TNO innovation for life

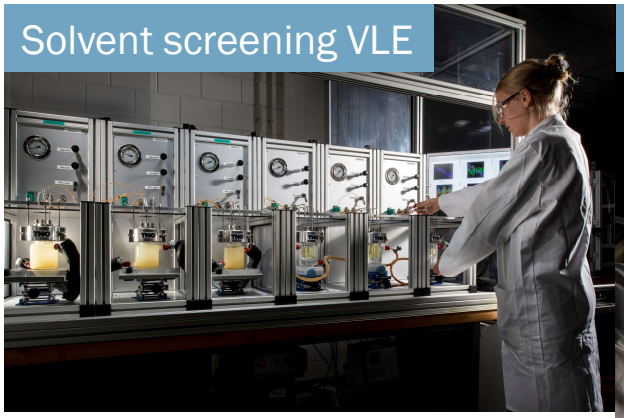
POST-COMBUSTION CO2 CAPTURE

TOBIAS ROELOFS

October 2025

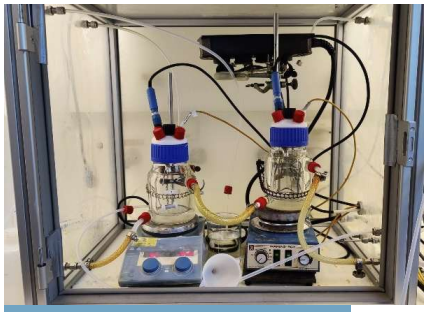
ADVANCING POST-COMBUSTION CAPTURE TECHNOLOGIES
TNO INSTALLATIONS

Solvent screening VLE



Absorption kinetics

Thermal stability



Oxidative stability

Microplant

Miniplant

THE MINIPLANTS

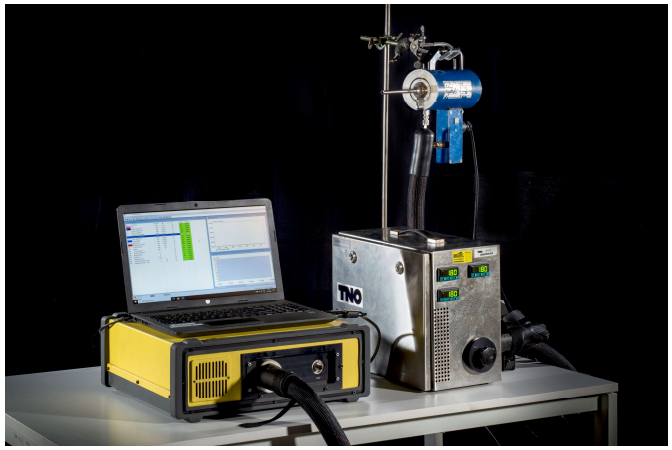
Lab version: stays at TNO and is used for research

On-site version:

- Easily transportable by truck
- Operate with real flue gases on location
- Can be use in hazardous areas (ATEX certified)

ADVANCING POST-COMBUSTION CAPTURE TECHNOLOGIES

TNO INSTALLATIONS – ON-SITE DIAGNOSIS



On-site diagnosis: de-risk application

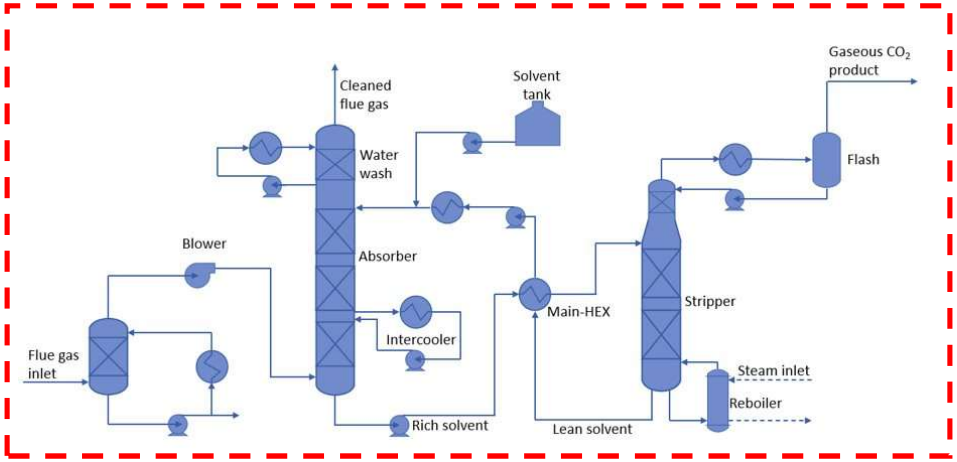
Evaluate the quality of the flue gas, and estimate the impact of impurities and particles on a future CO_2 capture plant

- FTIR: gas composition, including acidic impurities that can lead to the formation of heat stable salts
- ELPI+: characterization of particles in the flue gas that could lead to aerosol-based solvent emissions
- Evaluation of the flue gas under dynamic conditions (e.g.: change of fuels, maintenance in the line, ramping up/down)

FEASIBILITY STUDY

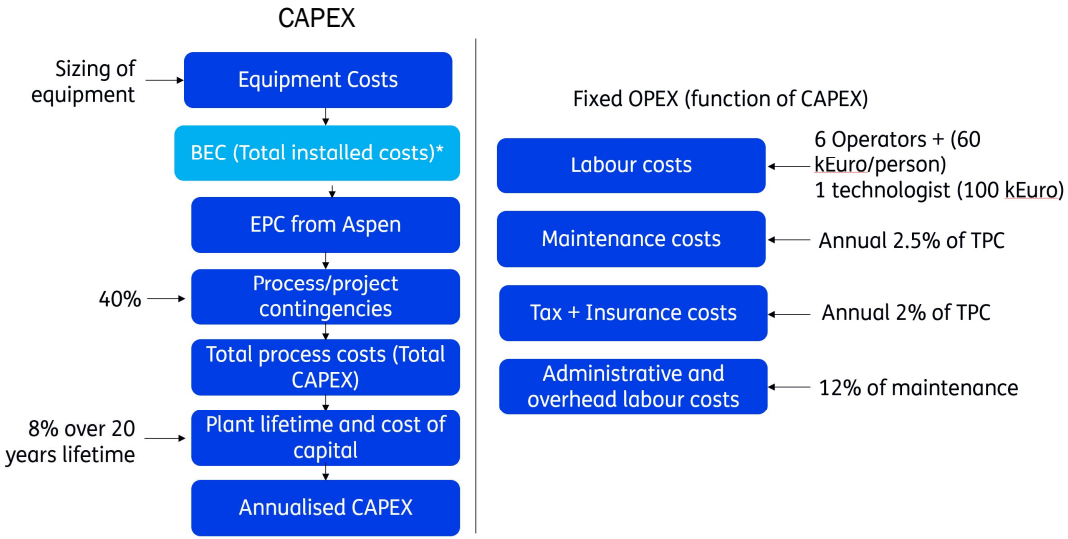
1. DEFINITION OF BOUNDARY CONDITIONS

Example of process boundary conditions



- Flue Gas Composition & Flow conditions
- Cleaned Flue Gas
- CO_2 stream
- Flash gases from e.g. Solvent Tank
- Utility connections: steam, power, coolant etc

Example of Techno-economic Assesmetn framework



- TEA Framework can lead to
  - Discussion how to calculate the final results for OPEX and CAPEX
  - Overall Net Present Value Analysis of different line-ups

2017-2019

Accelerating Low CarboN Industrial Growth through CCUS

WP1 (CAPTURE) HIGHLIGHTS

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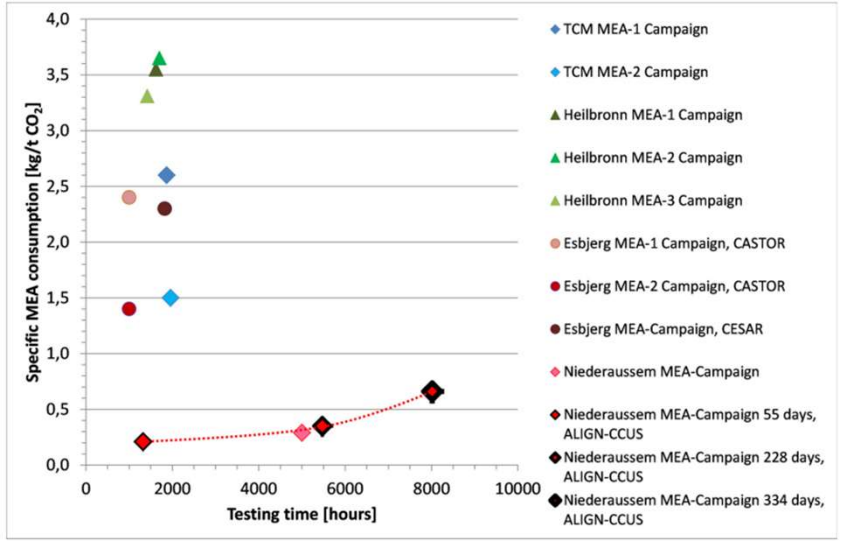
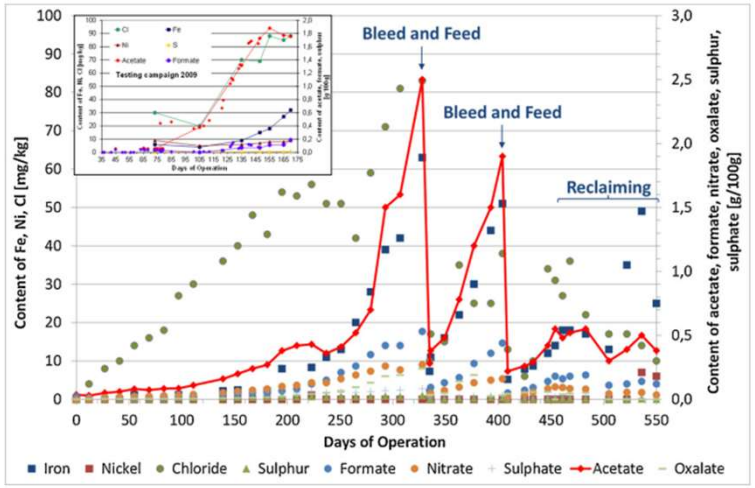
Results of the 18-month test with MEA at the post-combustion capture pilot plant at Niederaussem – new impetus to solvent management, emissions and dynamic behaviour

Peter Moser[a,*], Georg Wiechers[a], Sandra Schmidt[a], Juliana Garcia Moretz-Sohn Monteiro[b], Charithea Charalambous[c], Susana Garcia[c], Eva Sanchez Fernandez[c]

[a] RWE Power AG, Huyssenallee 2, 45128, Essen, Germany
[b] TNO, Leeghwaterstraat 44, 2628 CA, Delft, The Netherlands
[c] Research Centre for Carbon Solutions (RCCS), School of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh, EH14 4AS, United Kingdom



Relatively low MEA consumption as compared to previous projects



Degradation spiraling out of control after ca. 250 days

2023-2027: DEGRADATION AND CO2 QUALITY

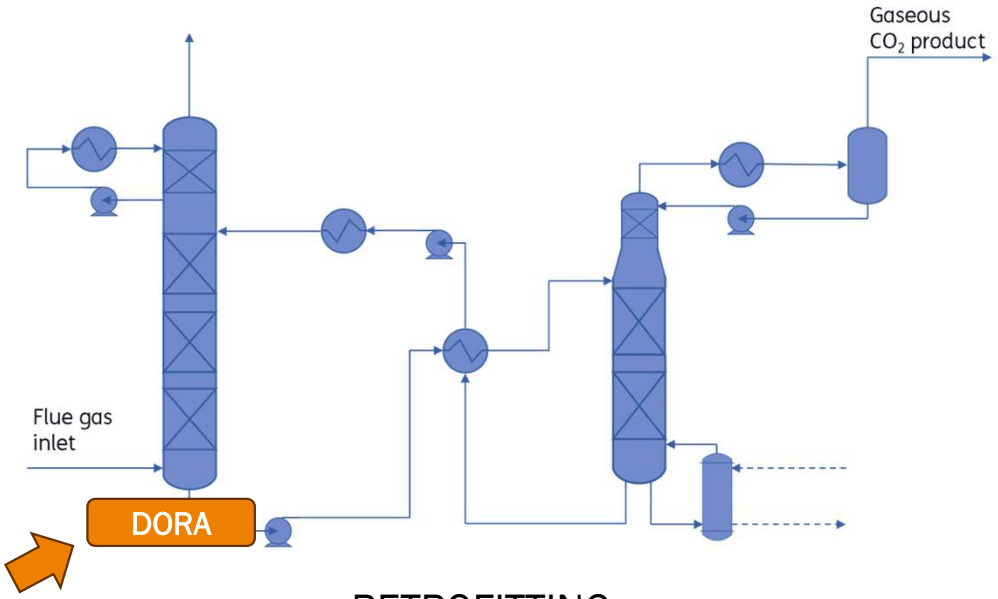
Membrane technology to reduce amine degradation and improve CO2 quality

MeDORA
Oxygen Removal System

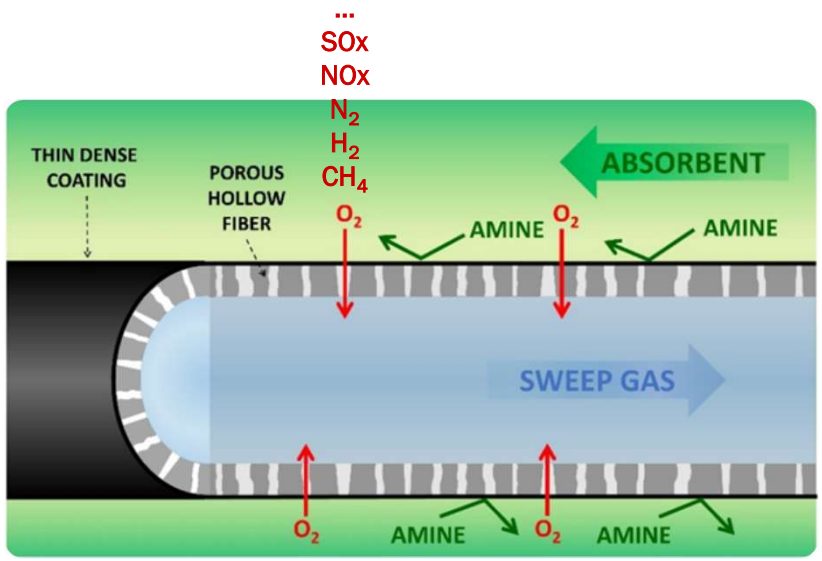
Funded by The Research Council of Norway (grant n. 340946), Projekttraeger Juelich (grant n. 03EE5160) and PPS-toeslag TKI-Energie (Ref: TKI 2023 MeDORA, program: Nieuw Gas/CCS)

DORA TECHNOLOGY

- DORA (Dissolved O_2 Removal Apparatus) is a membrane-based technology which can make amine-based carbon capture cheaper and more sustainable

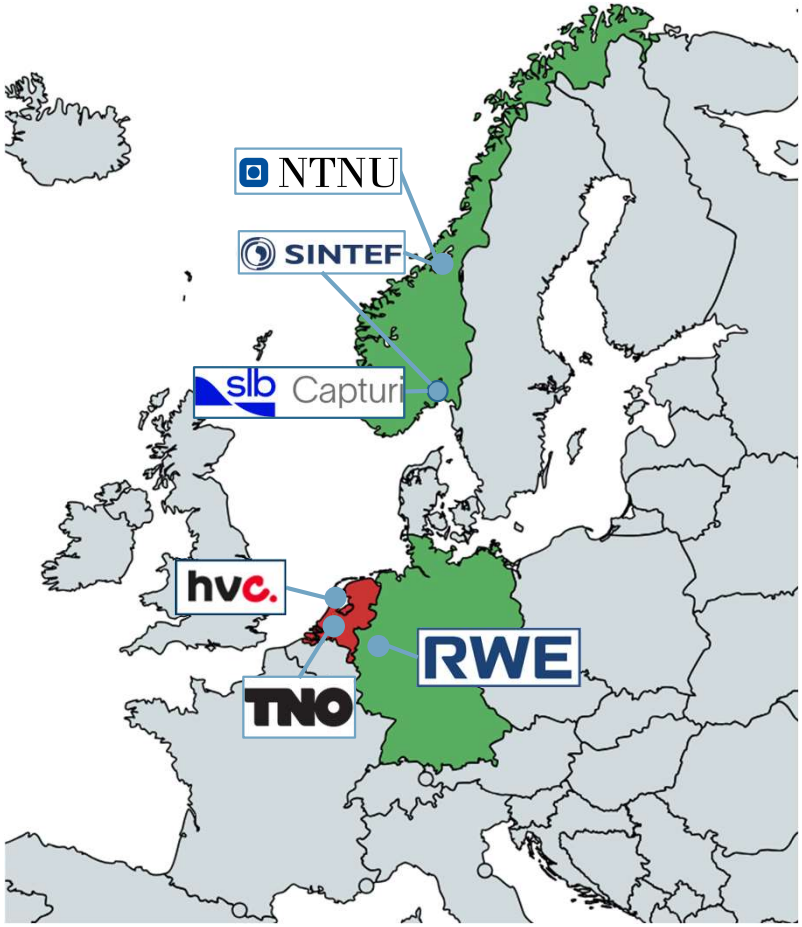


RETROFITTING



WORKING PRINCIPLE

CONSORTIUM AND PILOT CAMPAIGNS



Plant	Plant type & capacity	Flue gas & solvent	Campaign duration
HVC Alkmaar NL	Biomass energy plant (wood-waste) 540 kg CO_2/h	11% CO_2, 5% O_2 in N_2 MDEA/ PZ blend	2 years
RWE Niederhausen DE	Power plant (lignite-fired) 300 kg CO_2/h	14% CO_2, 6% O_2 in N_2 CESAR1 (AMP/PZ)	18 months
SINTEF Tiller NO	Propane burner 50 kg CO_2/h	10% CO_2, 5 – 15% O_2 in N_2 MEA	4 weeks

INITIATE project concept and vision

CONCEPT

Industrial symbiosis between **iron and steel** sector and **ammonia/urea** production

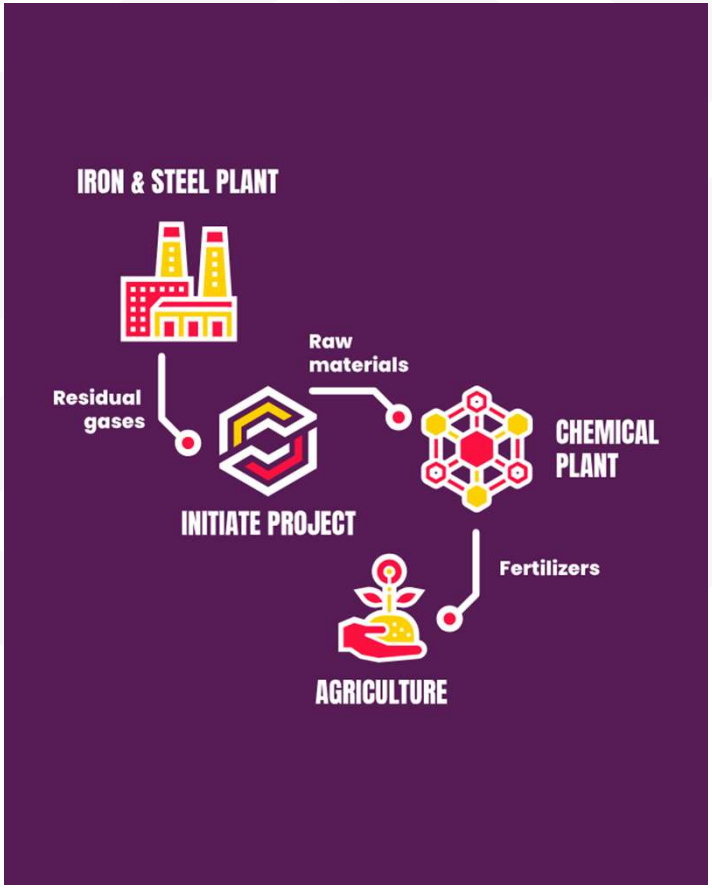
VISION

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 FOAK plant**

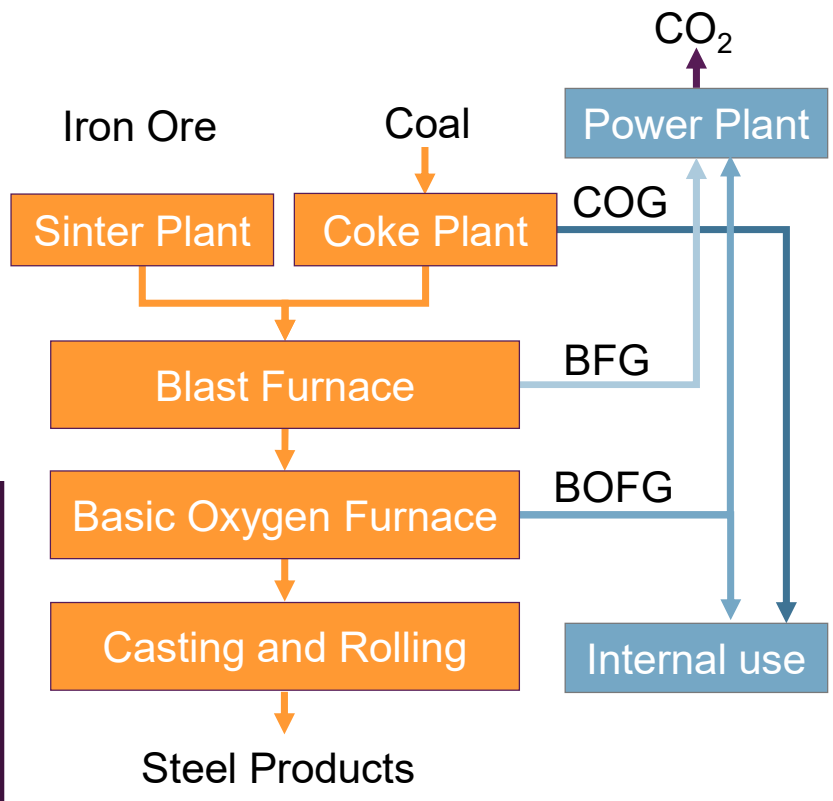
- Demonstration of continues production of NH_3 from BOFG at 1.3 t_{NH3}/d scale
- Site identification
- Business plan development
- IP&R, ownership, collaboration

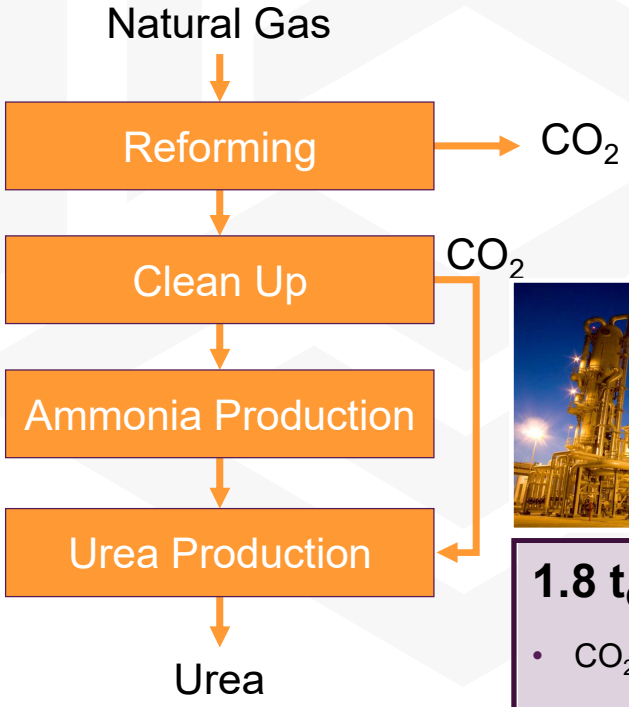


Multiple routes towards CO_2 neutrality

2 t_{CO2}/t_{HRC}

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

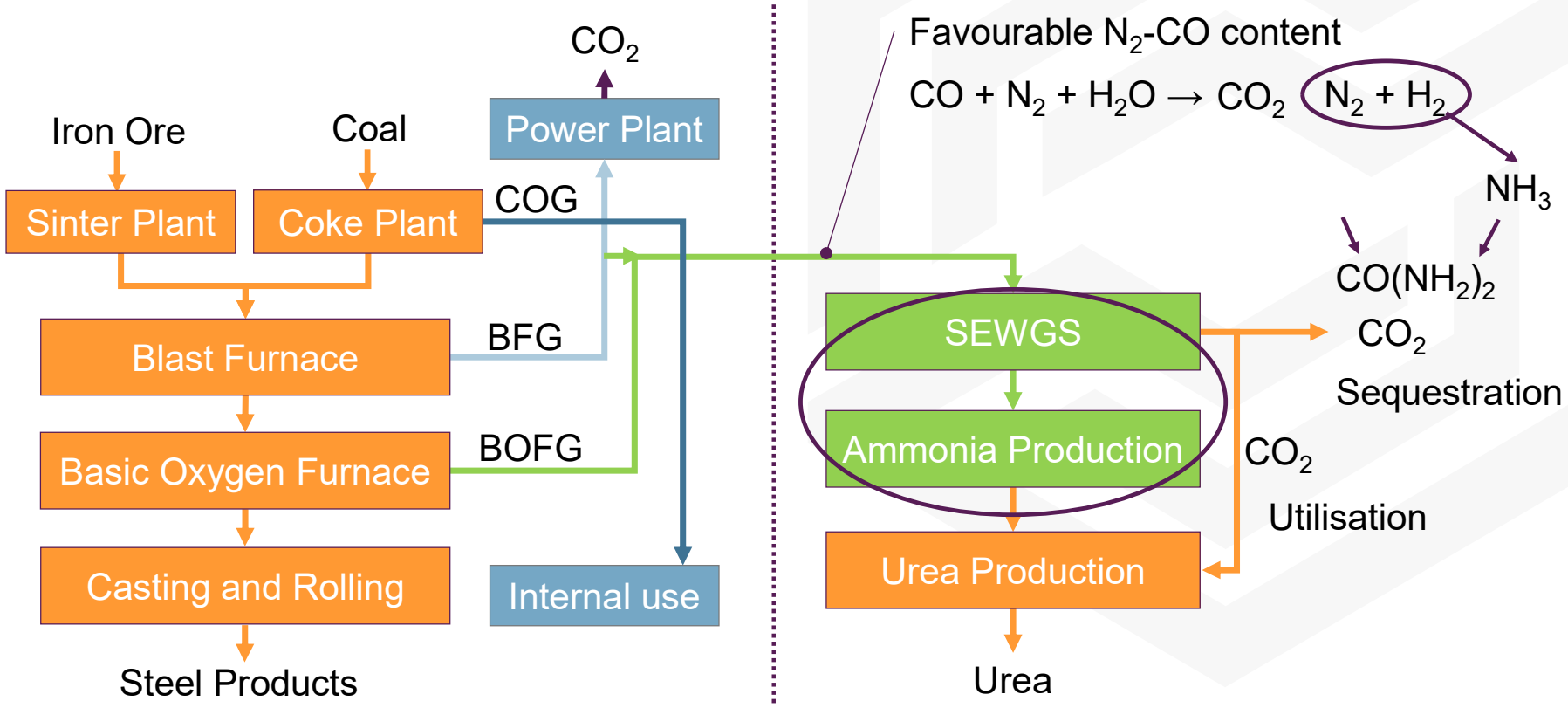




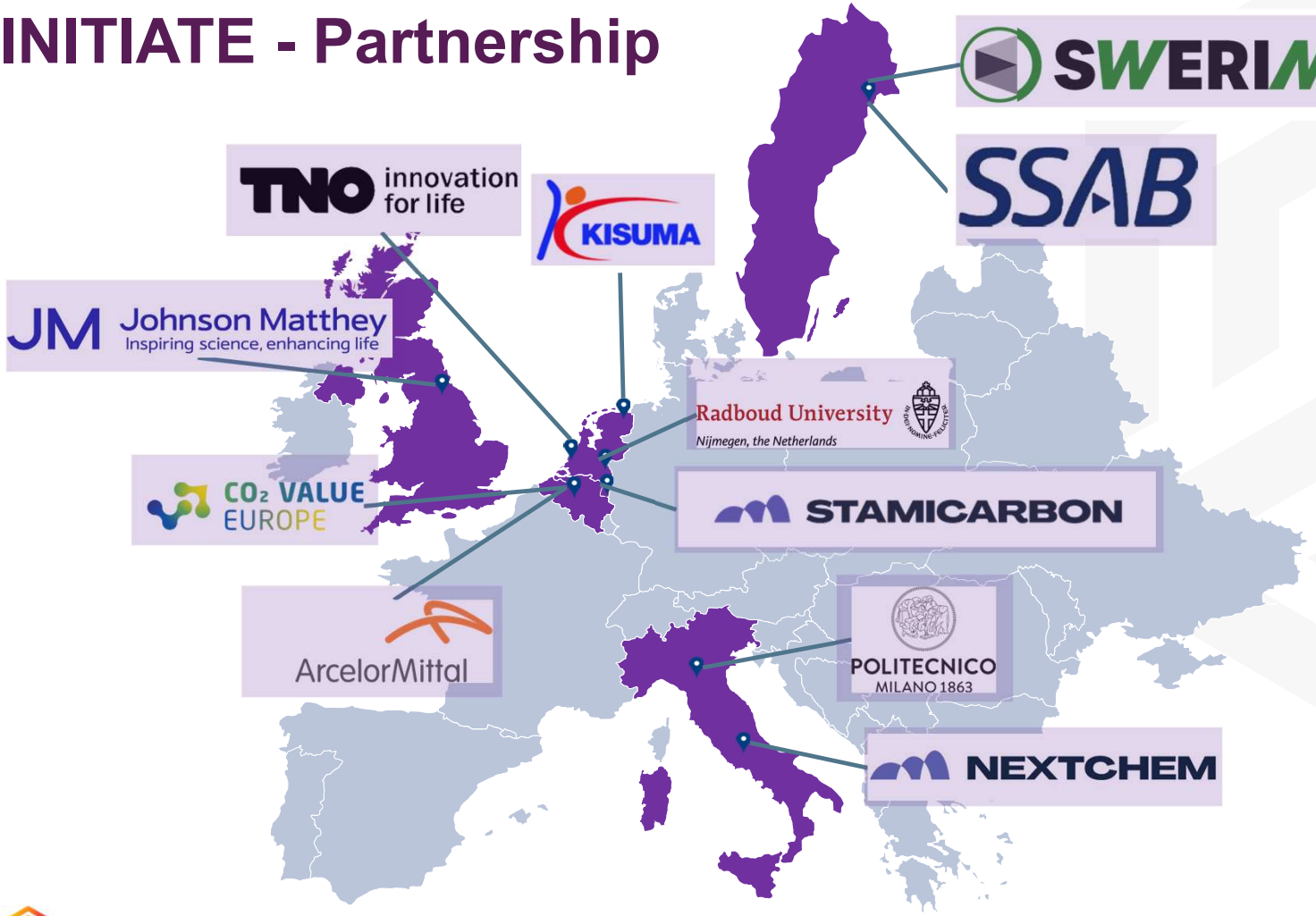
1.8 t_{CO2}/t_{NH3}

- CO_2 capture
- Green H_2

INITIATE Industrial symbiosis



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

THANK YOU FOR YOUR TIME

Tobias.Roelofs@tno.nl

+31 (0)88 866 3130

Kessler Park 1, 2288 GS Rijswijk

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