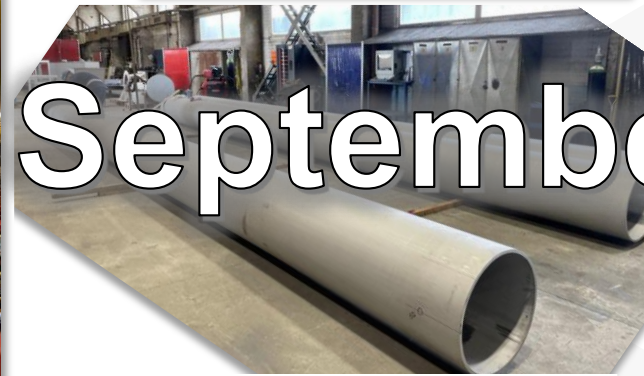


2023

Column dismantling
for reuse



Galaxy A54 5G

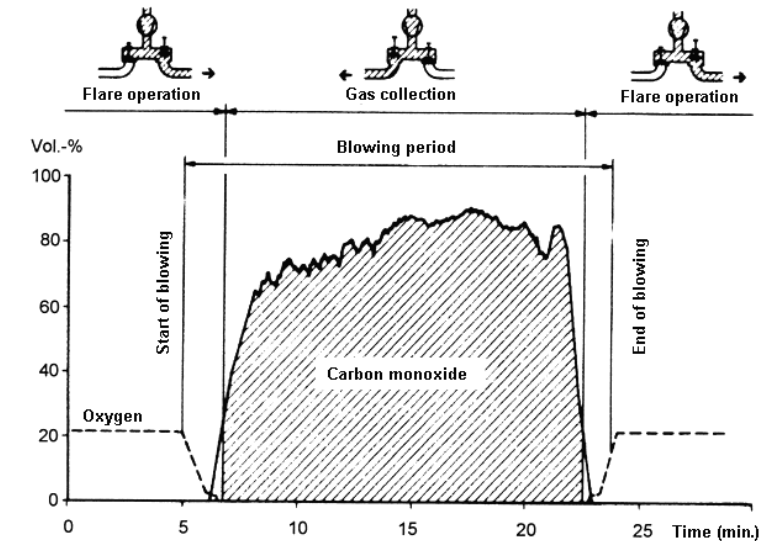
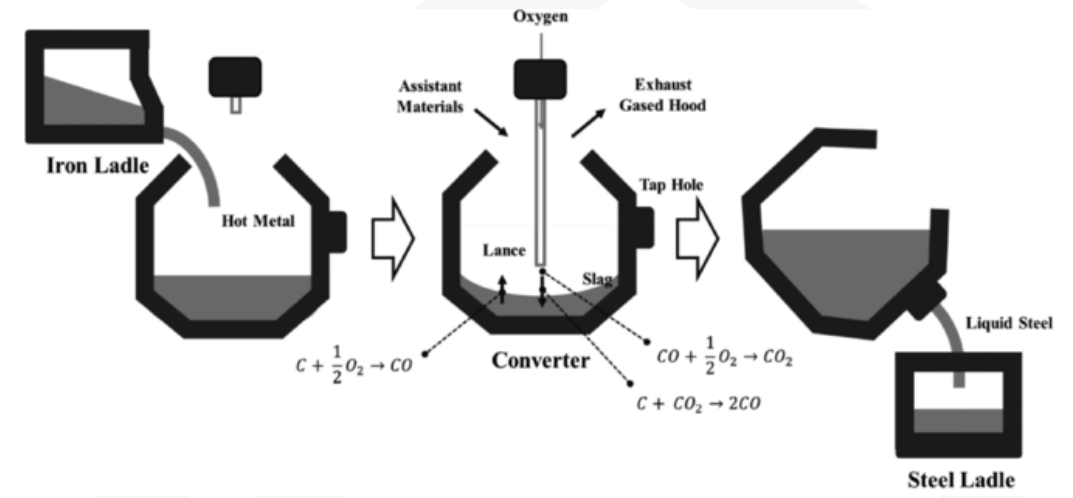
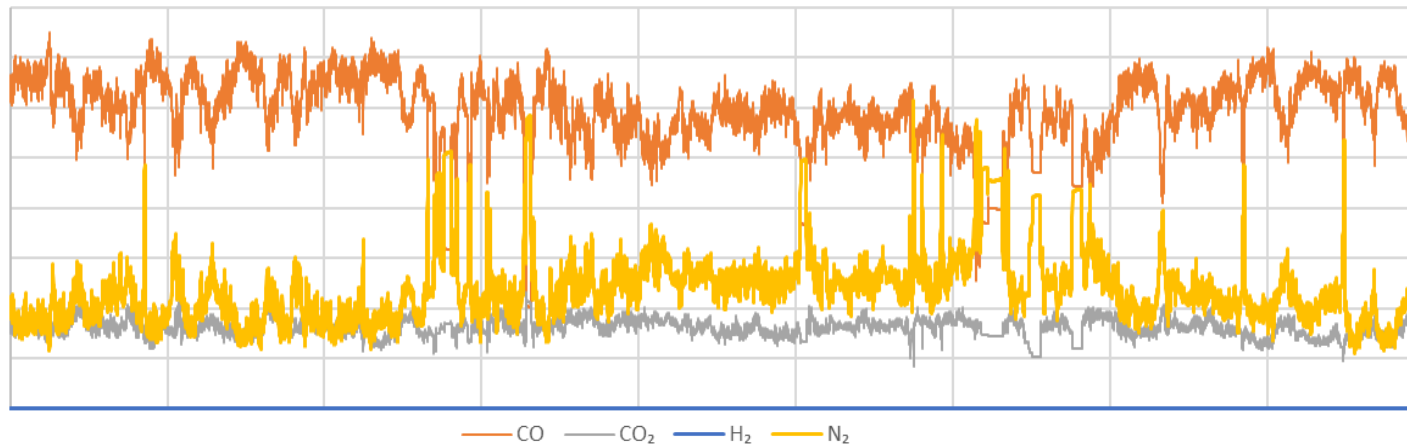


1st campaign: September 2024

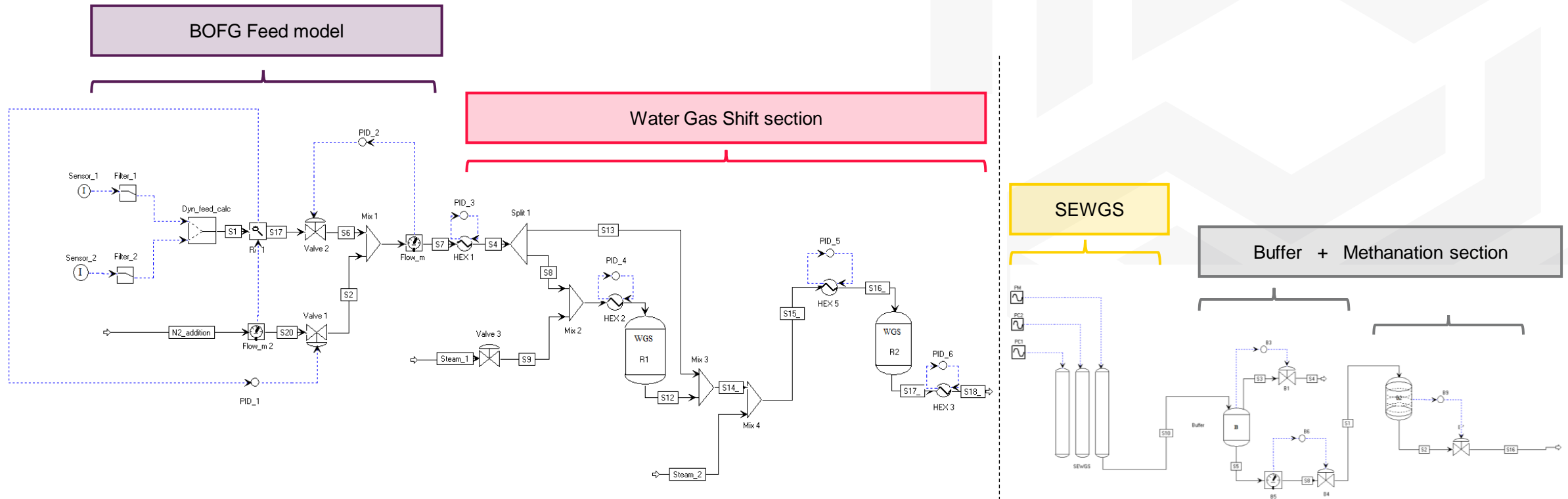
Modeling dynamics

BOFG challenge: dynamic behavior

- BOF is a batch process
- BOFG holder for buffering
- Understanding and efficiency optimization



Dynamic modeling in Aspen Custom Modeller



› NH₃ loop on-going

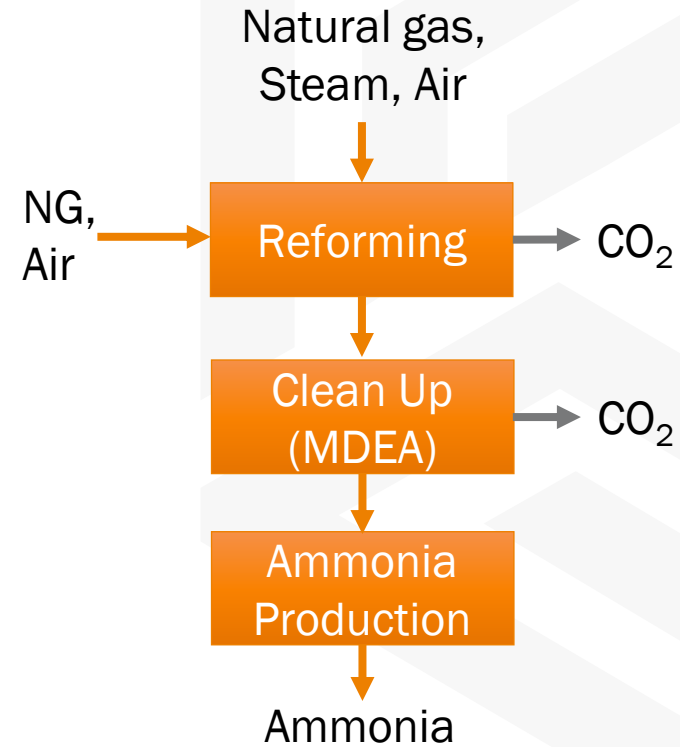
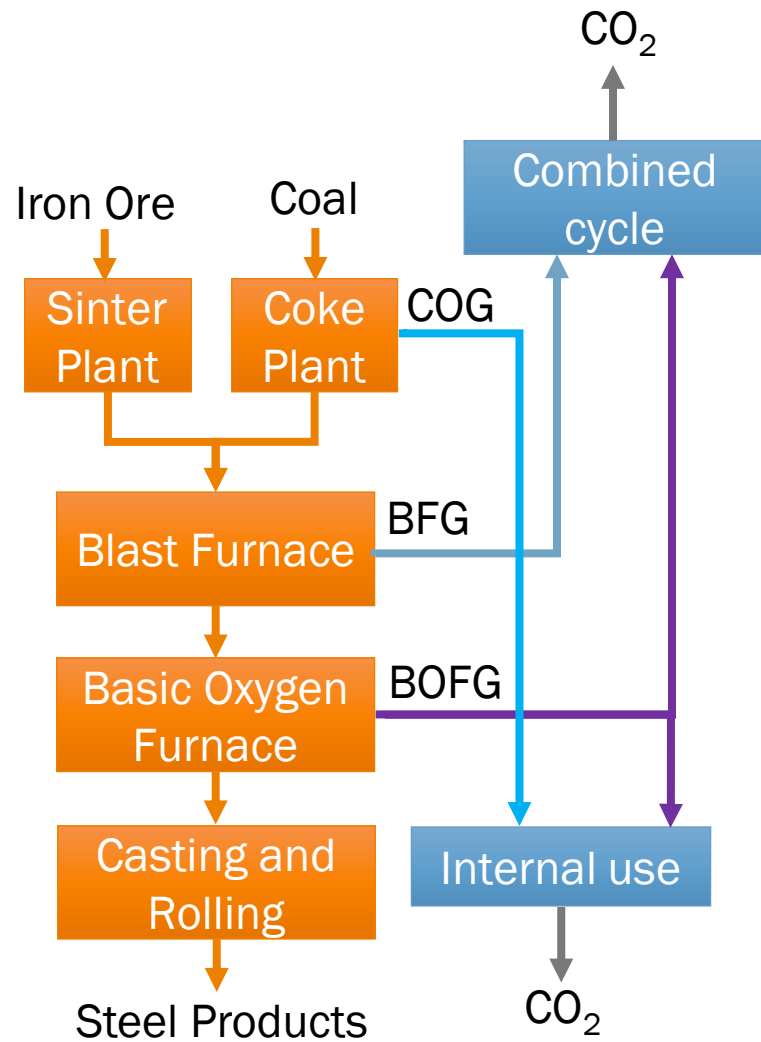
TEA, LCA and business case modeling

Quantitative analysis for direct comparison

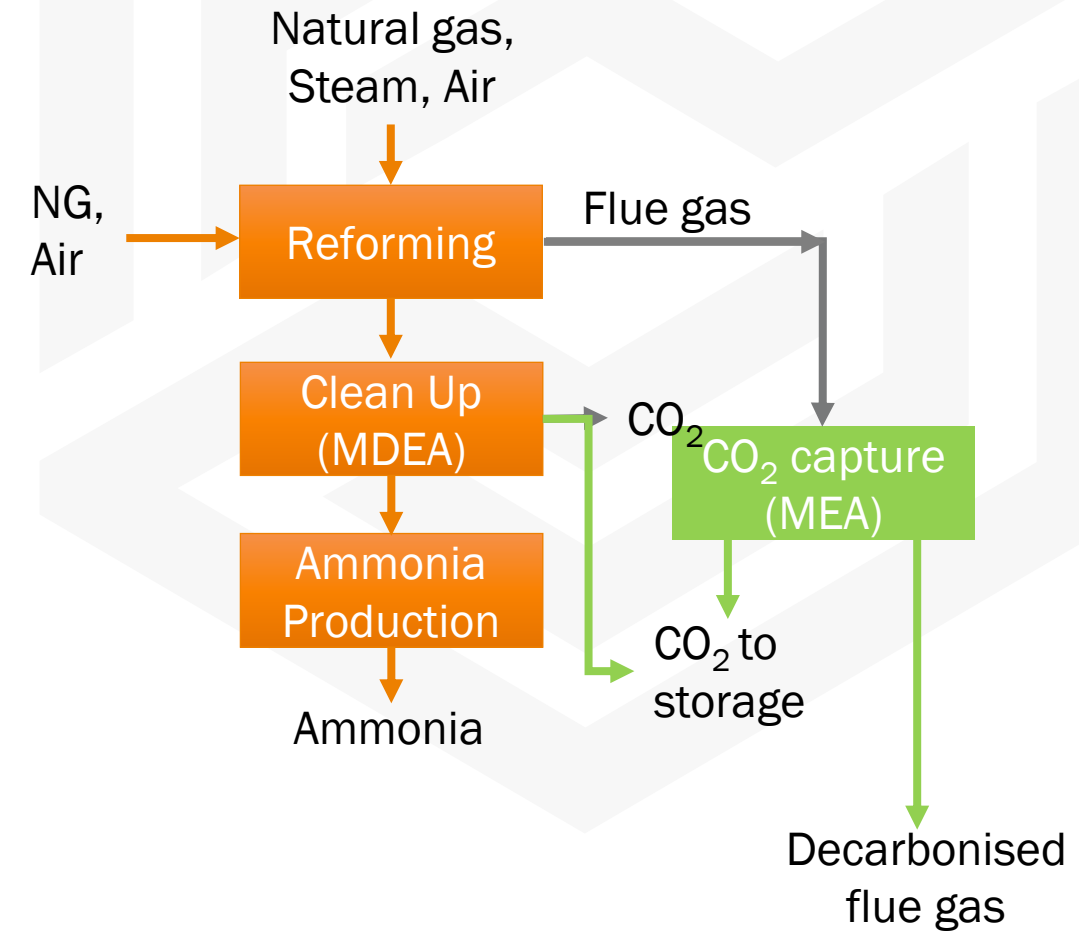
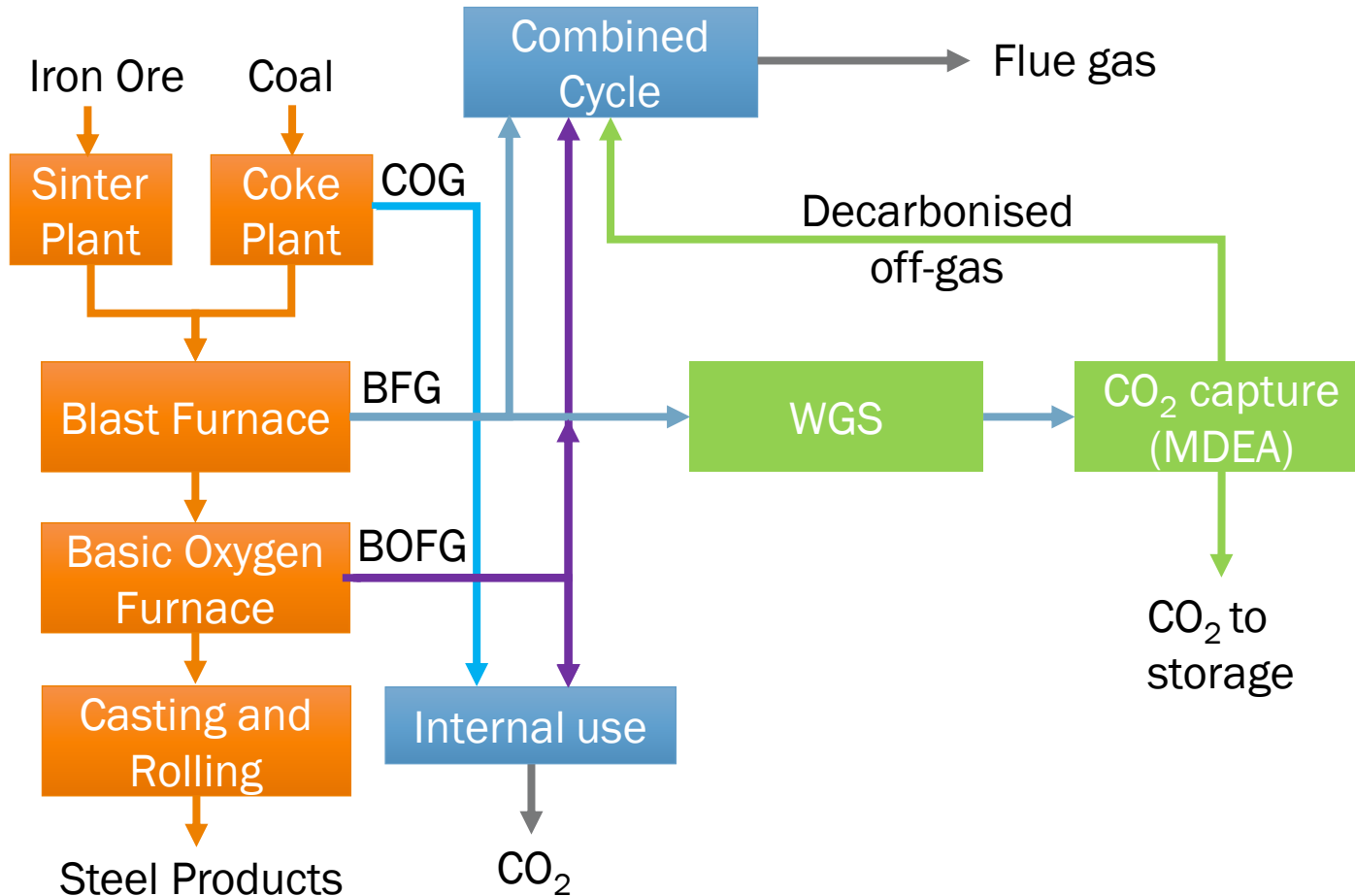
- Base case – reference cases – INITIATE case
- Scenarios for evaluation of electricity CO₂-footprint, fuel mix, pricing
- Location dependent assumptions

Plant	Capacity	Technology	Reasoning
Steel	3160 kt/y HRC	BF/BOF	Reference steel plant
NH ₃	47 kt/y	NG reforming	BOFG to NH ₃
NH ₃	310 kt/y	NG reforming	BOFG + BFG to NH ₃

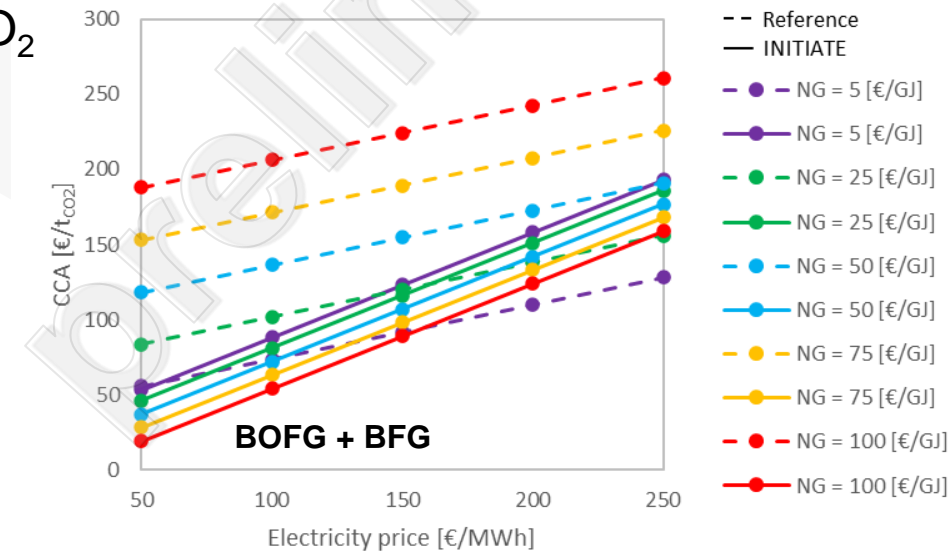
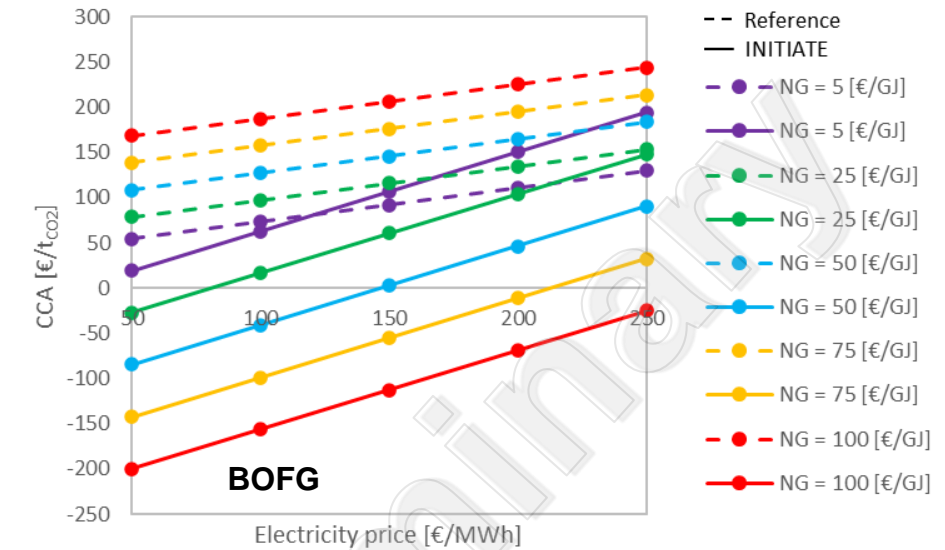
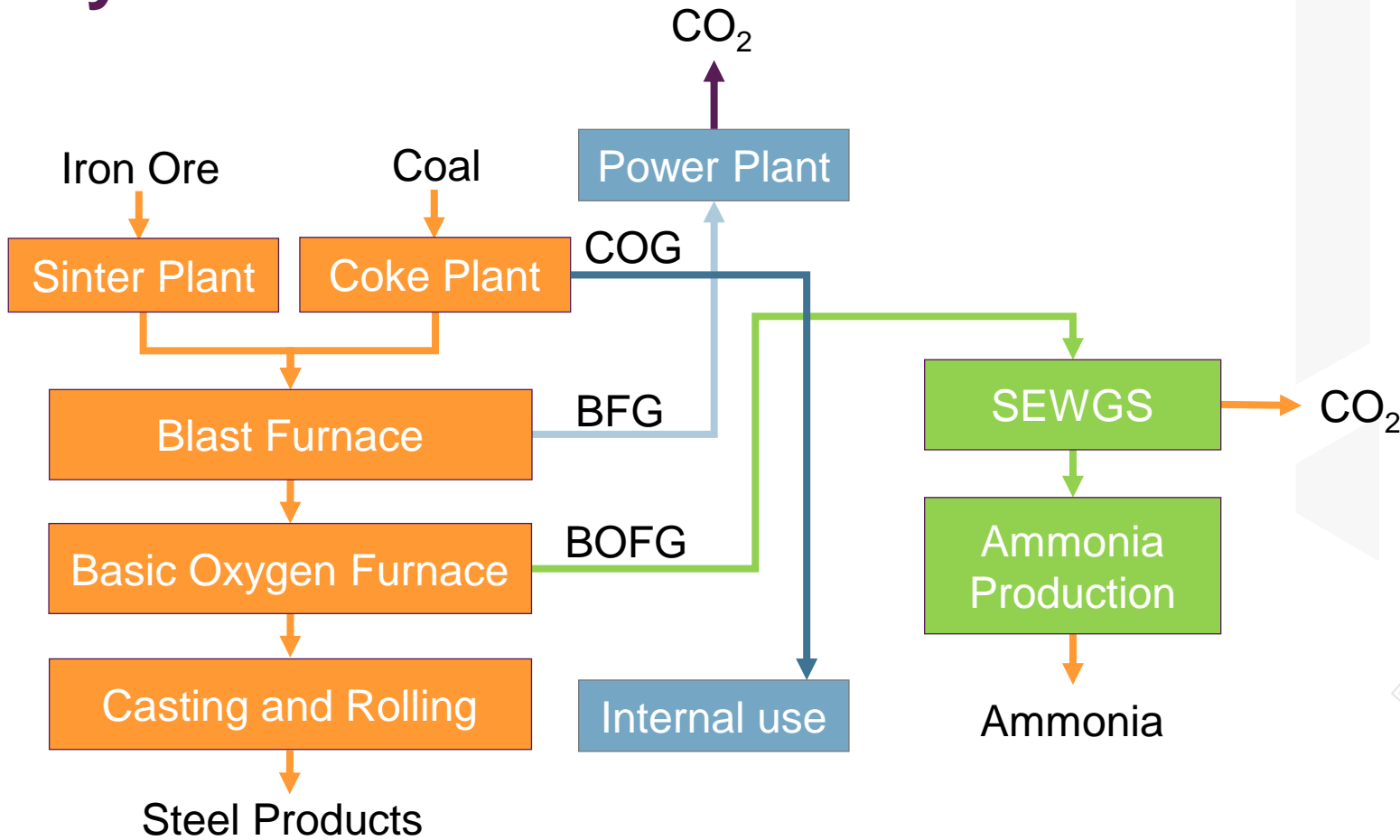
Base Case – commercial plant lay-outs



Reference Case - State-of-the-art commercially available plants with CO₂ capture technologies



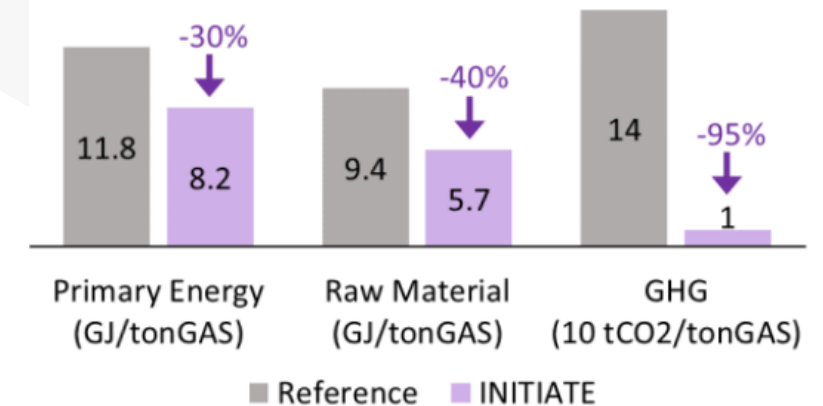
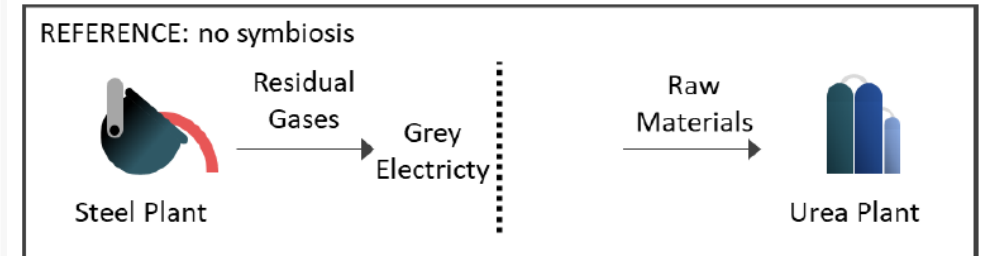
INITIATE Case – demonstrating symbiosis



Towards a first of a kind plant

Beyond demonstration

- Value engineering and integration to reduce cost
- Pre-FEED for a bankable, first-of-a-kind plant at selected location
- AI based control for BOFG dynamics
- Quantify social, economic and environmental impact of industrial symbiosis in Europe



Intensity values per ton of residual steel gas



Thank you !

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www.initiate-project.eu



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Back-up slides

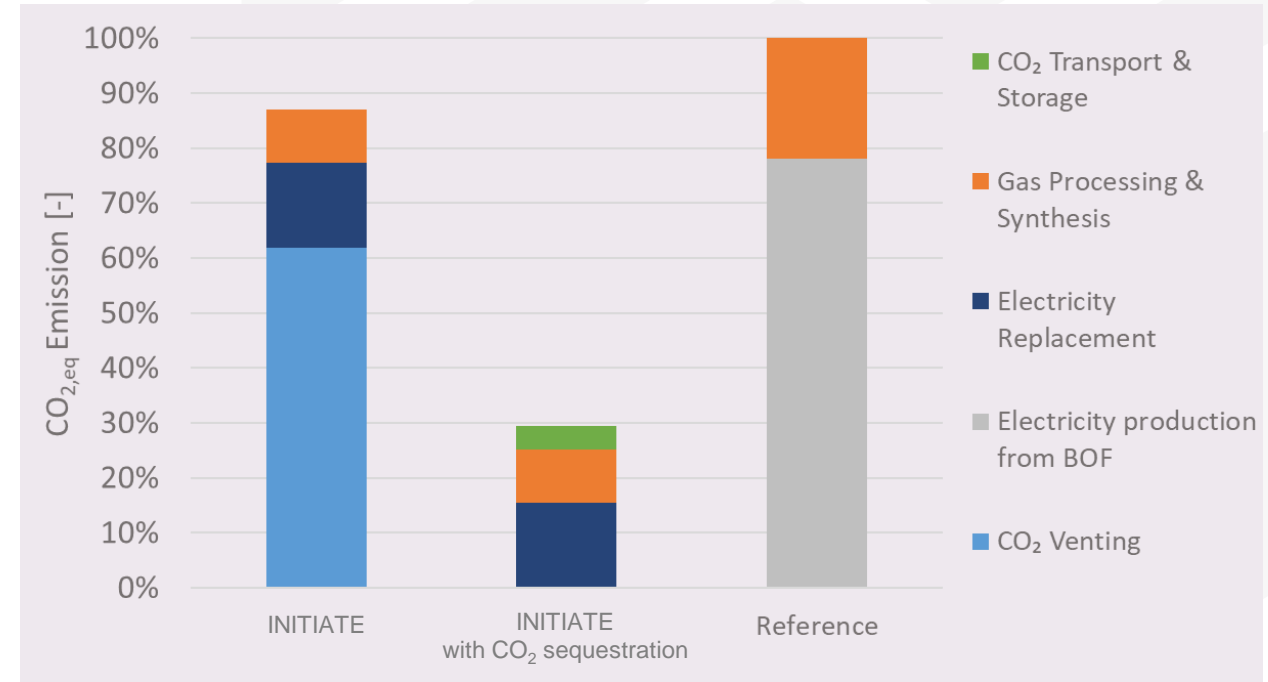


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BOF2Urea – Pre-study

Focus on TEA, LCA and market potential

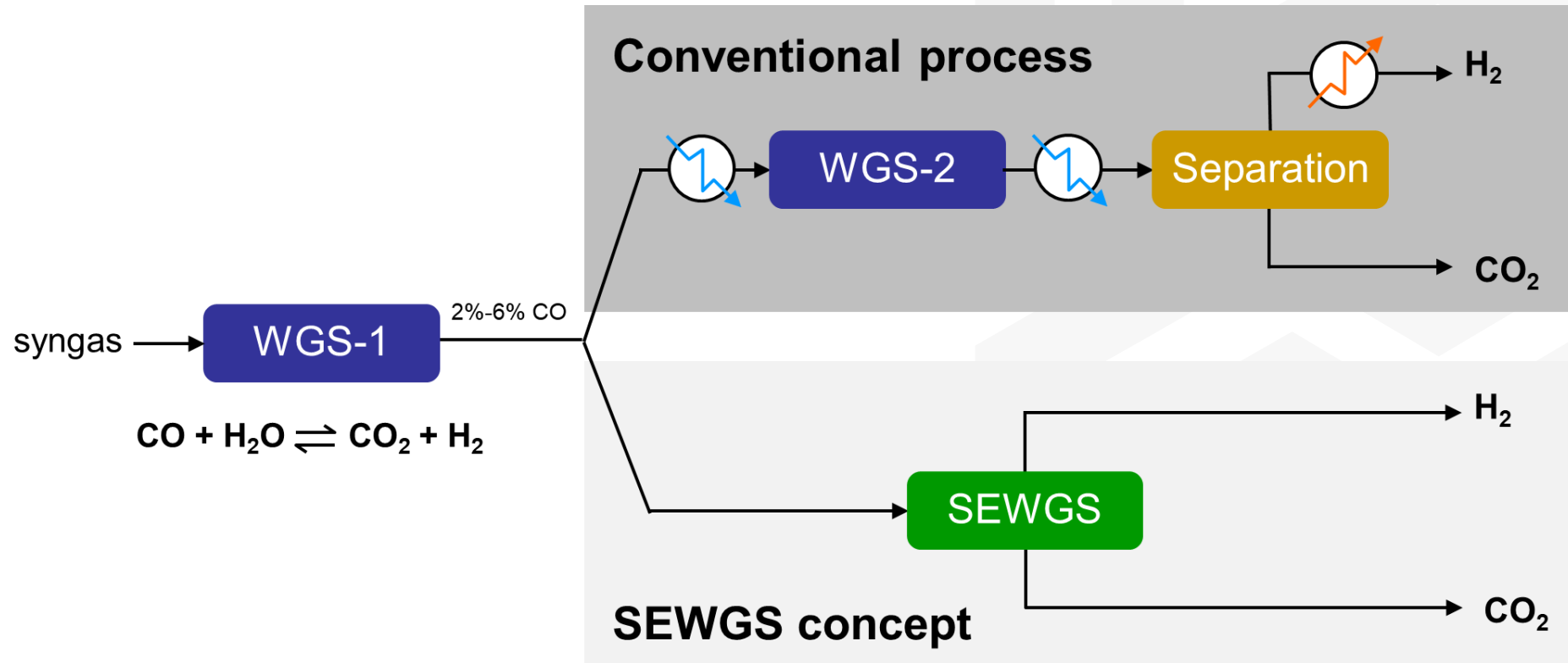
- Economical feasibility
 - Positive business case for urea derivative
 - Site locations of BOF availability and urea demand
- Environmental benefits
- Strong consortium



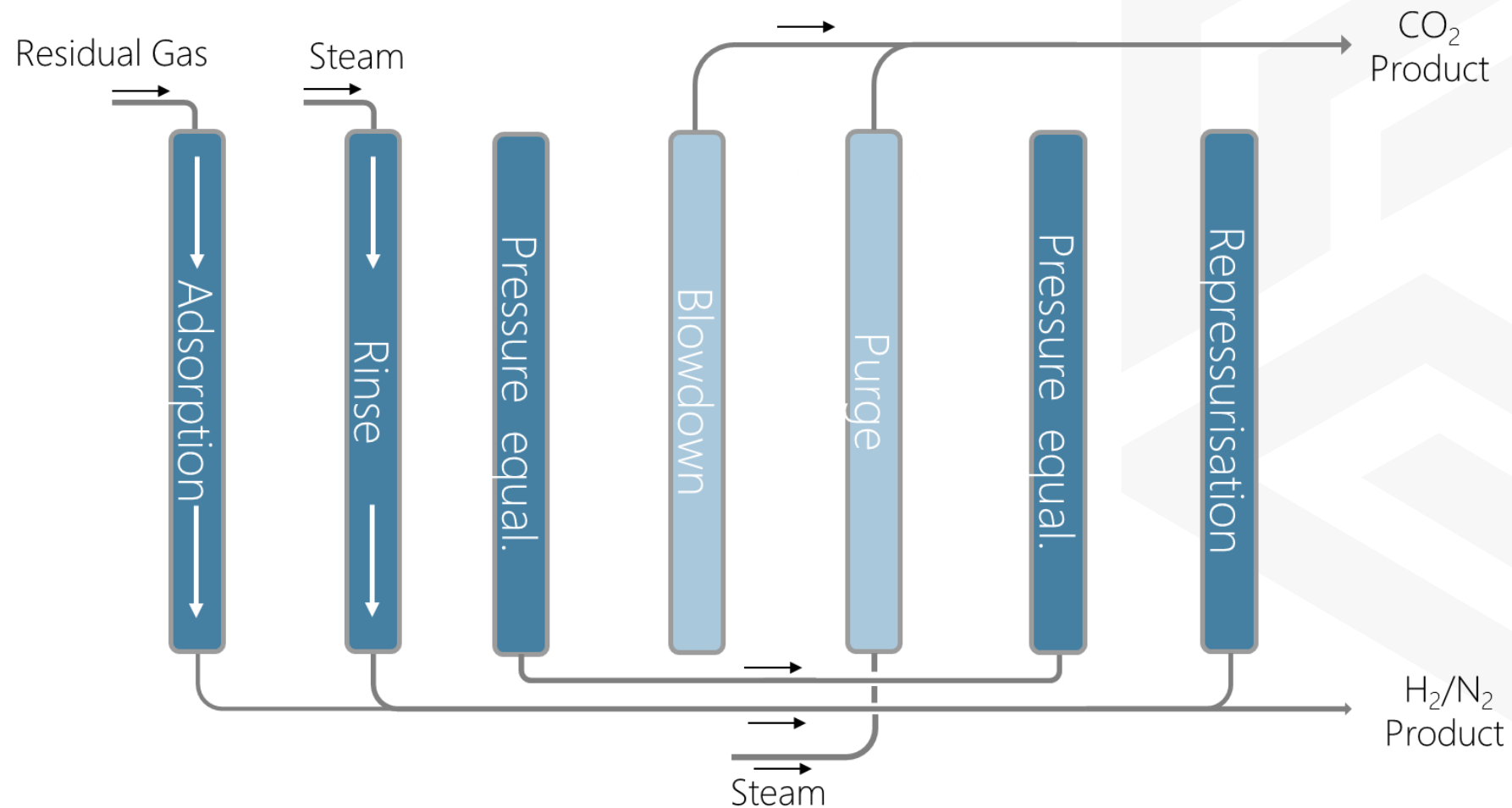
Demonstrate, validate, and FOAK preparation

Process intensification

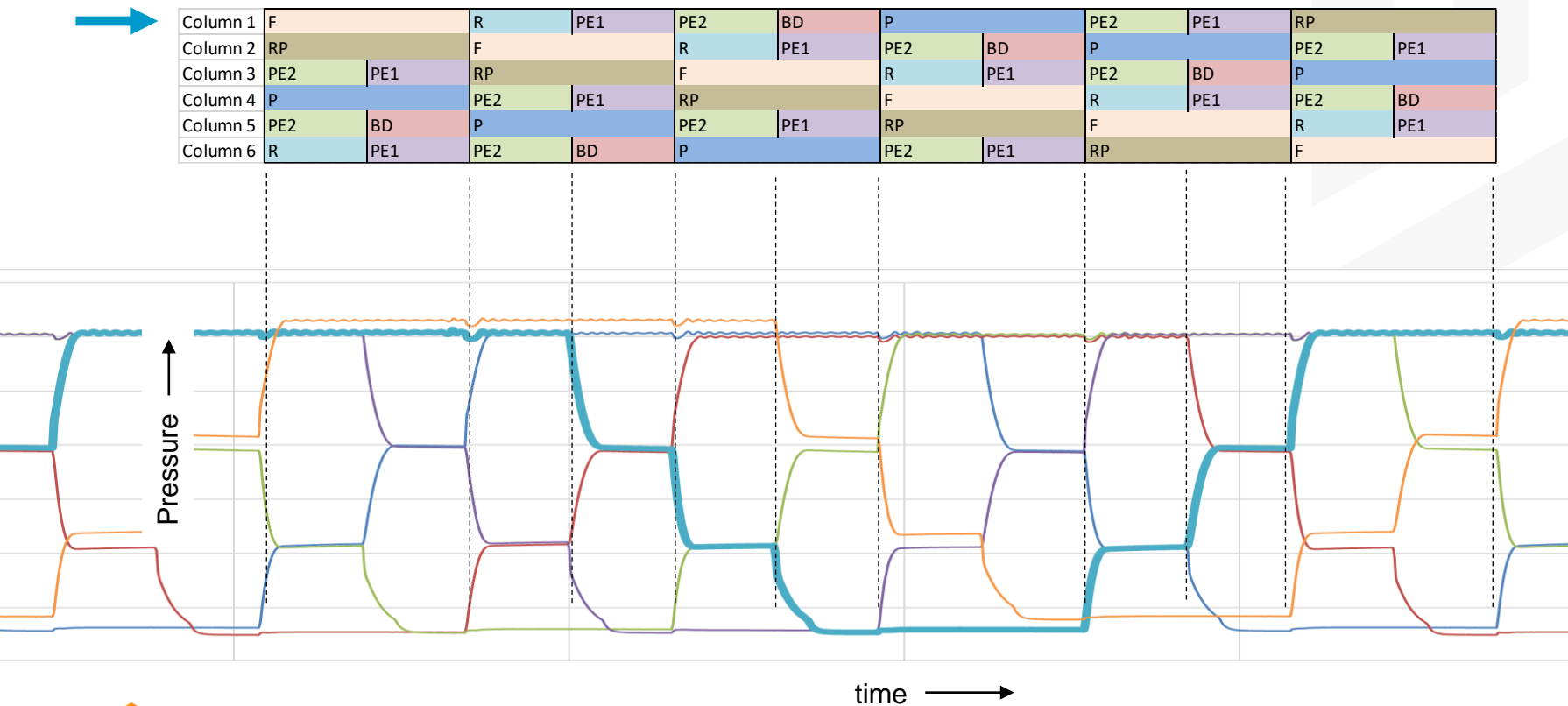
SEWGS = combining CO₂ separation with WGS reaction



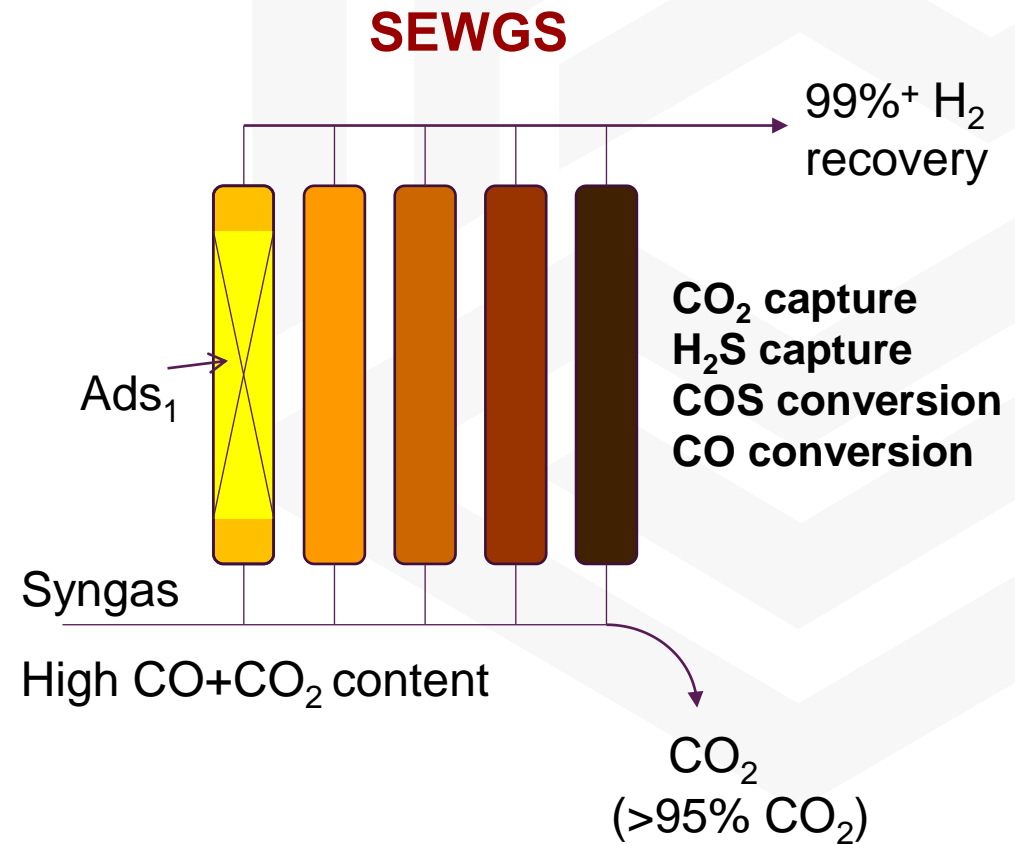
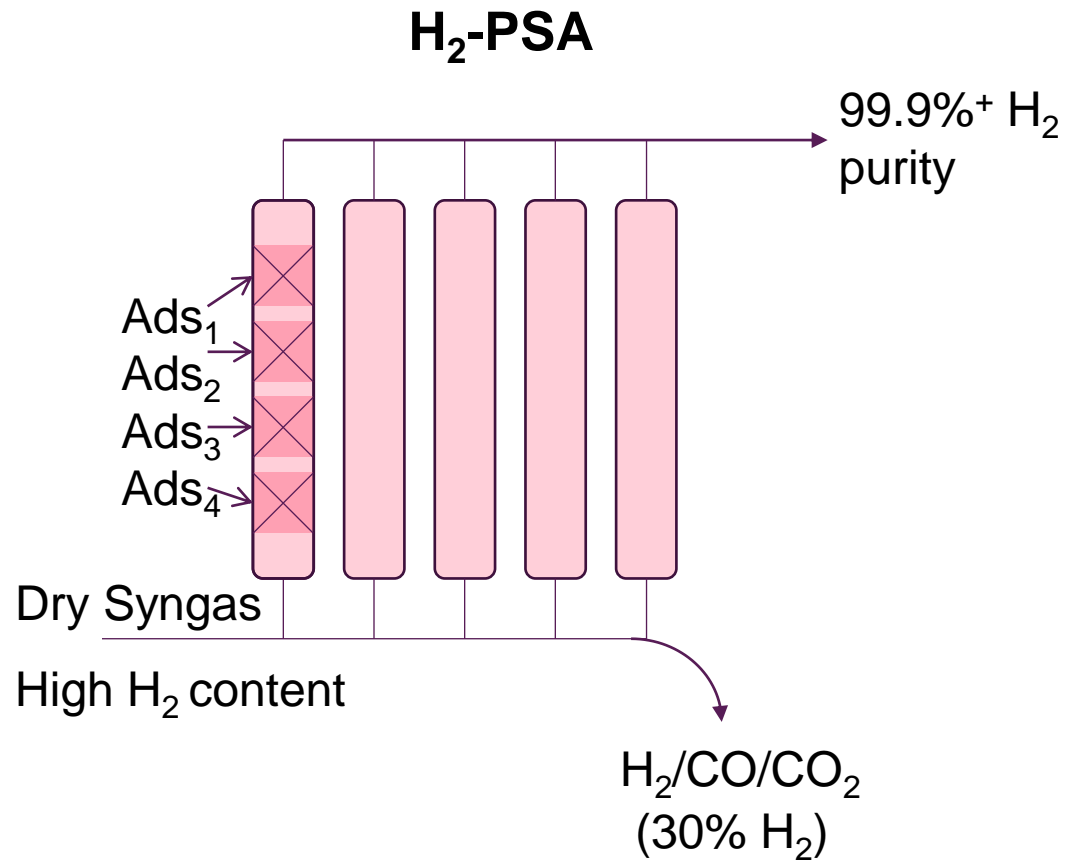
SEWGS principles



SEWGS principles



Process intensification



SEWGS Development path

Internal	1 st experiments, gram scale
CATO	Lab-scale
CACHET	Bench scale
CAPTECH	Materials development
CEASAR	Low steam usage
CATO-II	Process development
STEPWISE	Validation in industry, ton scale
FReSMe	To methanol
INITIATE	Prototype for NH ₃

