



thyssenkrupp Industrial Solutions

Sustainable Solutions

June 27th 2018 | Dr. Uwe Boltersdorf & Dr. Reinhold Achatz
thyssenkrupp Industrial Solutions

engineering.tomorrow.together.

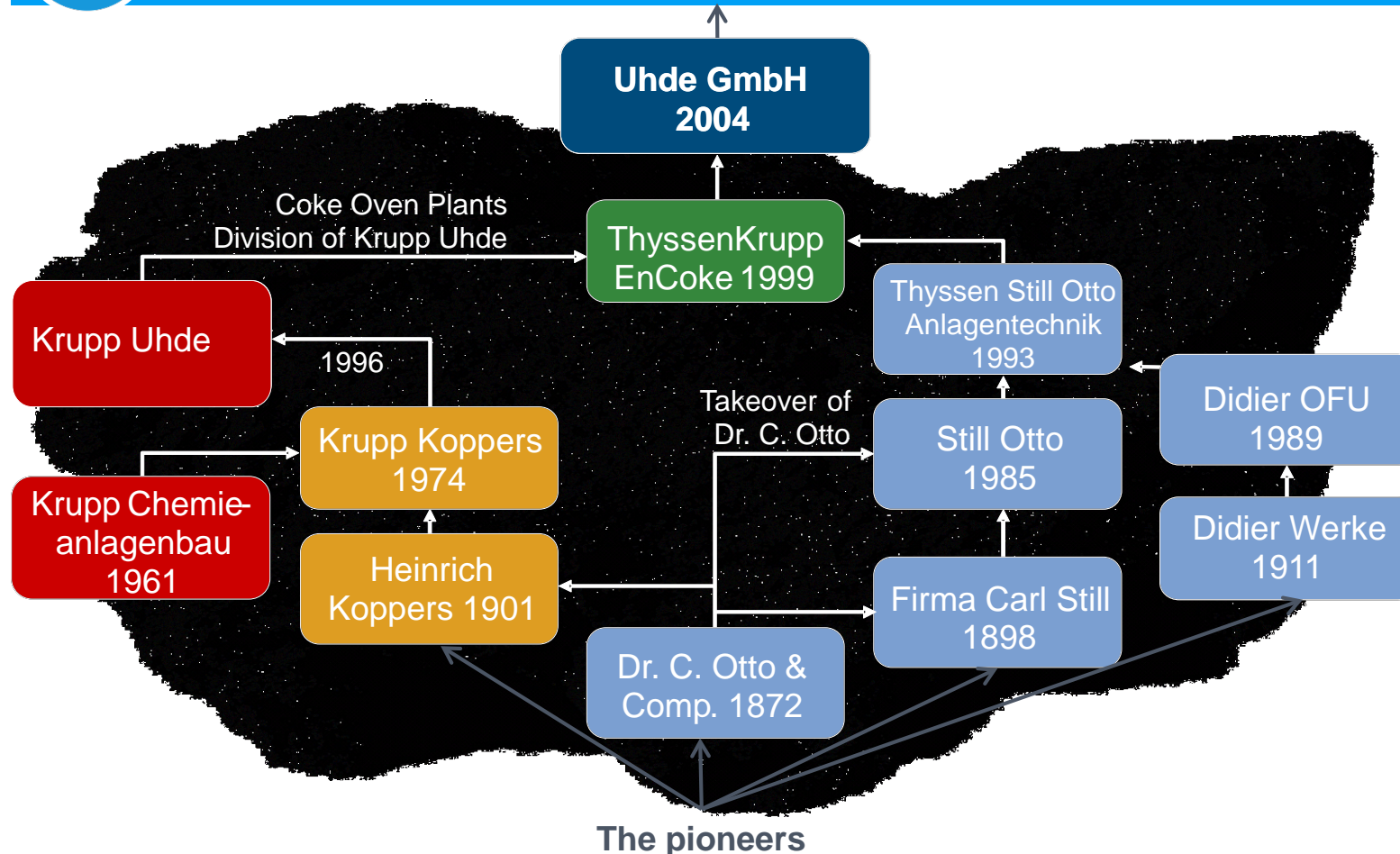


thyssenkrupp

140 years of experience in coke plant technologies...



thyssenkrupp Industrial Solutions Coke Plant Technologies



Sustainability

- Develop innovative technologies for an **environmentally friendly industry**
- **Maximizing yields** on raw material, **minimizing environmental impact**

Innovation

- Utilization of **long-term experience** and global **cross-industry network** allows for broad expertise to focus on **integrated concepts** to increase efficiency and operability
- **Digitization** of production process to further **increase efficiency**



industries

Product Integration

Environmental Services

- OXISULF
- Cyclasulf
- Monoclaus
- CO₂ removal
- EnviBat
- Morphysorb
- Jet Loop Reactor

...and many other technologies



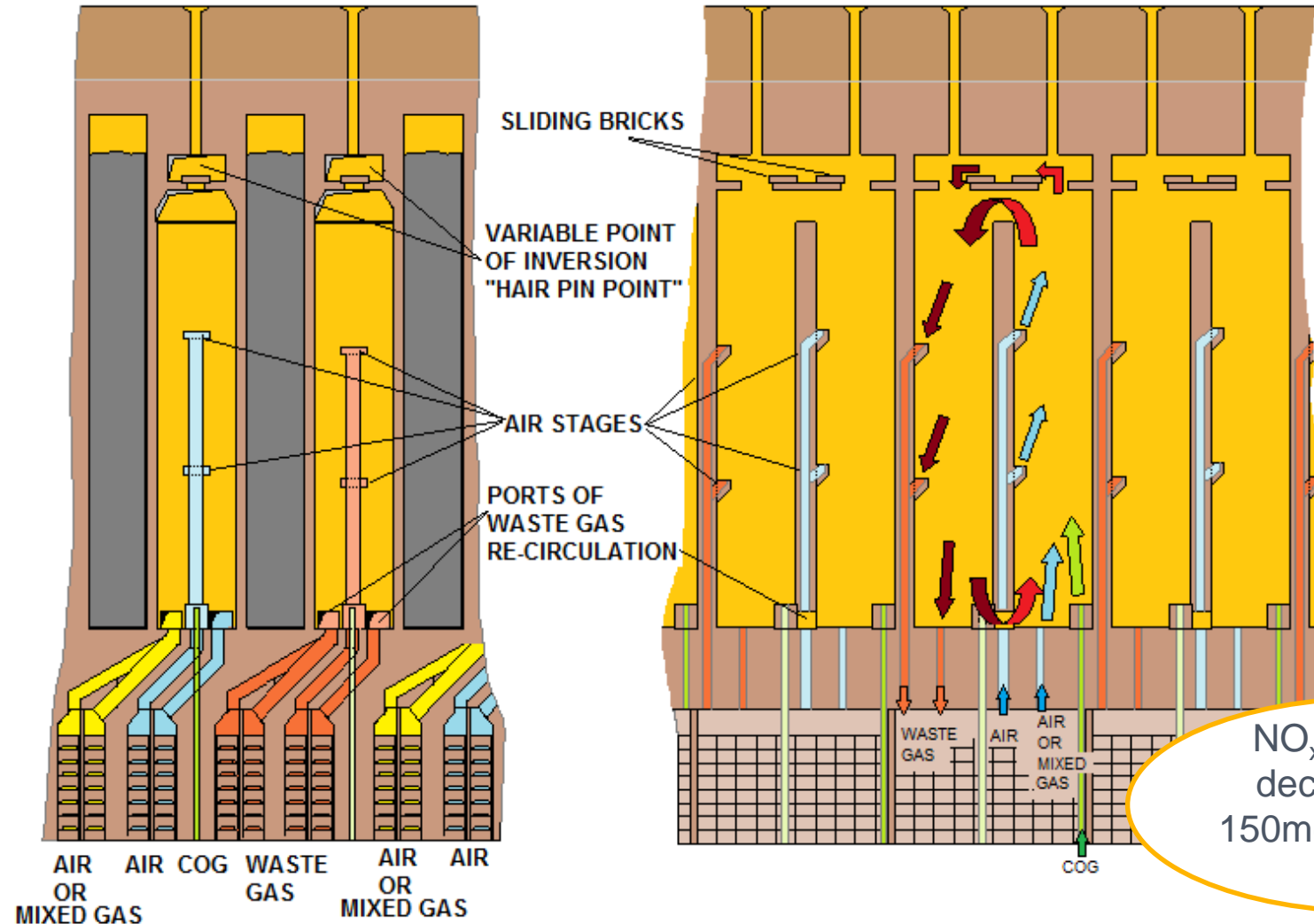
Valuable Products

- Coke
- H₂
- N₂
- Sulfur
- Sulfuric Acid
- Ammonium sulfate
- Ammonia
- Ammonium Bi-Carbonate
- Crude Tar
- Aromatics (BTX)

Energy Integration



Innovation @ sustainability: compliance with future regulations



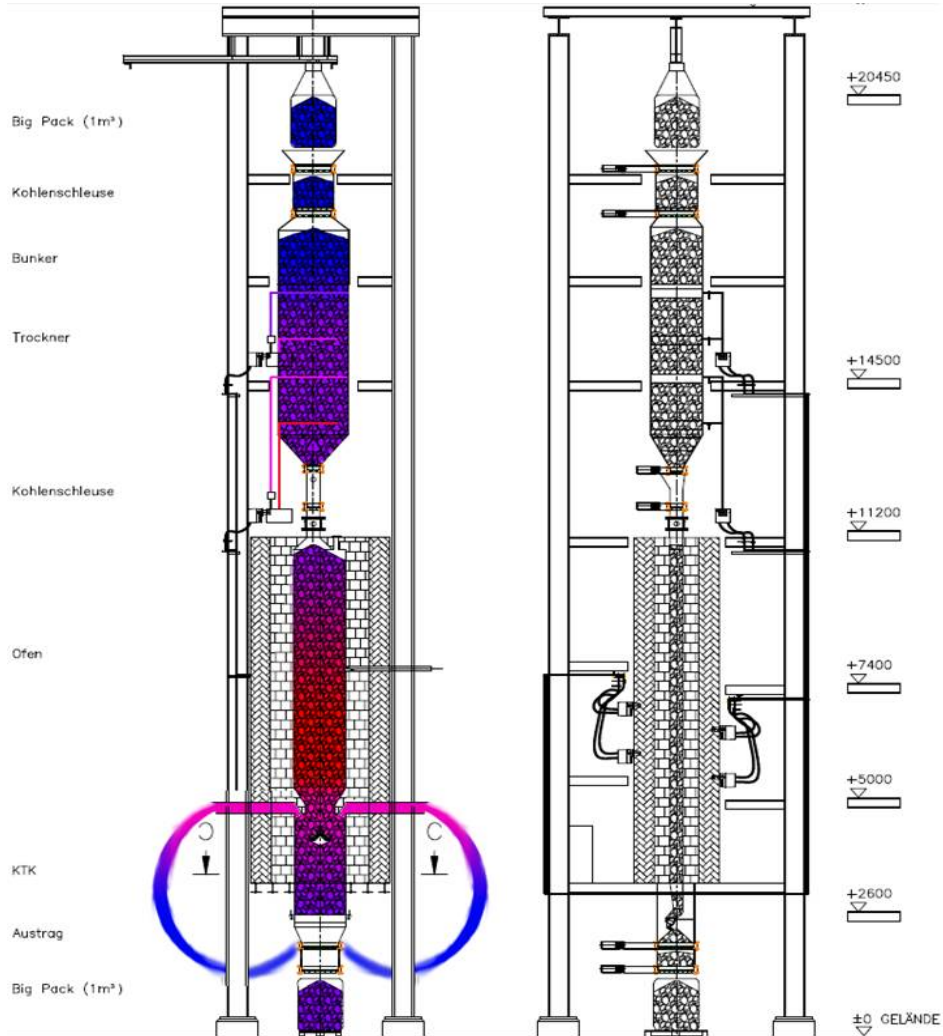
NO_x reduction...

- Compliance with NO_x regulations
 - Past years have shown high pressure on emission limits including continuously decreasing NO_x limits
- CAPEX optimization
 - Optimal process parameters lead to minimum number of excess ports
- fulfill regulatory limits and decrease CAPEX

NO_x limits may decrease from 150mg to < 100mg (-33%)



Innovation @ sustainability: efficient use of all available resources



Vertical Chamber Oven...

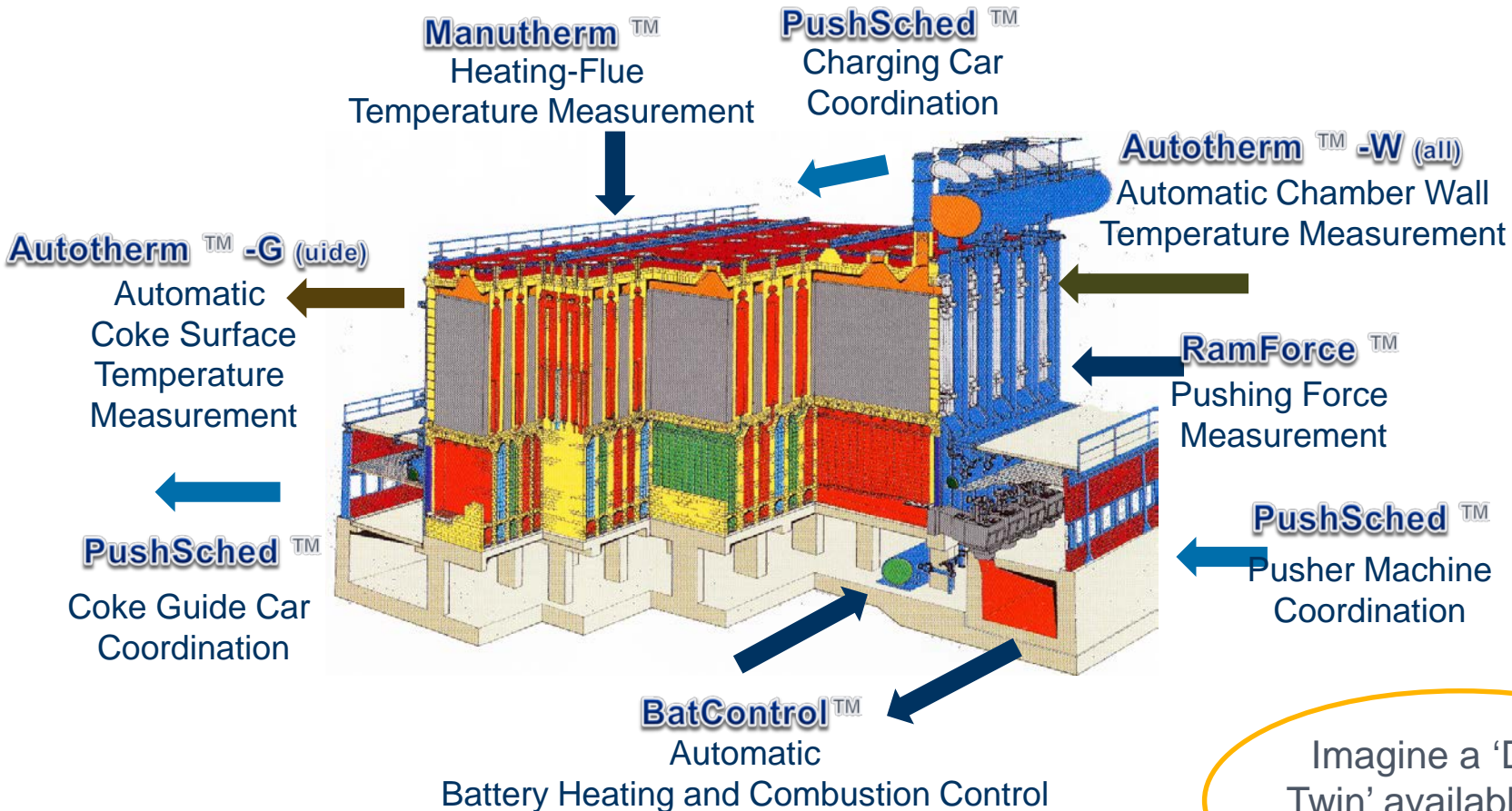
...covers a broader spectrum of applicable coal-types including:

- sub-bituminous coals
 - brown coal/lignite's
 - lean coals and anthracite's
- Acts on decrease in supply of good coking coal (for natural, technical, economical reasons)
 - Alternative to thermal usage of coal

Extension of
applicable raw
materials (coal)



Digitization: next level of productivity targeted



Digitization

As of today:

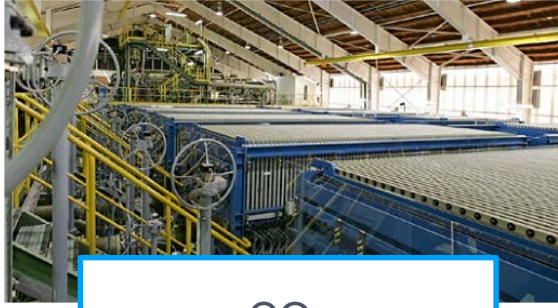
- Various automation systems available
- Model based training and simulation available
- Process optimization available

- Combining engineering data with real time operation data
- Visualization of process conditions that noone can measure

Imagine a 'Digital Twin' available short term



Coke oven gas – a source for platform molecules for different industries



CO₂

- CO₂ removal



Sulfur applications

- Claus Units
- Sulfuric acid
- Ammonia sulfate



H₂

- Hydrogen with different purities possible



Tar processing

- Pitches
- Light oils and aromatics

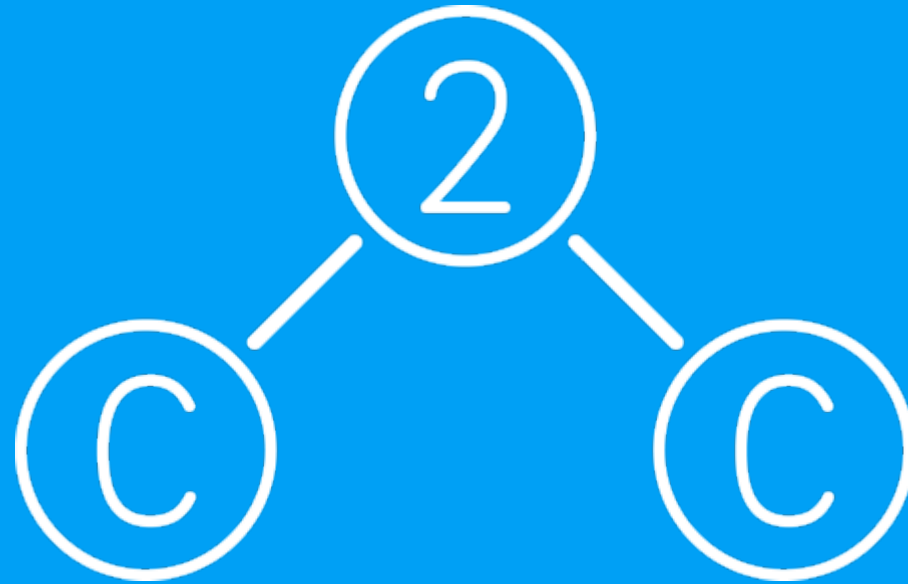


- Methanol
- Fertilizers
- Gasoline

Lighthouse project
Carbon2Chem

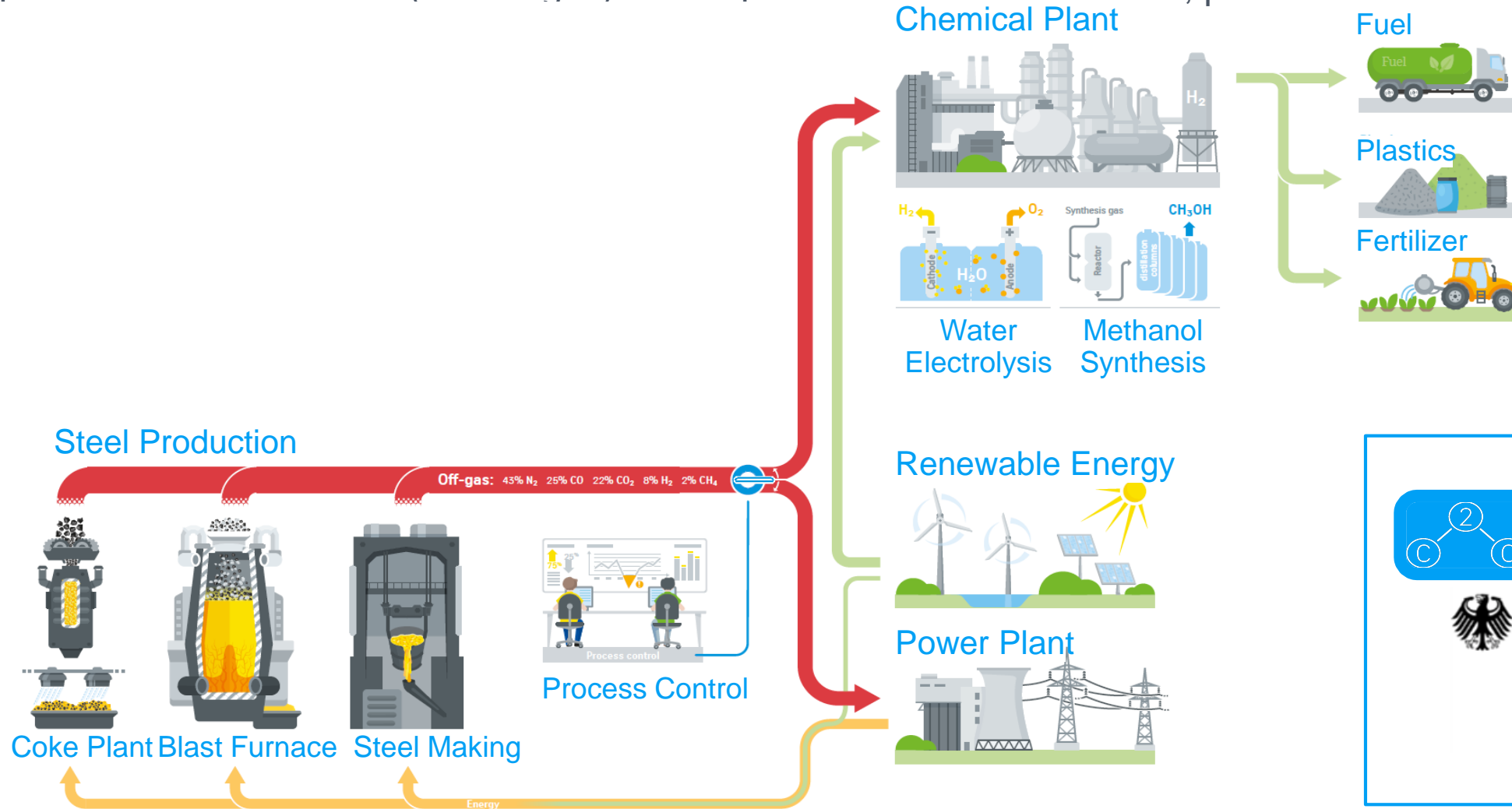
thyssenkrupp's aspiration: emission free plants and enabling integrated value chains

Carbon2Chem[®]



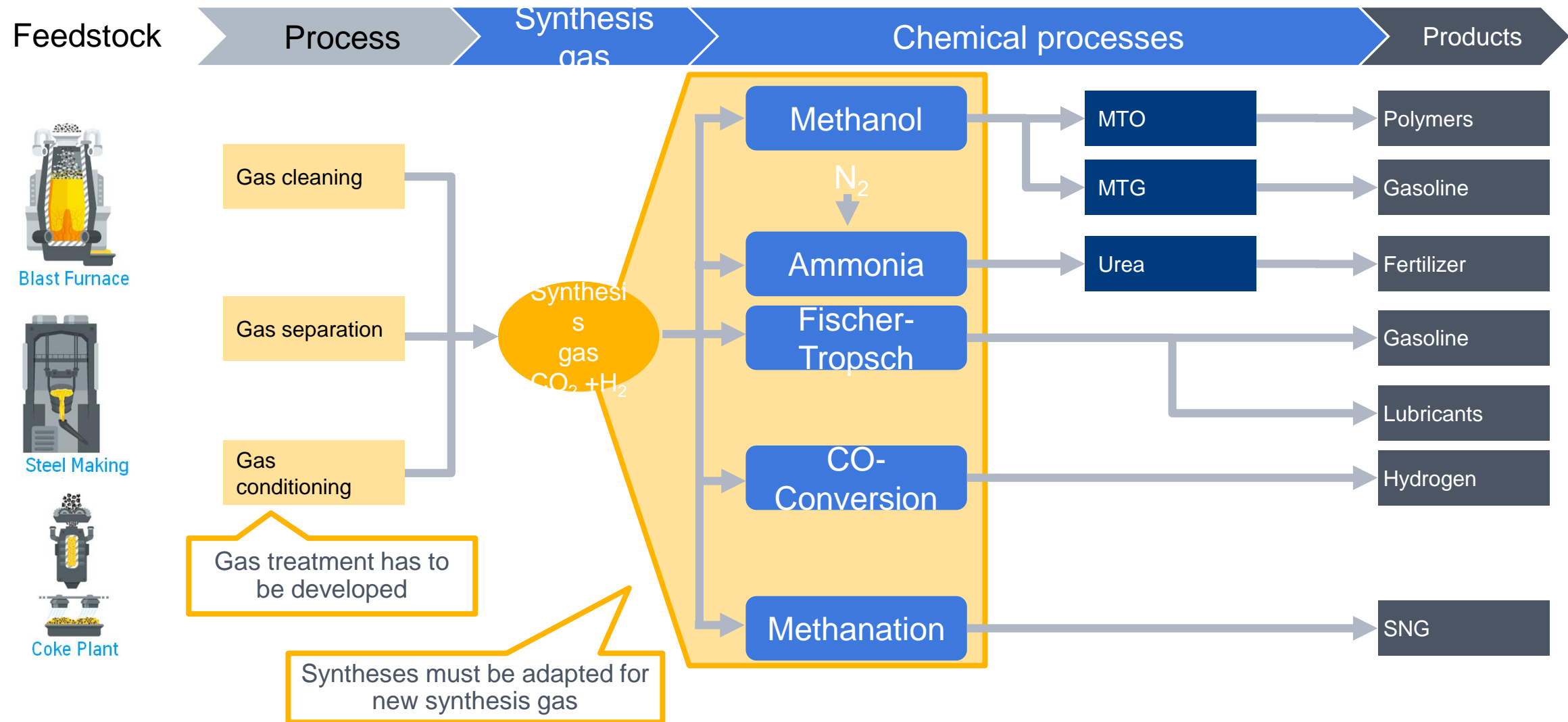
Carbon2Chem® – Recycling of top gases from steel production through cross-industry collaboration

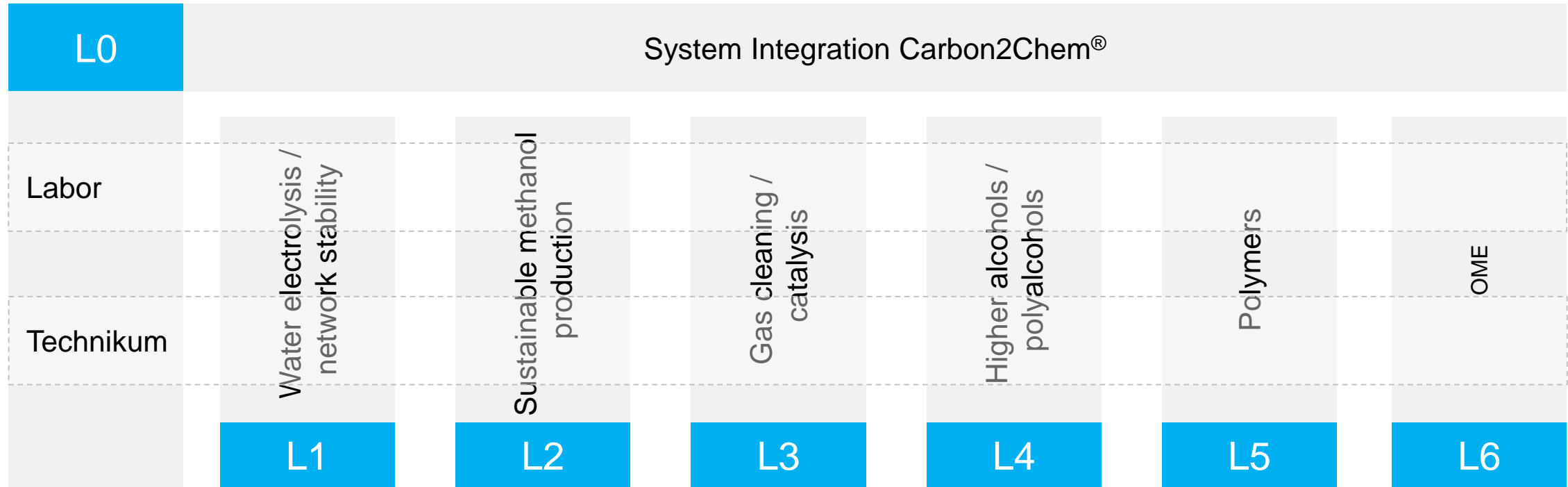
Replacement of fossil fuels (oil and gas) for the production of artificial fuels, plastics and fertilizer



Carbon2Chem[®]: Transform top gases into chemical products

Replacement of fossil fuels (oil and gas) for the production of artificial fuels, plastics and fertilizer





MPI-CEC
Umsicht
Siemens



ZBT
(University Duisburg-
Essen)



ISE
MPI-CEC
RUB
Umsicht
Clariant
thyssenkrupp



RUB
MPI-CEC
Umsicht
Clariant
thyssenkrupp



RUB
RWTH-ITMC
Umsicht
thyssenkrupp



MPI-CEC
MPI-KOFO
RWTH-ITMC
RWTH-LTT
RWTH-AVT
RWTH-CAT



Umsicht
KIT-IKFT
TU KL
VW
Eni
Linde
thyssenkrupp

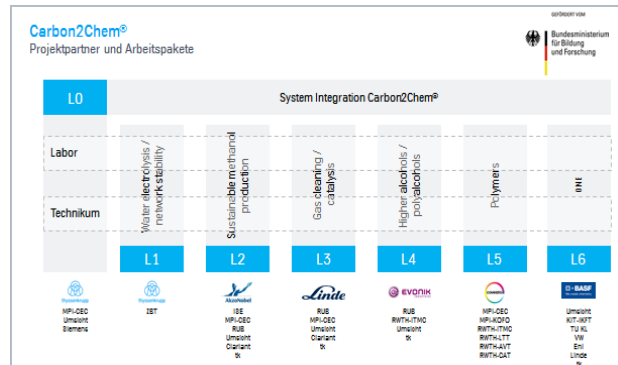


Carbon2Chem®: From idea to commercial implementation

Research in Carbon2Chem®

Carbon2Chem® Pilot plant

Commercial implementation



Basics / Lab phase

IP is created (**closed level**)

Transfer Ideas to the pilot plant



Operating experience

Phase I: Proof of concept

Start: 2015

End: 2020



Contribution to the commercial implementation

Phase II: Industrial scale-up

Start: from 2020

Industrial commercialization

Start: from 2030



Carbon2Chem® Pilot Plant (Technikum)



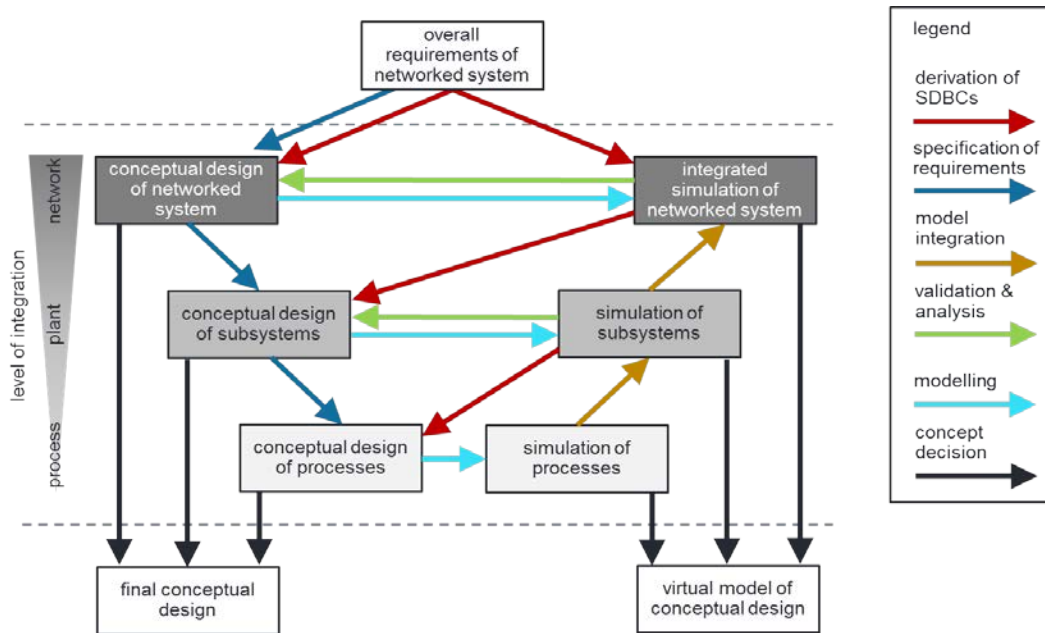
Carbon2Chem® Water Electrolysis - 2 MW



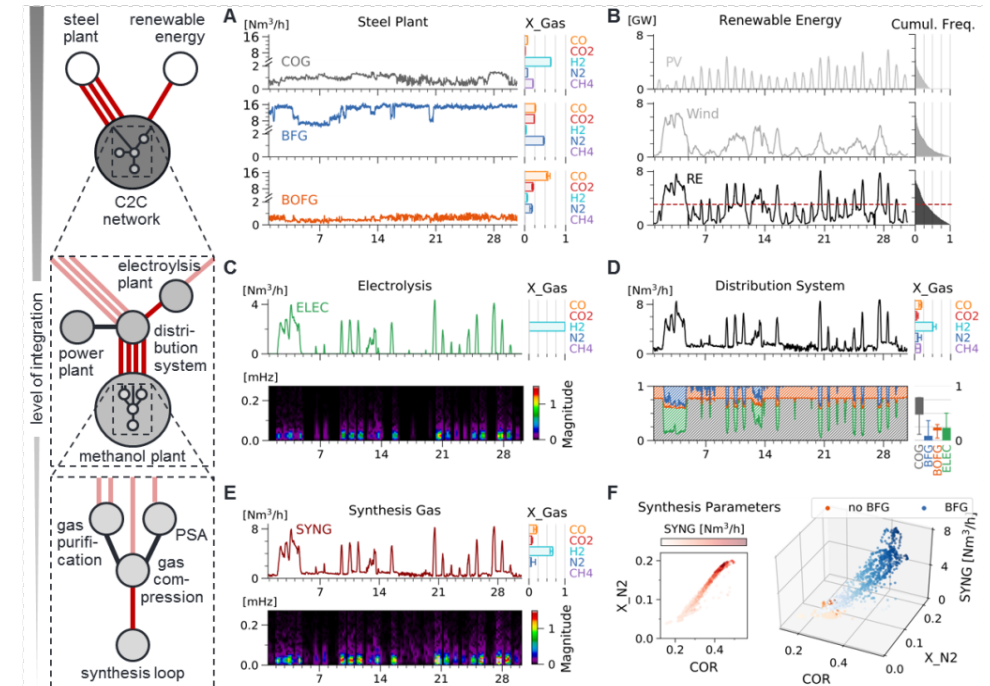
Modeling, Simulation and Analytics

Modern IT-Technologies ensure performance

Conceptual Design Model

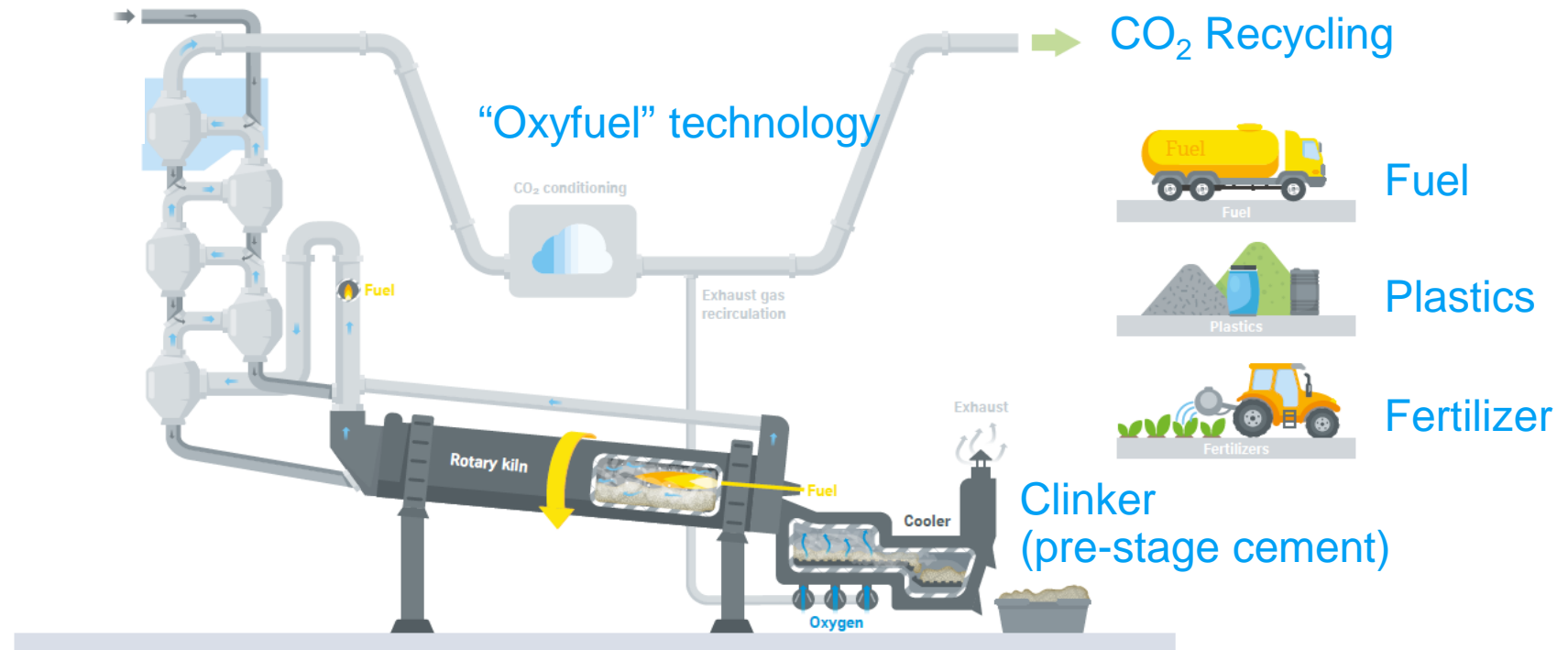


Simulation results based on Conceptual Design Model



Carbon2Chem® - Technology modules can be offered for other CO₂ intense industries as well

Example: Industrial Solutions
Carbon capture and utilization
(CCU) for cement production



- Oxyfuel technology can be combined with any kind of modern cement production technology
- thyssenkrupp's outstanding position in cement production technology is a key lever for Oxyfuel technology roll-out



Q&A

