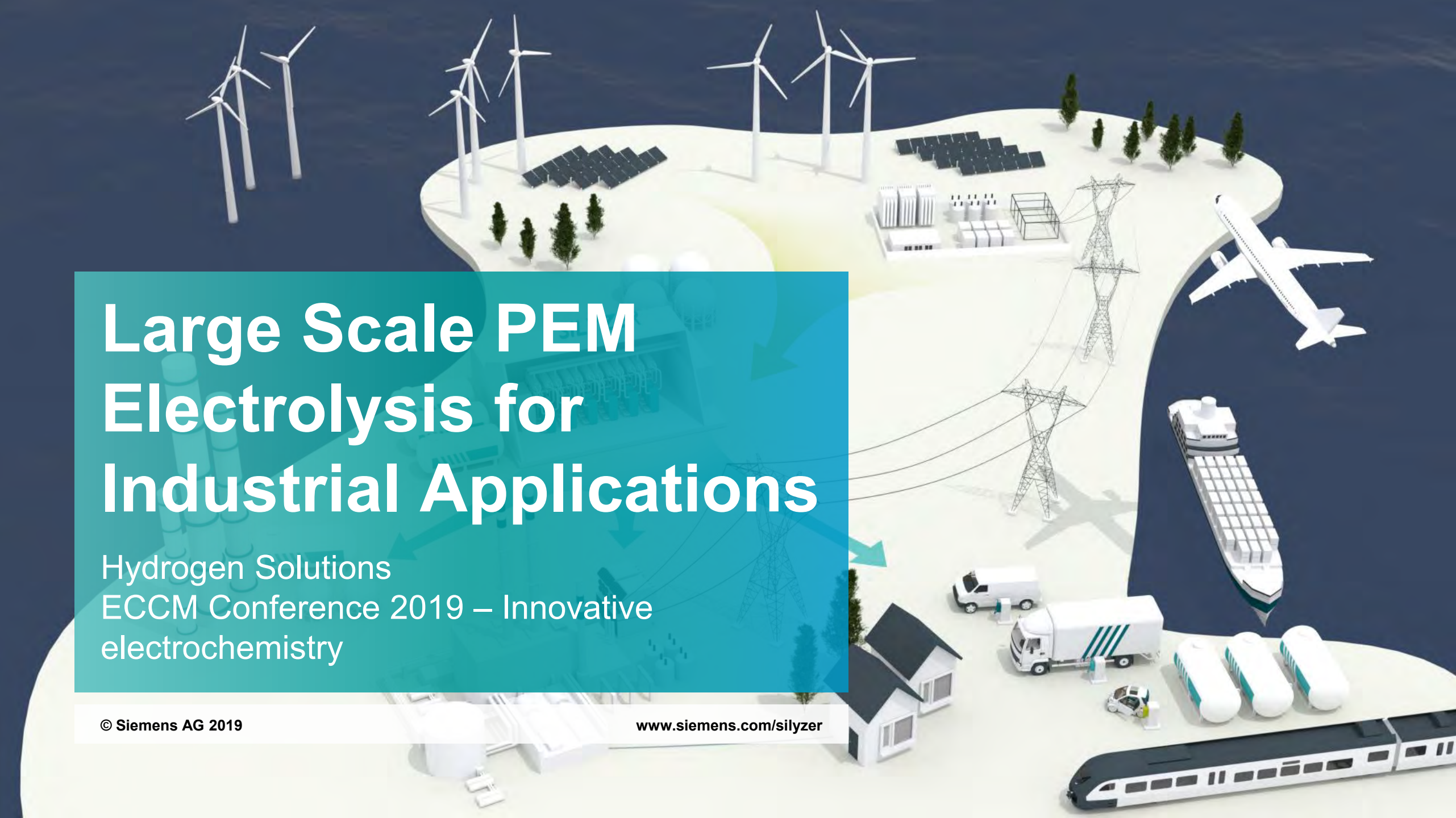

Large Scale PEM Electrolysis for Industrial Applications

Hydrogen Solutions
ECCM Conference 2019 – Innovative electrochemistry

www.siemens.com/silyzer

Hydrogen from renewables enables large scale long term storage and sector coupling

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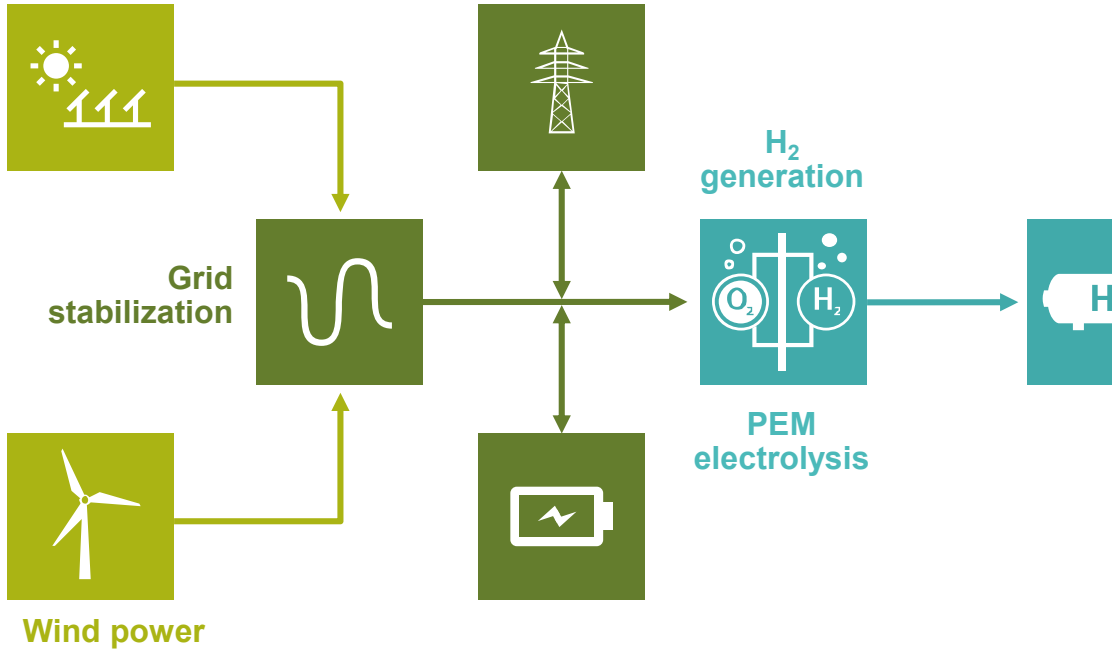
Ingenuity for life

Volatile electricity generation | Grid integration | Conversion/ storage | Applications



Exports for different applications

Industry
Hydrogen for ammonia production, petroleum refinement, metal production, flat glass, etc.

Mobility
Hydrogen as alternative fuel or as feedstock for green fuels

Energy
Hydrogen blending (gas grid)
Remote energy supply/Off-grid

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

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Silyzer portfolio roadmap

0,1 MW → 1 MW → 10 MW → 100 MW → 1000 MW

2011

Silyzer 100
Lab-scale demo
~4.500 op.h[1],
~150k Nm³ of H_2

2015

Silyzer 200
~86.500 op.h
~7.3 mio Nm³ of H_2

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

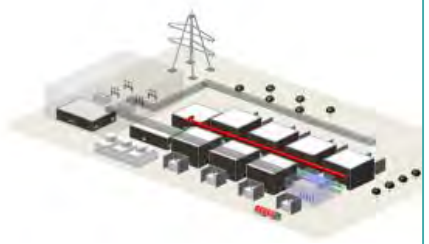
2018

Silyzer 300

Biggest PEM cell in the world built by Siemens!

2023+

Next generation
Under development



2030+

First investigations in cooperation with chemical industry

[1] op.h.: operating hours; Data op.h & Nm³ as of Jan. 2019

Silyzer 300 –
the next paradigm in PEM electrolysis

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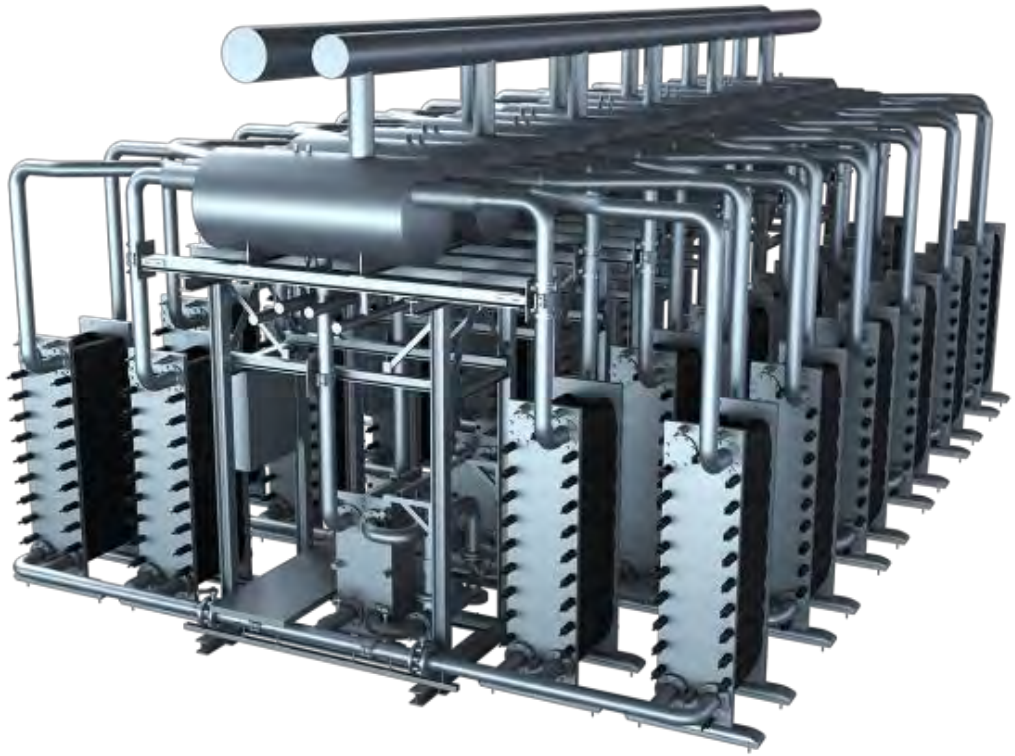
17.5 MW	Power demand per full Module Array (24 modules)
75 %	System efficiency (higher heating value)
24 modules	to build a full Module Array
340 kg	hydrogen per hour per full Module Array (24 modules)



Silyzer 300 – Module Array (24 modules)

The Silyzer 300 enables primary reserve services with efficient hydrogen yield and maximum dynamics

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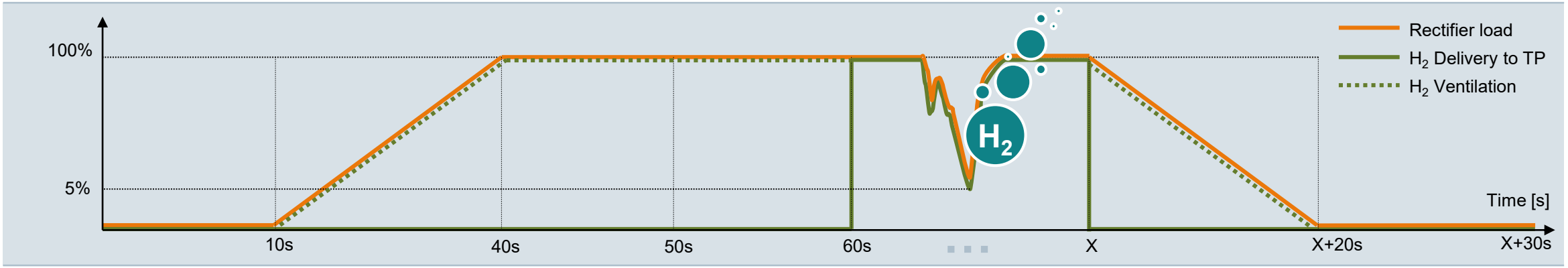
	Start 0-100% H2	<1min, enabled for PFRS[1]
	Dynamics in range	≥ 10%/s in range 0-100%



1) PFRS: Primary Frequency Reserve Service

Five main drivers for H_2 production cost

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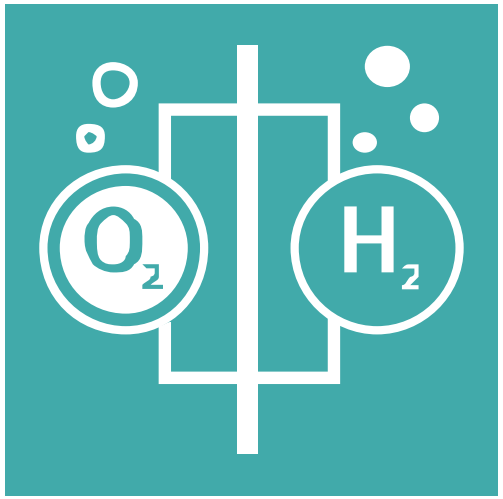
Technology specific drivers

Efficiency

Electrolyzer plant CAPEX

Maintenance cost

H2 production cost



Site specific drivers

Electricity price

Uptime

With the Silyzer 300 you get a highly efficient plant

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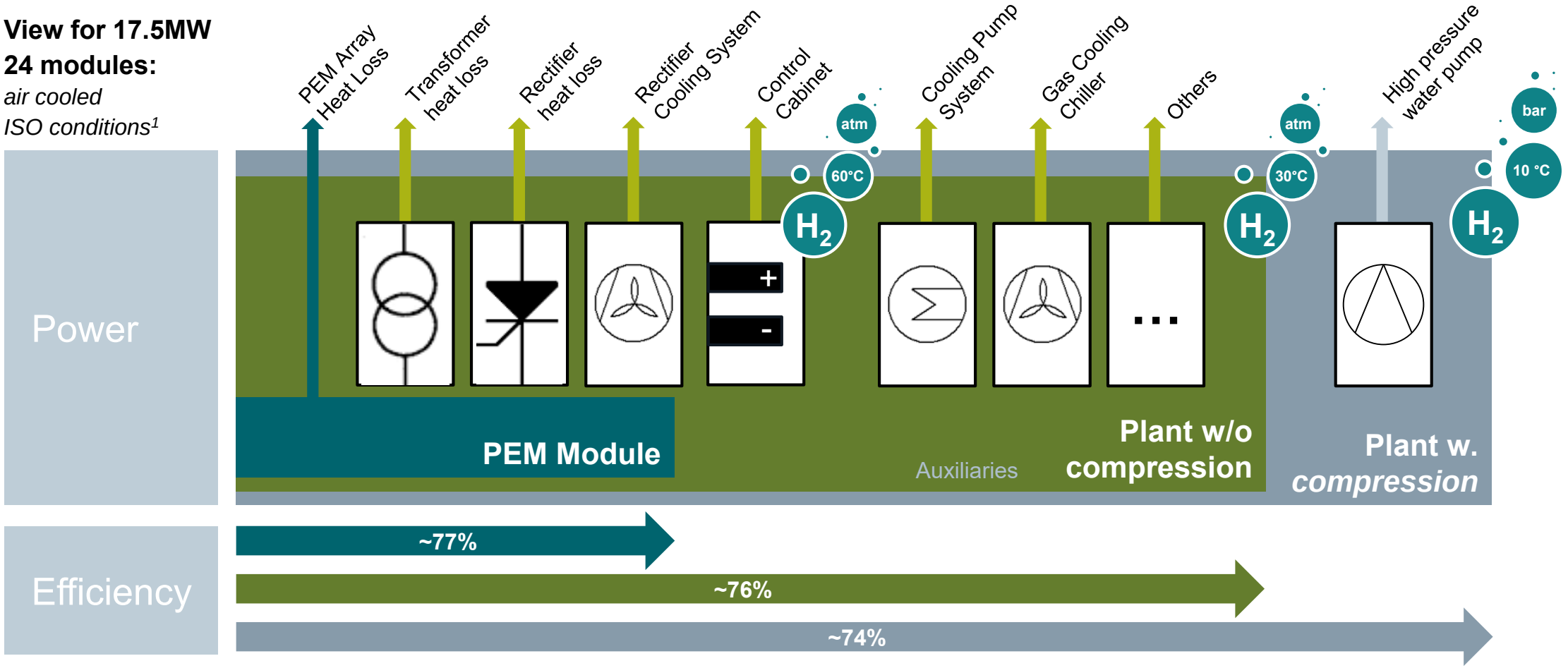
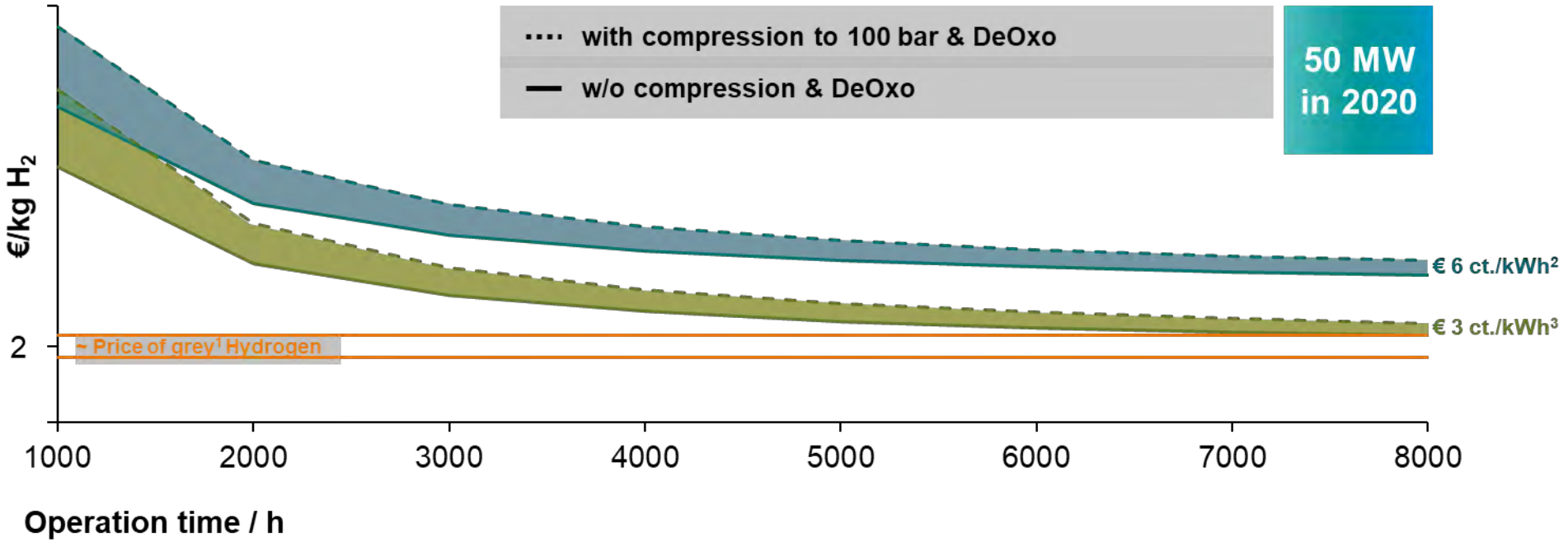
View for 17.5MW
24 modules:
air cooled
ISO conditions[1]



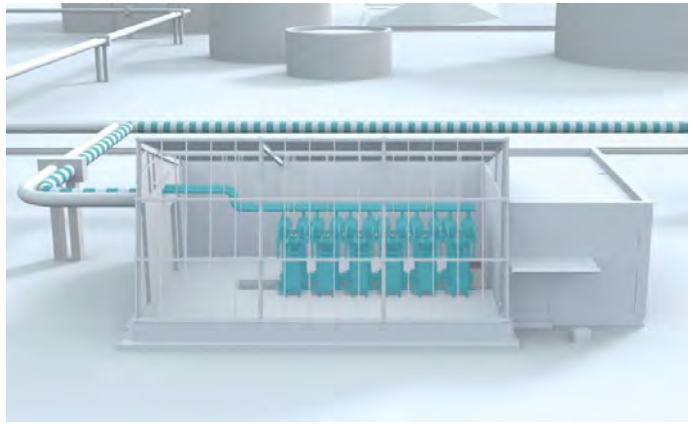
1) ISO conditions: 15° C, 1013mbar, 0m, 60% rel. hum.

Hydrogen Production Cost in 2020



1) Grey H_2 : Hydrogen produced by conventional methods as steam methan reforming
2) € 6 ct./kWh: e.g. on shore wind (4-6ct./kWh) or PV in Germany
3) € 3 ct./kWh: Reachable in renewable intense regions like Nordics (Hydro Power), Patagonia (Wind), UAE (PV)

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

Use cases

Hydrogen for the steel making process

Supply grid services

6 MW

Power demand based on Silyzer 300

1.200 Nm^3

of green hydrogen per hour

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%

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

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 735503. This Joint Undertaking receives support from the European Union‘s Horizon 2020 research and innovative programme and Hydrogen Europe and NERGHY.

Thank you!

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