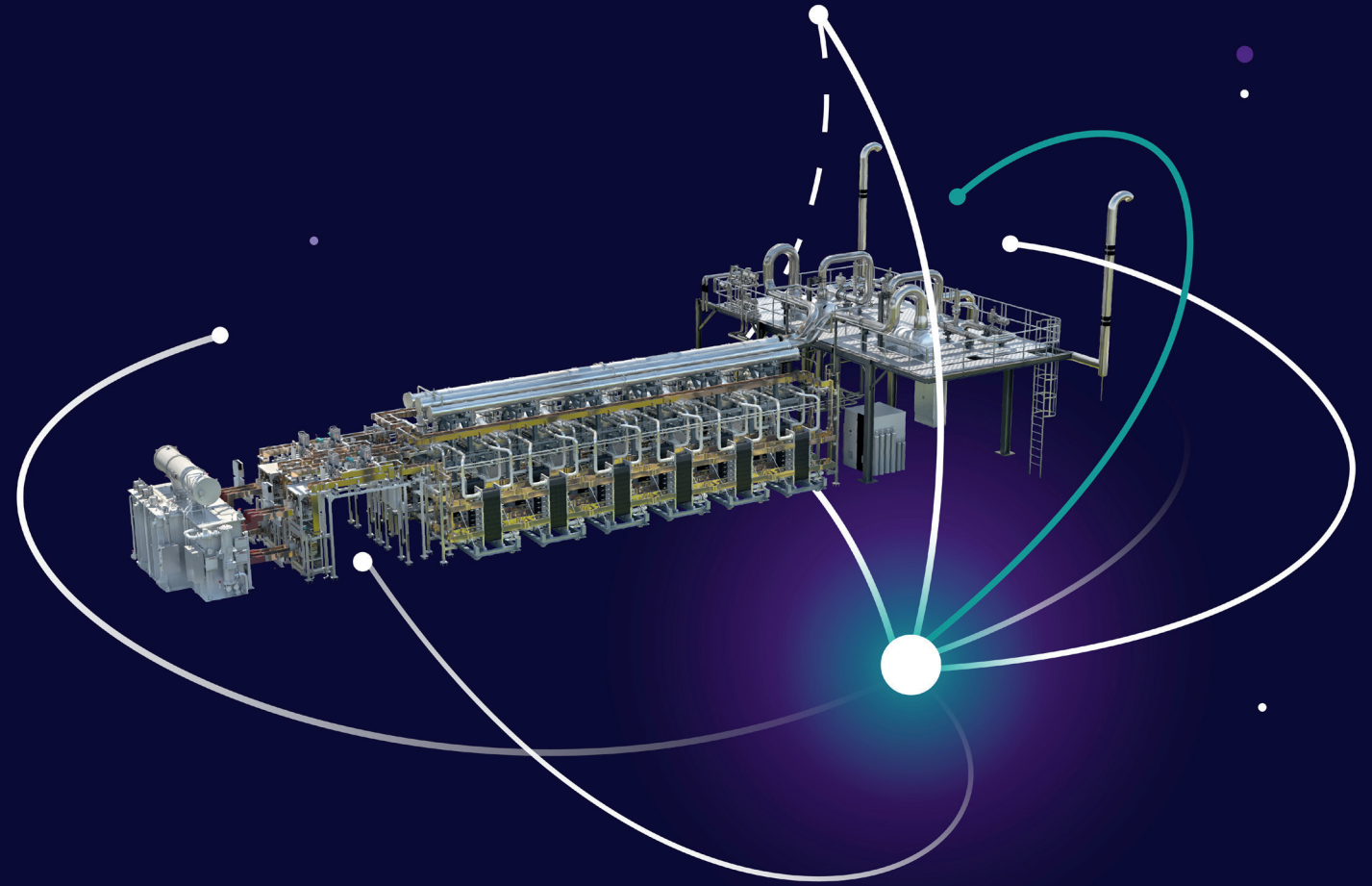


# Hydrogen and Power-to-X solutions

Versatile and scalable technology to make  
a difference in the energy transition



# Challenges

- How to decarbonize industry, mobility, buildings, and other sectors, which cannot easily be electrified?
- How to harness sector coupling to use renewable hydrogen and its derivatives – including e-Methanol, e-Ammonia, and e-Fuels – to make green energy available to these hard-to-abate sectors?
- How to bring renewable energy from energy-rich regions like South America, North Africa, and Australia to energy-hungry industrial centers like North America, Europe, and Japan?

## Other challenges:



Cost-efficient green hydrogen from renewable energy



How to ensure the availability and reliability of this young technology



Up-scaling of the existing technology and manufacturing



Financing

# Solutions

- We offer products, engineering and strong solution capabilities and a strong partner ecosystem across the whole hydrogen and Power-to-X value chain for the industry, mobility, and energy sectors.
- Gigawatt-scale production: We are prepared for delivery at Gigawatt scale through automation and digitalization of manufacturing.
- Scale-up is becoming a reality with projects in implementation based on our modular Silyzer 300 platform from 6 MW in H2Future to 200 MW in Normand'Hy and more to come in all sectors.
- CertaLink™ Energy Certificate provides tamper-proof documentation that a product has a renewably generated origin.
- Services delivered from Siemens Energy's global service network. We offer our customers services that extend from installation to maintenance of the electrolyzer system throughout its entire lifecycle, including recycling and refurbishment.

# Electrolyzer references







## Trailblazer Project – Green Hydrogen for Air Liquide pipeline infrastructure

**Power dimension:** up to 20 MW based on Silyzer 300

**Installation:** 2022

**Location:** Oberhausen, Germany

**Customer:** Air Liquide

**Use cases:**

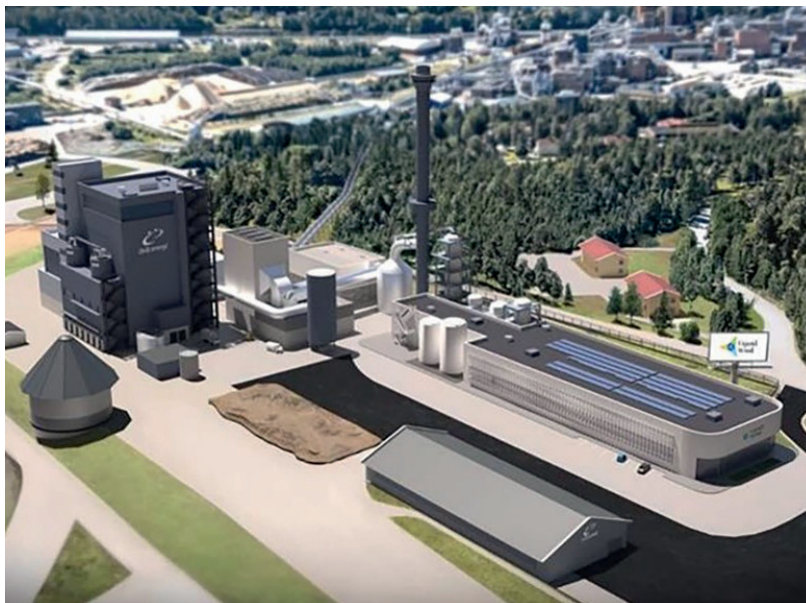
- Hydrogen for Industry and mobility

**Potential:**

- Connect hydrogen production to both existing hydrogen and oxygen pipelines
- Potential to expand to 30 MW total planned capacity

**Solution:**

- Operation of a 24-module array Silyzer 300
- One of the largest renewable hydrogen and oxygen production plants of Germany



## FlagshipONE – Largest commercial product plant for CO<sub>2</sub> neutral e-Methanol for marine use

**Power dimension:** 70 MW

**Installation:** scheduled in 2025

**Location:** Örnsköldsvik, Sweden

**Customer:** FlagshipONE

**Use cases:**

- Hydrogen for eMethanol – 50.000 tones per year from 2025
- Decarbonize the world's shipping industry

**Potential:**

- Blueprint: Liquid Wind plans 10 facilities by 2030
- FlagshipTWO electrolyzers capacity of 140 MW planned

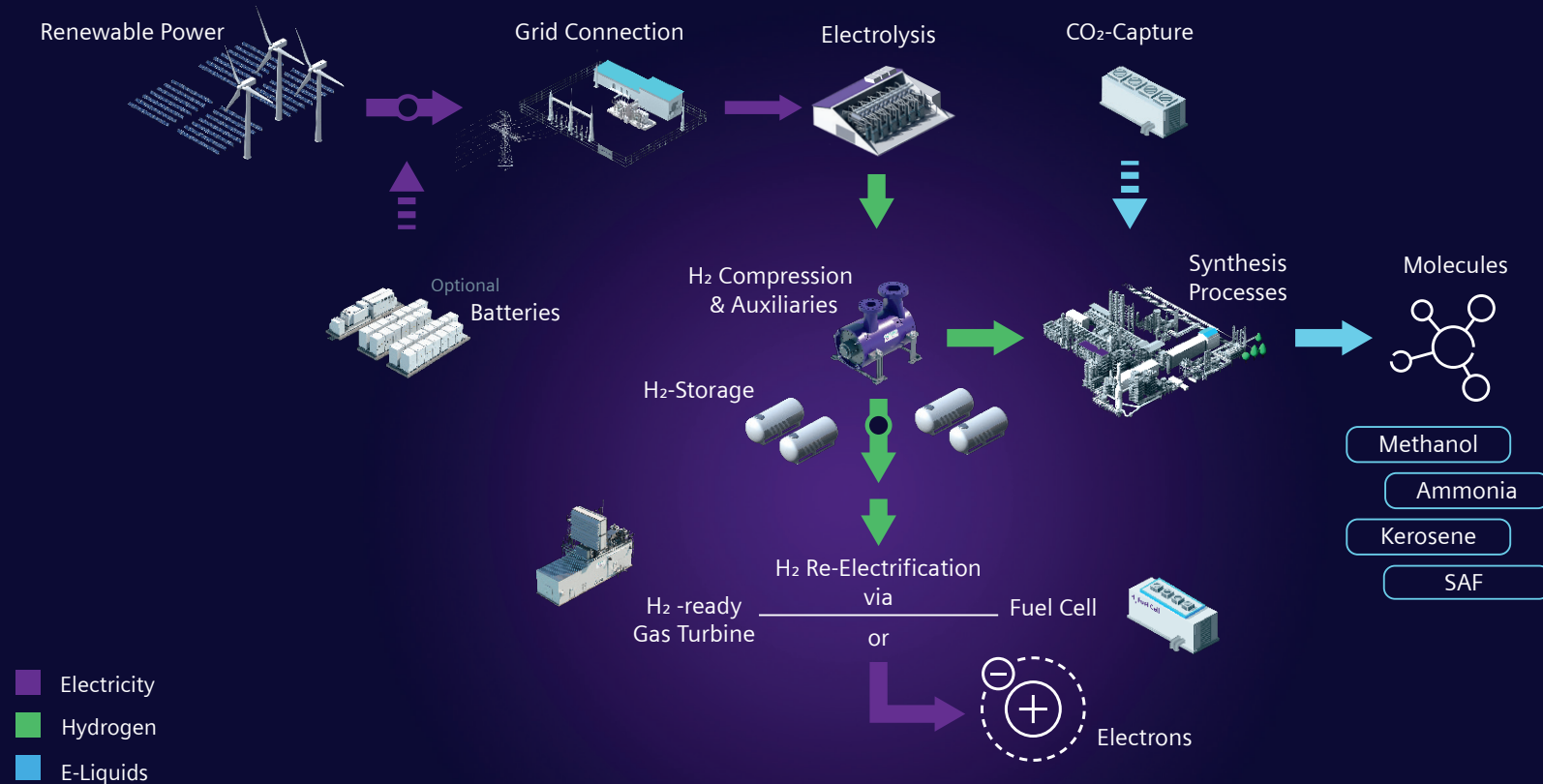
**Solution:**

- Plant wide electrification and automation system, digitalization solutions (digital twins), power distribution and compressor



# Energy Landscape: Power-to-X and Hybrid Solutions

Decarbonization and cost optimization through integrated, customized technology.



Power-to-X (PtX) and hybrid solutions are always a subset of the depicted energy landscape. In PtX applications, hydrogen is converted into molecules along the energy landscape via a synthesis process, but there is no re-electrification.

By integrating different technologies, our customized solutions are tailored to your local challenges and needs, regardless of remote locations, grid access, existing network or decarbonization requirements.

The challenges are many - but the solution is simple with a Power-to-X or hybrid solution from Siemens Energy.

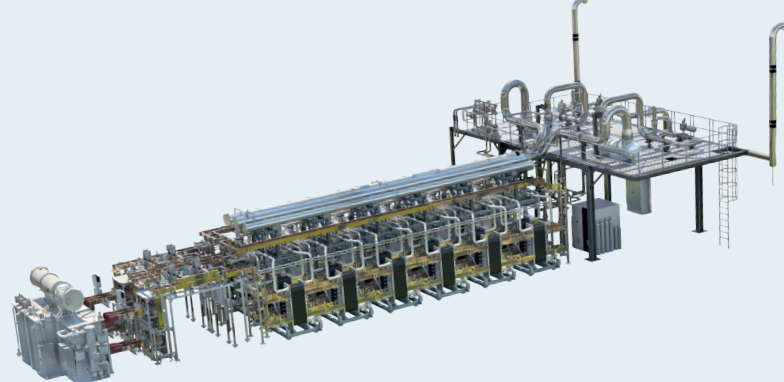
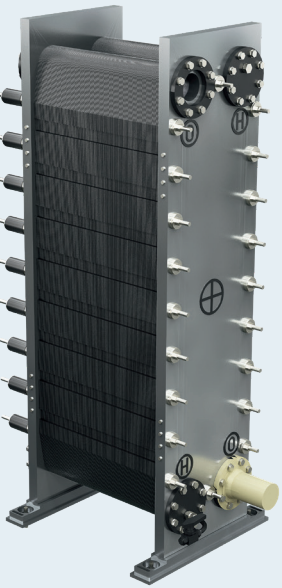
- Powerful and intelligent  
Integrating multiple technologies through advanced control capabilities for simplified, improved and efficient operation of complex energy systems
- Powerfully sustainable  
through an increased share of renewable energies in power generation
- Powerful and reliable  
through the integration of storage solutions

# Silyzer 300 – Technical Data

## Benefits of PEM Electrolysis

- High power density
- High dynamic operation range; direct coupling to renewables
- High efficiency and low module internal losses
- High gas purities
- Extreme low standby consumption
- Low maintenance needs
- Consumes only water and power, no hazardous chemicals

<b>Electrolysis type:</b>	PEM Atmospheric
<b>Output Pressure (array):</b>	100 mbar
<b>Plant efficiency:</b>	>75.5%
<b>Minimum load:</b>	down to 40%
<b>Demineralized water consumption:</b>	< 10 l per kg hydrogen
<b>Hydrogen quality:</b>	up to 99.999% with de-oxo dryer
<b>Startup time:</b>	< 1 minute
<b>Dynamics:</b>	up to 10 %
<b>Stack design:</b>	Optimized for 80k EOH*. Operation beyond 80k EOH possible.

**24**  
stacks

to build a full  
stack array

**17.5 MW**

plant power  
demand

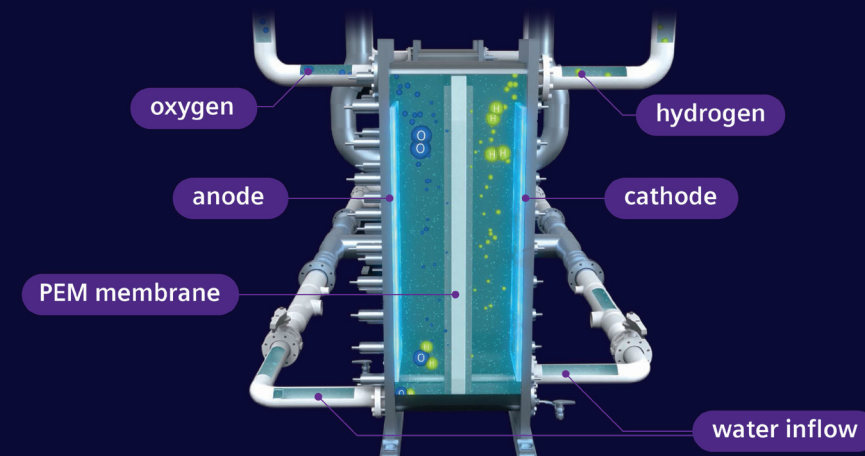
**>75.5 %**

plant efficiency

**335 kg**

hydrogen  
per hour

## PEM Electrolysis – how does it work?

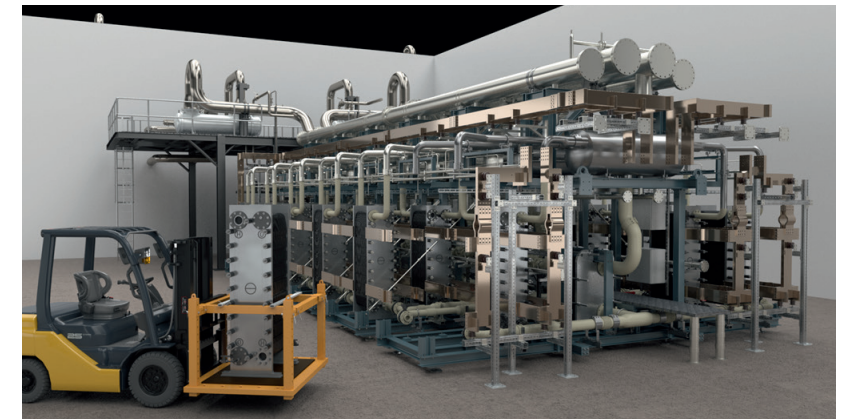


For our hydrogen electrolyzer system, we focus on PEM technology taking its name from the proton exchange membrane. The membrane's special property is that it is permeable to protons but not to gases such as hydrogen or oxygen. As a result, in an electrolytic process the membrane takes on, among other things, the function of a separator that prevents the product gases from mixing.

\*Equivalent Operating Hours

# Service

Together we outperform: Custom-tailored service contracts



## Service packages

**Basic:** Get the foundation for a smooth, economical and safe operation of your electrolysis system with a package of maintenance, spare parts, hotline support & digital services.

**Advance:** Best insurance against unforeseen downtime. Expanded the basic package to further reduce risks and to safeguard your business case for your electrolysis plant.

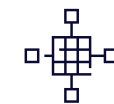
**Integrated:** Total peace of mind - since operating efficiency and value creation are your priorities, let us take care of your electrolysis plant. We strive to enhance the value of your plant operations.



## Digital services

We offer innovation by utilizing state-of-the-art digital service to drive operational excellence of your plant.

We are prepared for the future of scheduled maintenance, asset management or digital twin studies to maximize your plant availability and operating efficiency.



## Performance enhancement services

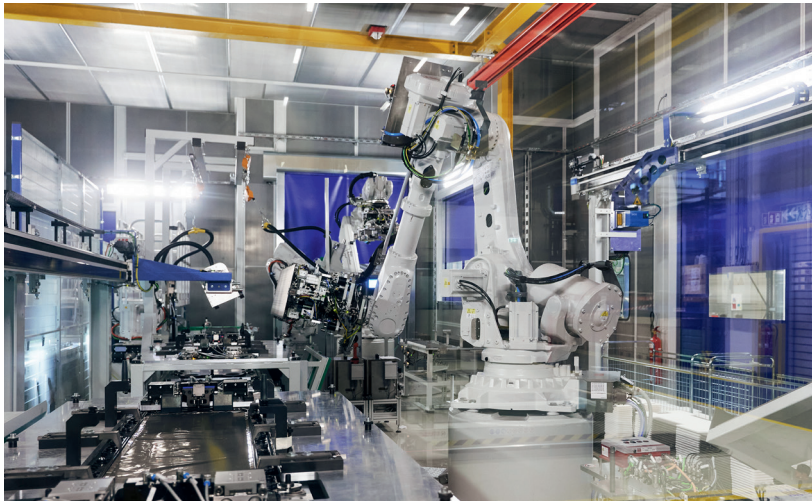
Your path to maximum performance assuring operational reliability and efficient performance of your electrolysis plant.

Discover our stack exchange offerings of

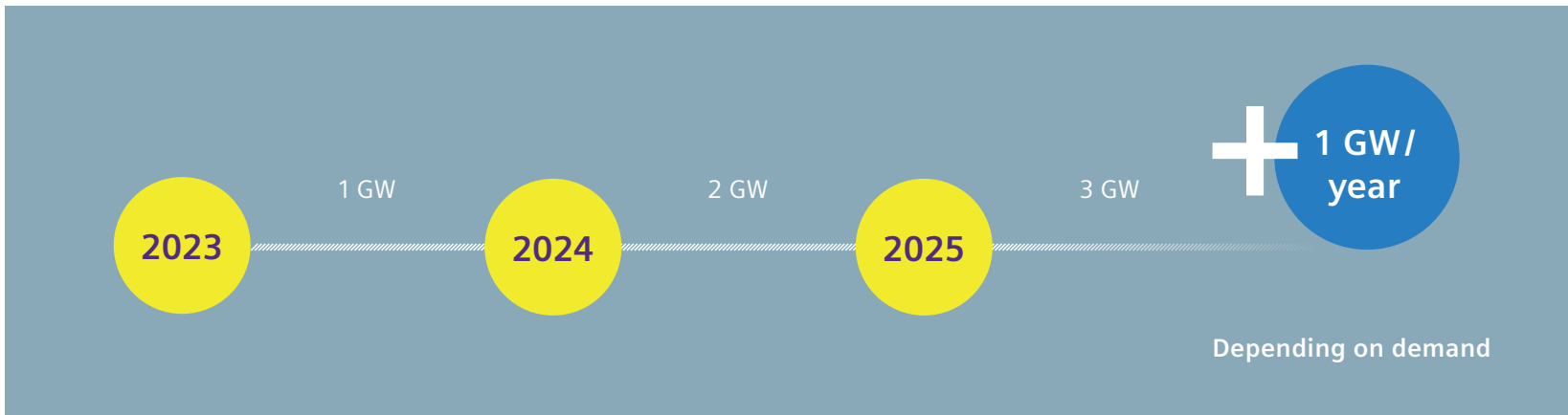
- recycled and refurbished stacks. Ensuring quality without compromising your budget and sustainability goals
- stack upgrades based on our continuous research and development for the latest technical enhancement.



# Industrial scale production of Electrolyzer in Berlin



Both the United States and European Union are aiming for many Gigawatts of electrolyzer manufacturing capacity to drive the energy transition. We are starting the required massive scaling-up and acceleration of manufacturing: In 2023, industrial production of PEM electrolysis stacks began at our multi-Gigawatt electrolyzer facility in Berlin – highly automated according to latest production standards – and will be ramped up to an annual production capacity of three Gigawatts by 2025.



## Cost efficient multi-Gigawatt stack factory

- Highly automated central PEM manufacturing according to latest production standards
- Large quantities and strong supply chain management
- Strong partner relationships for supply of key components



## Localized decentralized packaging

- High quality by pre-assembling
- Transportable units
- Local Packagers in key regions facilitate local value chain

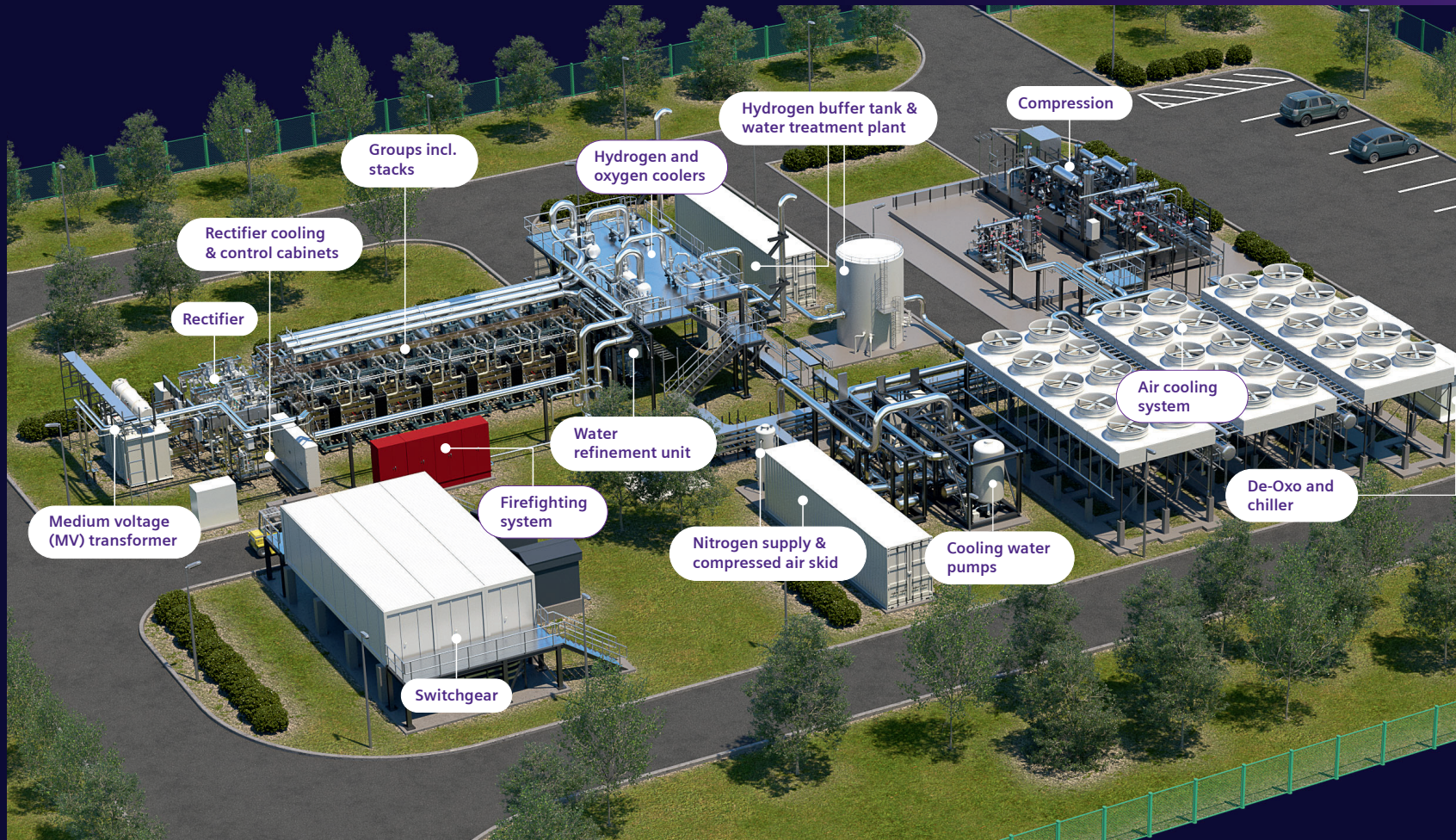


## Scalable electrolysis system

- Minimize on-site installation
- Clearly defined interfaces maximize standardization
- Pre-engineered for contract manufacturing



# Silyzer 300-based hydrogen plant



The electrolysis system and compressor are indoor equipment. The halls have been removed to explain the components

## We deliver what we promise



Highest standards in safety and project excellence

- Certified project managers
- ISO9001 Quality Management System
- Safety is IN our DNA



Cost efficiency and operational performance

- Fast start-up and shut-down
- Highest operational flexibility
- Cold start capability
- Reduction of OPEX due to maintenance-free stack and available recycling concept
- Competitive hydrogen price per kg at green electricity prices below 3 ct/kWh



Green Hydrogen Solutions

- Proven industrial-grade large-scale electrolyzer systems >200,000 operating hours in MW range



# Optimized plant design



## 50 MW reference plant

Rated plant power: 50 MW

Hydrogen production (kg per hour) approx. 1,000

Oxygen production (kg per hour) approx. 8,000



## 100 MW reference plant

Rated plant power: 100 MW

Hydrogen production (kg per hour) approx. 2,000

Oxygen production (kg per hour) approx. 16,000



## Industrial scale

- Double-digit Megawatt PEM electrolysis system.
- Modular design scales up to Gigawatt plants
- Ready for high volume production: Automated production for a flexible ramp up of the Gigawatt factory.



## Lowest investment costs

- Modular design / scaling effects minimize investment costs for large-scale industrial electrolysis plants.
- Simple design for economic system and reliable operation with natural circulation within the array
- Pre-engineered, standardized and pre-packaged arrays reduce project risks and accelerate execution
- Recycling concept enables cost reduction for modernizations and upgrades



## Future proof

- High dynamics meet the challenge of integrating fluctuating renewable energy sources.
- Plant design flexibility
- Dependable service concept
- Different packages for different project needs: from basic maintenance activities to comprehensive all-round service using state-of-the-art data analysis.



# Prove your product is green with CertaLink™ Energy Certificate

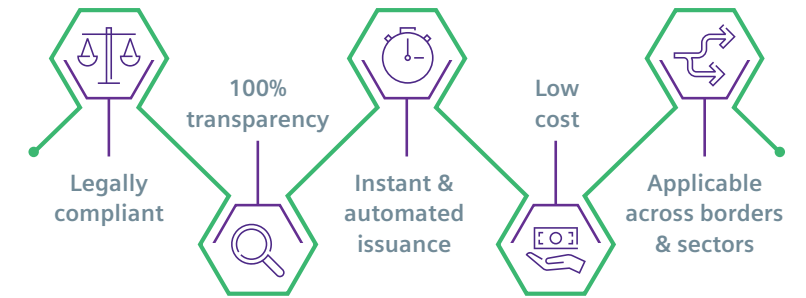


Siemens Energy offers the Clean Energy Certification digital service to track the environmental impact of energy production by issuing automated, timely, and government-approved certificates across sectors and across borders through partnerships with independent, accredited bodies and other companies in the energy sector.

CertaLink™ Energy Certificate ensure traceability of the carbon-neutral origin of energy production, energy imports, and energy consumption. Getting green versions of products and fuels will be a significant part of the transition to a carbon-neutral economy.

Our CertaLink™ Energy Certificate will establish the proof of origin of energy and will satisfy the market needs of the whole range of Power-to-X customers, allowing them to:

- Gain customs and tax reductions,
- Achieve higher market prices for products produced by clean energy,
- Meet future governmental requirements (e.g. EU program "Fit for 55"), and
- Enable the trading of clean energy on stock exchanges and in other marketplaces.



CertaLink™ Energy Certificate ensure traceability of the carbon-neutral origin of energy production, energy imports, and energy consumption. Getting green versions of products and fuels will be a significant part of the transition to a carbon-neutral economy.



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