



thyssenkrupp

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# Building a sustainable industrial and energy infrastructure

AEA Conference, November 16<sup>th</sup> to 18<sup>th</sup>

thyssenkrupp Industrial Solutions, Tobias Birwe, November 17<sup>th</sup>



We are a global corporation with

~ €34 bn sales and 109,000 employees &

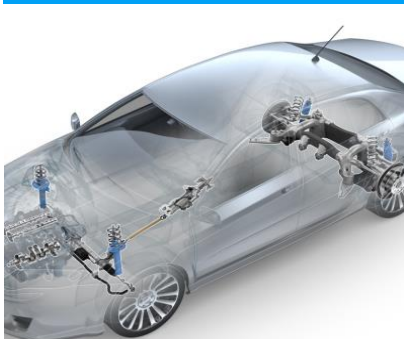
presence in 60 countries with ~1,090 locations



# Overview of our businesses

## Automotive Technology

### Automotive Components



### System Engineering



## Industrial Components

### Forged Technologies



### Bearings



## Solutions provider

## Plant Technology

### Chemical & Process Technologies



### Mining Technologies



### Cement Technologies



## Marine Systems

### Submarines



### Surface Vessels



### Naval Electronic Systems



## Materials Services

### Raw Materials & Trading



### Production



### Distribution



### Supply Chain Services



## Applicant

## Steel Europe

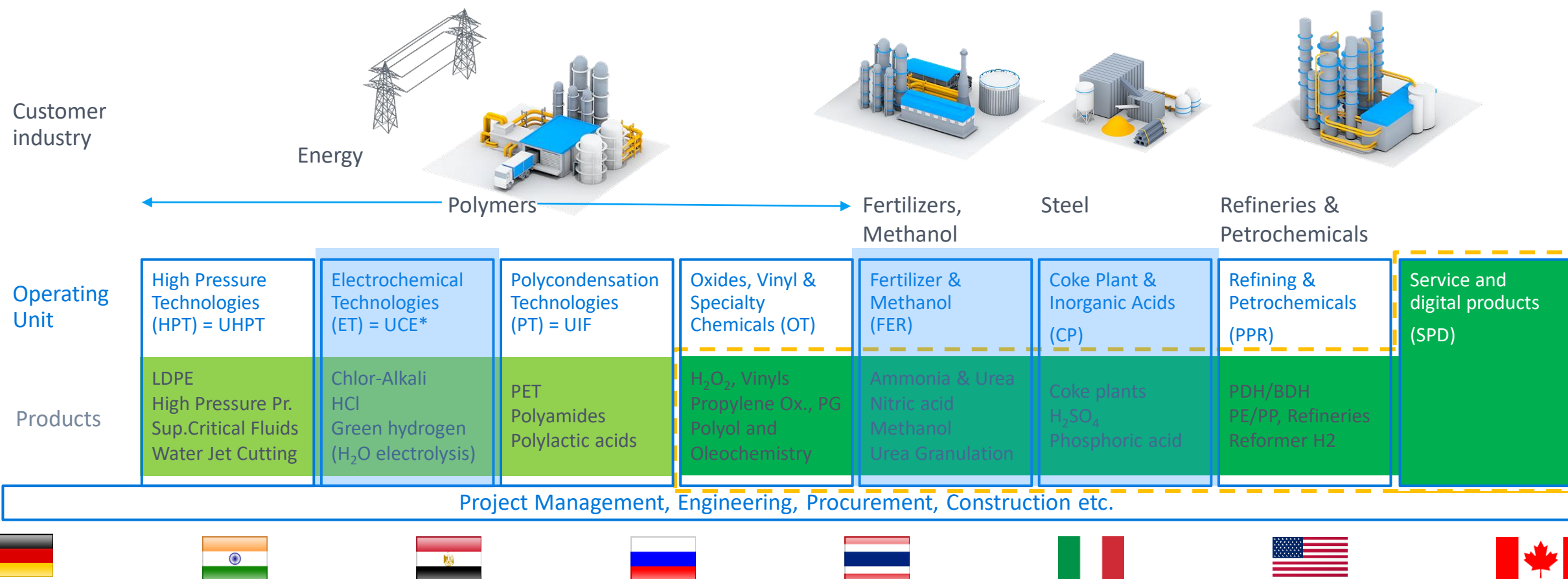
### Production & Service



# Business Unit Chemical & Process Technologies (formerly Uhde)

## Technology Portfolio

### Business Unit Chemical and Process Technologies (CPT)



\* Joint venture with Denora S.p.A





Location of Carbon2Chem<sup>®</sup> Technical Center  
at thyssenkrupp Steel site in Duisburg



Carbon2Chem®

First products

supported by  
Federal Ministry  
of Education  
and Research

BMBF funding numbers 03EK3037 to 03EK3043

$H_2$



Syngas



Methanol

Ammonia

Water electrolysis

Gas cleaning

1<sup>st</sup> production:  
18<sup>th</sup> December 2018

# Carbon2Chem<sup>®</sup>: Pilot plant is in full operation since April 2018

2 MW water electrolysis



Gas cleaning



	Water electrolysis	Gas cleaning
Completion	April 2018	April 2018
Capacity	440 Nm <sup>3</sup> /h H <sub>2</sub>	coke oven gas 100 Nm <sup>3</sup> /h converter gas 70 Nm <sup>3</sup> /h blast furnace gas 70 Nm <sup>3</sup> /h
Manufacturer	thyssenkrupp Uhde Chlorine Engineers	thyssenkrupp Plant Technology (BU-CPT)



# Smart Solutions for Climate Protection — Alkaline Water Electrolysis

Carbon2Chem in Duisburg



# Water Electrolysis

key technology for sustainable hydrogen value chains

Experience cannot be copied.

#1

49% market share

supplier for electrolytic  
hydrogen production

600

electrochemical  
plants realized  
worldwide

over

10 GW

of power installed

Hydrochloric  
acid  
diaphragm  
electrolysis



Hydrochloric  
acid ODC<sup>+</sup>  
membrane  
electrolysis



Chlor-alkali  
membrane  
electrolysis



<sup>+</sup> ODC: Oxygen Depolarized Cathodes



# Water Electrolysis by thyssenkrupp - proven technology with established supply chain

>300,000

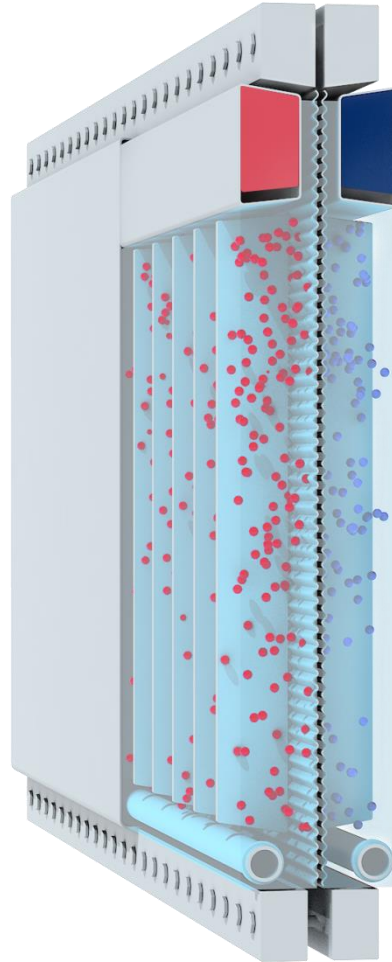
of elements manufactured<sup>1</sup>

>1.6 million m<sup>2</sup>

of electrodes produced<sup>1</sup>

>1,000 MW

can be installed each year<sup>2</sup>



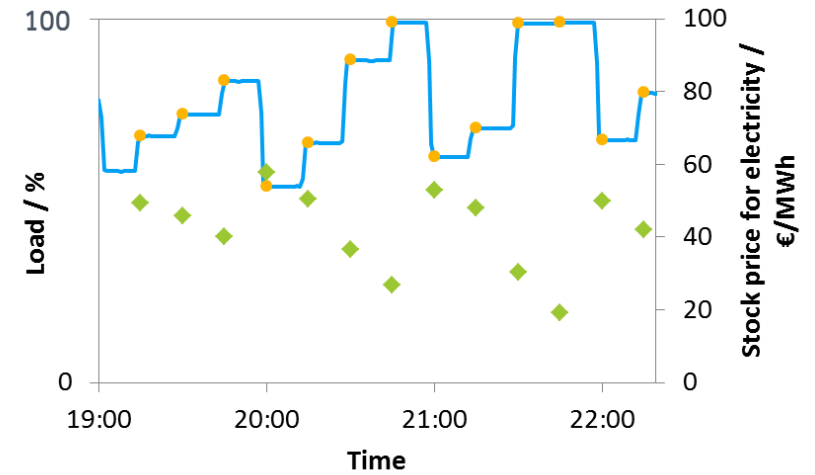
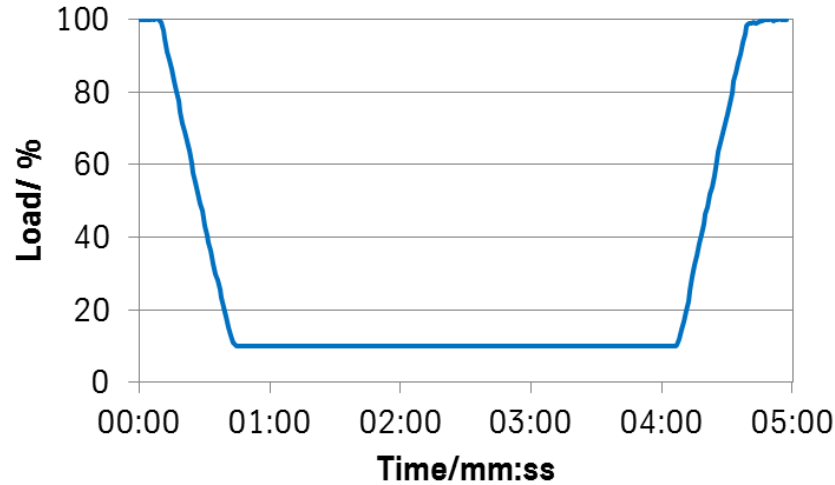
- Proven zero-gap technology
- Introduction of **high efficiency cathode design and coating** (with De Nora) for hydrogen evolution, proven in chlor-alkali technology
- Introduction of **high efficiency anode design and coating** (with De Nora) based on proven chlorine technology
- **Optimized high-performance separators and diaphragms** based on proven design

<sup>1</sup>for chlor-alkali plants producing hydrogen as co-product, <sup>2</sup>for electrolytic hydrogen production



# tkUCE large scale Water Electrolysis

thyssenkrupp Water Electrolysis system is validated at industrial scale for dynamic operation



## Operation of technical evaluation plant at Carbon2Chem, Duisburg

- Capacity: up to 2 MW
- H<sub>2</sub> production: 440 Nm<sup>3</sup>/h
- H<sub>2</sub> purity: > 99.95 % (dry basis)

## Fast ramping capabilities proven

- Load changes between 10% and 100% in less than 30sec
- Enables utilization for primary control reserve

## Power price optimized operation

- Power price based load management established
- Enables optimization of average power price

Carbon2Chem<sup>®</sup>

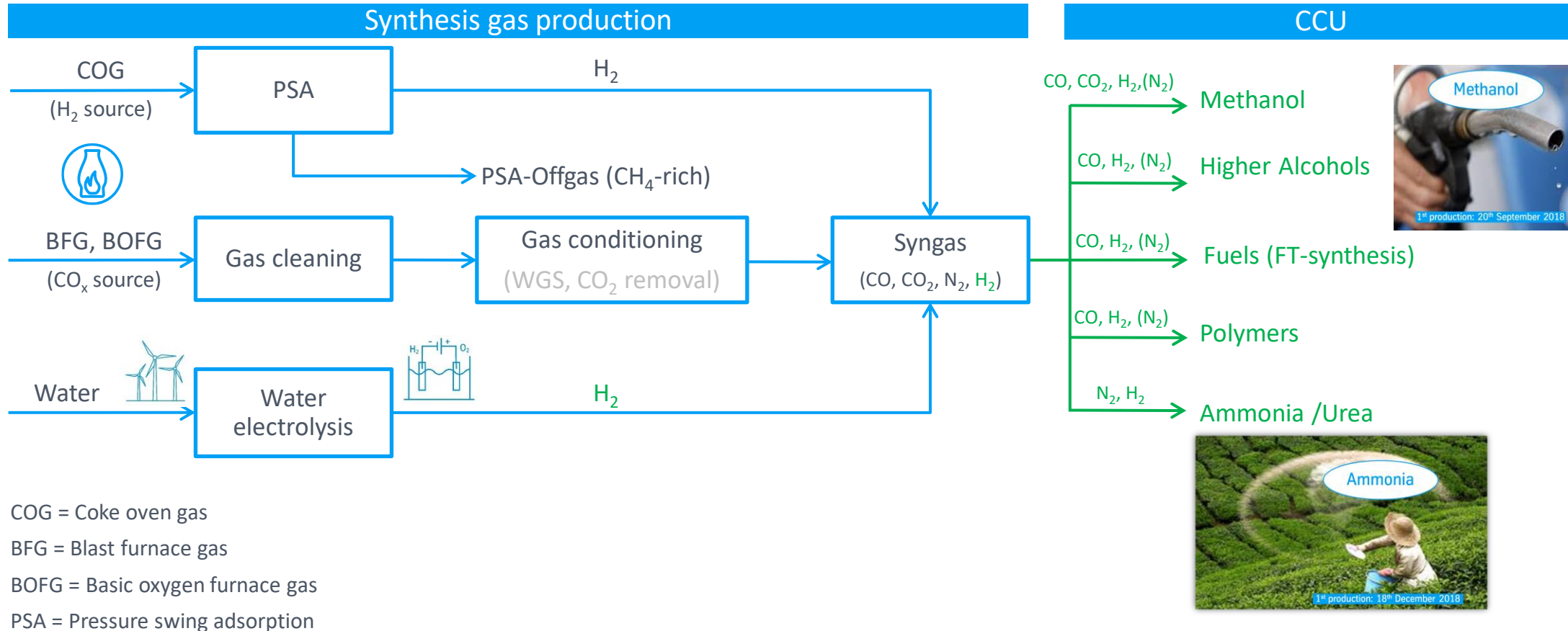
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# Introduction to Carbon2Chem<sup>®</sup>

## Production of syngas / chemicals from steel mill gases



Steel mill gases can be used for the production of purified syngas and for the production of chemicals.



# Cutting-edge ammonia technology since 1928

## uhde® ammonia process

- One of the leading technology providers in ammonia field
- Improved energy efficiency and higher capacities
- Reassuring reliability
- Pioneers in critical plant equipment

Experience cannot be copied.

#1

supplier in EPC  
business for ammonia  
plants

≈ 130

ammonia plants  
realized worldwide

> 90

years of turnkey EPC  
solutions



thyssenkrupp

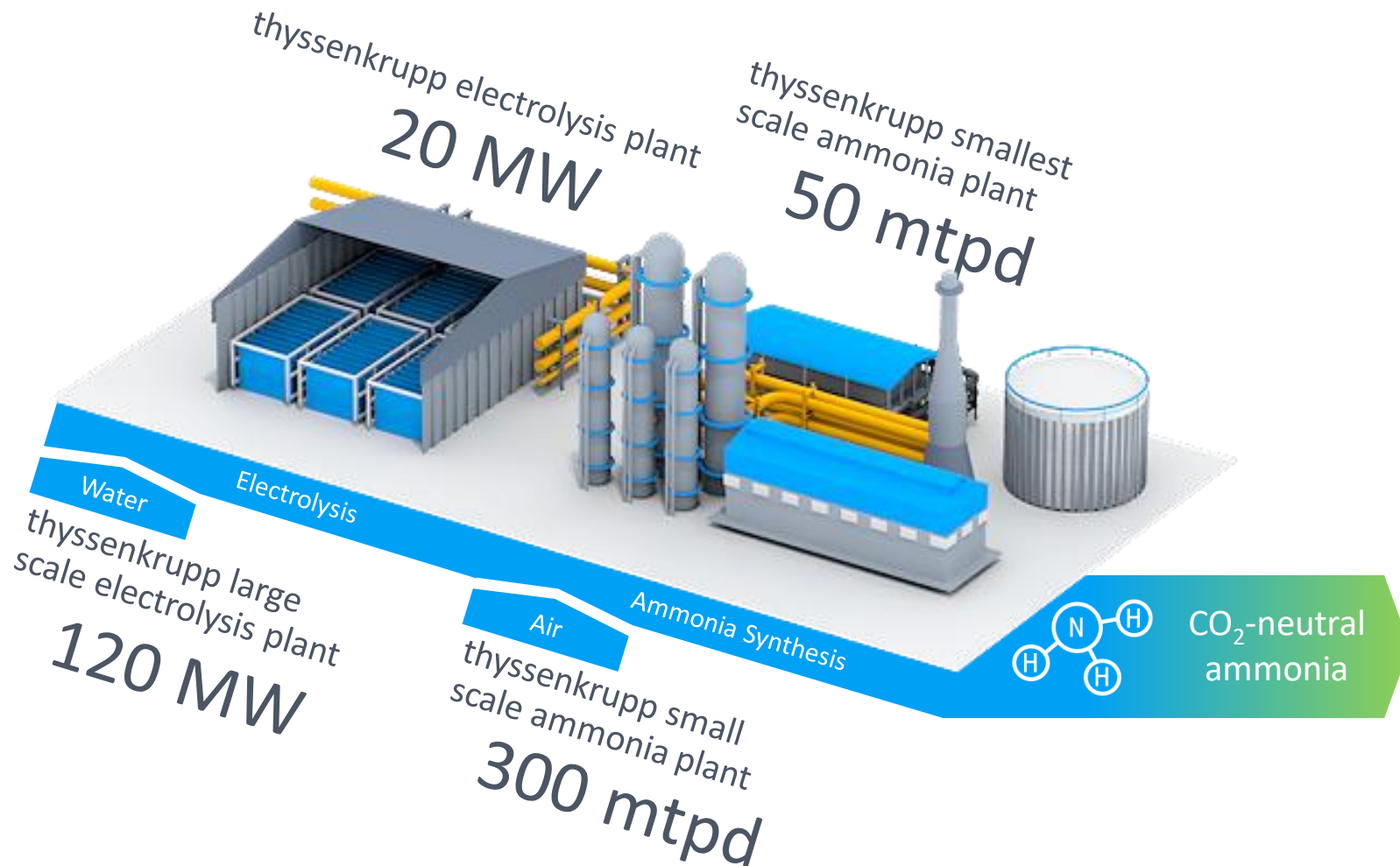
# Introducing green ammonia by thyssenkrupp

2 worldwide leading processes

1 holistic solution

0 CO<sub>2</sub> emissions<sup>1</sup>

<sup>1</sup> depending on E-power source

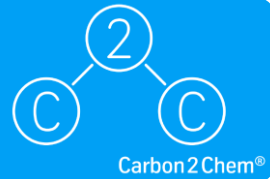


20/50 and 120/300 being fully modularized and standardized ready for the market, tailor-made up to 5000mtpd



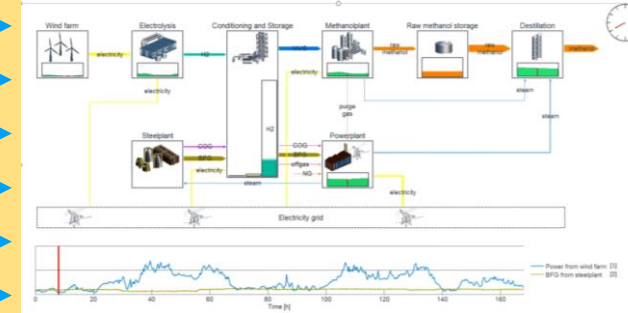
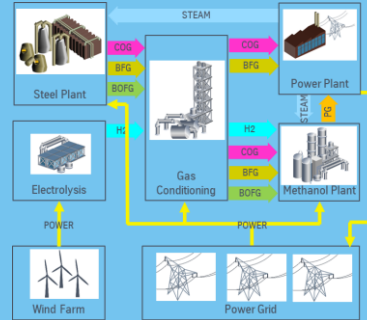
# Introduction to Carbon2Chem®

Results from 1<sup>st</sup> phase and main objectives for the 2<sup>nd</sup> phase



Building and operation of C2C technical center

Development and simulation of concepts for the cross-industrial network



Demonstration of long-term stability

Development of business cases



1st phase  
2016 - 2020

2nd phase  
2020 - 2024

Production of methanol and ammonia from steel mill gases and hydrogen from alkaline water electrolysis



Implementation of the C2C technology into other industries (e.g. cement, lime, waste)

Carbon2Chem® can reduce the CO<sub>2</sub> emissions of the cross-industrial network if renewable hydrogen is available

Proof that industrial network is technical feasible



# Thank You for Your Attention.



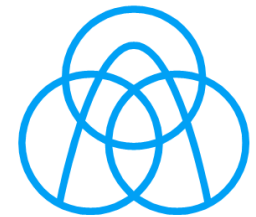
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