New Energy Business
Large-scale PEM Electrolysis for Industrial Applications
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New Energy Business

By enabling the green hydrogen economy, we lead the transition towards a decarbonized world together with our customers and partners.

Hydrogen Systems
Industry grade Power-to-hydrogen systems and services

Power-to-X-Solutions
- Power-to-Hydrogen and Power-to-Liquids solutions and services
- Turnkey solution package

Energy Consulting & Digital Services
- Electrolyzer-integrating Energy system design
- Power-to-X digital services and optimization solutions
Focus on Proton Exchange Membrane (PEM) electrolyzer system technology

Operational performance
- **Fast start-up** and shut-down
- Highest operational flexibility
- Cold start capability

Clean by nature
- Highest hydrogen purity >99.9%
- No aggressive chemical electrolyte
- No contaminants – only water, hydrogen and oxygen in the system

Competitiveness
- Small footprint compared to alkaline systems
- Lower OPEX compared to alkaline systems due to maintenance-free stack
- Competitive hydrogen price per kg at green electricity prices below 3 ct/kWh
We are front runner in industrial scale PEM technology innovation based on our in-house expertise

In-house expertise

• Membrane Electrode Assembly (MEA): Highly efficient and unique electrode design, perfectly matching the membrane properties and the Gas Diffusion Layer (GDL)

• Electrode coating, cell and system design, testing and production

Industry Scale design

• Vertical cell design: Optimization of water and gas transport dynamics through the stack

• Specific cell frame material: Enables safe and long-lasting operation of modules

Intellectual Property

• Broad set of Patents: ~200 patents about hydrogen generation by electrolysis and electrolyzer technology

• Patented GDL design: Cost efficient, fluid-dynamically optimized for water and gas transport, avoiding gas pockets and ensuring best cooling
Siemens Energy Electrolyzer portfolio scales up by factor 10 every 4 – 5 years

Silyzer portfolio roadmap

<table>
<thead>
<tr>
<th>Year</th>
<th>Capacity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>0.1 MW</td>
<td>Silyzer 100 Lab scale demo, ~20 kOH\textsuperscript{1}, ~30 t of H\textsubscript{2}</td>
</tr>
<tr>
<td>2015</td>
<td>1 MW</td>
<td>Silyzer 200, ~130 kOH\textsuperscript{1}, ~1700 t of H\textsubscript{2}</td>
</tr>
<tr>
<td>2018</td>
<td>10 MW</td>
<td>Silyzer 300, biggest PEM cell in the world built by Siemens</td>
</tr>
<tr>
<td>2023+</td>
<td>100 MW</td>
<td>Silyzer 300 plant, pre-engineered and pre-fabricated electrolyzer plants</td>
</tr>
<tr>
<td>2028+</td>
<td>1,000 MW</td>
<td>Large scale, modular design electrolyzer plants</td>
</tr>
</tbody>
</table>

\textsuperscript{1} Operating Hours; Data OH & tons as of Oct 2020

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

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Silyzer 300 – Full Module Array
The next paradigm in PEM electrolysis

Silyzer 300
Full module array
(24 modules) …

… and close-up of 6 modules (Linz plant)

17.5 MW
plant power demand

>75.5%
plant efficiency

24 modules
to build a full module array

335 kg
hydrogen per hour
German government funding drives innovation and development of electrolyzer production and technology

H₂Giga project draft accepted by Ministry of Education and Research

<table>
<thead>
<tr>
<th>Initiator</th>
<th>Duration</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>German Federal Ministry of Education and Research</td>
<td>5/2021 to 4/2025</td>
<td>H₂Giga project draft accepted by BMBF – full application ongoing</td>
</tr>
</tbody>
</table>

01 SEGIWA
Development of **GW scale serial production** of PEM type water electrolyzers

02 DERIVA
**Green H₂ based** biogenic kerosene production

SEGIWA – SEries production GlgaWAtt
DERIVA – DERIsking of VAue chain
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

- Ramp-up of manufacturing towards a lean Gigafactory
- Flexible expansion to Multi-GW
- Automated, highest-quality Silyzer production
Strong partnerships facilitate NEB business success

Project-specific/technology partners
Development of dedicated projects and coverage of complementary technologies in the PtH₂/PtL value chain

Partnerships with regional focus
Strengthened regional market access and localized parts of the value creation

Long-term, strategic alliance
Joint projects, manufacturing, innovation and eco system

Siemens ecosystem
SGRE and Siemens Mobility
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

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

6 MW
Power demand based on Silyzer 300

1,200 Nm³
of green hydrogen per hour

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
Haru Oni Pilot Project
First integrated plant for climate-neutral e-fuel production from wind and water

Project
- Customer: HIF (Highly Innovative Fuels)
- Off-taker: Porsche AG
- Country: Chile, Patagonia
- Installation: 2021
- Product: Power-to-methanol solution based on SE Electrolyzer

Opportunity
- Huge wind energy potential in Magallanes
- Existing industry and port infrastructure

> Perfect conditions to export green energy from Chile to the world

Use cases
- E-Fuel for Porsche cars
- Potential for adding Kerosene or Diesel production in future phases
- Methanol for ship motors

Solutions
- Production of e-gasoline and e-methanol at one of the best spots worldwide for wind energy
- Co-developer Siemens Energy realizing the system integration from wind energy to e-fuel production
- International Partners like Porsche and AME

750,000 liters of e-methanol per year from 2022
(130,000 liters of e-gasoline)

>55m liters
e-fuel per year
planned from 2024

>550m liters
e-fuel per year
planned from 2026
Competitiveness to grey hydrogen expected by 2025 based on large scale commercial projects in operation

- **16 US$/MWh**
- **6,000 OHs per year**
- **1.5 US$/kg**

**Assumptions:** GW manufacturing, 100 MW electrolyzer capacity, scope w/o gas treatment/compression systems.

**OHs:** Operating hours
Conclusions

WHY
• Green hydrogen is the second stage of the energy transition
• Indispensable for decarbonization

WHAT
• In-house PEM electrolysis technology
• Large Power-to-X solutions enabled by the full Siemens Energy competence
• Digital twin and service concepts

HOW
• Secure technology and cost leadership
• Implement Giga factory
• Strong international partner ecosystem

We know how to industrialize technologies!