

# PEM electrolyser technology

## Flexible, efficient and scalable

New Energy Business

Business  
Representation  
for Siemens  
Energy

**SIEMENS**

# New Energy Business

## At a glance | Overview

## Early Engagements



HIGHLIGHT

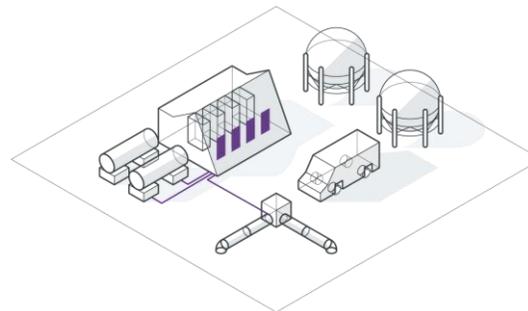
## Enable Hydrogen Economy

Decarbonization of steel production based on hydrogen

H2FUTURE<sup>1</sup> – A European Flagship project for the generation and use of hydrogen with the world's **largest and most advanced** hydrogen pilot facility in Linz, Austria

Partner H2FUTURE<sup>1</sup>

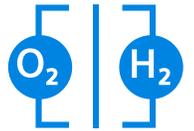
Siemens | VERBUND | Voestalpine | Austrian Power Grid | K1 MET | TNO Project funded by EU



## Our offerings

### Hydrogen Systems

Industry grade and highest quality green electrolyzer-based Power-to-hydrogen systems and services



### Power-to-X-Solutions

- Electrolyzer-based Power-to-Hydrogen and Power-to-Liquids solutions and services
- Electrolyzer-based turnkey solution package



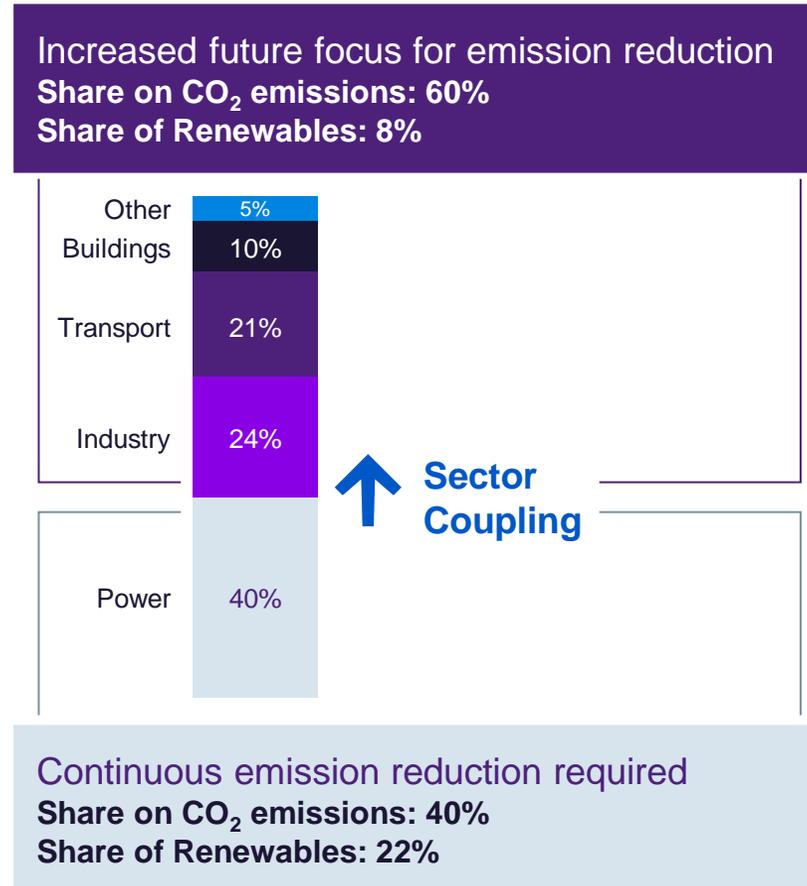
### Energy Consulting & Digital Services

- Electrolyzer-integrating Energy system design
- Specific Power-to-X related digital services and optimization solutions

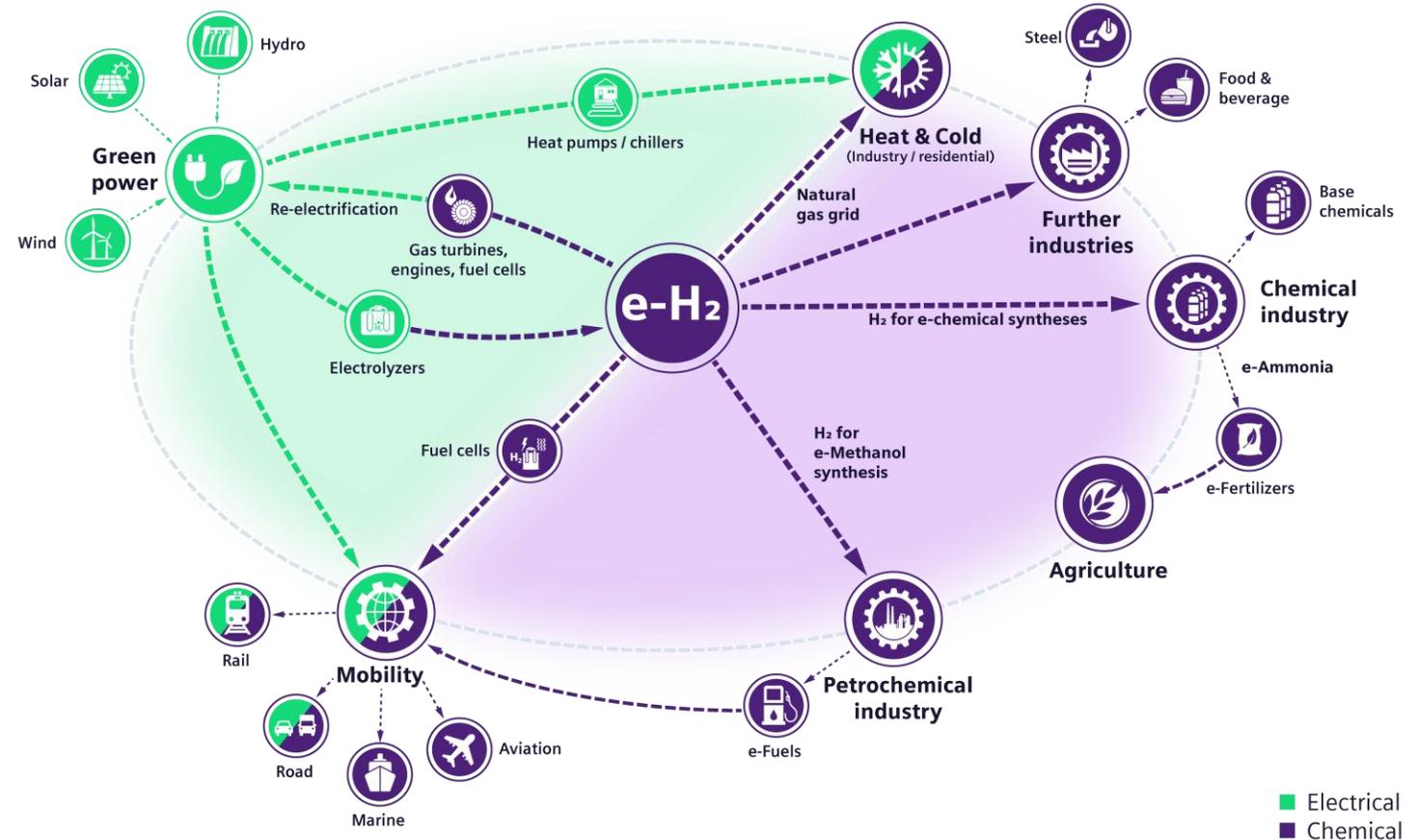


# “Sector Coupling” is the key lever for decarbonization of all end-user sectors

## Shares in global CO<sub>2</sub> emissions by sectors



## Sector Coupling – Links and Interactions



Source: World Energy Balances 2018

# Why a Proton Exchange Membrane (PEM) electrolyzer system?

## PEM is the natural choice for our future renewable energy system



- Incredibly fast start-up and shut-down
- Highest operational flexibility
- Cold start capability

## PEM is clean by nature



- No CO<sub>2</sub> emissions, unlike SMR<sup>1</sup>, which emits 8 – 10 kg CO<sub>2</sub> for each kg of hydrogen
- There is nothing except water, hydrogen and oxygen in the system
- Highest hydrogen purity >99.9%
- Oxygen as the only “contaminant”
- No aggressive chemical electrolyte (e.g. KOH in alkaline systems)

## PEM is competitive

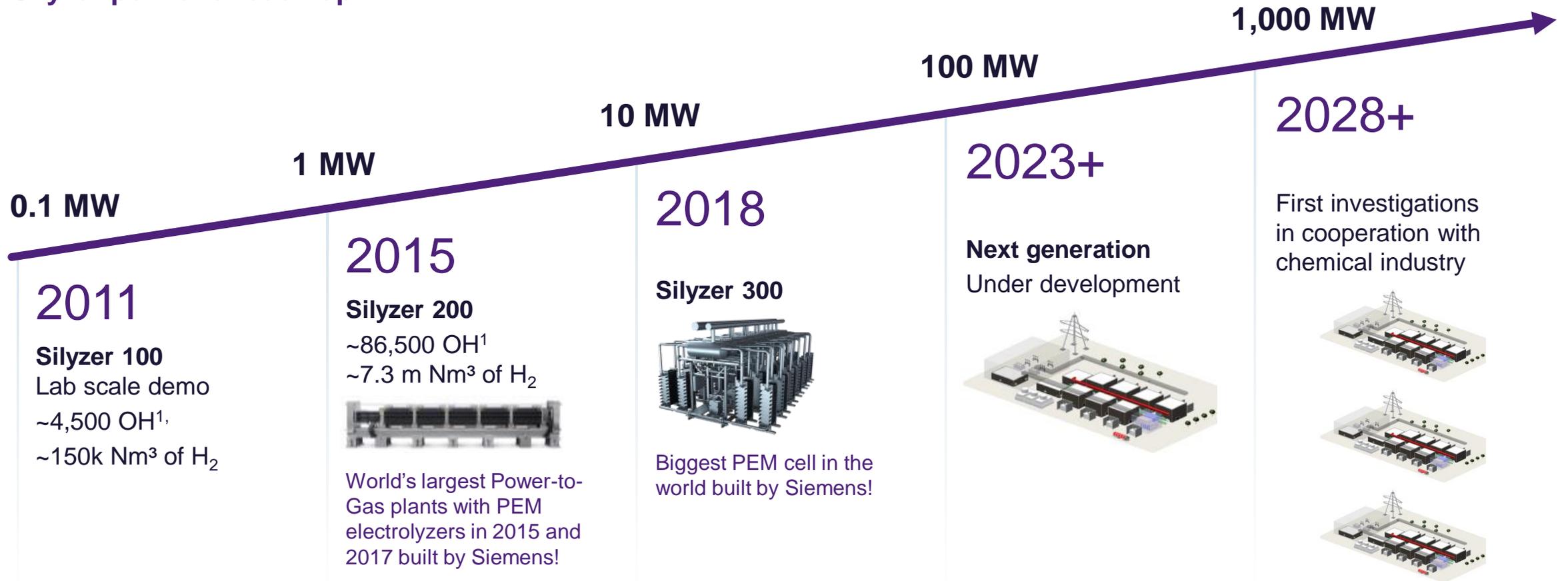


- Competitive hydrogen price per kg at green electricity prices below 3 ct/kWh
- Small footprint
- Significantly lower OPEX<sup>2</sup> due to maintenance-free stack

# Silyzer portfolio scales up by factor 10 every 4 – 5 years driven by market demand and co-developed with our customers



## Silyzer portfolio roadmap



<sup>1</sup> Operating Hours; Data OH & Nm<sup>3</sup> as of Dec 2019

# Silyzer 300

The next paradigm in PEM electrolysis

**17.5** MW

Power demand  
per full Module Array  
(24 modules)

**>76** %

System efficiency<sup>1</sup>  
(higher heating value)

**24** modules

to build a  
full Module Array

**335** kg

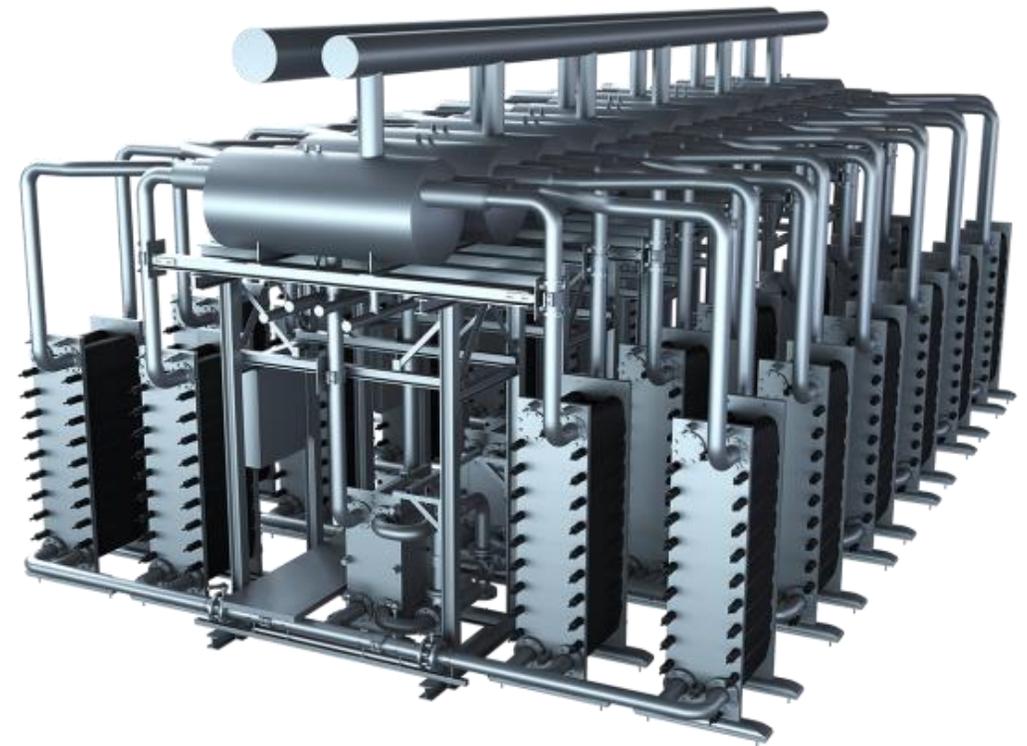
Hydrogen per hour  
per full Module Array  
(24 modules)

<sup>1</sup> Ambient temperature 15° C, air cooled

July 2021

## Silyzer 300

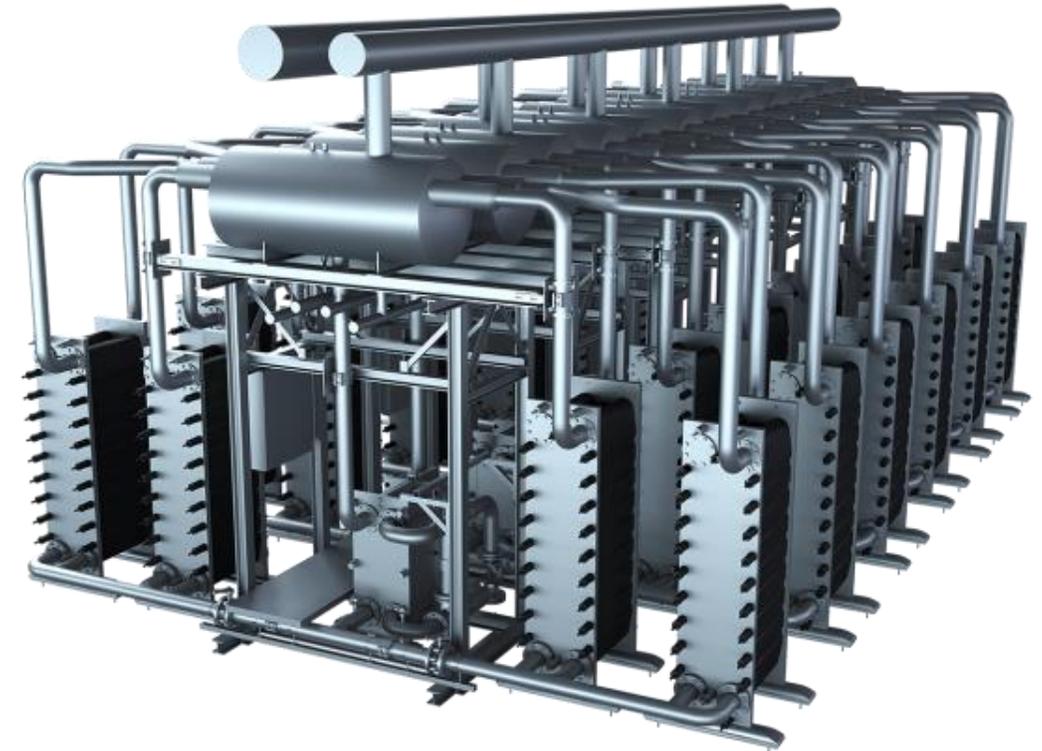
Module Array (24 modules)



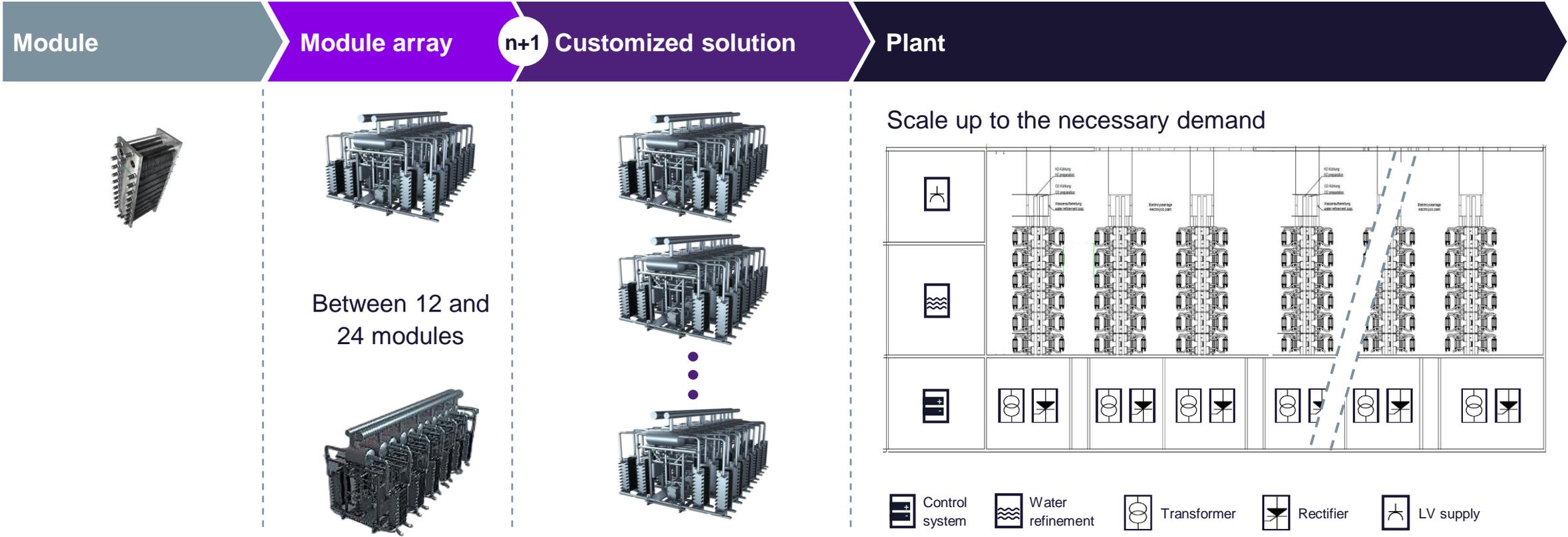
# Silyzer 300

## Fact Sheet

	Hydrogen production	335 kg/h
	Plant efficiency (HHV <sup>1</sup> )	>75.5%
	Power demand	17.5 MW
	Start-up time	<1 min, enabled for PFRS <sup>2</sup>
	Dynamics in range	10%/s in 0 – 100%
	Minimal load	20% single module
	Dimension full Mod. Array	15.0 x 7.5 x 3.5 m
	Array lifetime	>20 a (Module ≈10 a)
	Plant availability	~95%
	Demin water consumption	10 l/kg H <sub>2</sub>
	Dry gas quality <sup>3</sup>	99,9999%
	Delivery pressure	Customized



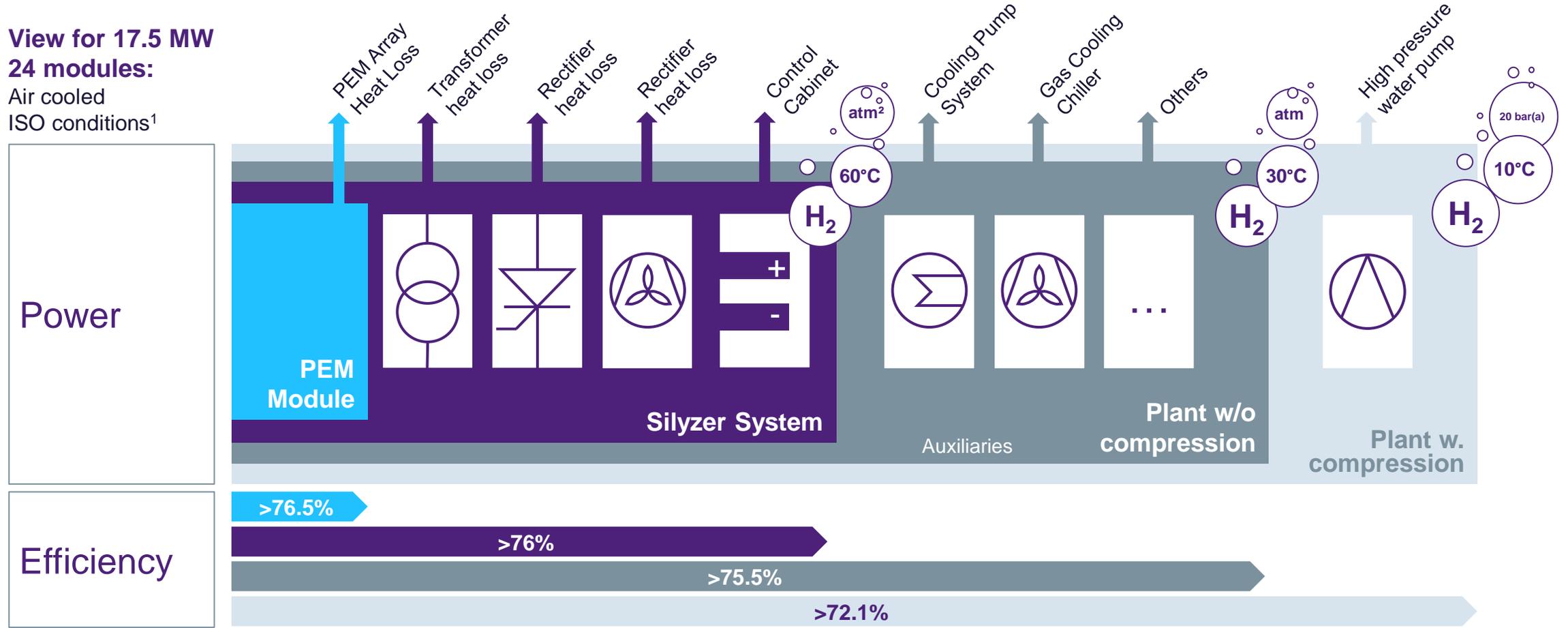
# The modular design of Silyzer 300 can be easily scaled to your demands



**! Modular concept to cover wide production rate**

# With the Silyzer 300 you get a highly efficient plant

View for 17.5 MW  
24 modules:  
Air cooled  
ISO conditions<sup>1</sup>



## ! Cooling system site specific optimized

<sup>1</sup> ISO conditions: 15° C, 1013 mbar, 0 m, 60% rel. humidity | <sup>2</sup> Atmospheric

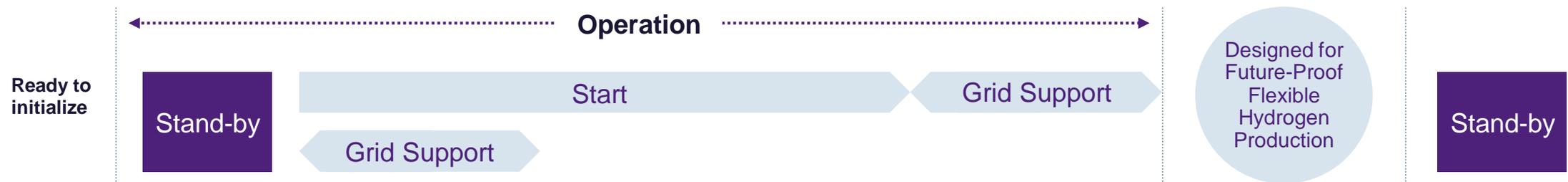
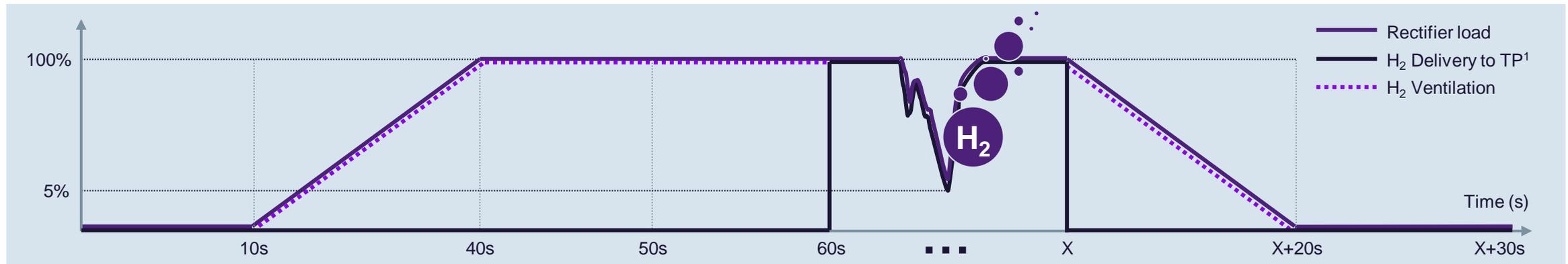
# The Silyzer 300 enables grid support services with efficient hydrogen yield and maximum dynamics



Start 0 – 100% H<sub>2</sub> <1 min, enabled grid support



Dynamics in range 10%/s in range 0 – 100%



# Silyzer 300

Latest and most powerful product line in the double-digit megawatt class



## High performance

High efficiency: System >76%  
Modular: H<sub>2</sub> production range 100 – 2,000 kg/h

## Maintenance friendly

Maintenance free module 80,000 OH<sup>1</sup>  
Easy exchange of modules  
No cleaning effort  
World wide service coverage

## Digitally enabled

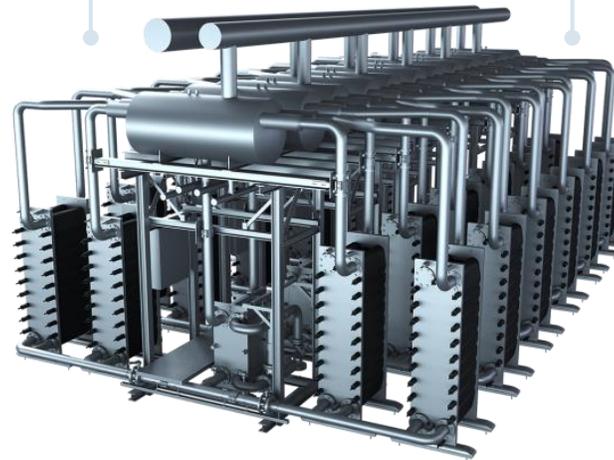
Data Driven Operation and Service  
Secure Remote Support  
Mindsphere

## High availability

Advanced design for low degradation  
Robust industrial design

## Flexible operation

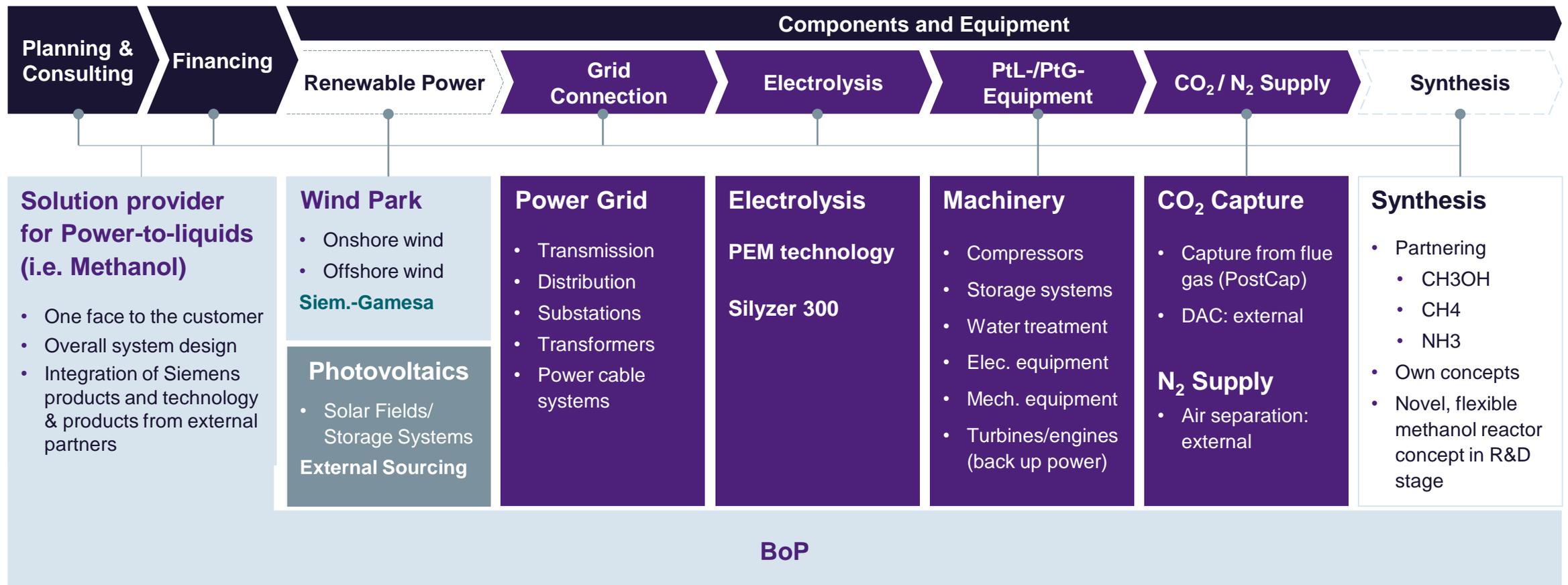
Fast start-up and shut-down  
High dynamics  
High Gas purity  
No hazardous chemicals  
Power factor compensation (optional)  
No permanent operating personnel required



# What can Siemens Energy offer to the P2X customers?

## Siemens Energy competence along the value chain

Siemens Energy covers important parts of the value chain to deliver Power-to-X projects on turnkey basis



DAC: Direct air capture: Under development; no Siemens Energy activities | CCU: Carbon Capture and Utilization | typical share in value addition

# Energiepark Mainz

World's largest PEM electrolysis facility in 2015



## 3.75 MW

Power demand/6.0 MW peak power (limited in time) based on three Silyzer 200

### Project

- Customer: Energiepark Mainz (JV of Linde and Mainzer Stadtwerke)
- Country: Germany
- Installed: 2015
- Product: Silyzer 200

### Use cases



Green hydrogen is fed into the local natural gas grid



Delivery to surrounding industrial companies



Hydrogen for regional filling stations

### Challenge

- Installation of world's first PEM electrolysis plant in the multiple megawatt range
- Provision of balancing energy
- High degree of automation

### Solutions

- Installation of three Silyzer 200 with a maximum power consumption of 6 MW
- Highly dynamic power consumption
- State-of-the-art process control technology based on SIMATIC PCS 7
- Hydrogen processing, condensing, and storage (provided by Linde)



# 6 MW

Power demand based on  
Silyzer 300

# 1,200 Nm<sup>3</sup>

of green hydrogen per hour

## H2FUTURE

### A European Flagship project for generation and use of green hydrogen

#### Project

- Partner: VERBUND (coordination), voestalpine, Austrian Power Grid (APG), TNO, K1-MET
- Country: Austria
- Installed: 2019
- Product: Silyzer 300

#### Challenge

- Potential for “breakthrough” steelmaking technologies which replace carbon by green hydrogen as basis for further upscaling to industrial dimensions
- Installation and integration into an existing coke oven gas pipeline at the steel plant
- High electrolysis system efficiency of 80%

#### Use cases



Hydrogen for the steel making process



Supply grid services

#### Solutions

- Operation of a 12-module array Silyzer 300
- Highly dynamic power consumption – enabling grid services
- State-of-the-art process control technology based on SIMATIC PCS 7



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