

Siemens Energy

13. Niedersächsische Energietage

Fachreferat: Wie kann der Hochlauf einer H₂-Wirtschaft aus technischer Sicht gelingen?

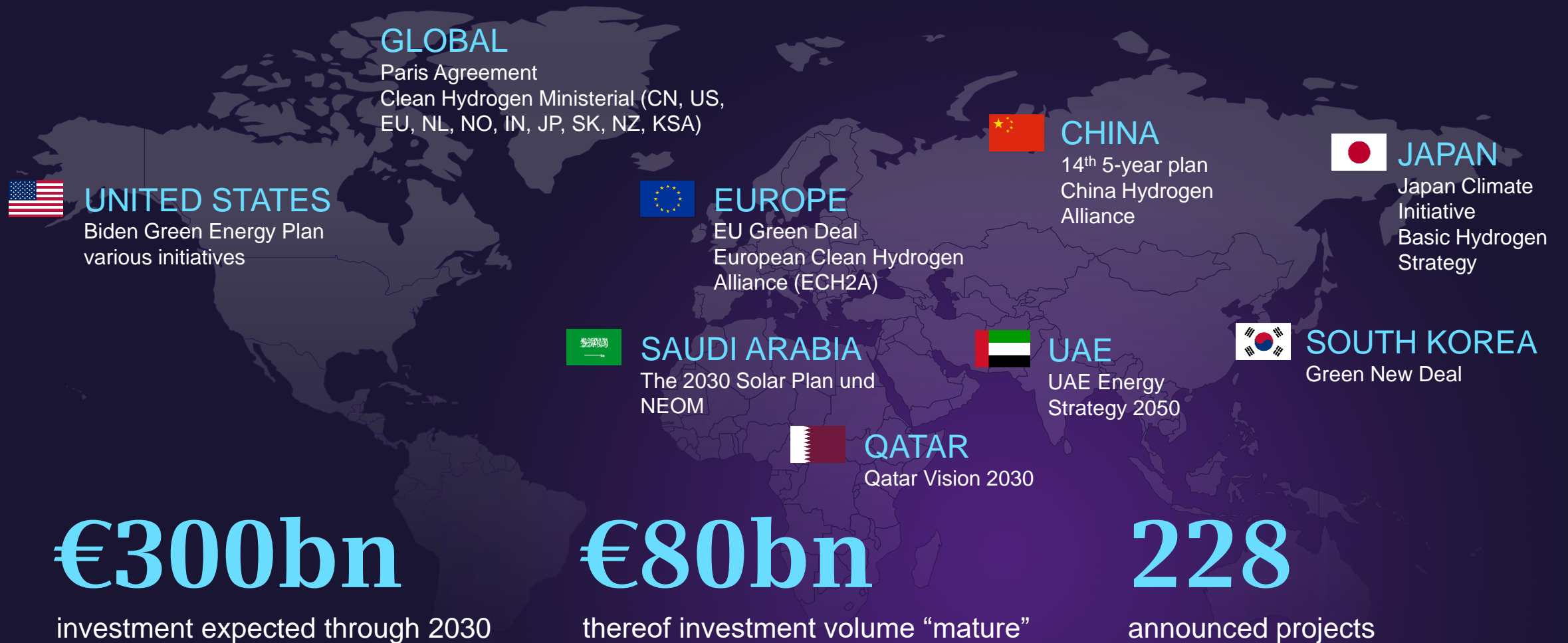
02nd November 2021

Stefan Engelshove



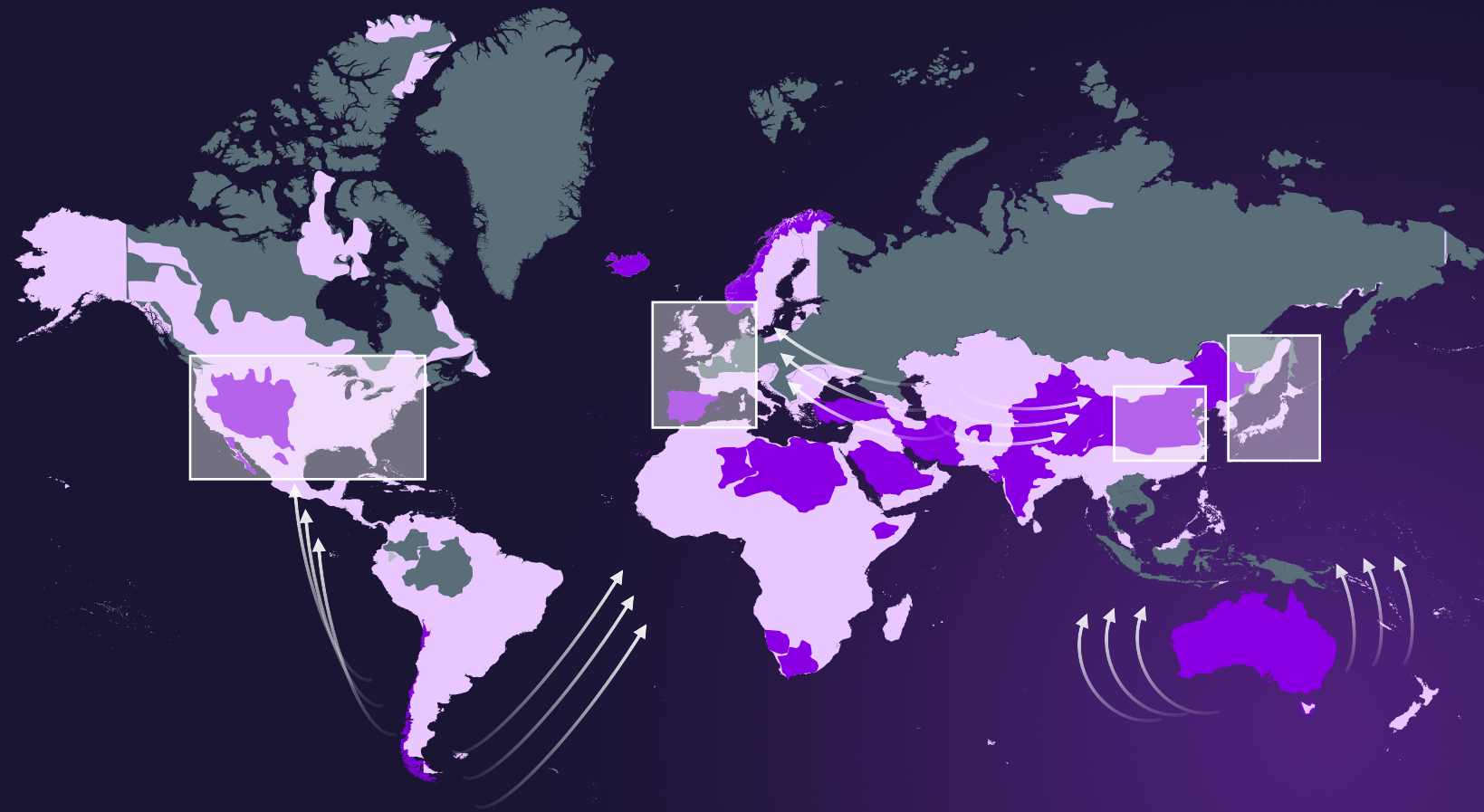
Boundary conditions are changing

Major green initiatives drive hydrogen related initiatives and investments



Source: Hydrogen Council, McKinsey “Hydrogen insights report 2021”




Today's challenge: Green energy needs to travel from lowest cost regions to decarbonize demand centers




33 Giga tons

Total energy-related emissions in 2019

-  **10.8** Giga tons
-  **5.3** Giga tons
-  **2.6** Giga tons
-  **1.7** Giga tons
-  **1.1** Giga tons
-  **0.7** Giga tons

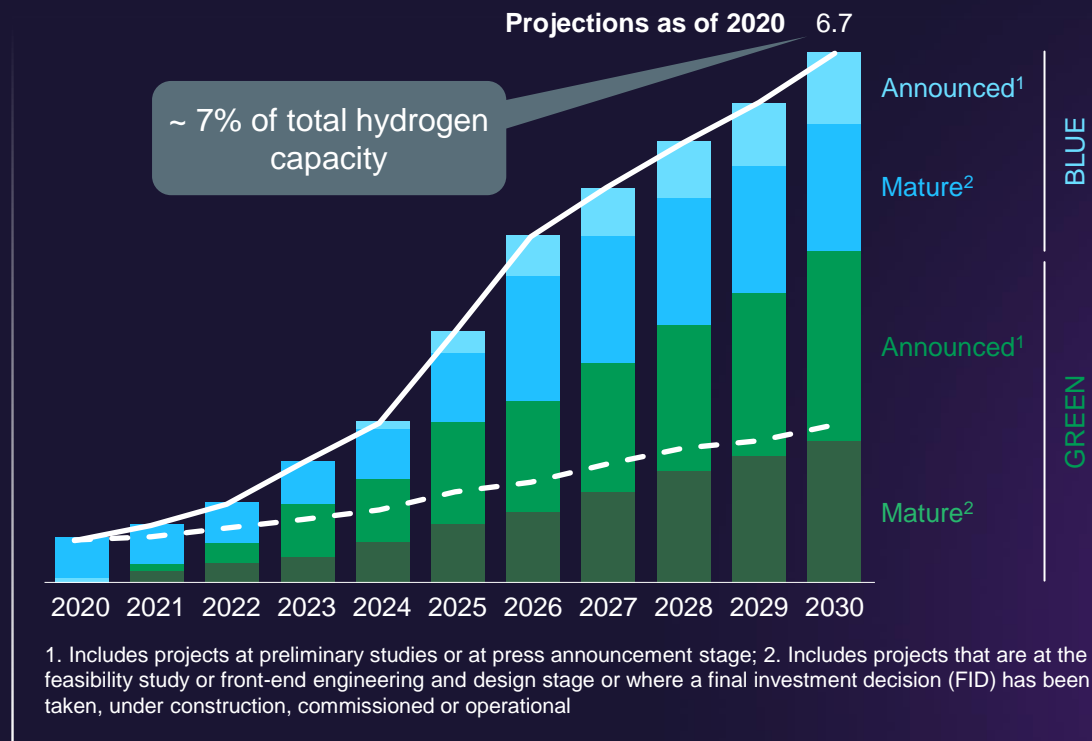
Least    Most
PV/wind resources for renewable hydrogen production

X.X – CO₂-Emissions
 Demand centers with high CO₂ emissions

Strong growth in green hydrogen production drives cost competitiveness

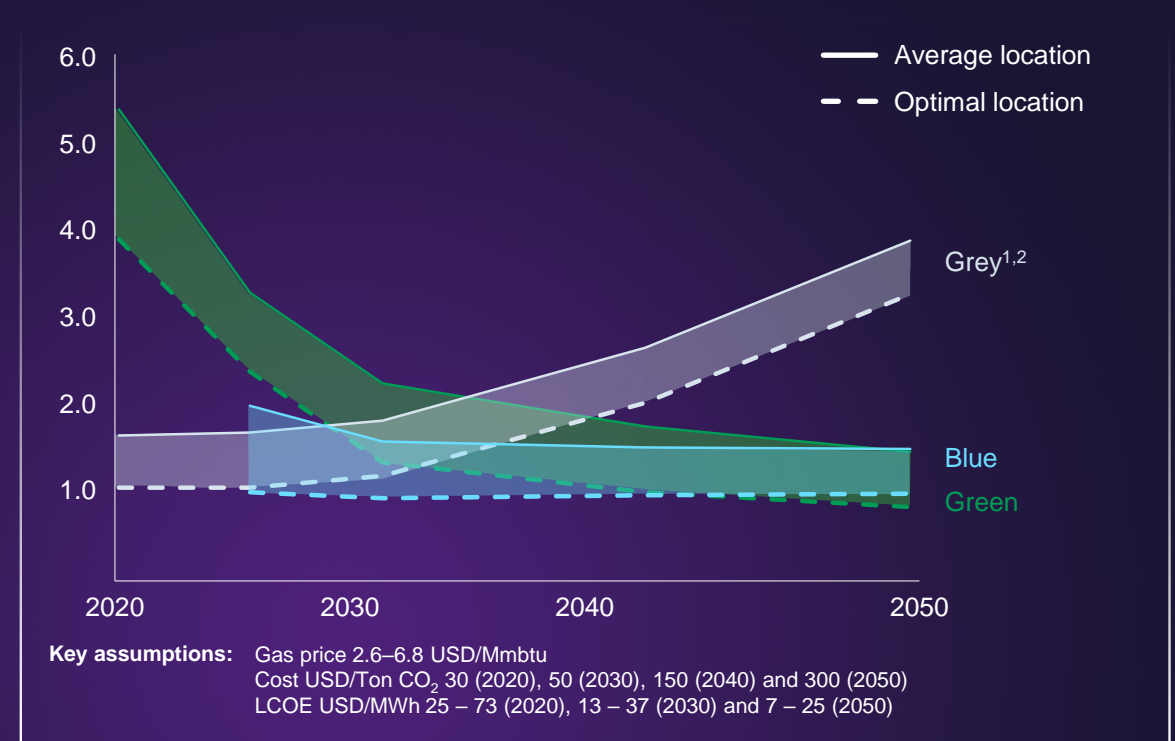
Announced clean hydrogen capacity through 2030

Production capacity
Mt p.a.



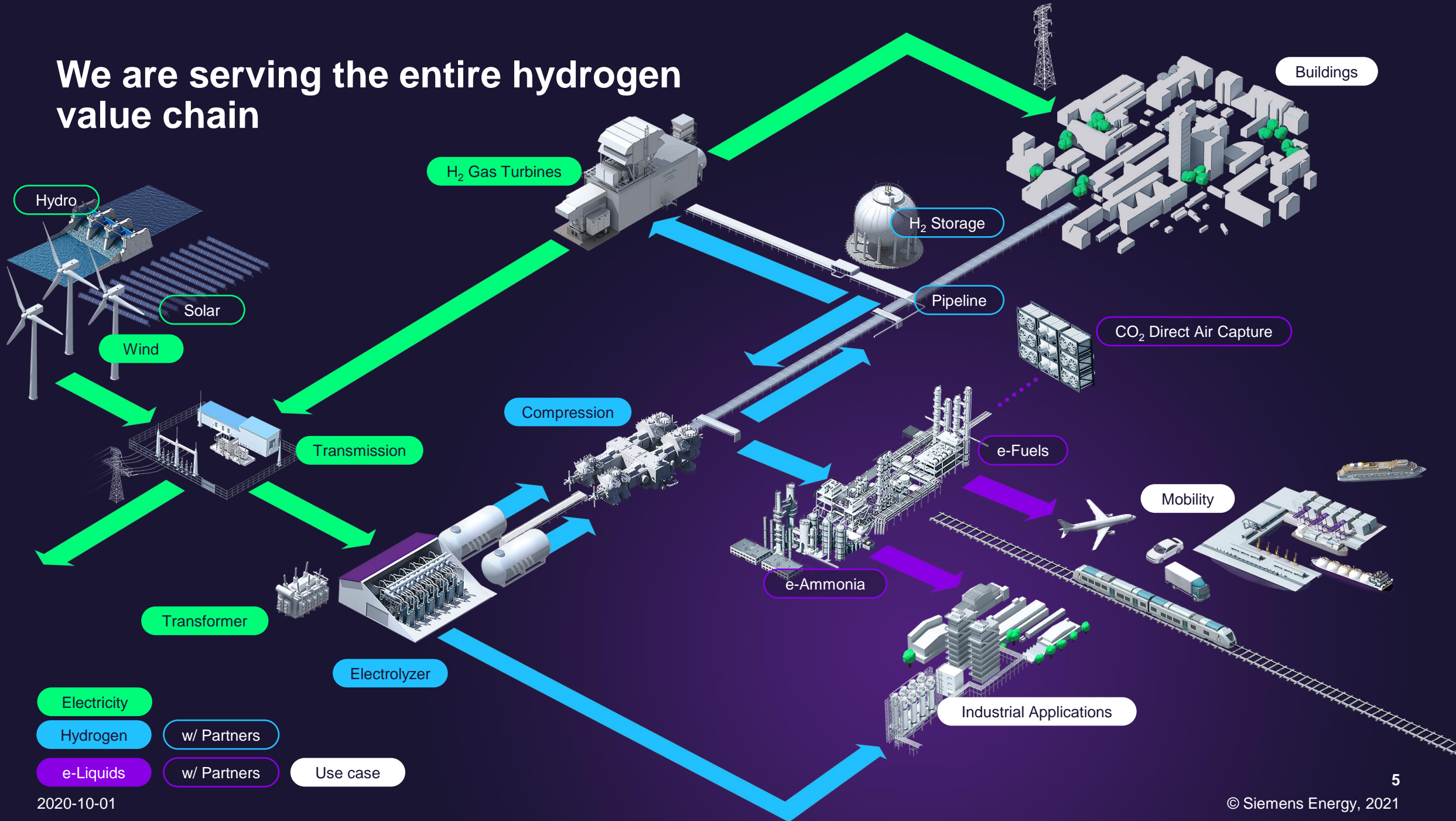
Hydrogen production pathways, including carbon costs

Production cost of hydrogen
USD/kg

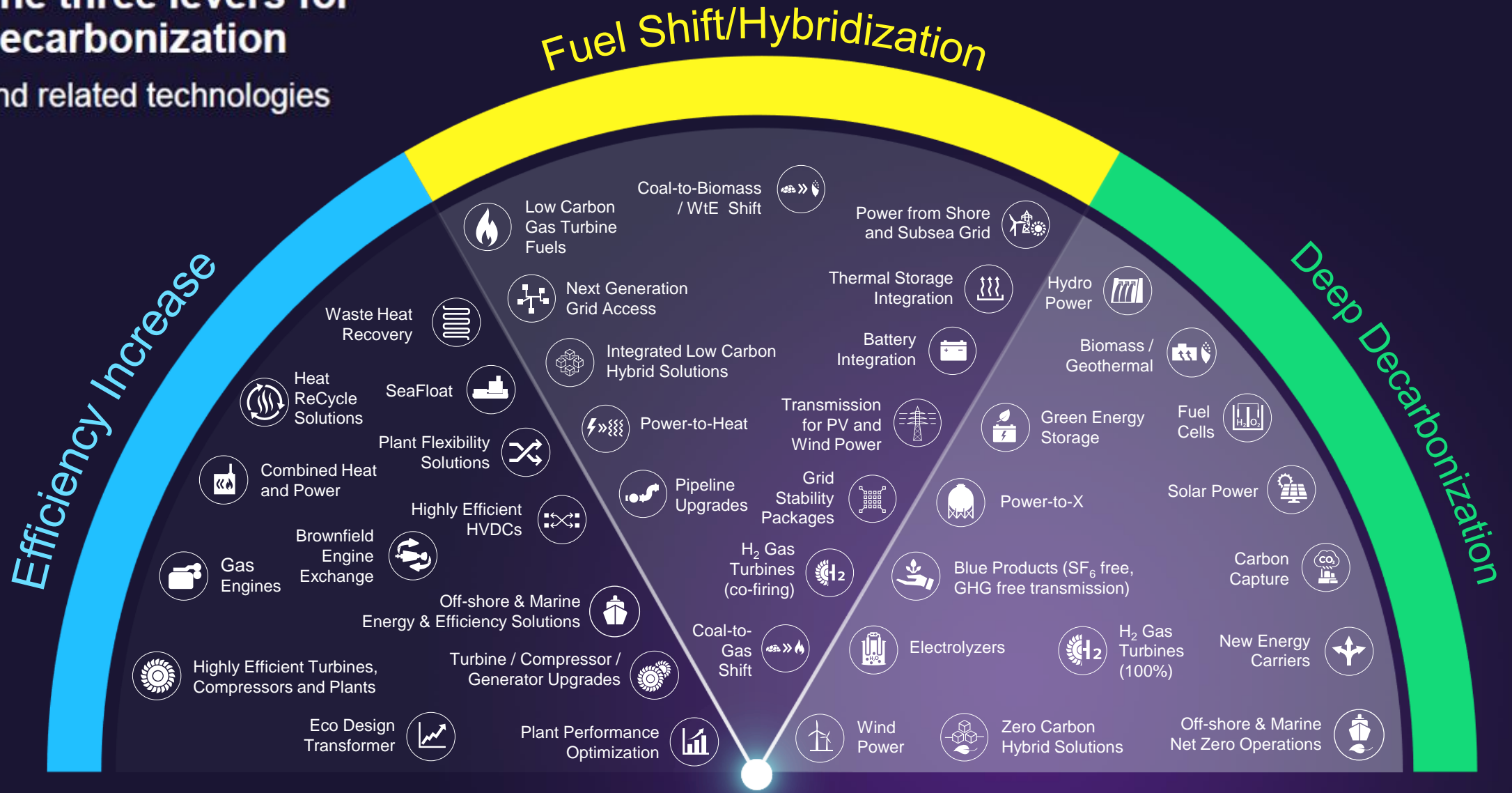


Source: Hydrogen Council, McKinsey “Hydrogen insights report 2021”

We are serving the entire hydrogen value chain



The three levers for decarbonization and related technologies



The Design of Future proof Energy Systems is Core Element for Decarbonized Energy Systems

Technologies:

- Heat pump
- H₂ capable gas turbine
- ...

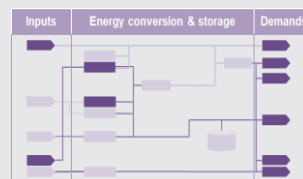


Energy System Design:

Customer Challenge



Optimized Energy System



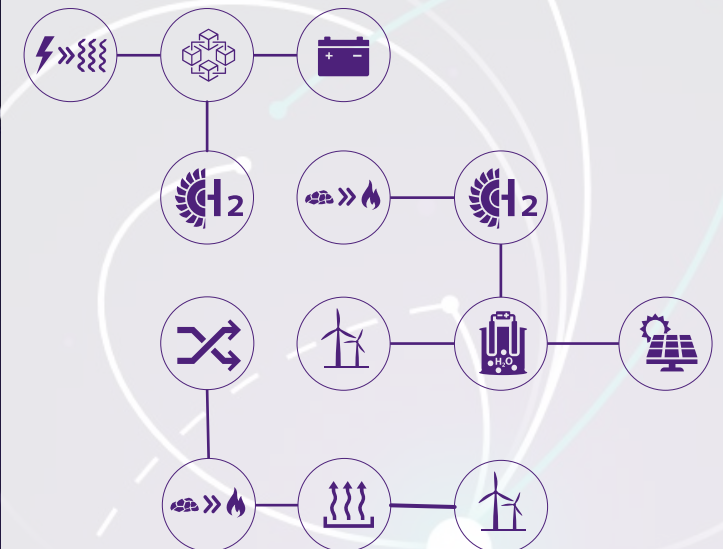
AV Site specifics

€ Cost

CO₂ Carbon

Decarbonization Project Types:

- Hybrid
- Heat
- ...



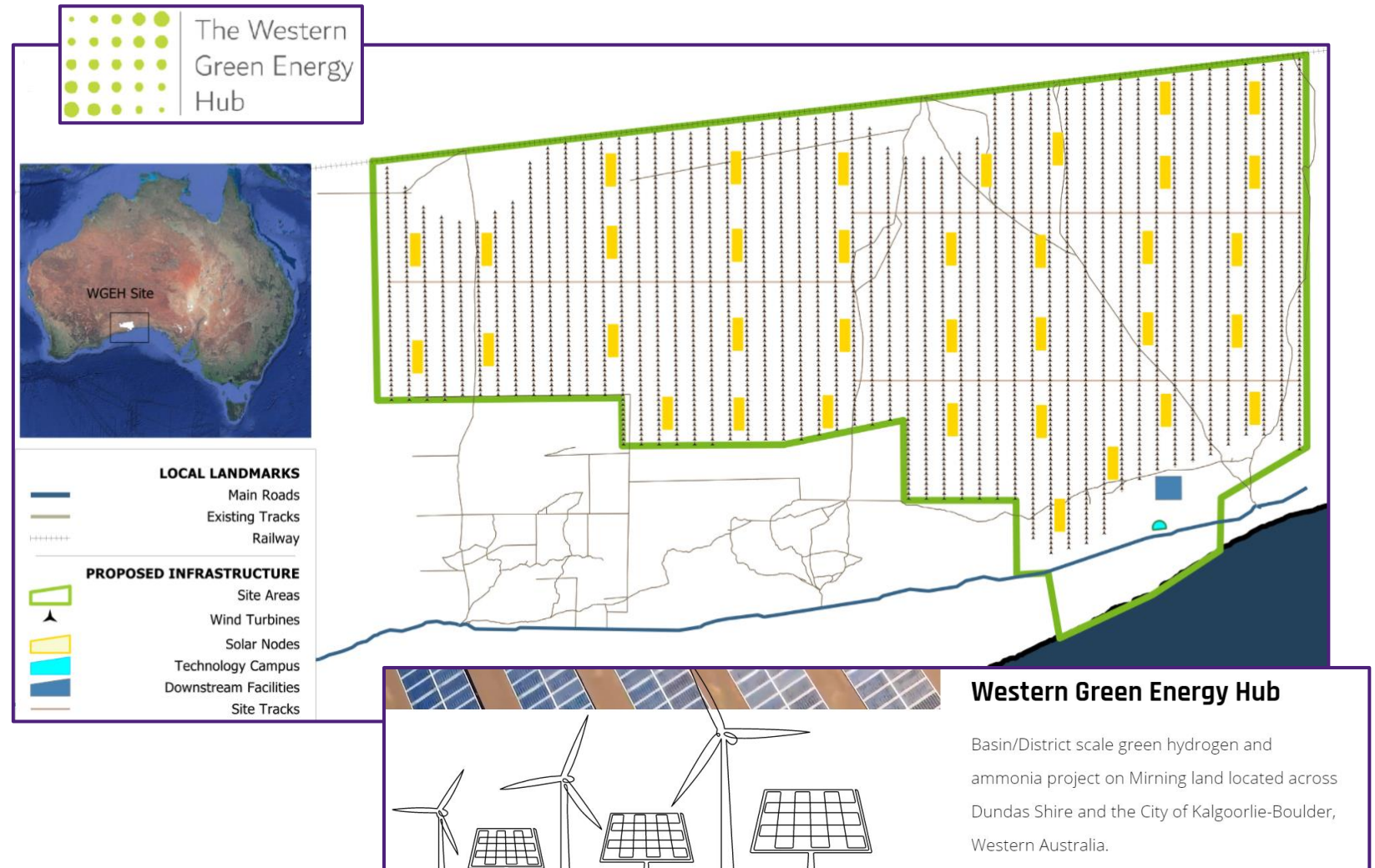
Project at a glance

Western Green Energy Hub (WGEH)



General Information

- Project Level: Market Intelligence
 - Project Phase: Feasibility Study
 - Lead Division: SE
 - Lead Customer: WGEH
 - Country of Installation: Australia 
 - Start of Operation: FID 2028
 - Initiative / Program: InterContinental Energy / CWP Global / Minning Green Energy
 - Type of Hydrogen: green
 - Brownfield / Greenfield: Greenfield
 - Power of demand: 28 GW (50 GW upstream / 20 MTPA ammonia)
 - Salesforce ID: ...
- million tonnes per annum (mtpa)




Source Pictures: InterContinental Energy

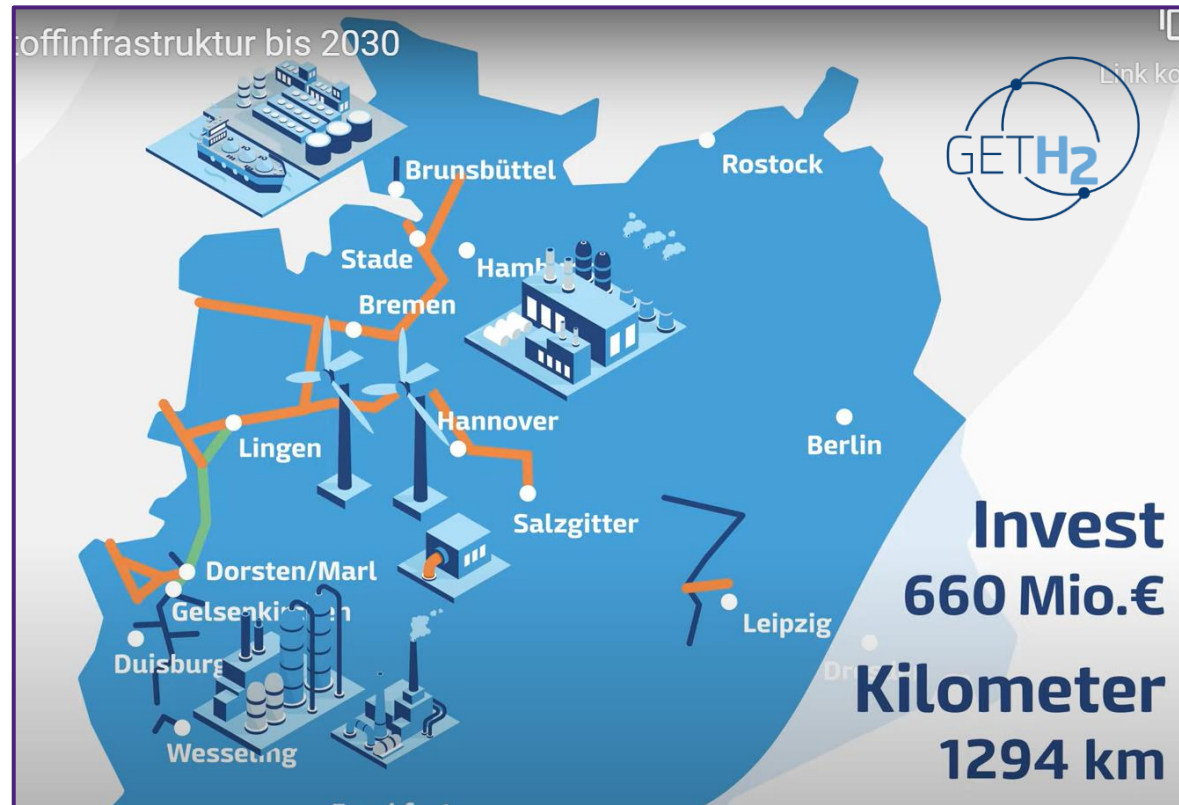
Project at a glance

GET H2 - Germany

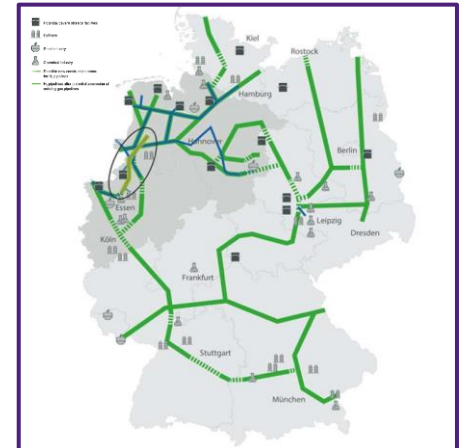


General Information

- Project Level: Target Project
- Lead Division: SE
- Lead Customer: RWE; BP; nowega; OGE; Evonik; Gascade; BASF; Uniper; Thyssengas
- Country of Installation: Germany 
- Start of Operation: 2030
- Initiative / Program: GET H2
- Type of Hydrogen: Green
- Brownfield / Greenfield: Brownfield / Greenfield
- Power of demand: ... (Elektrolyzer)
- Salesforce ID: ...



DoWin4 and BorWin4 Hanekentfähr:
Project start in autumn 2020




Source Pictures: GET H2

Source Picture: Amprion

Project at a glance

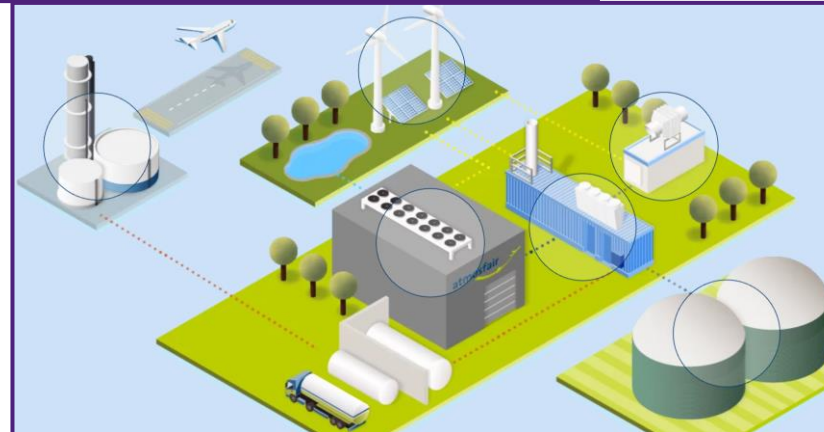
Fairfuel atmosfair – PtL in Werlte - Germany

General Information

- Project Level¹: ...
- Project Phase²: ...
- Lead Division: SE NEB
- Lead Customers: atmosfair
- Country of Installation: Germany 
- Start of Operation: 2021
- Initiative / Program: ...
- Type of Hydrogen³: green
- Brownfield / Greenfield: Greenfield
- Power of demand: 1,25 MW (Elektrolyzer)
- Salesforce ID: ...



Source Picture: Siemens




Source Picture: atmosfair

Air capture module

With this module we extract CO₂ directly from the atmosphere. This process is very energy-intensive.

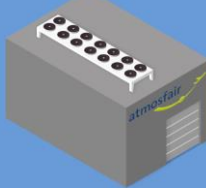
For fuel to be CO₂-neutral, the same amount of CO₂ emitted during the flight must first be extracted from the atmosphere. One way to do this is using Direct Air Capture. In this approach CO₂ is extracted directly from the atmosphere via filters. Since the concentration of CO₂ in the air is low, this process is significantly more energy and raw material intensive than CO₂ extraction at a point source. At our plant, Direct Air Capture provides about 5% of the CO₂ needed.



Electrolyser

In the electrolyser, hydrogen is produced from water using electricity.

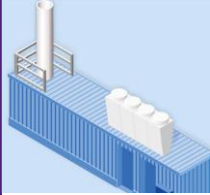
Besides carbon, hydrogen is the second main component in the production of synthetic fuels. Hydrogen is produced from water via electrolysis. Our electrolyser is based on a membrane surrounded by water which separates H₂ and O₂ using electricity (Proton Exchange Membran - PEM). This component was built by Siemens Energy.



Fischer-Tropsch synthesis

Here, carbon and hydrogen are synthesised into hydrocarbons which is the feedstock for the refinery.


In the synthesis unit carbon dioxide and hydrogen are turned into a syngas, from which synthetic crude oil, the pre-product for atmosfair fairfuel, is produced. This is achieved via the Fischer-Tropsch process, which was developed by the German chemists Franz Fischer and Hans Tropsch in the 1920s. At 150°C to 300°C, long-chain hydrocarbons are produced in the presence of metal catalysts, which are processed into kerosene in a refinery.



Refinery

Here the synthetic hydrocarbons are processed into kerosene and shipped as jet fuel to the airport.



The atmosfair fairfuel is processed into kerosene at the Heide refinery before it is shipped to Hamburg Airport. There, it reduces the use of kerosene from fossil oil.

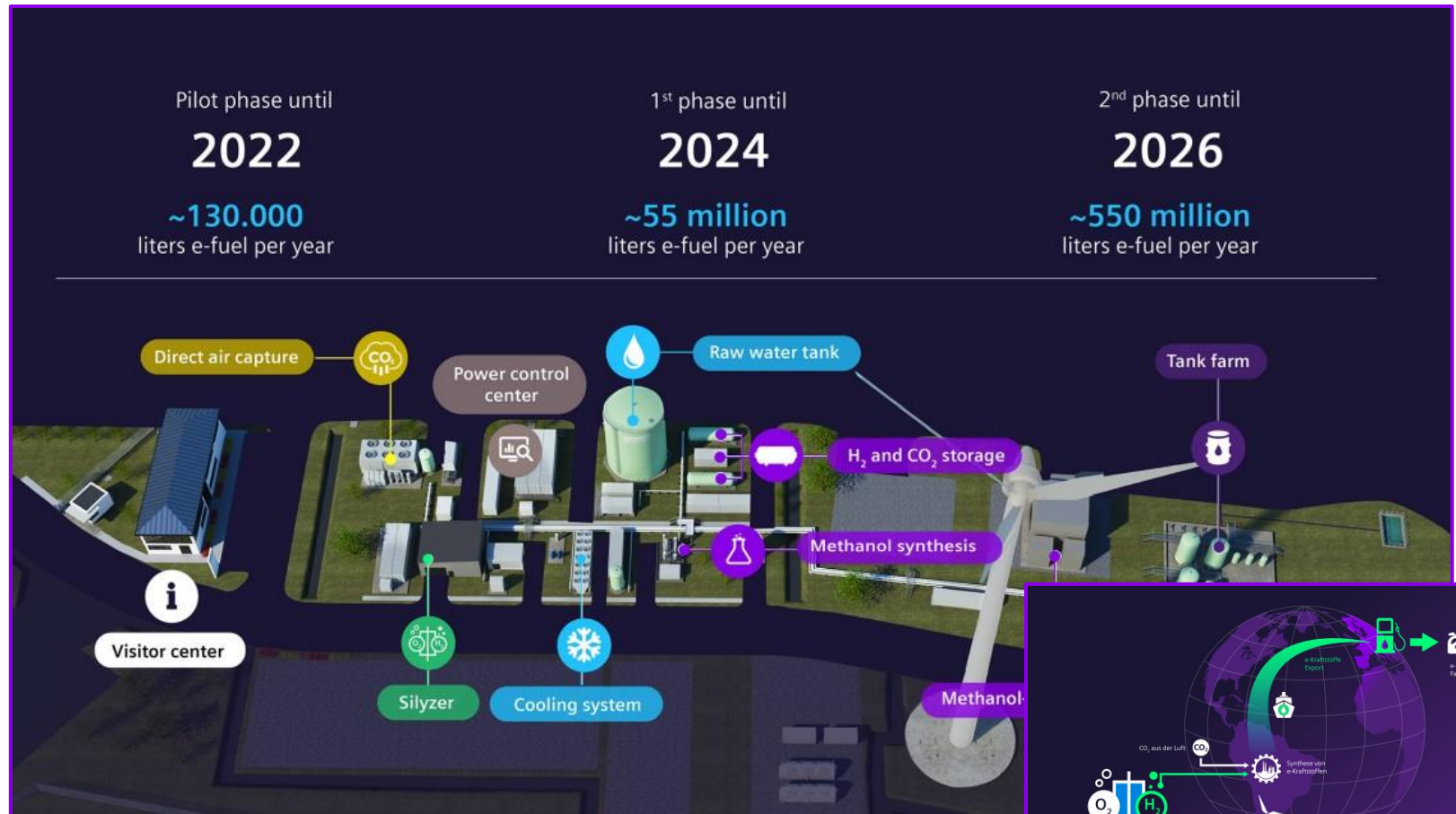


Project at a glance

Haru Oni - Chile

General Information

- Project Level: Target Project
- Lead Division: SE NEB
- Lead Customer: Porsche 
- Country of Installation: Chile, Magellanes 
- Start of Operation: Pilot phase 2022
- Initiative / Program: Highly Innovative Fuels (HIF)
- Type of Hydrogen: Green / eMethanol & eFuels
- Brownfield / Greenfield: Greenfield
- Power of demand: ... (Elektrolyzer)
- Salesforce ID: ...



Source Picture: Siemens Energy

Siemens Energy Electrolyzer portfolio scales up by factor 10 every 4 – 5 years

Silyzer portfolio roadmap

0.1 MW

1 MW

10 MW

100 MW

1,000 MW

2011

Silyzer 100

Lab scale demo

~20 kOH¹,

~30 t of H₂

2015

Silyzer 200

~130 kOH¹

~1700 t of H₂



World's largest Power-to-Gas plants with PEM electrolyzers in 2015 and 2017 built by Siemens

2018

Silyzer 300



Biggest PEM cell in the world built by Siemens

2023+

Silyzer 300 plant



Pre-engineered and pre-fabricated electrolyzer systems enhanced with optimized operational concepts (digital twin)

2028+

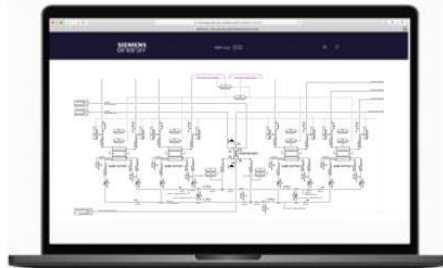
Large scale, modular design electrolyzer plants



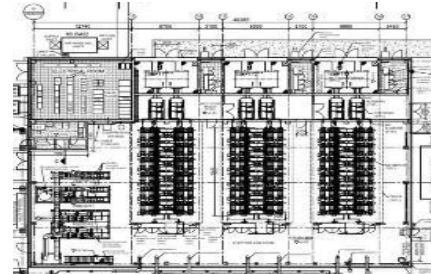
¹ Operating Hours; Data OH & tons as of Oct 2020

Prepared for delivery at Gigawatt scale

Standardization, Modularization and Manufacturing



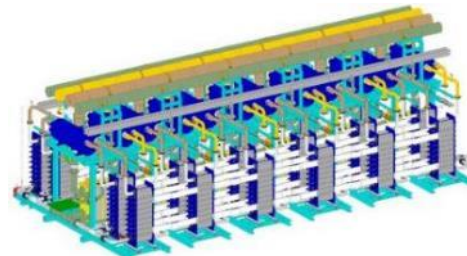
Digital engineering



50 MW plant design based on Silyzer 300



Prefabricated group of 4 modules



Silyzer 300 array system design

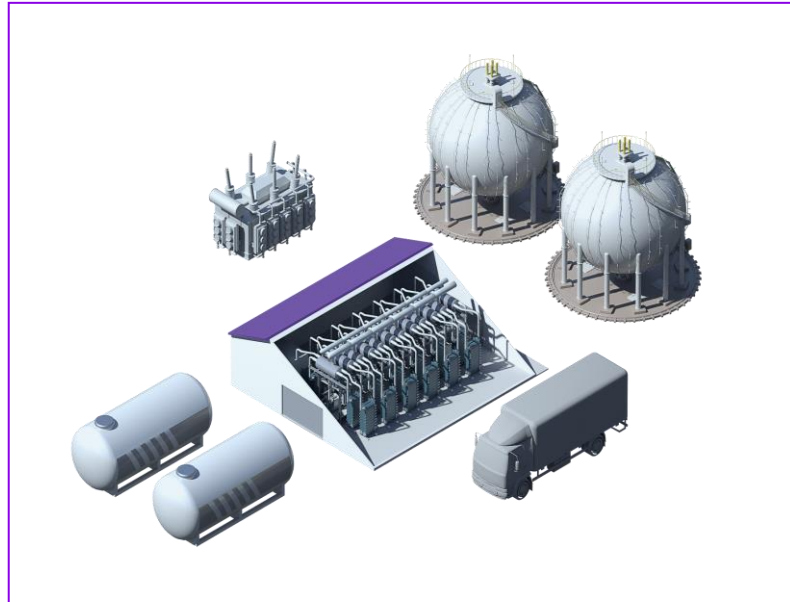


- **Standardized plant design** based on **modular** building-blocks
- **Pre-fabricated groups** with pre-defined interfaces
- Integrated **digital engineering** tools

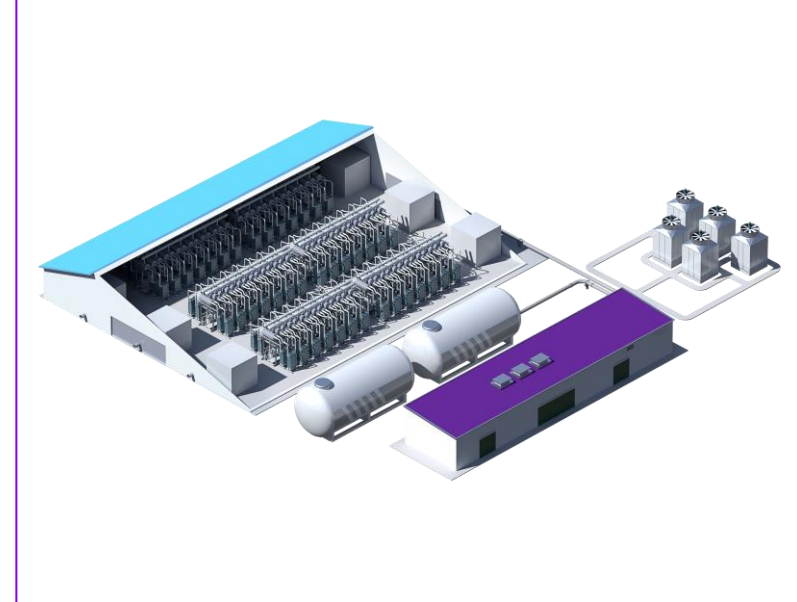
- Ramp-up of manufacturing towards a lean **Gigafactory**
- Flexible **expansion to Multi-GW**
- **Automated**, highest-quality Silyzer production

Prepared for delivery at Gigawatt scale

Standardization, Modularization and Manufacturing

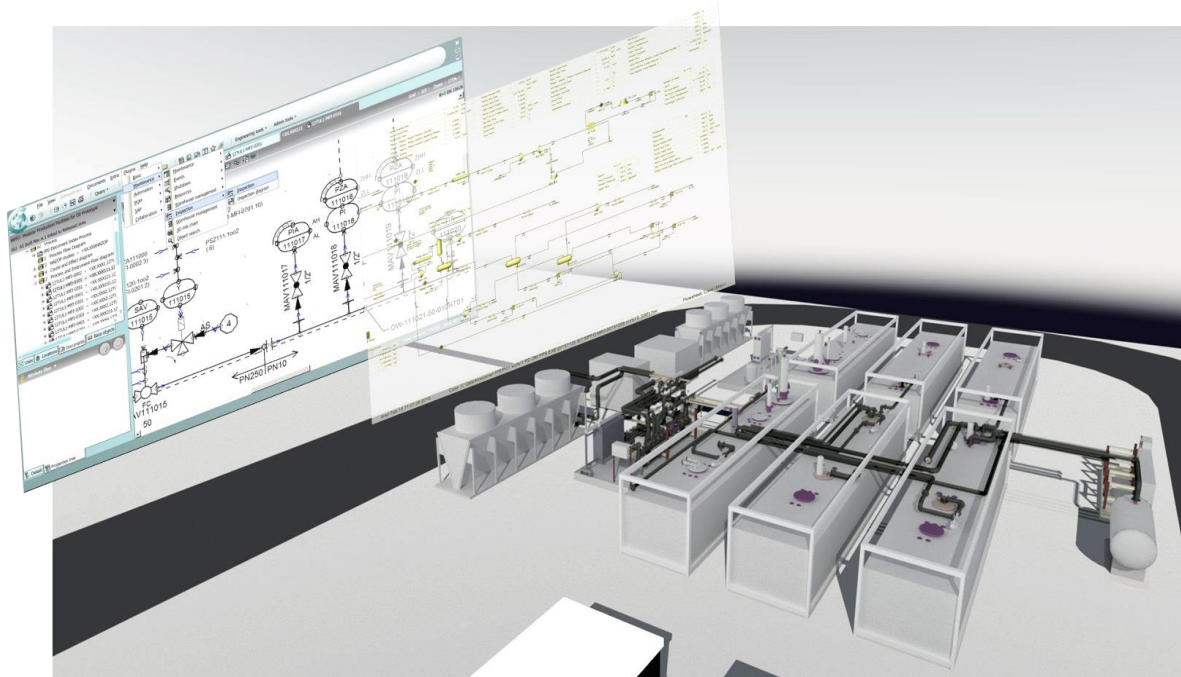


- **Standardized plant design** based on **modular** building-blocks
- **Pre-fabricated groups** with pre-defined interfaces
- Integrated **digital engineering** tools



- Increase the scaling in a system up to GW scale
- Flexible **expansion** to **GW** production
- **Footprint reduction** due to compact design
- Cost-optimized and pre-engineered solutions

MPFO as an idea for modular systems „Plug and produce“ – „Modular Production Facilities Oil“



Unmanned
operation



20% lower
CAPEX/
OPEX



Reduction of
inst. comm.
time by 70%



Production
optimization

MPFO – Development

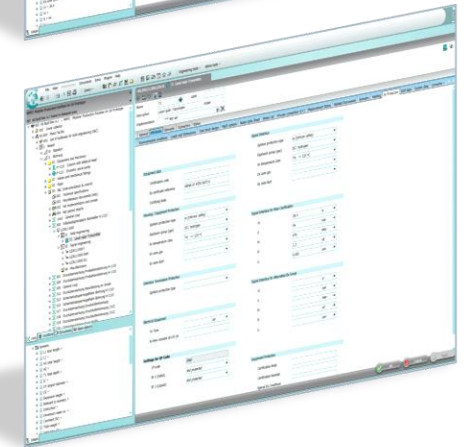
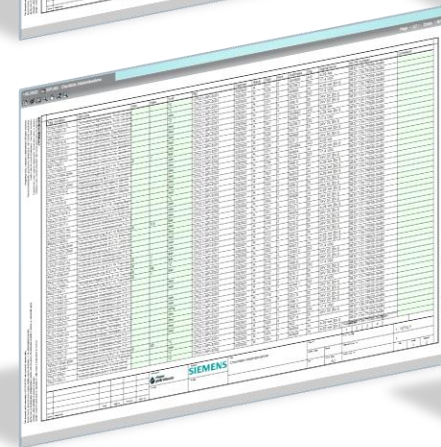
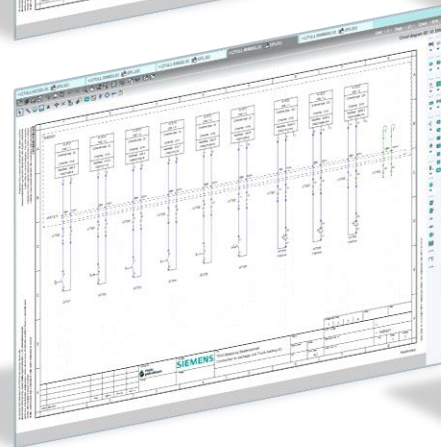
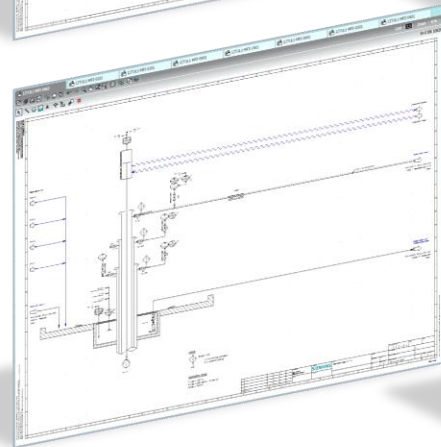
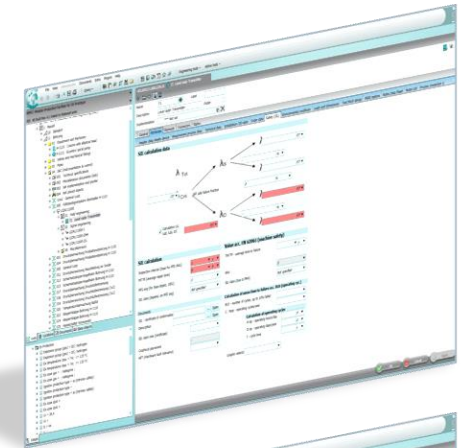
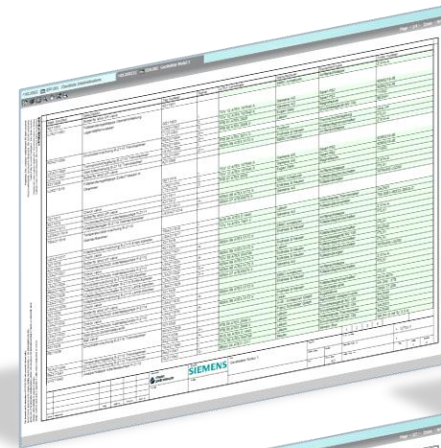
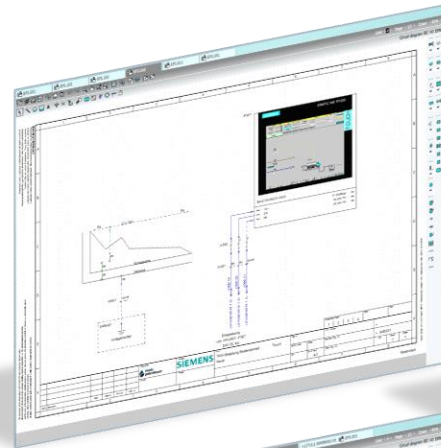
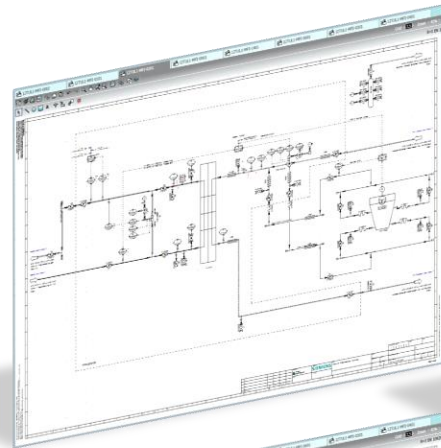
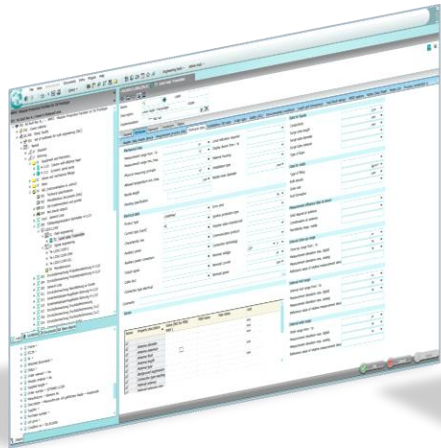
Further targets

- Cost reduction due to barrel price collapse
- Unmanned operation
- Production optimization
- Reduction of installation and commissioning time

Development MkII – Digitalization

- Modular Automation (ZVEI White Paper – 2015 / ISA 106)
 - State based control concept
 - Automated modules integration
- Expert Advice System
 - Automated operating sequences
 - Operating advices
 - Support functions
 - Plant status visualization
 - KPI Dashboard
 - Production optimization

MPFO as an idea for modular systems „Plug and produce“ – „Modular Production Facilities Oil“



Comos

P&ID

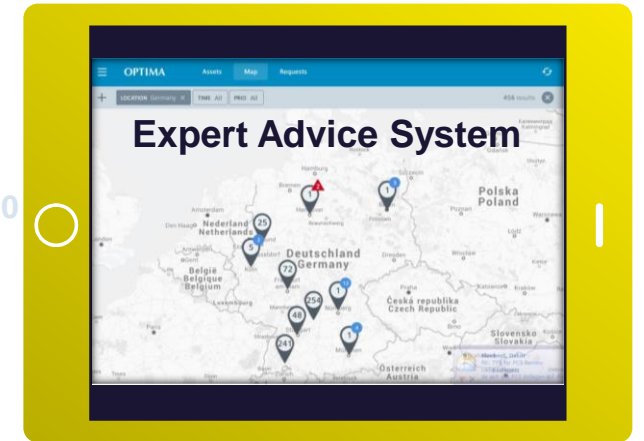
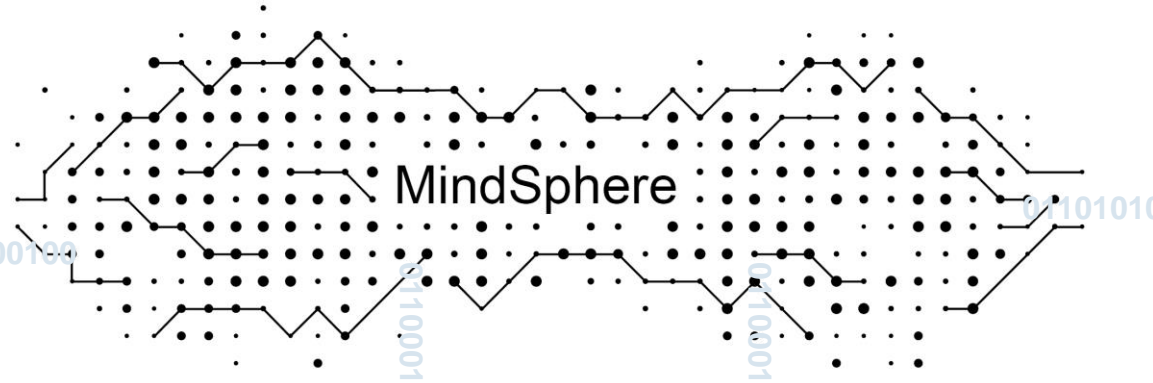
Electrical

Equipment

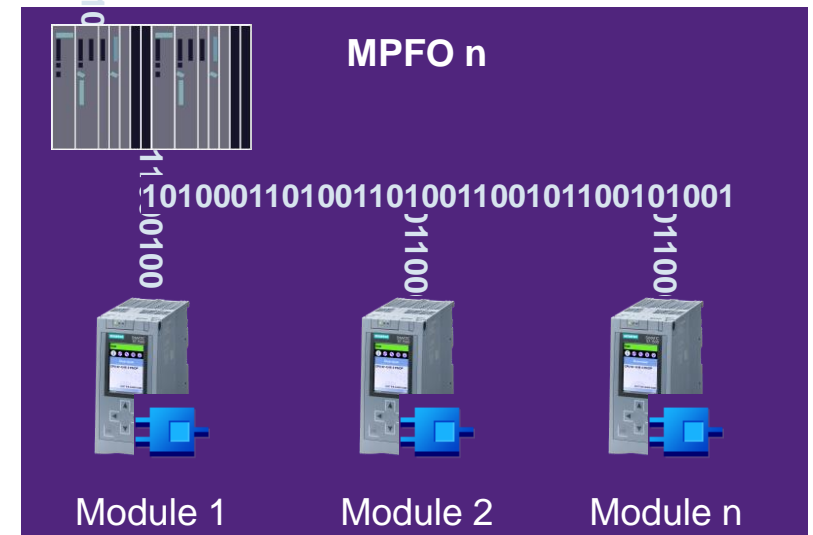
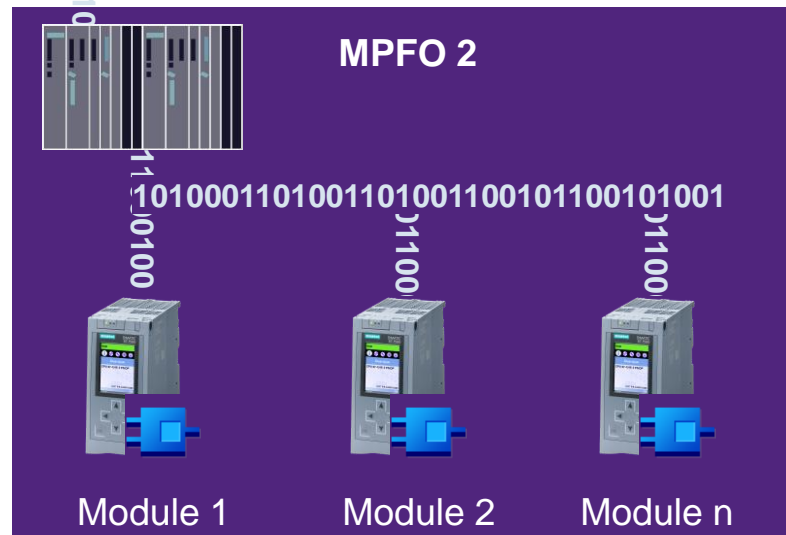
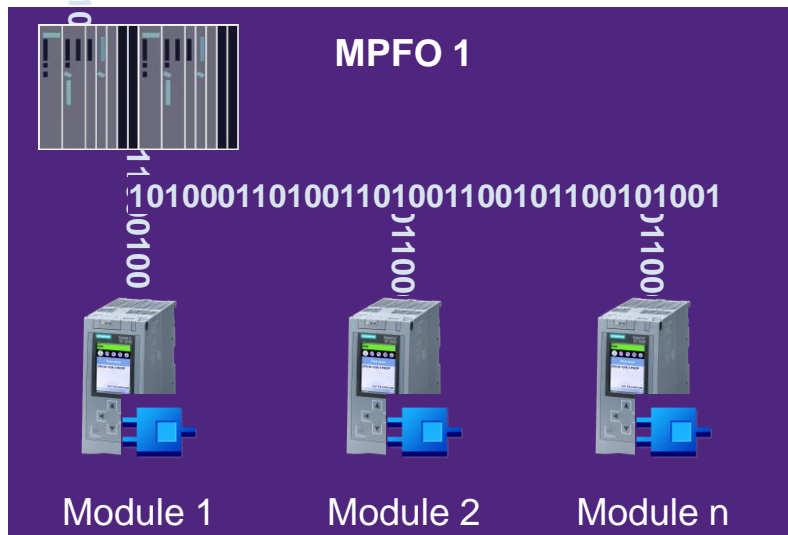
SIL / Ex(i)

MPFO as an idea for modular systems Integrated Operation

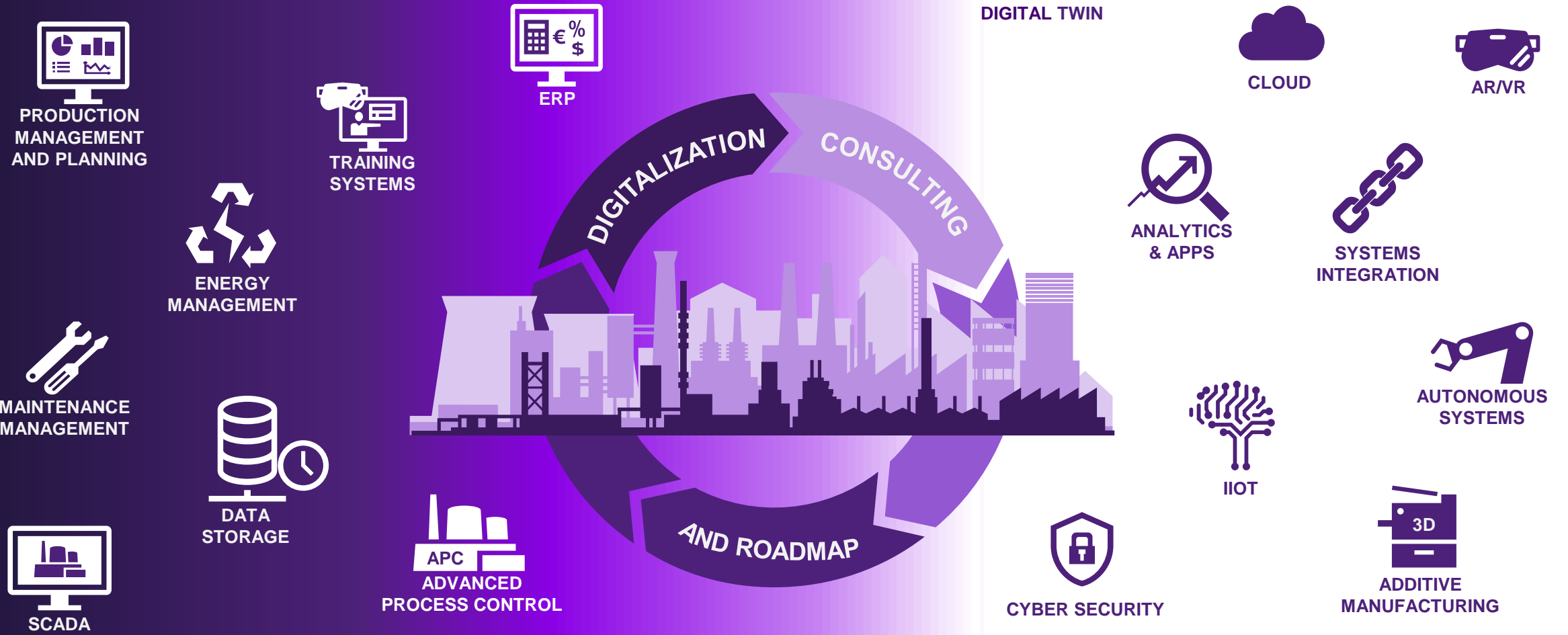
Reservoir
information
Injection rate
Well potentials
...



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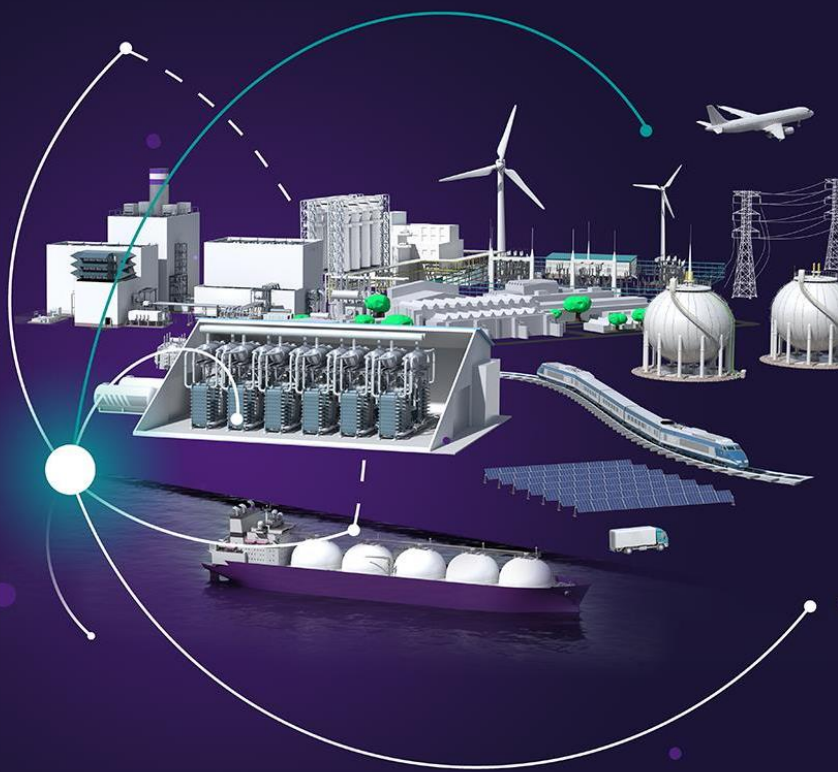
Digitalization



TRADITIONAL SYSTEMS

DIGITALIZATION CORE TECHNOLOGIES

Conclusions



WHY

- A quick technical setup is required to achieve the climate goals.
- Hydrogen is the second stage of the energy transition
- Indispensable for decarbonization

WHAT

- Large Power-to-X solutions enabled by the full Industry competence
- Digital twin and service concepts

HOW

- Secure technology and modularization
- High standardization systems
- Integrated digitalization system
- Strong international partner ecosystem
- Training concepts for employees – qualification systems

We know how to industrialize technologies!