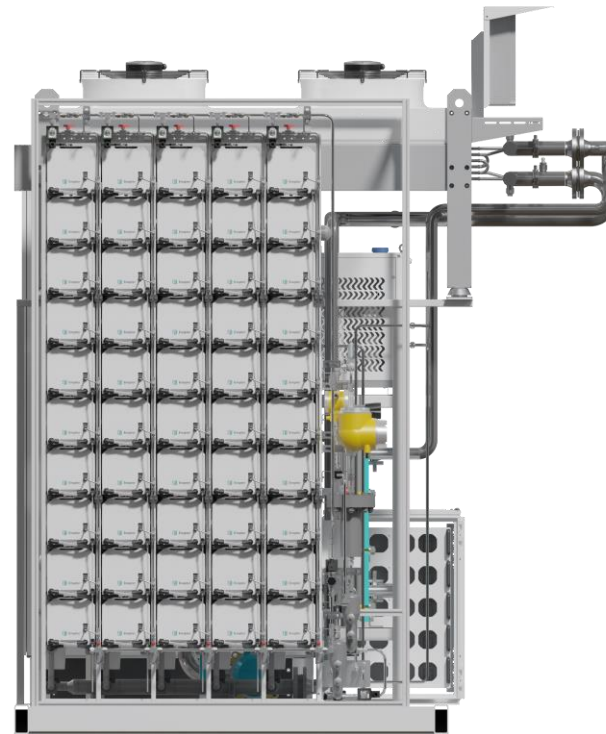
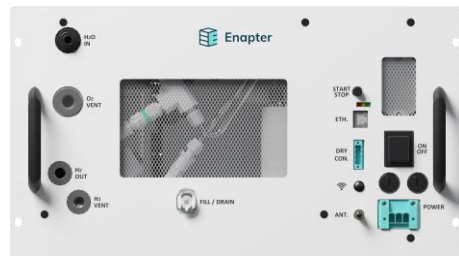




Technical Presentation

The AEM Electrolyser



Our company

Enapter at a glance



Started in November 2017

Builds on technology with a >10-year track record at that time



Pioneer and commercial leader in AEM electrolysis.

With 4.7k+ electrolyzers ordered by 340+ customers across 50+ countries so far



Changing the paradigm for electrolyzers with a high-volume focus

>150 partners integrate Enapter products into solutions of all sizes



Hardware, electronics and software in harmony for a next-generation experience.

Smart, Connected, Adaptable



Scaling up from a handful of units per month to **for mass production.**



Registered office: Heidelberg, DE
Stock exchange: Frankfurt/Hamburg Regulated Market

Customers around the world

340+ customers in 50+ countries to date

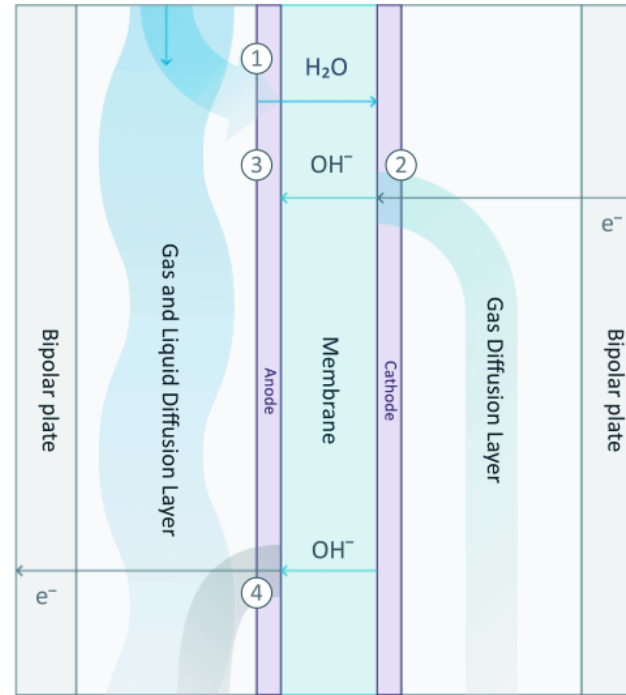


Many more [here](#)

Patented AEM technology

Our secret sauce

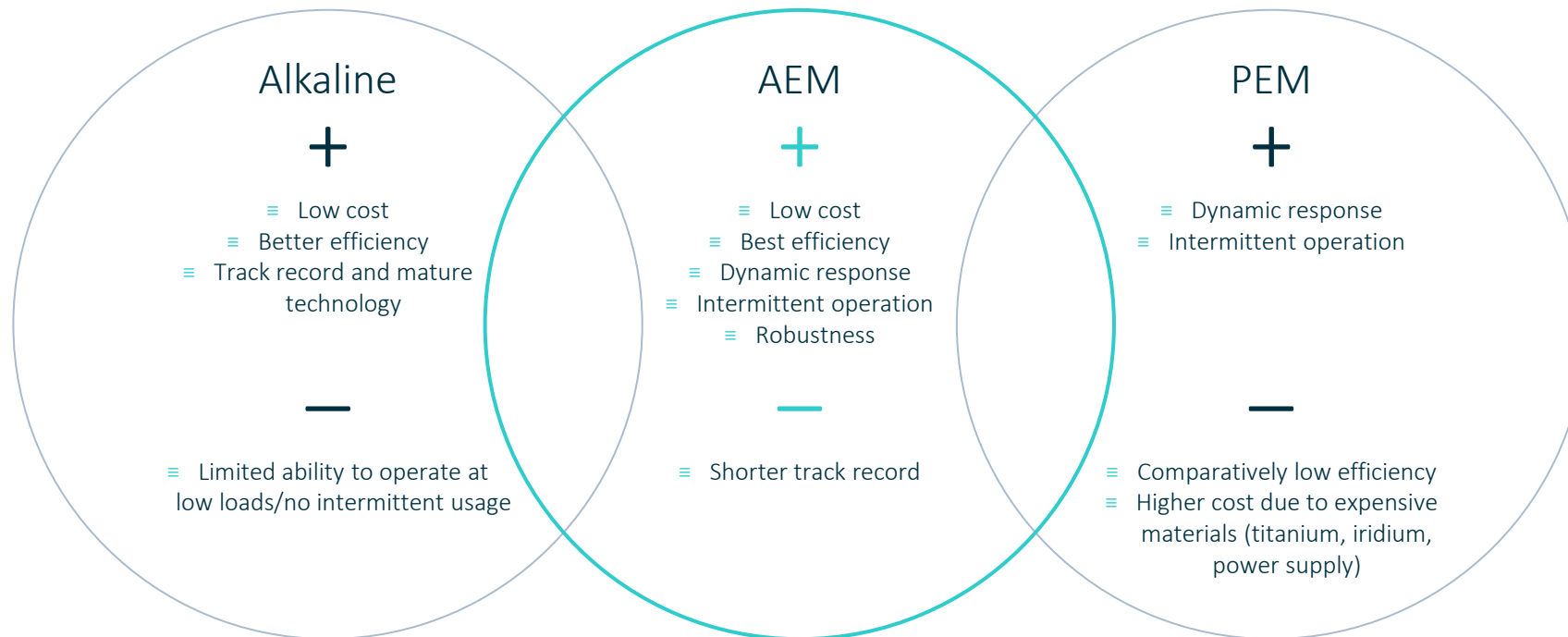
- ≡ Combining the best of Alkaline and PEM technology
- ≡ Low-cost materials and setup
- ≡ Simple BoP
- ≡ Top efficiency
- ≡ High H₂ pressure
- ≡ Low maintenance
- ≡ Strong patents granted, more pending



- ① Water travels from the anode half-cell through the membrane.
- ② Hydrogen is produced at the dry cathode and released via the gas diffusion layer.
- ③ OH⁻ moves back to the anode via the membrane.
- ④ Oxygen is produced from OH⁻ at the anode and released via the gas and liquid diffusion layer.

 Water Electrolyte Circulation  Electron Transport  Electron and Hydroxide Transport  Hydroxide Transport

The strengths of AEM Electrolyzers



At scale, standardised modules outcompete made to order plants

We have seen it before...



1981



today



2000

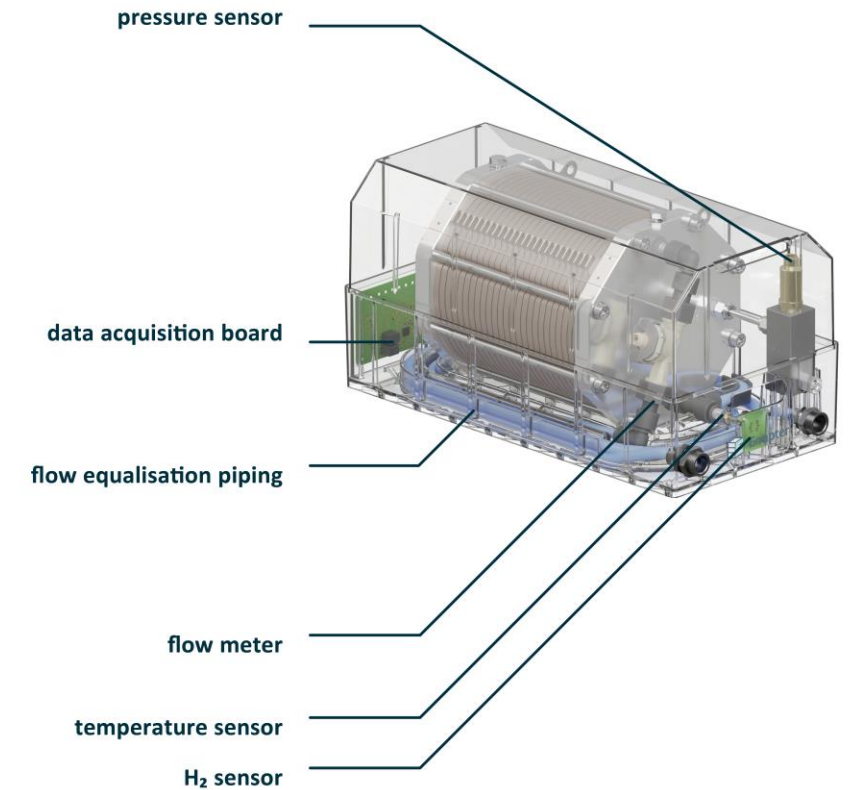
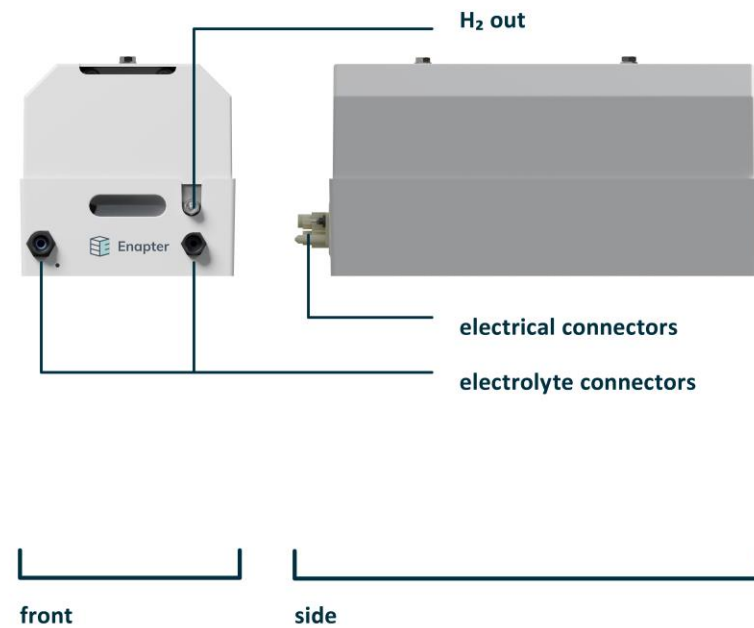


today

The core

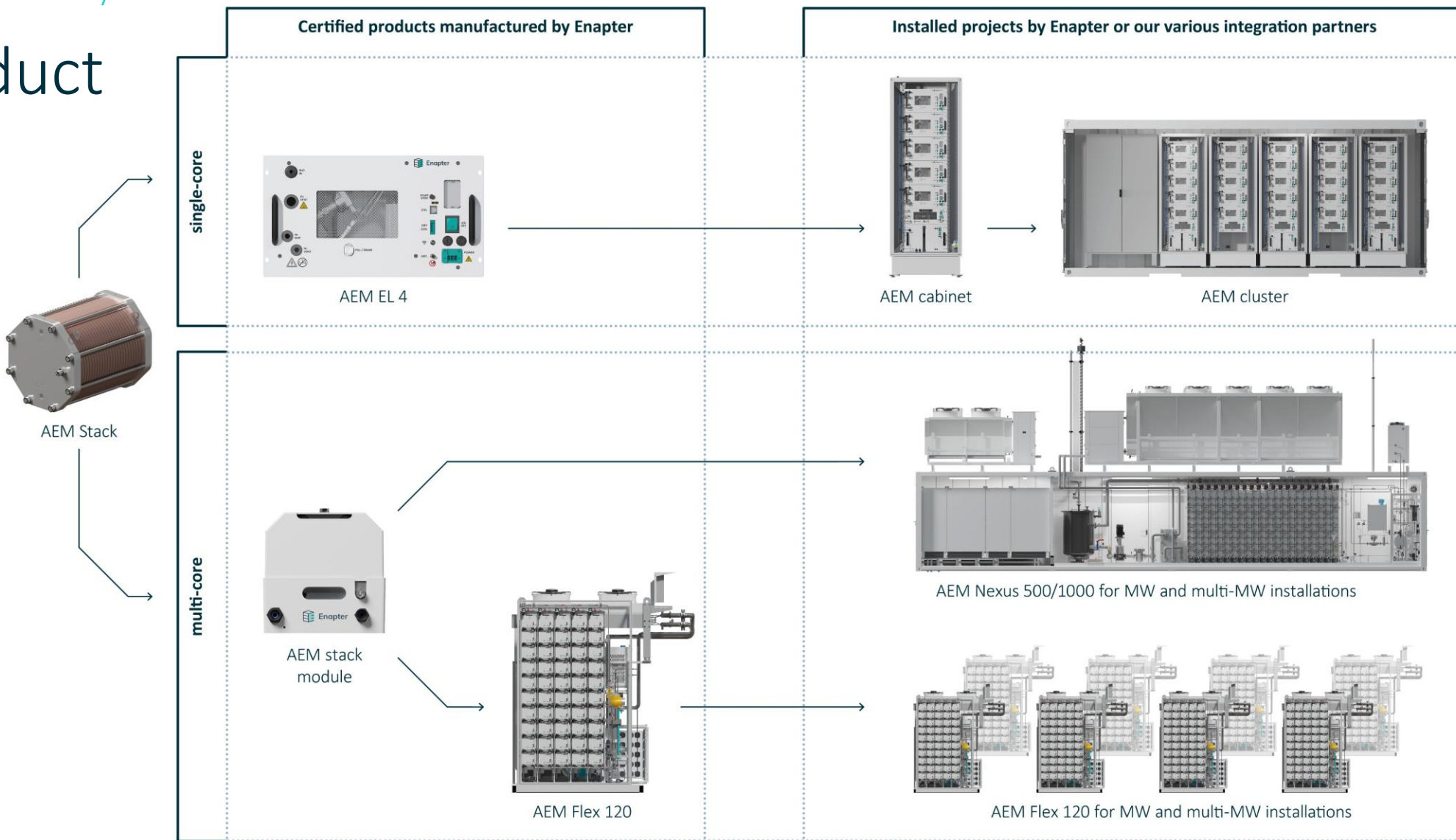
The AEM stack module

- ≡ Each stack module contains a data acquisition board and several sensors
- ≡ Each stack module can be replaced individually with ease
- ≡ Hydrogen & and water connections accessible from the front
- ≡ Electrical and data quick connectors on the back



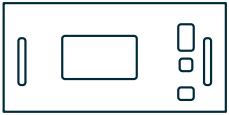
Enapter's AEM scalability

Our product platform



Single-core electrolyser series

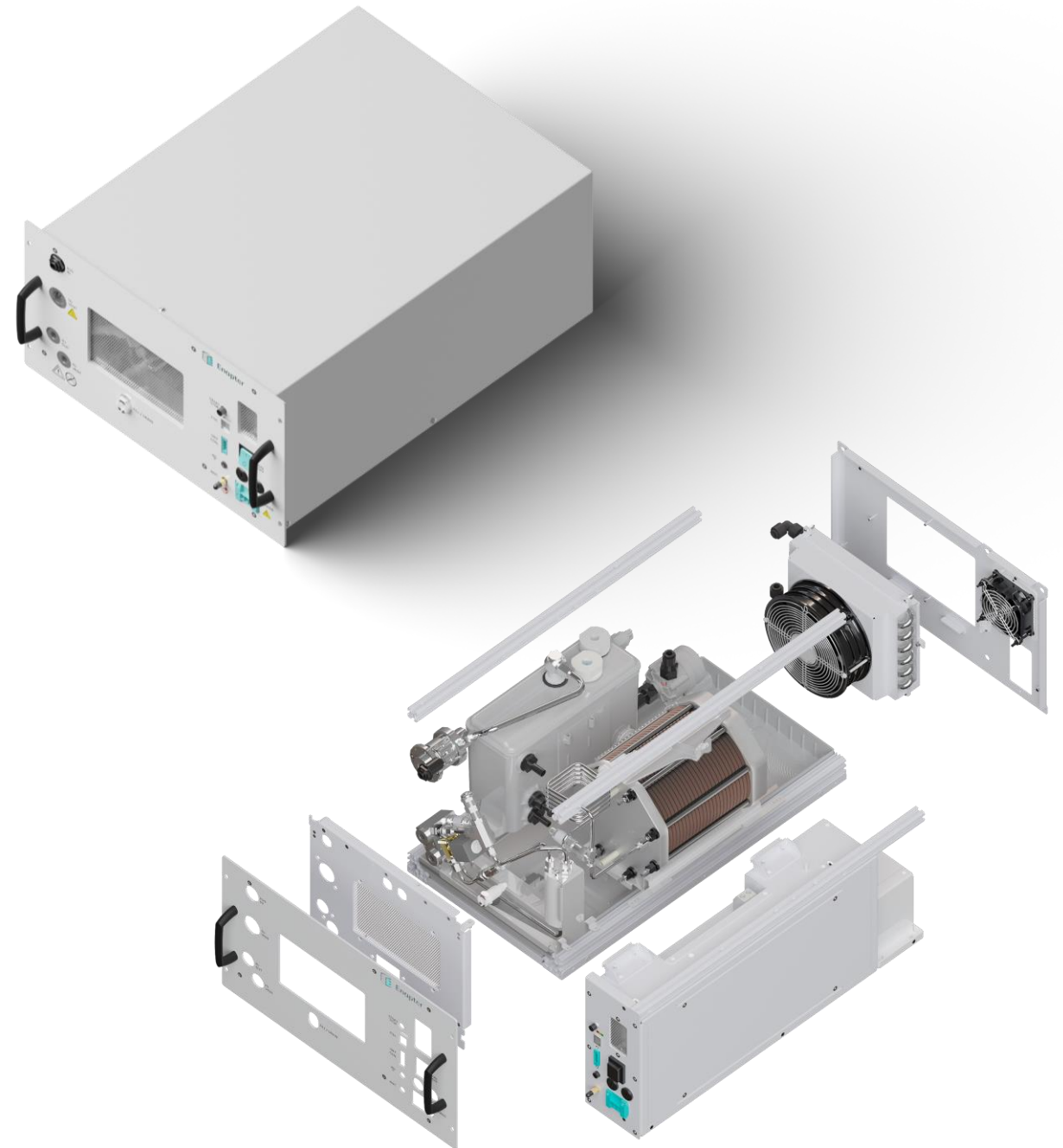
The Electrolyser EL 4



- ≡ Hydrogen Production: 500 NL/hr or 0.5 Nm³/hr
- ≡ Power Consumption: 2.4 kW
- ≡ Efficiency: 4.8 kWh/Nm³
- ≡ Hydrogen Purity: 99.9% or 99.999%
(with optional dryer)
- ≡ Output Pressure: 35 bar
- ≡ Modular and scalable

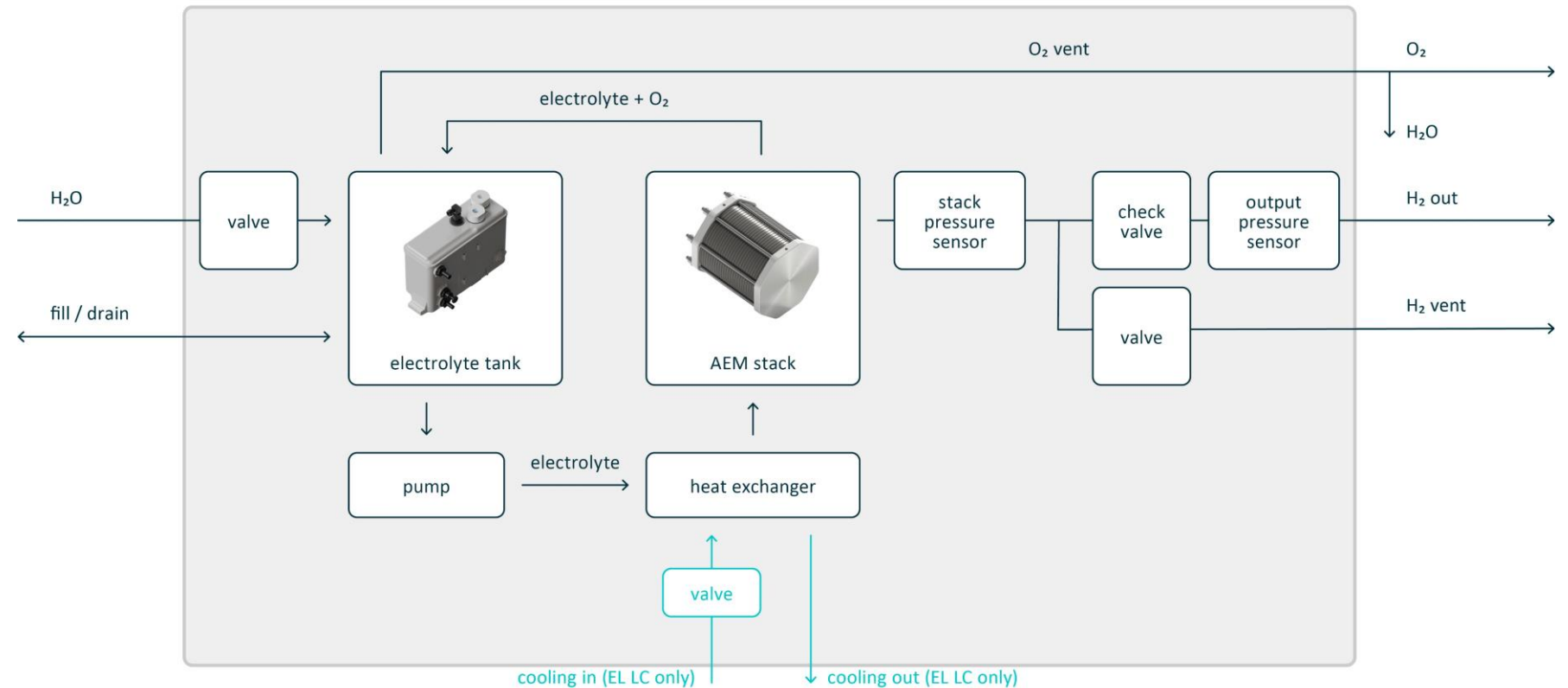
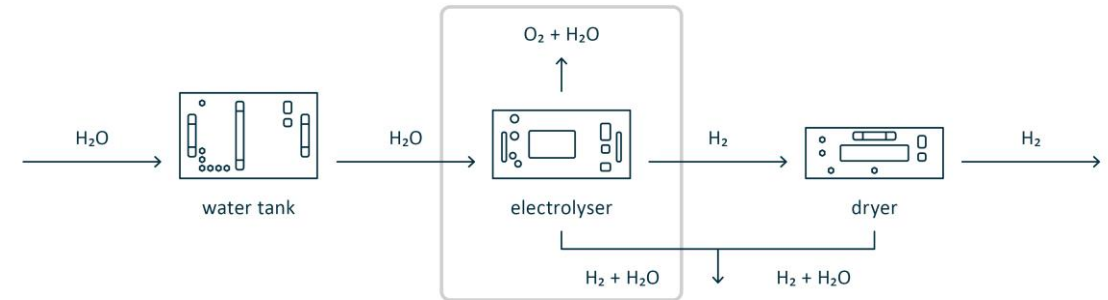
Datasheets:

- ≡ EL 4.1 AC (Air cooled / Liquid cooled)



Single-core electrolyser series

EL 4 Simplified P&ID



Auxiliary devices

The Dryer DRY 2.1



- ≡ Hydrogen flow rate at 35 bar: up to 2.5 m³/hr
- ≡ Hydrogen output purity: >99.999%
- ≡ Dewpoint (after drying): -70 °C
- ≡ Power consumption: 200 W (operative), 10 W (standby)
- ≡ Power supply: AC 200-240 Vac, 50/60 Hz
- ≡ One to five: Up to 5 AEM electrolyzers can be connected to the DRY 2.1

Datasheet:

- ≡ [Dryer DRY 2.1](#)



483 mm

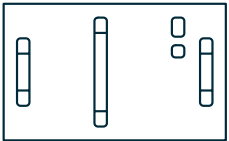
178 mm



490 mm

Auxiliary devices

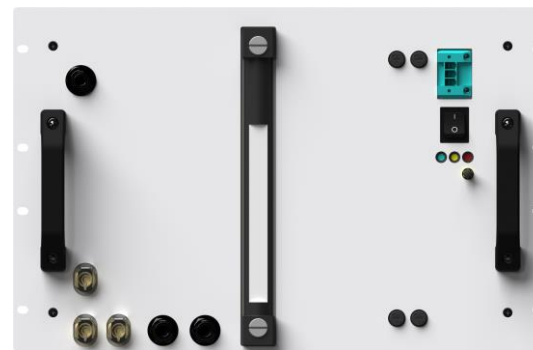
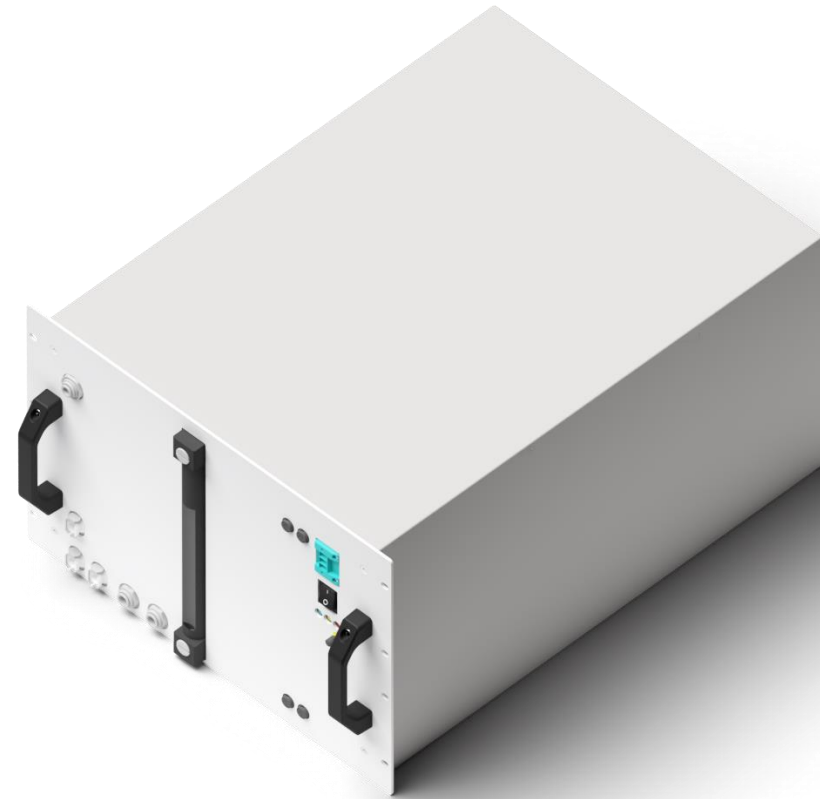
The Water Tank WT 2.1



- ≡ Capacity: 38.5 L
- ≡ Water input pressure requirement: 0-6 barg
- ≡ Maximum power consumption: 35W
- ≡ Power supply: AC 110-240 Vac, 50/60 Hz
- ≡ Recommended AEM electrolyzers to supply: 11

Datasheet:

- ≡ [Water Tank WT 2.1](#)



483 mm



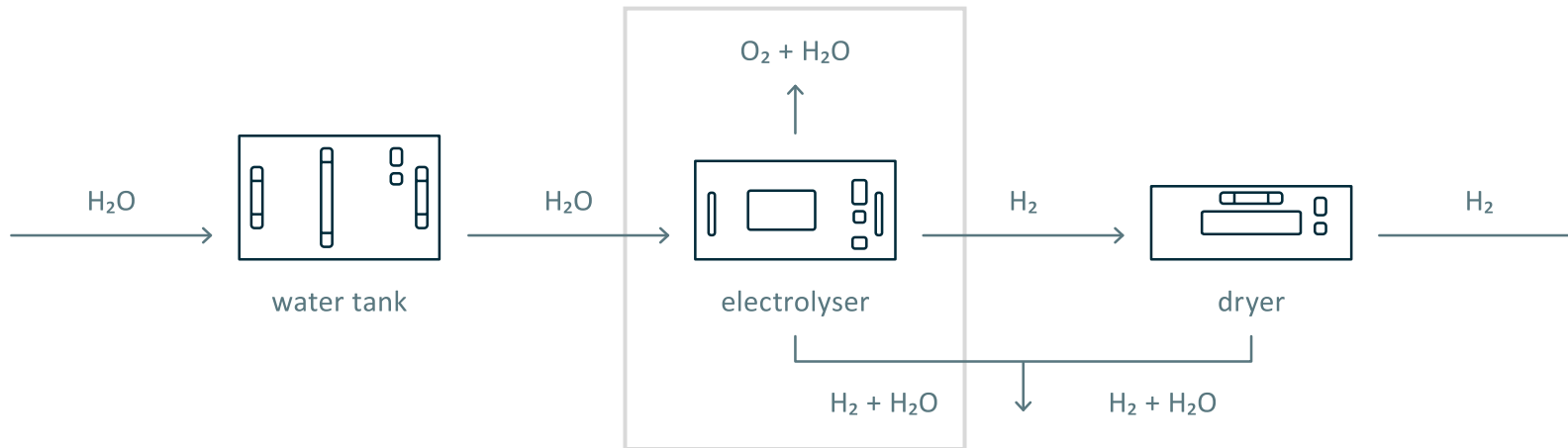
310 mm



640 mm

Multi-talents Enapter devices

How does it work?



Integration in Cabinets

AEM Cabinets

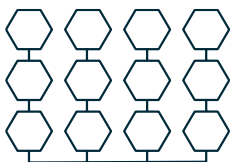
Enapter AEM electrolyzers are built to be easily integrated and stacked into standard 19" rack cabinets.

- ≡ Perfect for 1-20 kg/day production
- ≡ Up to 5 electrolyser, 1 dryer and 1 water tank can be stacked into a 42U cabinet
- ≡ Preassembled cabinets make it much faster to install and commission electrolyzers on-site
- ≡ Cabinets can also be IP rated for outdoor use



Multi-core electrolyser series

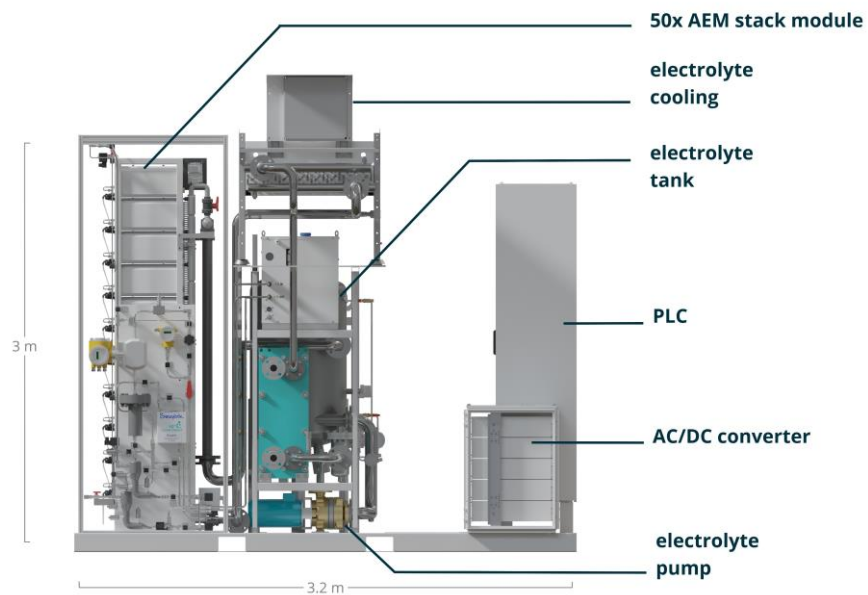
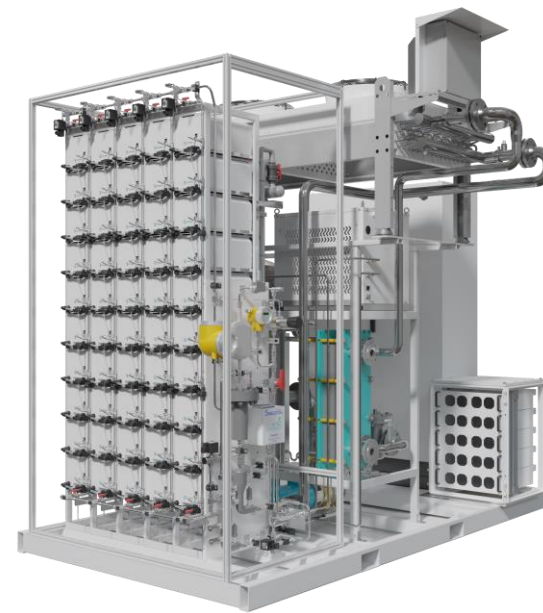
AEM Flex 120



- ≡ Hydrogen Production: 25 Nm³/h or 53.9 kg/d
- ≡ 99.95% or 99.999% purity, up to 35 barg
- ≡ Power consumption: 120 kW
- ≡ Efficiency: 4.8 kWh/Nm³
- ≡ Flexibility: 12% - 100%
- ≡ Hot Startup time: 0-100% in < 2 min
- ≡ Smart and fully automatic operation

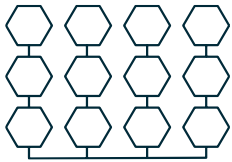
Datasheet:

- ≡ [AEM Flex 120](#)



Multi-core electrolyser series

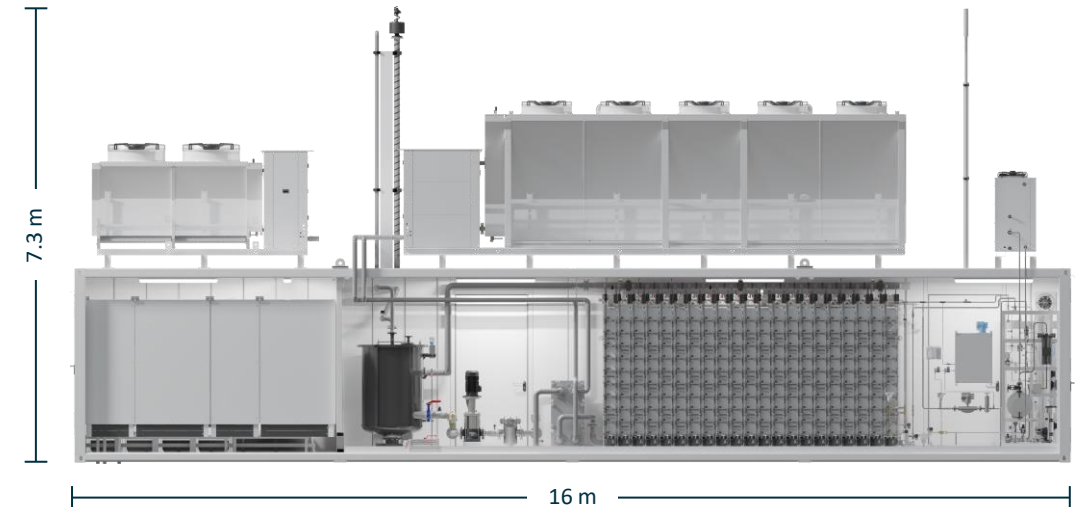
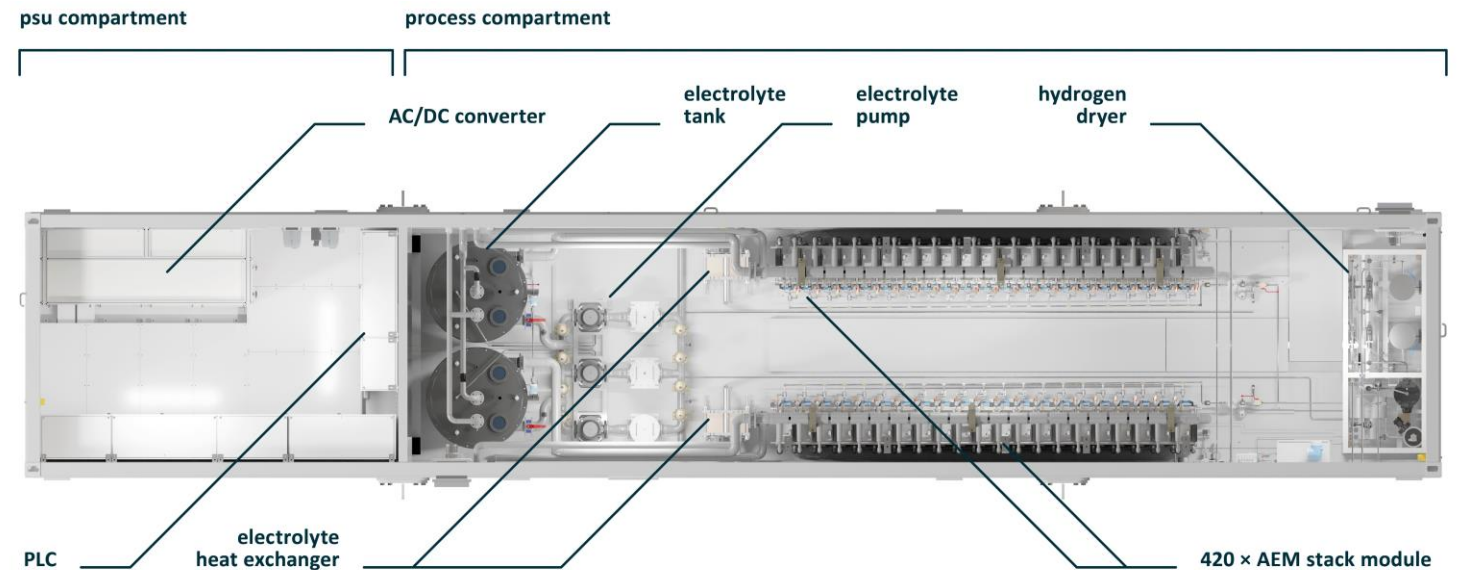
AEM Nexus



- ≡ Hydrogen Production: 210 Nm³/h or 453 kg/d
- ≡ Power consumption: 1,008 kW
- ≡ Efficiency: 4.8 kWh/Nm³
- ≡ Hydrogen Purity: 99.95% or 99.999%
- ≡ Flexibility: 3% - 100%
- ≡ Hot Startup time: 0-100% in < 2 min
- ≡ Output Pressure: Up to 35 bar

Datasheet:

- ≡ [AEM Nexus](#)



Quality and compliance

Certification

We are certified:

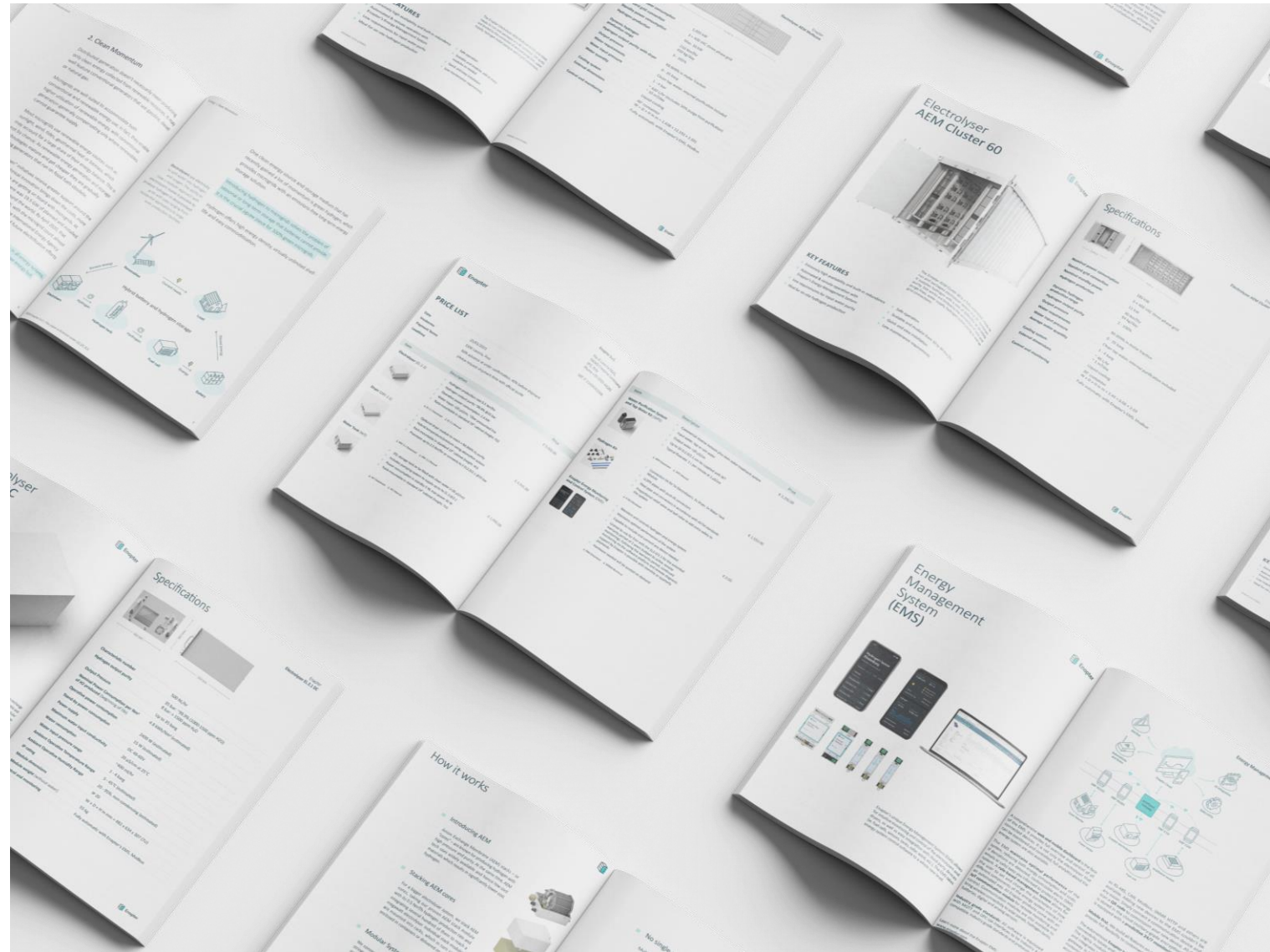
- ≡ ISO9001 Quality Management
- ≡ CE-certification according to Machinery Directive for our main products

We are pursuing:

- ≡ CE-certification and compliance to ISO22734 for future electrolyser products

We plan to pursue in the future:

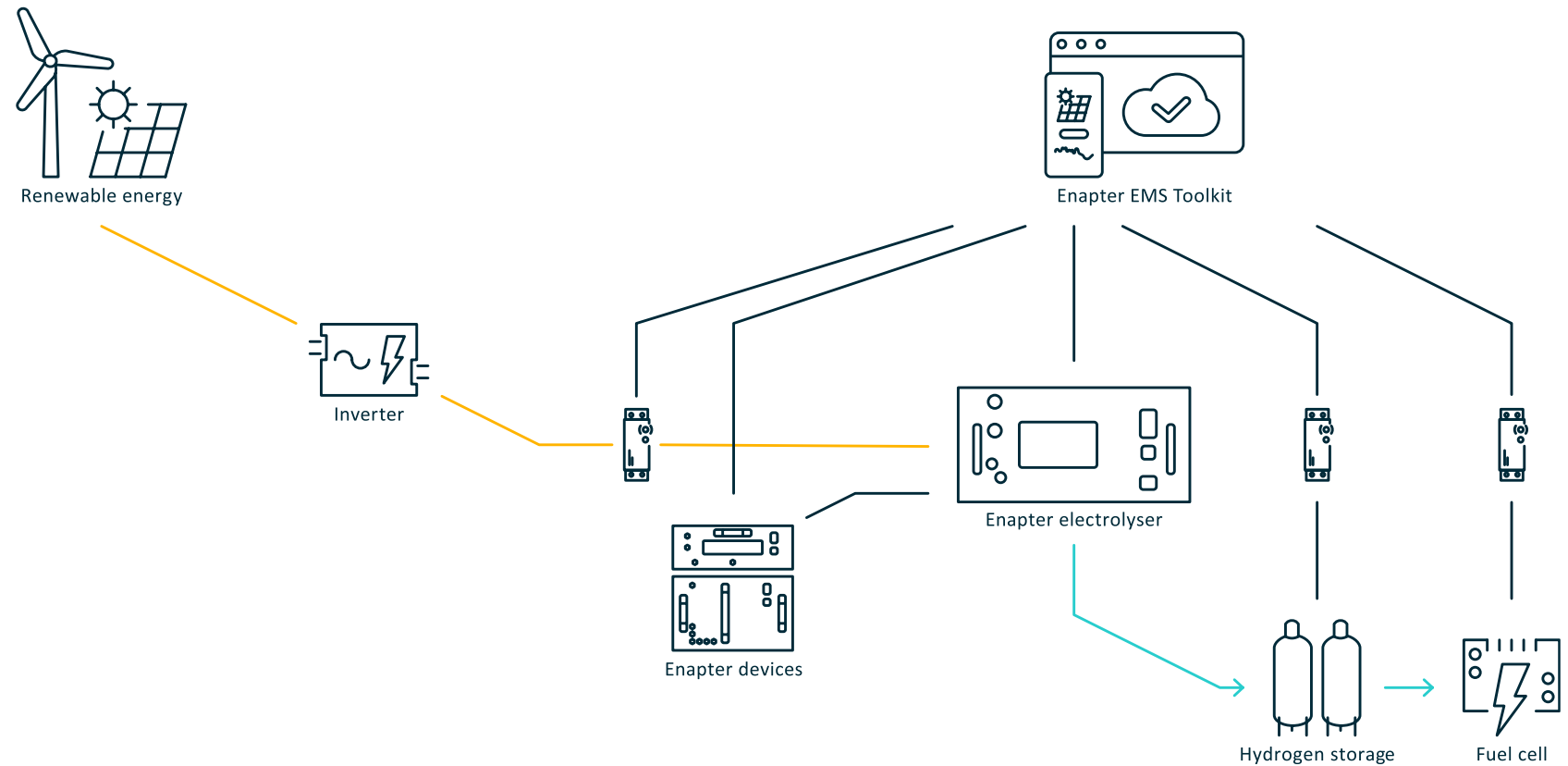
- ≡ ISO14001 Environmental Management System
- ≡ ISO 45001 Health and Safety
- ≡ ISO 50001 Energy Management System



Enabling the AEM Electrolyser

Enapter's Energy Management Toolkit

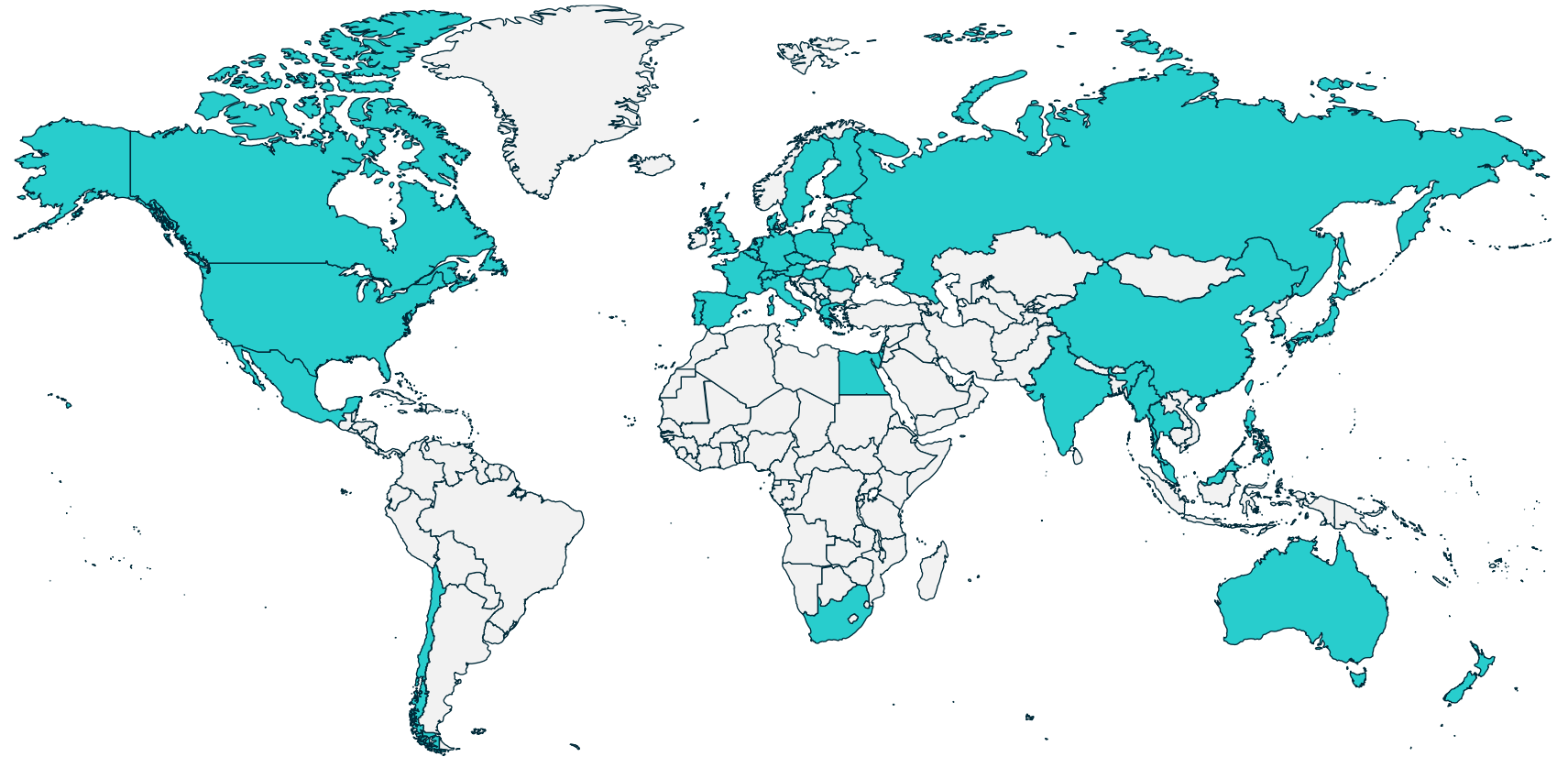
- ≡ Artificial Intelligence simulations
- ≡ Monitoring and controlling
- ≡ Automations & rule-based engine
- ≡ Machine Learning ready
- ≡ Industry-grade data encryption



AEM electrolyser rollout

Enapter's global product traction

- ≡ **3,700+ electrolyzers**
- ≡ **340+ customers**
- ≡ **50+ countries**



Power-to-X

H2Powerplant for backup energy

- ≡ Cluster of 96 AEM Electrolysers
- ≡ 29.8 m hydrogen storage tank
- ≡ Fuel cell supplied by Proton Motor
- ≡ The modular system should produce up to 10 tonnes of green hydrogen per year



Power-to-X

Grid Balancing on a Dutch Island

- ≡ 30 AEM Electrolysers
- ≡ InnovaHub District is a multifunctional power plant
- ≡ The role of hydrogen here is to store energy, act as a buffer for the grid, and promote H2 mobility.



Maritime

Refuelling boats

Baglietto's shore-based green hydrogen production, Italy

- ≡ Uses 10 AEM electrolyzers to produce green hydrogen
- ≡ Metal hydride cylinders at low pressure (35 bar)
- ≡ Arco Technologies, Bluenergy Revolution, Enapter, H2Boat, Siemens Energy, and the classification society RINA.



Power-to-X

Dynamic grid load management with electrolysis

Lancium Texas Houston, a US client of our certified partner H2 Core Systems, are using a system featuring Enapter's AEM Electrolysers to help achieve grid stability, assisting in the prevention of major power outages and grid damage.

- ≡ The turnkey green hydrogen production system is integrated into the client's variable load-management system, producing green hydrogen from fluctuating renewable electricity that can also destabilise the grid.
- ≡ When too much electrical energy is in the grid, the flexible AEM Electrolysis workload is increased to create more hydrogen, and decreased when too little energy is present.
- ≡ This on-demand ramp-up and ramp-down of production within seconds supports both grid stability and the production of cheap, regenerative green hydrogen.
- ≡ After multiple rounds of testing, next steps are planned to expand the system to a multi-megawatt level, with hydrogen sold to industry and mobility offtakers.

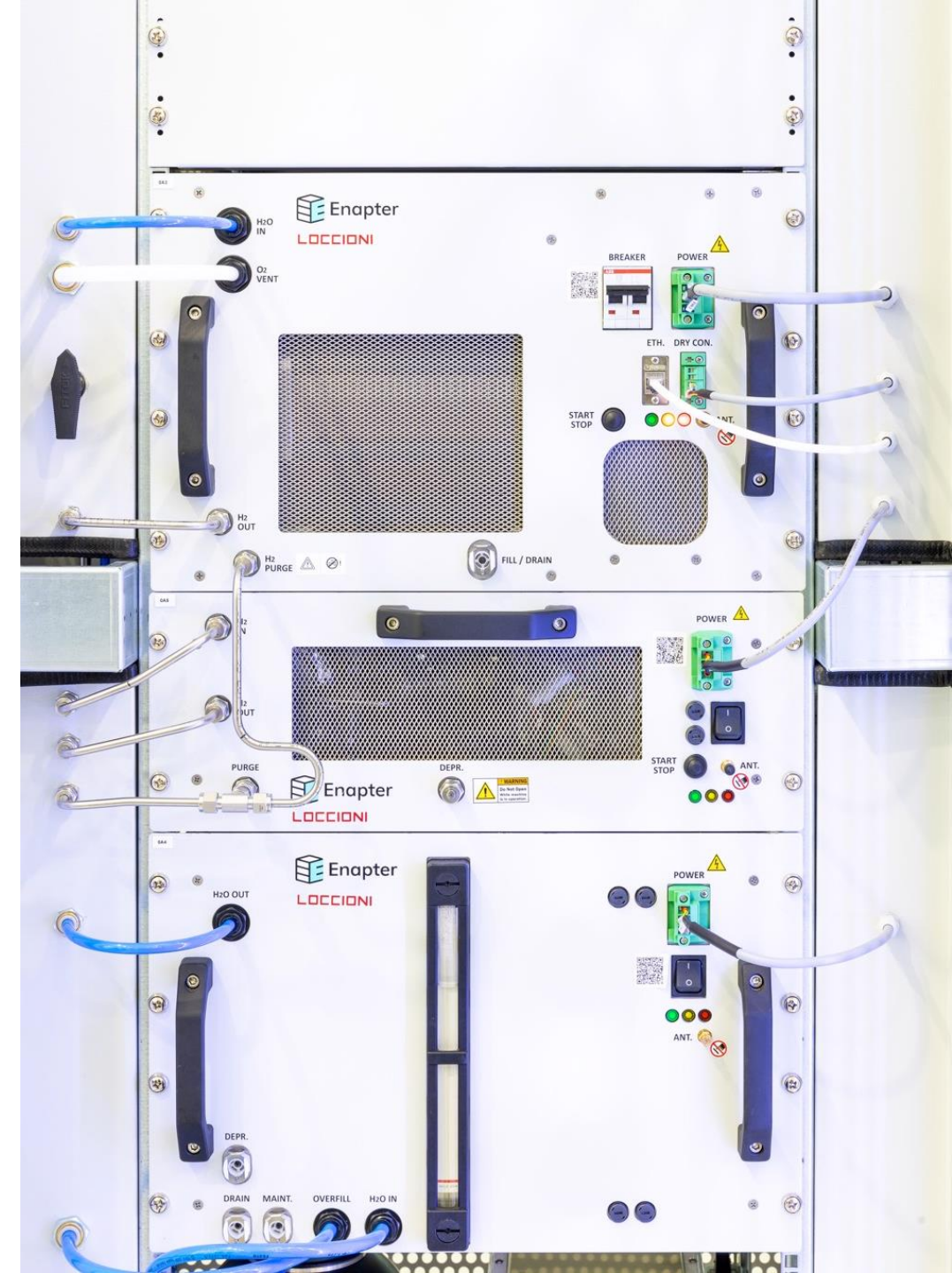


Power-to-X

Green H₂ production for Edison R&D

Europe's oldest energy company, Edison from Milan uses this installation to produce green hydrogen for R&D purposes. It includes a cabinet featuring one AEM Electrolyser, a Dryer, and a water tank module.

- ≡ Loccioni is an engineering specialist with decades of experience in transportation, energy, manufacturing, and health.
- ≡ The company is valued worldwide not only for its technical expertise, but also for its focus on peoples' wellbeing and aesthetics.
- ≡ With Loccioni, we're able to offer our scalable AEM Electrolysers in a variety of modular solutions from kW-MW.



Power-to-X

Ammonia Production

Starfire Energy is developing modular systems to produce carbon-free Ammonia (NH₃) ([read more here](#))

- ≡ Ammonia has a high energy density and stores and transports cheaply using well-developed technologies, codes, and standards
- ≡ 10 kg/day is first of several iterations, the goal for them is to have a modular NH₃ system with a production capacity of 50 tonnes/day
- ≡ Modular systems reduce business risk for the customer, which is 100% in line with Enapter's approach



Transport

Refueling planes

- ≡ Airports can become hydrogen production hubs. Instead of using the polluting supply chain of fossil fuels, a clean fuel can be made on site.
- ≡ A hydrogen electric plane uses a fuel cell and battery combination to fly emitting no CO₂.



Hydrogen Refuelling

Refuelling solutions

JA-Gastechnology GmbH (JAG) has developed a multi-function hydrogen refuelling system

- ≡ 30 AEM electrolyzers with gas dryers and gas compression to achieve 90 kW of electrolysis
- ≡ Integrated 350bar compressor unit allows efficient storage and direct refuelling of fleets with 350bar requirements such as forklifts
- ≡ Using the compact, modular AEM Electrolyzers will allow users to start small for testing purposes and then scale up with stackable modules as needed.



Transport

Fueling innovation

Protium Green Solutions ordered the largest AEM Electrolyser setup in the UK.

- ≡ The 100-kW container produces green hydrogen for testing air and road mobility applications at an innovation center. Any excess hydrogen from the 40 electrolyzers is used for energy storage.
- ≡ Fuel Cell Systems (UK) integrated the liquid cooled electrolyzers into the 20 ft container. They also use a hybrid energy monitoring system including Enapter's EMS toolkit.



Electricity storage

Lavo Hydrogen Battery

Lavo develops next generation green energy metal-hydride hydrogen storage.

- ≡ It's the world's first integrated hybrid hydrogen battery that combines with rooftop solar to deliver sustainable, reliable and renewable green energy to homes and businesses.
- ≡ Developed in partnership with UNSW, Sydney, Australia and Design + Industry, LAVO™ is a hydrogen hybrid battery that stores over 40kWh of electricity – enough to power the average Australian home for 2 days.
- ≡ Enapter provides the fitted AEM electrolyser. Together with Lavo, we work at the same speed and ambition to make a real dent in climate change.



Onsite Refuelling

H2 Mobility Solutions: Cars

- ≡ Another H2 refueling station with on-site production of hydrogen by two units of Enapter's AEM electrolyser EL 2.1 was recently commissioned in the "Milford Haven: Energy Kingdom" project in Wales (UK)
- ≡ Objectives of this projects are to provide an example and roadmap to decarbonization using decentrally produced green hydrogen, stimulate local growth and investment as well as education and job creation



Electricity storage

Phi Suea House

The Phi Suea House (Home of the Butterflies) is the world's first solar-hydrogen multi-house:

- ≡ Off-grid since 2015 in Thailand, it is a showcase for sustainable living
- ≡ Sunshine and rain cover all energy and water needs on the premises, facilitated by Enapter electrolyzers.
- ≡ Selected as a “Hydrogen Valley” on the Mission Innovation Platform. It is one of the world's most advanced H2 projects and is the only one in Southeast Asia.



Electricity storage

Peak Shaving with Hydrogen

Delta Green is the first energy-independent office building in France, with energy production exceeding user consumption.

- ≡ The aim of Delta Green is to showcase energy autonomy.
- ≡ The energy mix is made up of PV, geothermal and H₂ storage; with PowiDian integrating the hydrogen solution. Instead of using batteries, the tertiary building uses two Enapter electrolyzers to store hydrogen for peak shaving.
- ≡ The commercial benefit is that hydrogen is converted into electricity to fulfil demand and avoid demand spikes that would result in a higher electricity tariff



Power to heat

H2 Heating Solutions

In June 2019, the first hydrogen project for residential heating was officially opened in Rozenburg near Rotterdam in the Netherlands, planned by DNVGL.

- ≡ Enapter deployed 8 AEM electrolyzers, showcasing their unique modularity and flexibility.
- ≡ The produced hydrogen is safely transported to central boilers heating 25 apartments. 3 different hydrogen boilers are being tested in the setup.
- ≡ Since gas production in the Netherlands (Groningen) is winding down, the country has ambitious hydrogen plans to replace natural gas.



Power to Gas

Renewable methane

In Australia, green hydrogen is upgraded via a methanation process.

- ≡ The advantage: methane gas can easily be transported via the existing gas infrastructure.
- ≡ Power fuels are the missing link to bring green and environmentally sourced electricity to the heating, transport and industry sectors.
- ≡ In Queensland, solar electricity powers an Enapter electrolyser to generate hydrogen. The hydrogen is combined with carbon dioxide extracted directly from the air to create renewable methane.
- ≡ Southern Green Gas announced in May 2020 their scaling plans to produce 620kg of green hydrogen to be methanated and injected into existing methane pipelines.



Research

Biocatalytic Power-to-Methane

- ≡ Electricity from solar energy is converted into hydrogen by electrolysis.
- ≡ Hydrogen is then converted into natural gas by biocatalysis using carbon dioxide.
- ≡ The produced methane can be stored in the existing infrastructure.
- ≡ Carbon dioxide is produced during alcoholic fermentation, for example in the production of spirits or beer, but also in the production of bioethanol, which is added to the fuel.

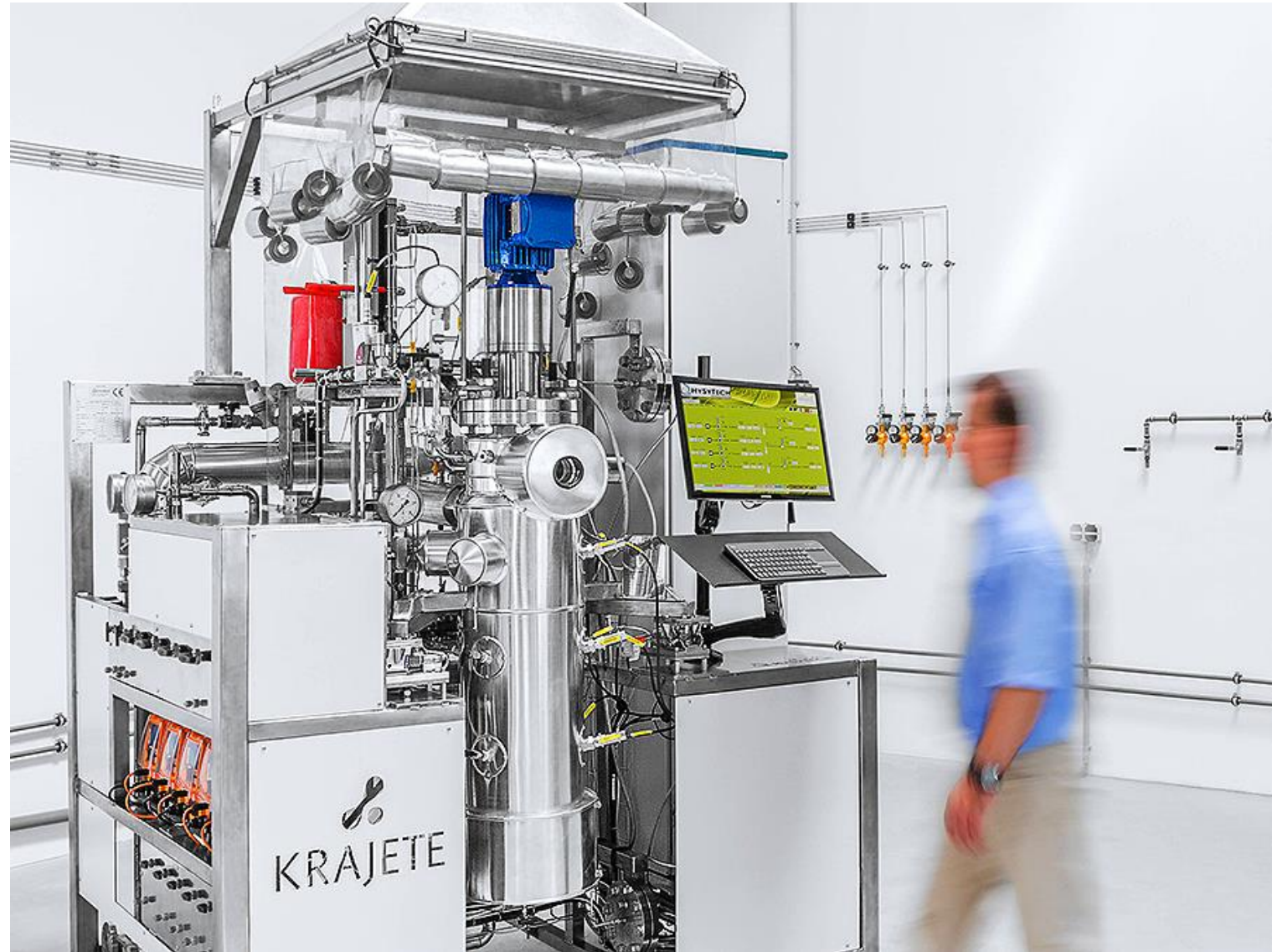


Power to Gas

CO₂ & green H₂ biomethanation

Krajete GmbH uses archaea microorganisms to catalyse the conversion of green H₂ and CO₂ into green methane for many applications. The Austrian company is now developing a biomethanation system that can function independent of grids, using 100% renewable energy to generate green hydrogen with AEM Electrolysers and sourcing CO₂ with carbon capture technology or by directly upgrading biogas.

- ≡ High purity methane used for methane mobility
- ≡ Strong CO₂ reductions compared to fossil fuel use
- ≡ Potential for use in villages, communities and stand-alone houses enabling energy storage and low-emission heating



Smart.
Simple.
Scalable.



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