APPLICATION GUIDE

# Protection solutions for Green Hydrogen production

Green hydrogen is pivotal in reaching the world's decarbonization objectives. Now is the time to establish a secure system to guarantee safe production, storage, and transportation of $H_2$.

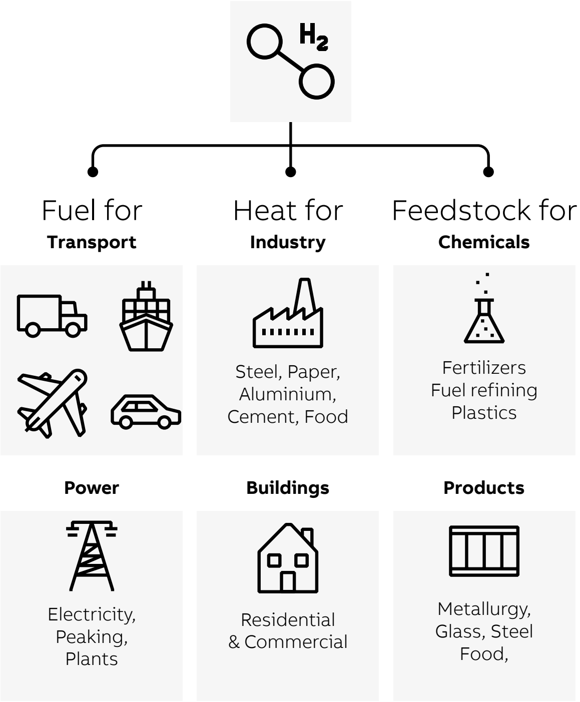
## What is green hydrogen?

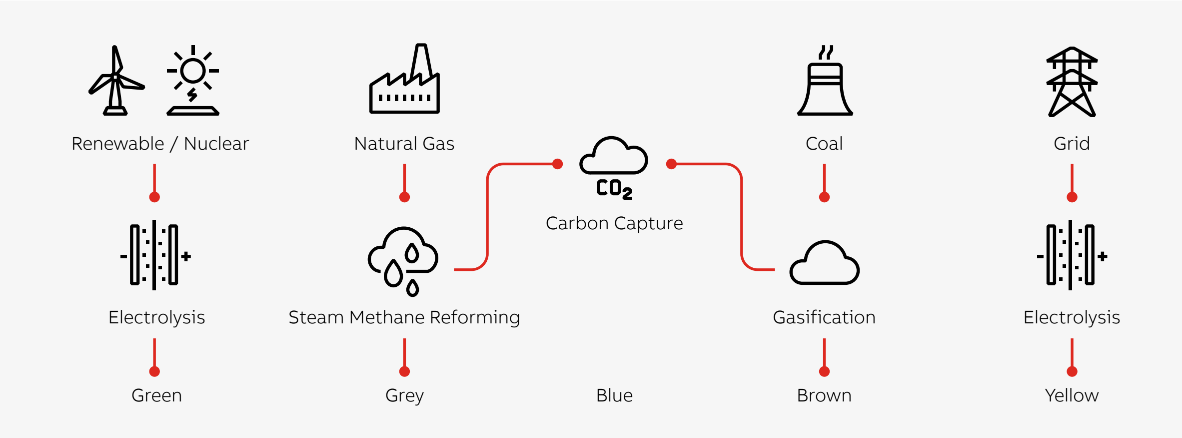
Hydrogen is the most prevalent element on Earth and across the universe, forming the primary composition of stars.

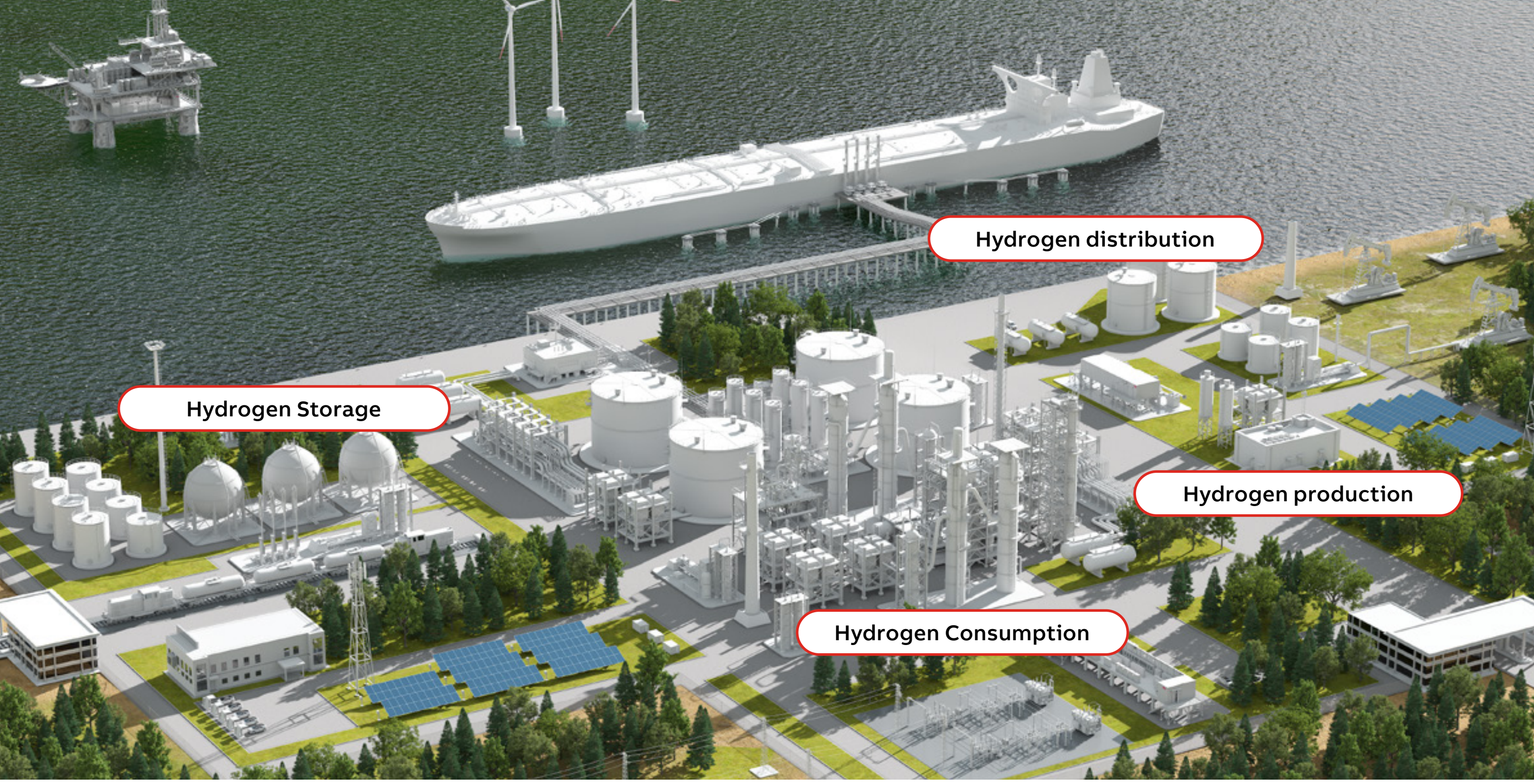
On Earth, hydrogen exists combined with oxygen in water or with carbon, constituting hydrocarbons like methane, a key component of natural gas.

When combusted, hydrogen produces no $CO_2$, only water vapor. However, obtaining hydrogen necessitates substantial electrical energy for powering either the electrolysis process – extracting hydrogen from water – or the reforming process, which retrieves hydrogen from hydrocarbons, yielding what is known as 'gray $H_2$'.

'Green hydrogen' refers to hydrogen obtained through electrolysis, employing electricity derived from renewable energy sources.







# ABB participates throughout the hydrogen ecosystem

**ABB Portfolio for the Hydrogen Ecosystem**

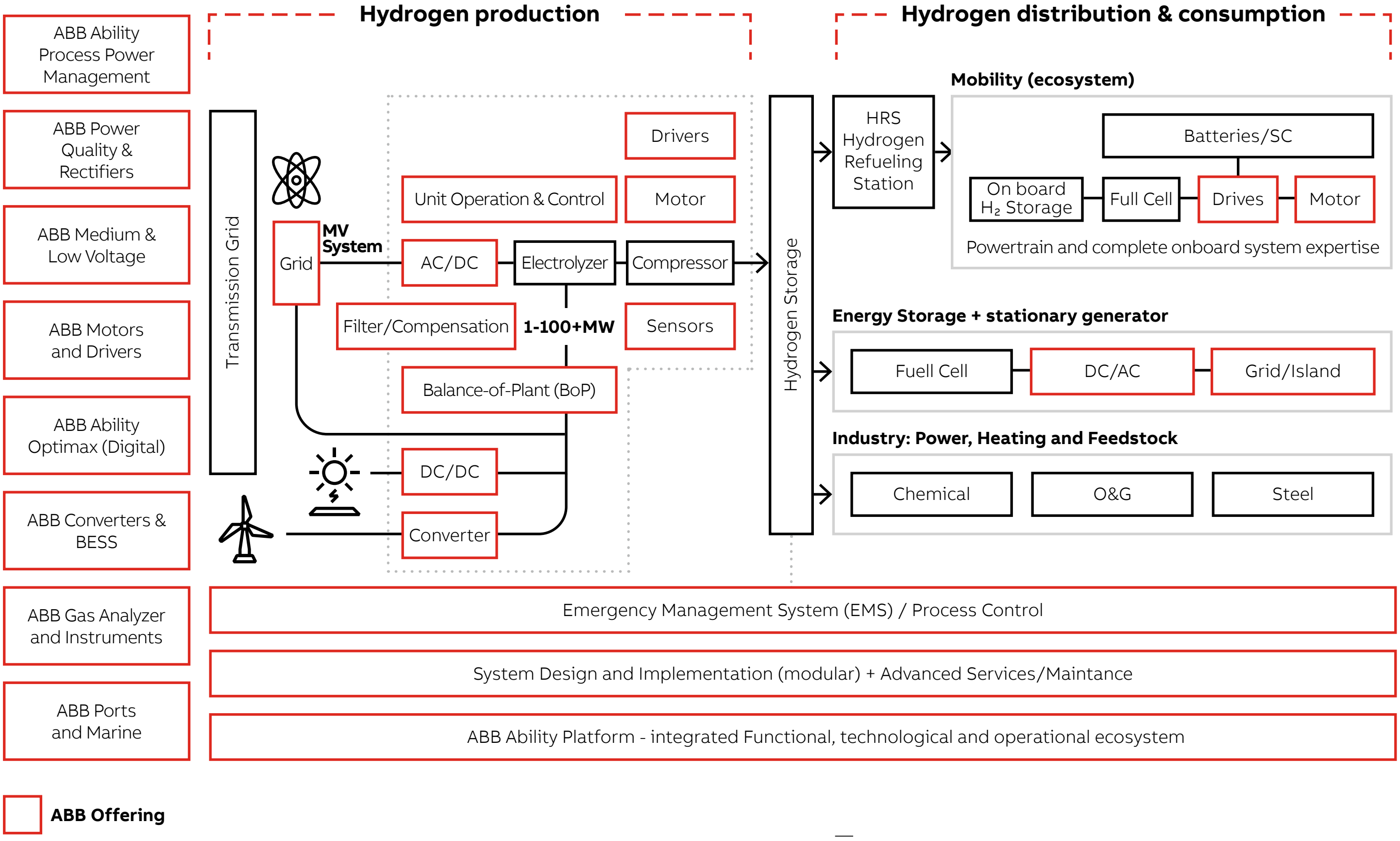
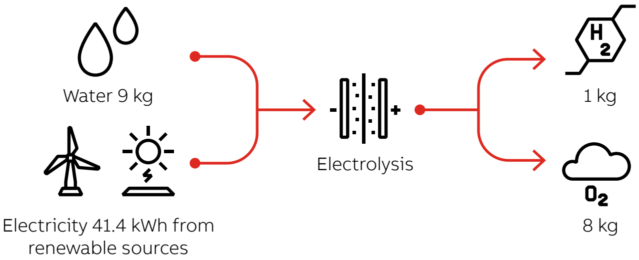


ABB IS PRESENT THROUGHOUT THE HYDROGEN ECOSYSTEM, WITH SOLUTIONS FOR HYDROGEN PRODUCTION, HYDROGEN STORAGE, AND HYDROGEN DISTRIBUTION AND CONSUMPTION. IN THIS DOCUMENT, WE WILL FOCUS ON HYDROGEN PRODUCTION.

## Main concerns and problems related with $H_2$

- Production and use is very energy inefficient,
- $H_2$ is light but requires more space for storage to offer similar energy capacity,
- Transport of $H_2$ is harder than transporting natural gas,
- $H_2$ cannot simply be stored and transported with existing infrastructure,
- High water usage,
- Danger of explosion.



Producing hydrogen from electricity and converting it back to energy incurs high energy losses. Nowadays, direct electrification is cheaper than $H_2$ in many instances.

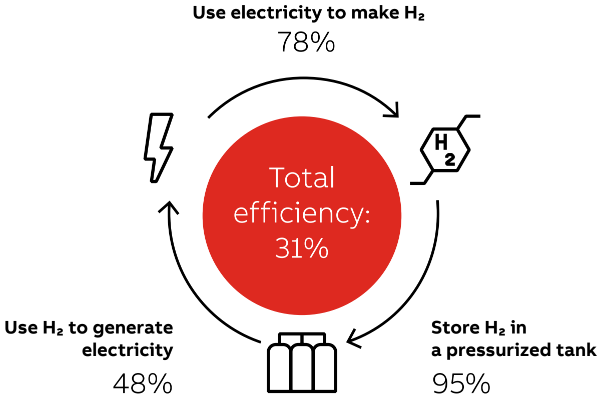
To make 1 kg of $H_2$ via electrolysis, normally 9 kg of water are required and, depending on electrolyzer type, efficiency and lifetime, around 50 kWh of electricity. That kg of $H_2$ contains 39.4 kWh of energy. That means 78% of efficiency.

Storing hydrogen in a tank requires energy for compressing the gas. At 500 bar pressure, the energy equivalent losses are around 5%. So, 95% of efficiency.

Finally, generating electricity from $H_2$ in an open cycle gas turbine has an efficiency close to 48%.

Then, the total efficiency of a hydrogen-fueled power plant is:

$$48\% \times 95\% \times 78\% = 35\%$$



One kilogram of hydrogen contains 3.1 times the energy of one kg of gasoline and 2.6 times the energy of 1 kg of natural gas.

Making $H_2$ from electricity does not guarantee low emissions. Electrolyzers supplied from an average grid can generate more $CO_2$ per kg of $H_2$ produced than gray hydrogen. Blue $H_2$, obtained from reforming process with carbon capture and storage, may emit less $CO_2$ than grid connected electrolysis. Only electrolyzers, powered by renewable energy, produce $H_2$ without emitting $CO_2$.

## What's an Electrolyzer?

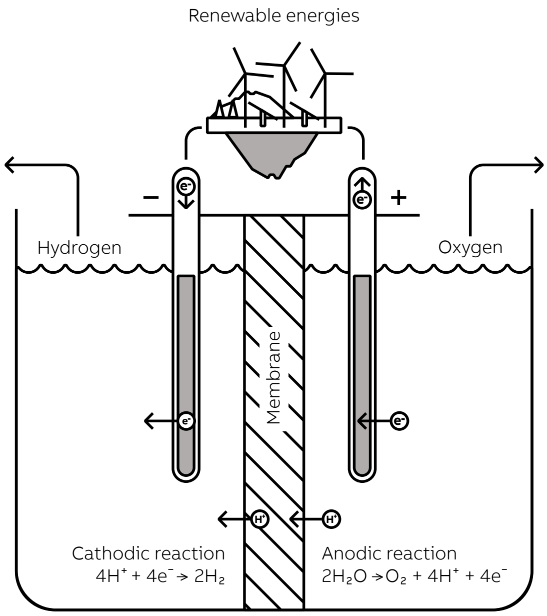
An electrolyzer is a device that produces hydrogen through a chemical process, namely electrolysis, which separates the hydrogen and oxygen molecules in water using electricity.

The electrolyzer comprises a conductive electrode stack separated by a membrane. A high voltage and current are applied to this assembly, generating an electric current in the water and subsequently breaking it down into its constituent components: hydrogen and oxygen.

From a thermodynamic perspective, the electrolysis process attains greater electronic efficiency at higher temperatures.

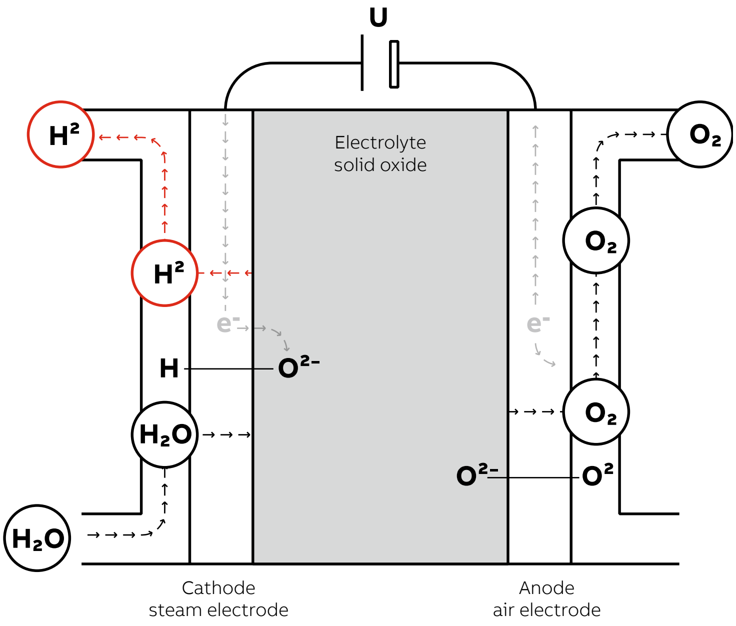
## Types of electrolyzers

**AEL process**



- **Alkaline or AEL**
  This type of electrolyzer uses a liquid electrolyte solution, typically potassium hydroxide (KOH), in water. Hydrogen is generated within a cell that includes an anode, a cathode, and a membrane. The cells are commonly assembled in series to produce more $H_2$ – this assembly is referred to as a 'stack'.
- **Acidic or PEM**
  PEM electrolyzers utilize a Proton Exchange Membrane, a solid polymer electrolyte, and pure water. When a current is applied, water separates into hydrogen and oxygen. Hydrogen protons pass through the membrane, forming $H_2$ gas on the cathode side. This process necessitates the use of expensive metals, such as platinum, titanium, or iridium, for catalyst layers.
- **SOEC or HTE**
  The Solid Oxide Electrolysis Cell operates at temperatures below 1,000 °C and is therefore also known as High Temperature Electrolysis. It uses a solid ceramic material as an electrolyte.
- **AEM**
  The Anion Exchange Membrane is in its early development stages and is an evolution of AEL, using a lower alkaline electrolyte concentration, and it does not require noble metals in the cells.

### SOEC process:



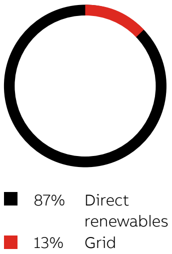
| Type | Op. temp. [°C] | Op. press. [Bar] | Cathode Gas | Anode Gas | Cost |
|---|---|---|---|---|---|
| Alkaline (AEL) | 15–220 | <30 | $H_2$<br>$H_2O$ | $O_2$<br>$H_2O$ | Lowest |
| Acidic (PEM) | 40–80 | <30 | $H_2$ | $O_2$<br>$H_2O$ | High |
| Solid Oxide | 500–1,000 | <10 | $H_2$<br>$H_2O$ | $O_2$ | Not commercial |

## Race to 2030:

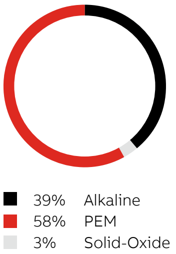
When examining future project scenarios, alkaline electrolyzers have been chosen for all projects that are connected to and powered by the grid. In contrast, PEM electrolyzers potentially offer cost benefits when directly connected to distributed intermittent renewable energy sources. Approximately 60% of the announced projects operating with a direct connection to renewables (either installed onsite or offsite via physical PPAs) have chosen PEM electrolyzers, while about 40% have selected alkaline ones.

Alkaline electrolyzers are slated for deployment with an average project size nearly twice as large (~120 MW), whereas PEM electrolyzers seem more distributed, with an average project size of approximately 70 MW.

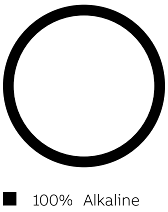
**Power source of projects planned between 2020-2030**



**Technology split of projects directly powered by renewables**

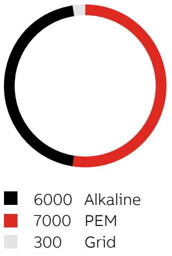


**Technology split of grid-connected projects**

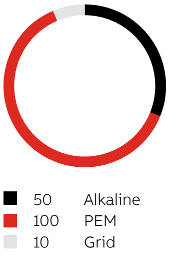


### 2030 electrolyzer project pipeline by technology

**Planned capacity 2020-2030 (MW) by technology**



**Number of projects 2020-2030 by technology**



## Levelized Cost of Hydrogen (LCOH)

The 3 major factors affecting LCOH are:

- CAPEX
- Electricity cost (LCOE)
- Utilization rate or capacity factor

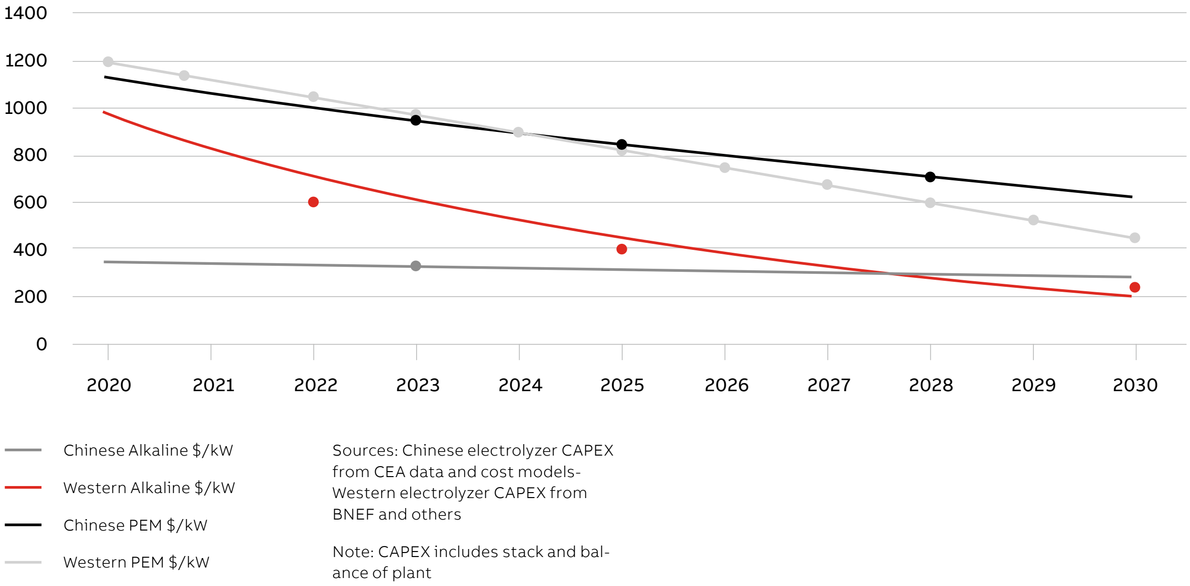
If an electrolyzer has a high scale of utilization, the Capital Expenditure (CAPEX) plays a less significant role. However, the capex becomes a crucial factor in medium and low utilization ranges, which are common when powered by renewable sources.

Currently, electricity costs account for more than 60% of the Levelized Cost of Hydrogen (LCOH) share in Alkaline Electrolyzer (AEL) systems and more than 40% in Proton Exchange Membrane (PEM) systems.

The scale effect demonstrates a decreasing trend for both Capital Expenditures (CAPEX) and Operations & Maintenance items. Approximately a 10% LCOH reduction is achieved by scaling an Alkaline system from 5 MW to 100 MW.

For a 5 MW PEM system, the LCOH over a 25-year lifespan is nearly 30% higher than that of an Alkaline system, due to the high CAPEX of the PEM system.

**Electrolyze System CAPEX Forecast**



Sources: Chinese electrolyzer CAPEX from CEA data and cost models- Western electrolyzer CAPEX from BNEF and others

Note: CAPEX includes stack and balance of plant

## Other elements of $H_2$ production:

**Transformer & Rectifier**
These convert the AC voltage supply into the DC current input at the necessary voltage.

**Electrolyte System**
This is the recirculation system for the electrolyte solution. The gas separators recover a part of the electrolyte, which is then chilled, filtered, and recycled into the electrolyzer.

**Gas Holder**
This serves as a buffer tank between the electrolyzer and the compression system.

**Gas/Water Separator**
This removes residual traces of the electrolyte.

**Deoxidizer**
The hydrogen from the electrolyzer is a very pure gas saturated with water. This component removes the last molecules of oxygen – less than 0.2% – through a catalytic reaction.

**Dryer**
This system dries the gas to achieve the appropriate dew point. Typically, it comprises twin towers filled with regenerative desiccant to absorb water.

**Compressor**
This is used to compress the gas from atmospheric pressure to the pressure necessary for the process or the storage/transport system (ranging from 80 to 900 bars).

The comprehensive system also includes filters – purer water enhances the performance of existing membranes – pumps & motors, heating and refrigeration systems, as well as instruments for measuring pressure, liquid level, gas content, temperature, and humidity. Finally, it incorporates storage tanks for oxygen (which could also be released into the atmosphere) and hydrogen.

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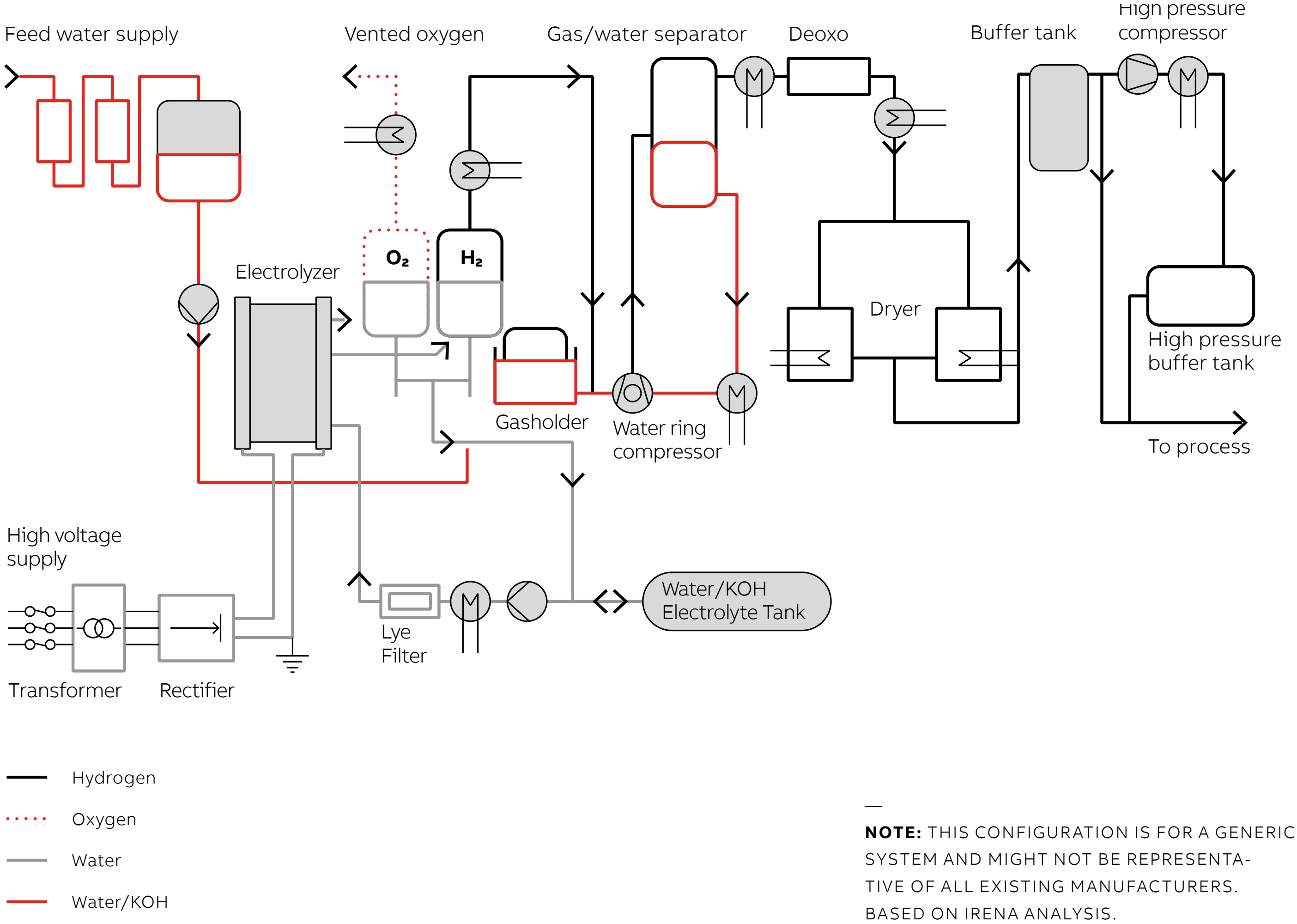
**Layout for an alkaline electrolyzer plant**



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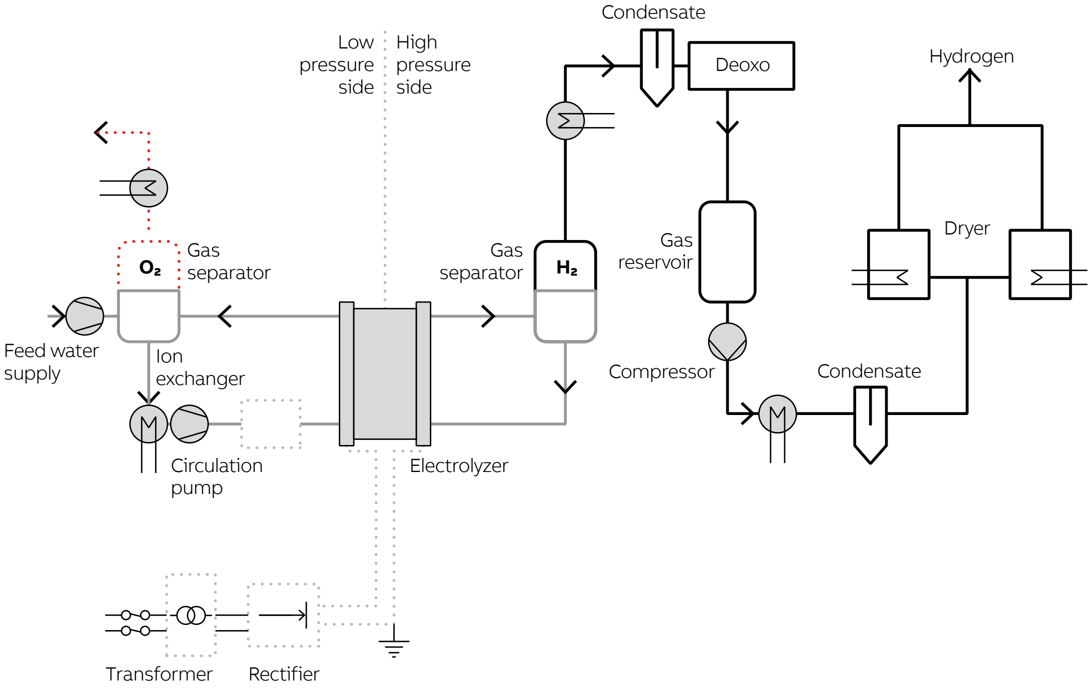
**NOTE:** THIS CONFIGURATION IS FOR A GENERIC SYSTEM AND MIGHT NOT BE REPRESENTATIVE OF ALL EXISTING MANUFACTURERS. BASED ON IRENA ANALYSIS.

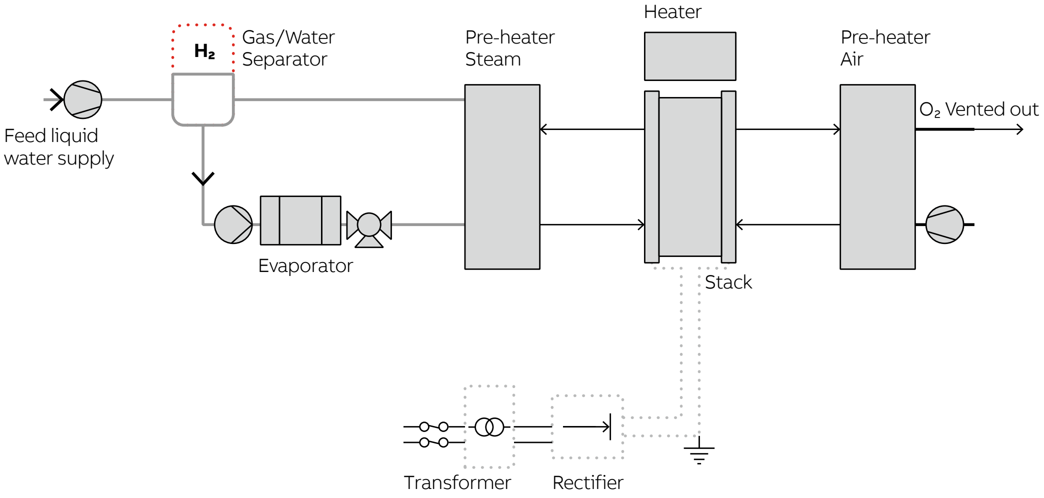
## Layout for a PEM electrolyzer plant



— Hydrogen
···· Oxygen
— Water

**NOTE:** THIS CONFIGURATION IS FOR A GENERIC SYSTEM AND MIGHT NOT BE REPRESENTATIVE OF ALL EXISTING MANUFACTURERS. BASED ON IRENA ANALYSIS.

## Layout for a SOEC electrolyzer plant



— Hydrogen
···· Oxygen
— Water

**NOTE:** THIS CONFIGURATION IS FOR A GENERIC SYSTEM AND MIGHT NOT BE REPRESENTATIVE OF ALL EXISTING MANUFACTURERS. BASED ON IRENA ANALYSIS.

## Different solutions – different production scales:

Commercially, PEM electrolyzers are available with hydrogen production capacities ranging from 0.27 to 1.05 Nm$^3$/h – suitable for replacing pressurized hydrogen cylinders – to 10, 30, and even up to 30 Nm$^3$/h.

Medium-sized units fall within the range of 100 to 800 Nm$^3$, and large-scale plants with PEM electrolyzers can generate up to 5,000 Nm$^3$/h. Alkaline electrolyzers, on the other hand, can range from 50 to 19,400 Nm$^3$/h.

But what is Nm$^3$? A normal cubic meter (Nm$^3$) refers to the amount of gas that fits into the volume of one cubic meter at a temperature of 0 °C and one atmospheric pressure (1 bar). Keep in mind: 1 kg of $H_2$ is equal to 11.12 Nm$^3$.

Typically, the DC energy consumption for 1 Nm$^3$ of $H_2$ is around 4–6 kWh. Therefore, a 4,000 Nm$^3$/h plant is capable of producing 360 kg of $H_2$ per hour while consuming 20 MWh.

Here are some examples of commercial configurations:

- Alkaline Electrolyzer (AEL):
- 15 Nm$^3$/h with 1 stack, energy consumption of 5.4 kWh/Nm$^3$, and a power rating of 80 kW.
- 100 Nm$^3$/h with 6 stacks, energy consumption of 5 kWh/Nm$^3$, and a power rating of 500 kW.
- Proton Exchange Membrane (PEM):
- 300 Nm$^3$/h with 1 stack, energy consumption of 5 kWh/Nm$^3$, and a power rating of 1.5 MW.
- 5,000 Nm$^3$/h with 10 stacks, energy consumption of 5 kWh/Nm$^3$, and a power rating of 25 MW.

| | AEL | PEM | SOEC | AEM |
|---|---|---|---|---|
| Nominal current density | 0.2–0.8 A/cm$^2$ | 1–2 A/cm$^2$ | 0.3–1.0 A/cm$^2$ | 0.2–2.0 A/cm$^2$ |
| Voltage range | 1.4–3.0 V | 1.4–2.5 V | 1.0–1.5 V | 1.4–2.0 V |
| Operating temperature | 15–220 °C | 50–80 °C | 500–1,000 °C | 40–60 °C |
| Load range | 15–100% | 5–120% | 30–125% | 5–100% |
| $H_2$ purity | 99.9–99.9998% | 99.9–99.9999% | 99.9% | 99.9–99.999% |
| Voltage efficiency | 50–68% | 50–68% | 75–85% | 52–67% |
| Electrical efficiency (stack) | 47–66 kWh/kg $H_2$ | 47–66 kWh/kg $H_2$ | 35–50 kWh/kg $H_2$ | 51.5–66 kWh/kg $H_2$ |
| Lifetime (stack) | 60,000 hours | 50,000–80,000 hours | <20,000 hours | 5,000 hours + |
| Stack unit size | 1 MW | 1 MW | 5 kW | 2.5 kW |
| Electrode area | 10,000–30,000 cm$^2$ | 1,500 cm$^2$ | 200 cm$^2$ | <300 cm$^2$ |

State of the art and key KPIs for all electrolyzer technologies
Source. IRENA. Green Hydrogen Cost Reduction. 2020

## Balance of Plant. Power supply

To convert AC to DC, thyristor-based rectifiers are typically employed. These rectifiers operate at DC voltage levels of several hundred volts, providing sufficient current for the stacks.

The degradation of electrolysis cells results in a higher cell voltage and increased operation hours. Consequently, the stack voltage needs to be augmented to produce the same amount of hydrogen with degraded cells. Therefore, rectifiers should be chosen taking into account the stack's minimum voltage (at the start of life) and maximum voltage (at the end of life).

To mitigate the effects of the converters' reactive power, filter circuits are incorporated into the system. Additionally, the power grid needs to be stable enough to endure the reactive power, potentially necessitating the installation of compensation systems such as Static Synchronous Compensators (STATCOMs).

Electrolysis plants with sizes below 100 MW typically connect to the medium-voltage grid (20–30 kV). A 100 MW plant would connect to the high-voltage grid (110 kV), and large-scale plants up to 1 GW would connect to the grid at 230–380 kV.

But rectifiers are supplied with low voltage (around 400 V) So, low voltage transformers are also required.

Rectifiers are typically connected to the stack, which is a series of electrolysis cells commonly connected in series.

The voltage and current vary depending on the number of cells in the stack design.

For splitting liquid water, a voltage of 1.48 volts is required. This is the voltage at which an electrolysis cell operating at 25 °C can function without producing excess heat. However, commercial cells operate above this voltage and generate excess heat; in fact, the actual cell voltage is typically around 1.8 V.

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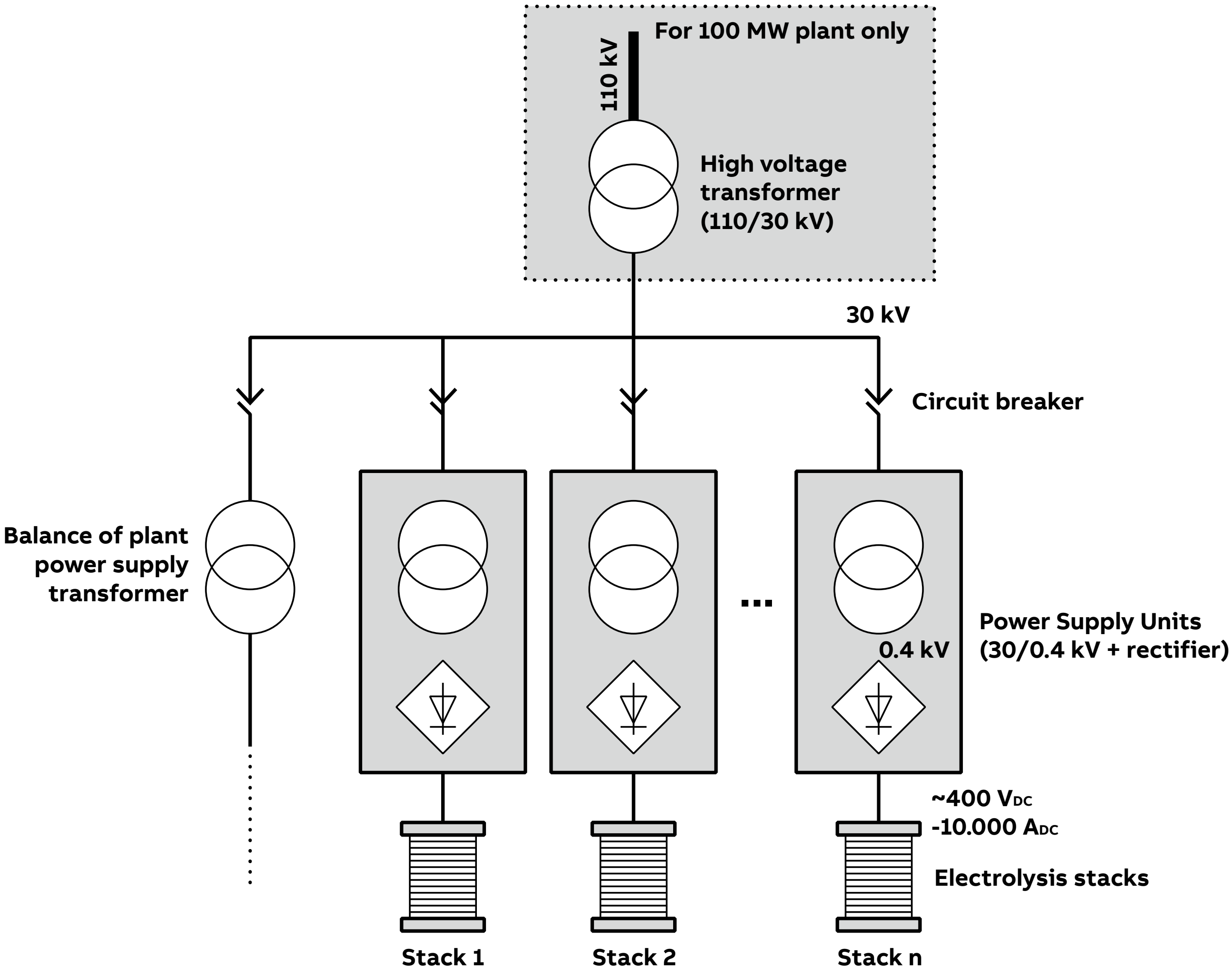
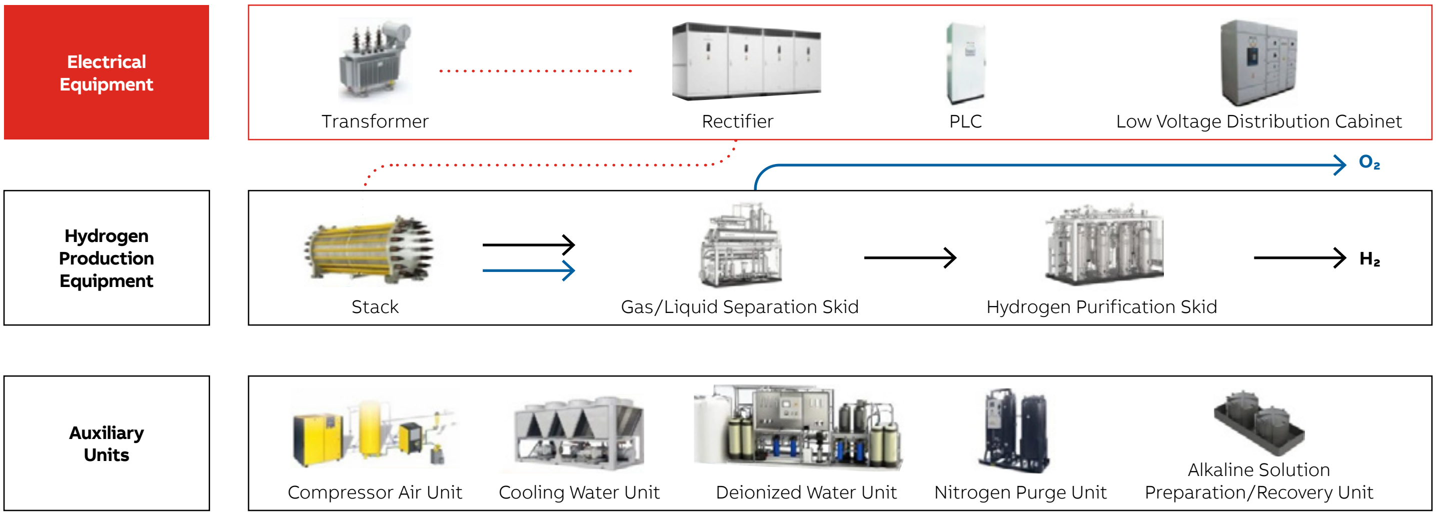
**Power supply for a system with several electrolysis stacks; adapted from Energiepark Mainz**





Source: Clean Energy Associates
PLC to control the system.
Low voltage distribution cabinet, to protect and supply energy to BoP Systems (auxiliary units)

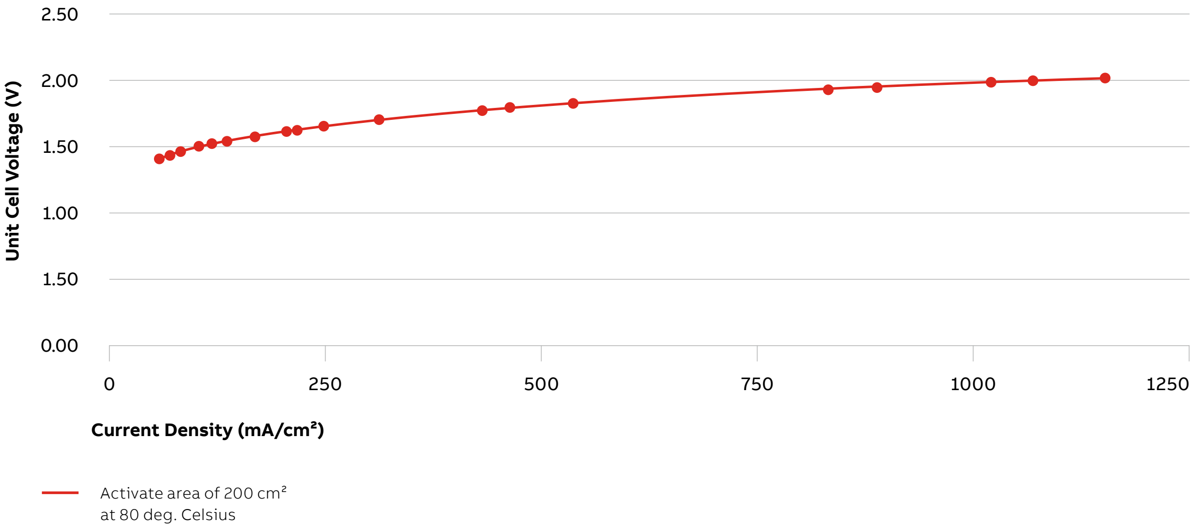
The number of cells in today's Proton Exchange Membrane (PEM) stacks ranges between 30–220, each with an active area of up to 1,500 $cm^2$. Most PEM electrolysis stacks feature a rectangular-shaped cell design and operate at temperatures of 55 to 70 °C with current densities roughly varying between 1.4–2.5 $A/cm^2$.

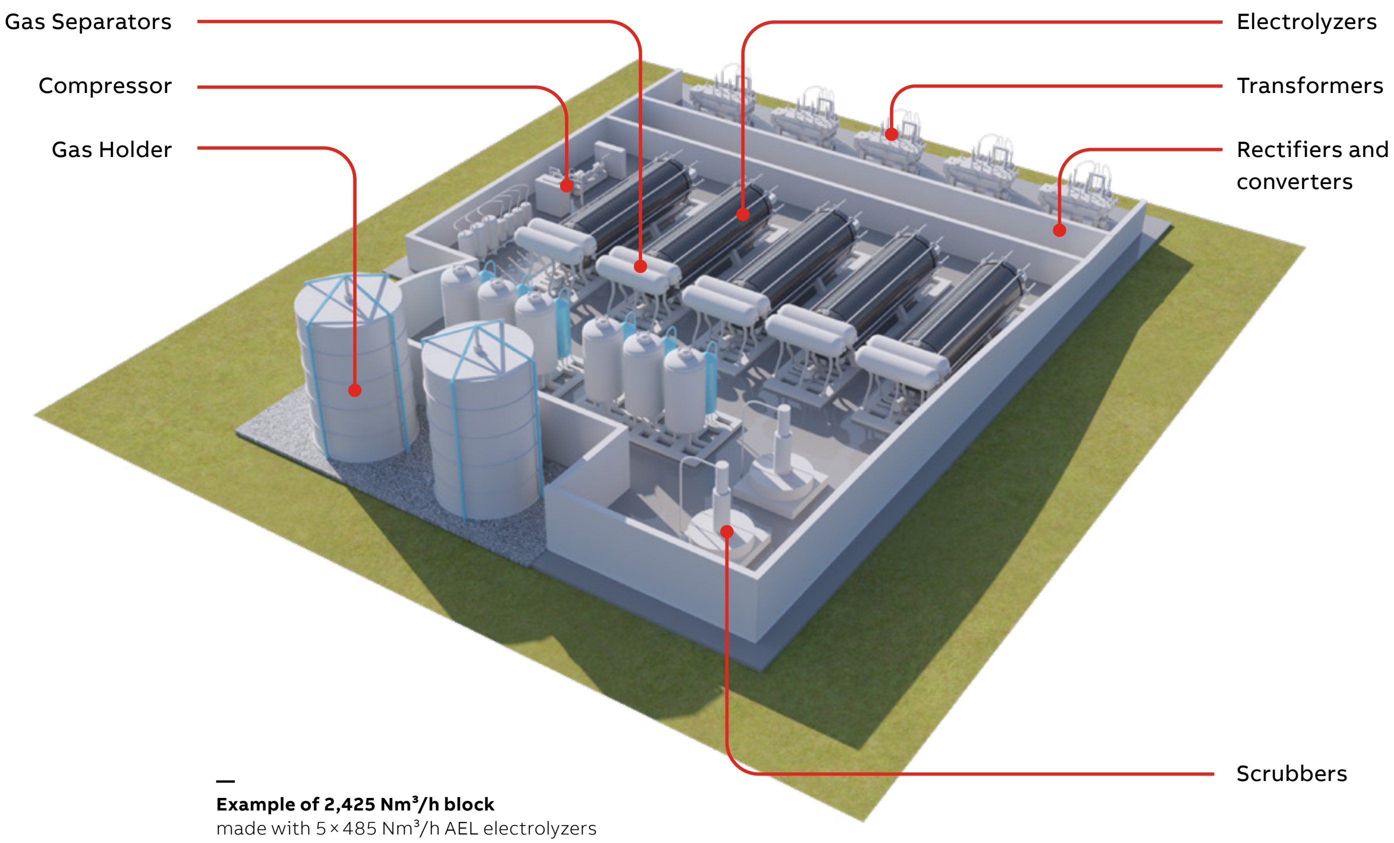
Therefore, depending on the stack configuration, PEM stacks could require from 50 V to 400 V and up to 3,800 A. For instance, a commercial PEM electrolyzer, with an active area of 290 $cm^2$ and a stack composed of 60 cells, provides 10 $Nm^3/h$ at 46 kWe.

Given that 290 $cm^2 \times 1.5\ A/cm^2 = 435$ A and 60 cells × 1.8 V/cell = 108 V, the resulting power would be 435 A × 108 V = 46.9 kW.

In AEL stacks, the current density is much lower, in the range of 0.2 to 0.8 $A/cm^2$ and 1.8 V per cell, and the active area is in the range of 10,000 to 30,000 $cm^2$.

Here an exemplary performance for a single AEL cell:





**Example of 2,425 Nm$^3$/h block**
made with 5 × 485 Nm$^3$/h AEL electrolyzers

Here is an example with a commercial AEL system, capable of delivering hydrogen and oxygen with one stack. This product has a stack current around 5,000 A, and stack voltage around 450 V DC.

485 Nm$^3$/h – 4.4 kWh/Nm$^3$ – 2.1 MW

An ABB DCS880 Thyristor converter, rated at 5,200 ADC and 500 VDC, could be utilized as a converter. To protect the converter and input cables, fuses such as the switch fuse OS are necessary.

Additionally, a network analyzer like M4M is required to measure consumption. Circuit breakers like the S800 are needed to provide protection in case of overload and short circuits.

Manual motor starters, such as the MS132, and contactors like the AF series, are required for the motor starting of internal fans. Auxiliary relays are also necessary to manage control signals.

To guard against ground faults, a Type B Residual Current Device (RCD) is required. Surge Protection Devices (SPDs) are also necessary to shield against transient surges.

## Different products are available to protect the installation of the converter or the rectifier.

Some key products are:

### Emax 2 switch disconnector

SACE Emax 2 MS/DC-E is the new Air Switch-disconnector at 1,500 V DC, available with IEC, UL and CCC approvals with short-time withstand current (Icw) up to 100 kA.

| **System Voltage** | **up to 1,500 V DC** |
|---|---|
| Current ratings | 4,000 A |

### OS Manual operated switch fuses

World-class performance in demanding applications. Our OS range includes manual operated switch fuses from 20 to 1,250 Amperes, available for all types of fuses: DIN, BS, NFC, CC, JJ and L types.

| **System Voltage** | **up to 1,000 V DC** |
|---|---|
| Current ratings | up to 20–1,250 A range |

### Switch disconnector for DC side isolation

The S800PV-SD provides isolation protection up to 125 A and 1,500 V DC with Icw = 1.5 kA in accordance with IEC 60947-3 and Annex D. With highly compact design for installation on the DIN rail, the S800PV-SD switch disconnector offers safety relevant isolation properties.

| **System Voltage** | **up to 1,500 V DC** |
|---|---|
| Current ratings | up to 125 A |

### S200 M UC range

ABB's universal current MCB for DC and AC applications.

The S200 M UC range of miniature circuit-breakers features permanent magnets on the internal arcing chutes able to extinguish an electric arc of up to 500 V DC with Icu = 4.5 kA, thus ensuring flexible control of both direct and alternating currents. Ideal for industry application because of the high breaking capacity of 10 kA.

| **System Voltage** | **up to 500 V DC** |
|---|---|
| Current ratings | up to 63 A |

### F200 B Type

Built to make the difference. The F200 Type B are universal current sensitive residual current circuit breakers RCCBs designed for industrial applications where there is an increasing use of devices like frequency converters, and UPS systems. The RCCB Type B protect faults occurred due to smooth DC residual currents or currents with low residual ripple which are common in the above applications.

| **System Voltage** | **up to 440 V AC** |
|---|---|
| Current ratings | up to 125 A |

### SACE Tmax T

The SACE Tmax range of switch-disconnectors offers an increasingly comprehensive, leading-edge solution that anticipates the market trends.

| **System Voltage** | **up to 1,500 V DC** |
|---|---|
| Current ratings | 1,600 A |

### Tmax XT Breaker based switch disconnectors

A based switch-disconnectors allows remote trip, remote operations and a full offers of accessories.

| **System Voltage** | **up to 750 V DC** |
|---|---|
| Current ratings | up to 1600 A |

### Surge Protective Devices OVR PV QS

Combined Type 1 and Type 2 SPD can guarantee an overvoltage reduction to protect end equipment, up to 1,500 V DC.

| **System Voltage** | **up to 1,500 V DC** |
|---|---|

In this example, an engineering team has calculated the design for a hydrogen production plant using Alkaline Electrolysis (AEL) electrolyzers.

In total, there are 416 AEL stacks, each one comprising 258 cells. The cells are connected in series electrically and the fluids run in parallel.

In this case, the cell voltage is 1.75 V, the current density is 0.175 A/$cm^2$, and the active cell area is 29,077 $cm^2$. Therefore, the stack voltage is 258 × 1.75 = 452 V, and the stack current is 29,077 × 0.175 = 5,088 A, which gives a stack power of 5,088 × 452 = 2.3 MW.

The goal is to develop a plant of 1 GW, or close to that value, with an optimized layout. Given a security factor of 20% (considering voltage variations due to the grid and the min-max voltage of cells during lifespan), the High Voltage (HV) Transformer could be 230 kV.

So, 230 ÷ 1.2 = 191.6 kV, and 191.6 kV ÷ 452 V = 423, which represents the maximum number of stacks. Hence, 2.3 MW × 423 stacks = 973 MW, providing the total power output of the plant.

Additionally, the plant includes various auxiliary voltages. For reasons of security, resiliency, optimization, and ease of maintenance, the plant's layout is duplicated, resulting in two sections, each producing around 500 MW of power.

This redundancy ensures that if one section encounters a problem, the other can continue to produce hydrogen. Hence, instead of 423 or 422 stacks, it is more efficient to consider 420 ÷ 2 = 210 or 416 ÷ 2 = 208 stacks per section.

Moreover, the plant is segmented into power blocks, each consisting of a transformer, a rectifier, and a certain number of stacks in parallel. This arrangement reduces the capital expenditure (CAPEX). The design includes either 26 or 30 power blocks, each with 16 or 14 stacks, respectively.

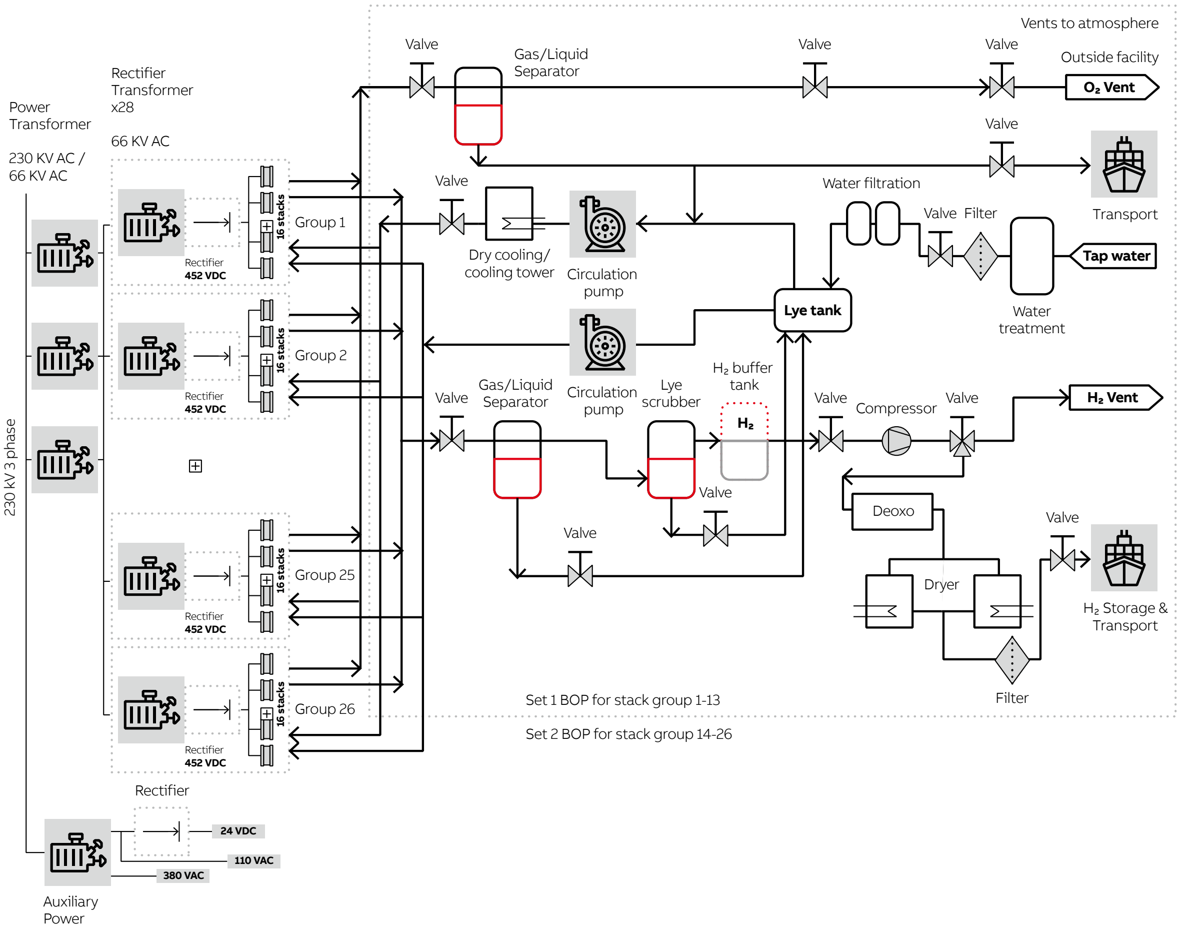
With this configuration, we have 2 × 13 groups of 16 stacks, totaling 416 stacks, or 2 × 15 groups of 14 stacks, totaling 420 stacks. A group of 16 stacks requires a transformer and rectifier capable of supplying 452 V and 16 × 5,088 A = 81,408 A, while a group of 14 stacks necessitates a transformer and rectifier capable of supplying 452 V and 14 × 5,088 A = 71,232 A.

This solution could optimize the plant's operation more effectively, compared to having a transformer and rectifier for each stack.

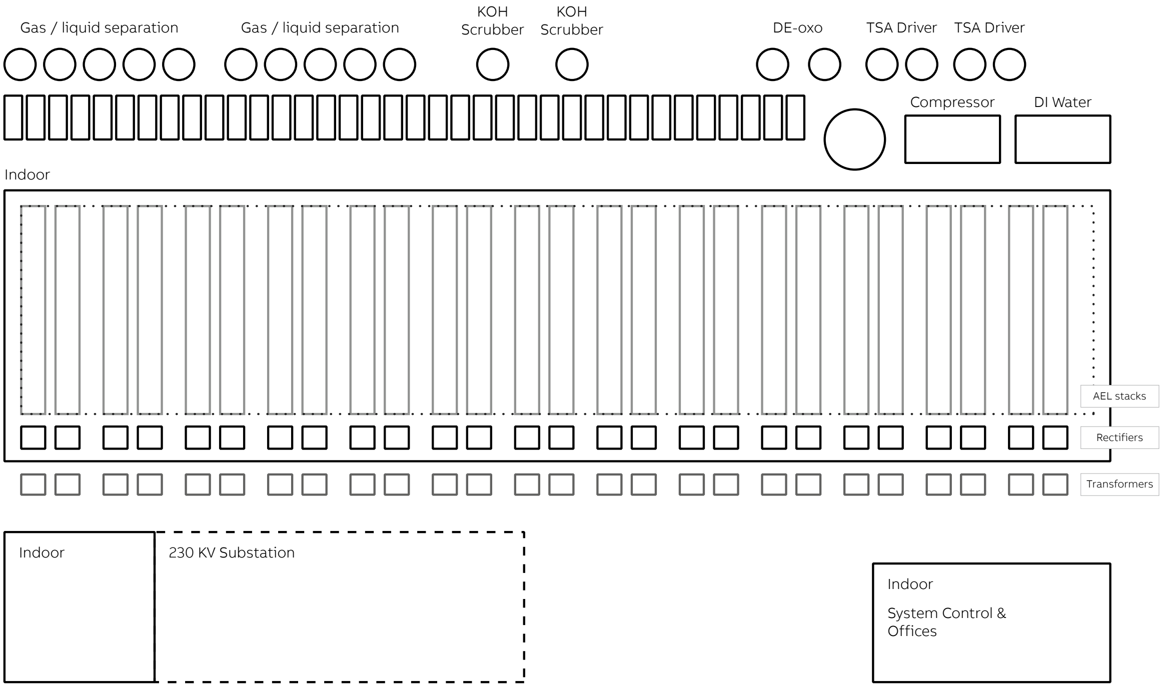
**Major stack specifications summary:**

| | Alkaline Electrolyzer | | PEM Electrolyzer | |
|---|---:|---:|---:|---:|
| **Parameter** | **Current KPI** | **Future KPI** | **Future KPI** | **Future KPI** |
| Plant size (MW, DC basis) | 957 | 960 | 960 | 960 |
| Stack size (MW) | 2.3 | 10 | 2.5 | 10 |
| # of stacks | 416 | 96 | 384 | 96 |
| Cell voltage (V) | 1.75 | 1.75 | 1.75 | 1.75 |
| Current density (A/$cm^2$) | 0.175 | 0.75 | 1.50 | 2.50 |
| # of cells | 258 | 258 | 258 | 258 |
| Stack voltage (VDC) | 452 | 452 | 452 | 452 |
| Stack Current (A) | 5,088 | 22,124 | 5,531 | 22,124 |
| Cell active area ($cm^2$) | 29,077 | 29,499 | 3,687 | 8,850 |
| Actual cell area ($cm^2$) | 34,208 | 34,704 | 4,852 | 11,644 |
| Operating Pressure (barg) | 0.02 | 0.06 | 30 | 30 |
| Stack production volume (GW/year) | 1 | 1 | 1 | 1 |
| Purity (%) | 99.99 | 99.99 | 99.99 | 99.99 |
| Oxygen limit | <5 ppm | <5 ppm | <5 ppm | <5 ppm |
| Moisture content | −65 °C dew point | −65 °C dew point | −65 °C dew point | −65 °C dew point |

## Current Alkaline: 1 GW Alkaline (2.3 MW stack), 2 sets of BOP, simplified layout



## Current Alkaline: 1 GW Plant Layout



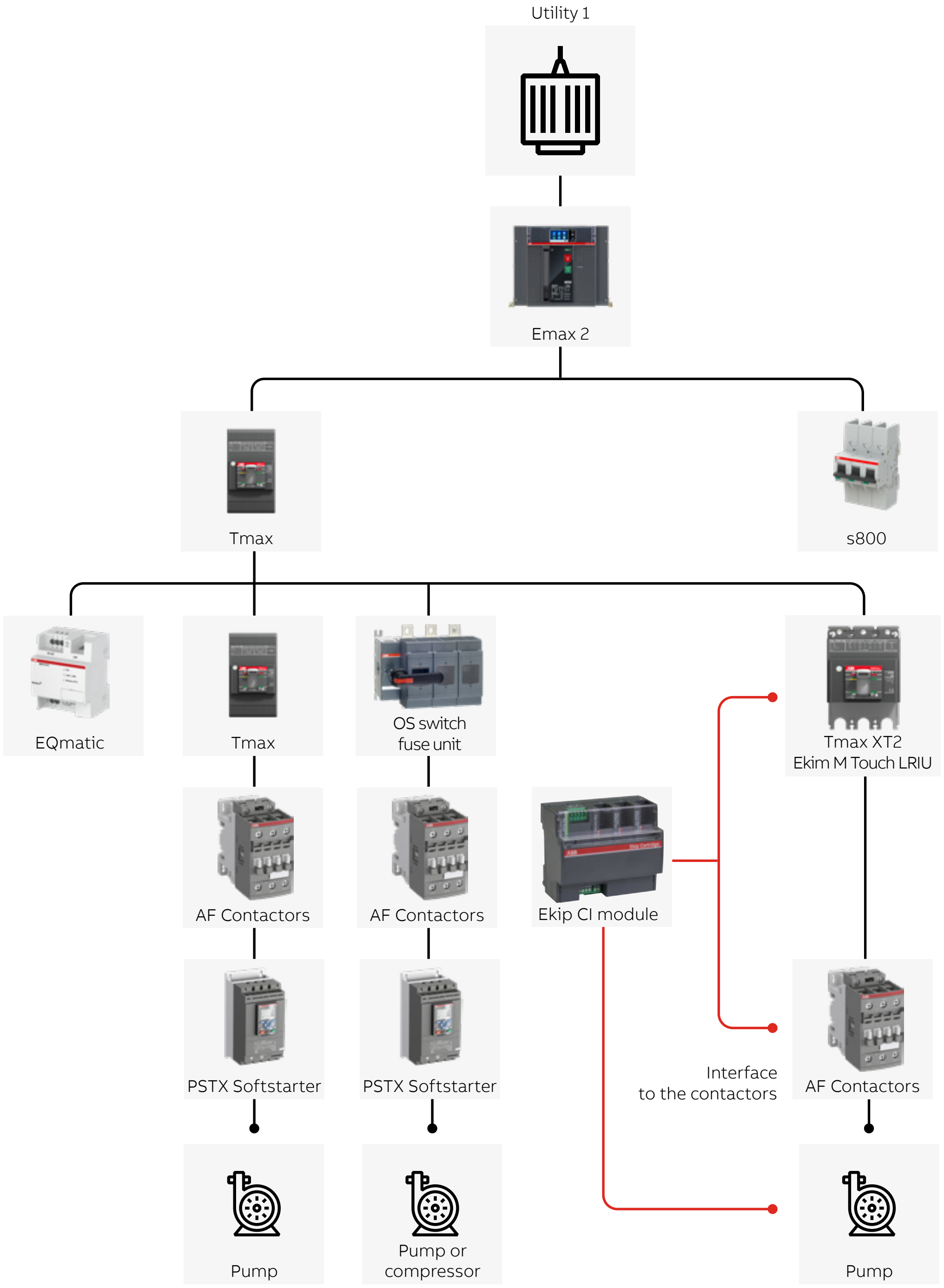
## LV protections

Protection for low voltage components is primarily needed in the rectifier (on both the AC and DC sides), the compressor, the cooling system, the heaters, and the water purification system. It's also necessary for all motor starters required for the system's pumps.

Typical voltage levels within the plant include 24 VDC, 110 VAC, 240 VAC, and 380 VAC. Depending on the plant design and stack configuration, the rectifier might be designed for 400 VDC or even for voltages in the thousands.

In a 100 MW electrolyzer plant, the power consumption for different systems is as follows:

- Circulation pumps consume 98 kW of power,
- The process cooling system consumes 892 kW of power,
- The gas purification system consumes 207 kW of power,
- The compression system consumes 2,600 kW of power (considering four four-stage reciprocating compressors, each using 650 kW).



Tmax XT
Molded
Case Circuit
Breaker

AF
Contractors

Emax 2
Air Circuit
Breaker

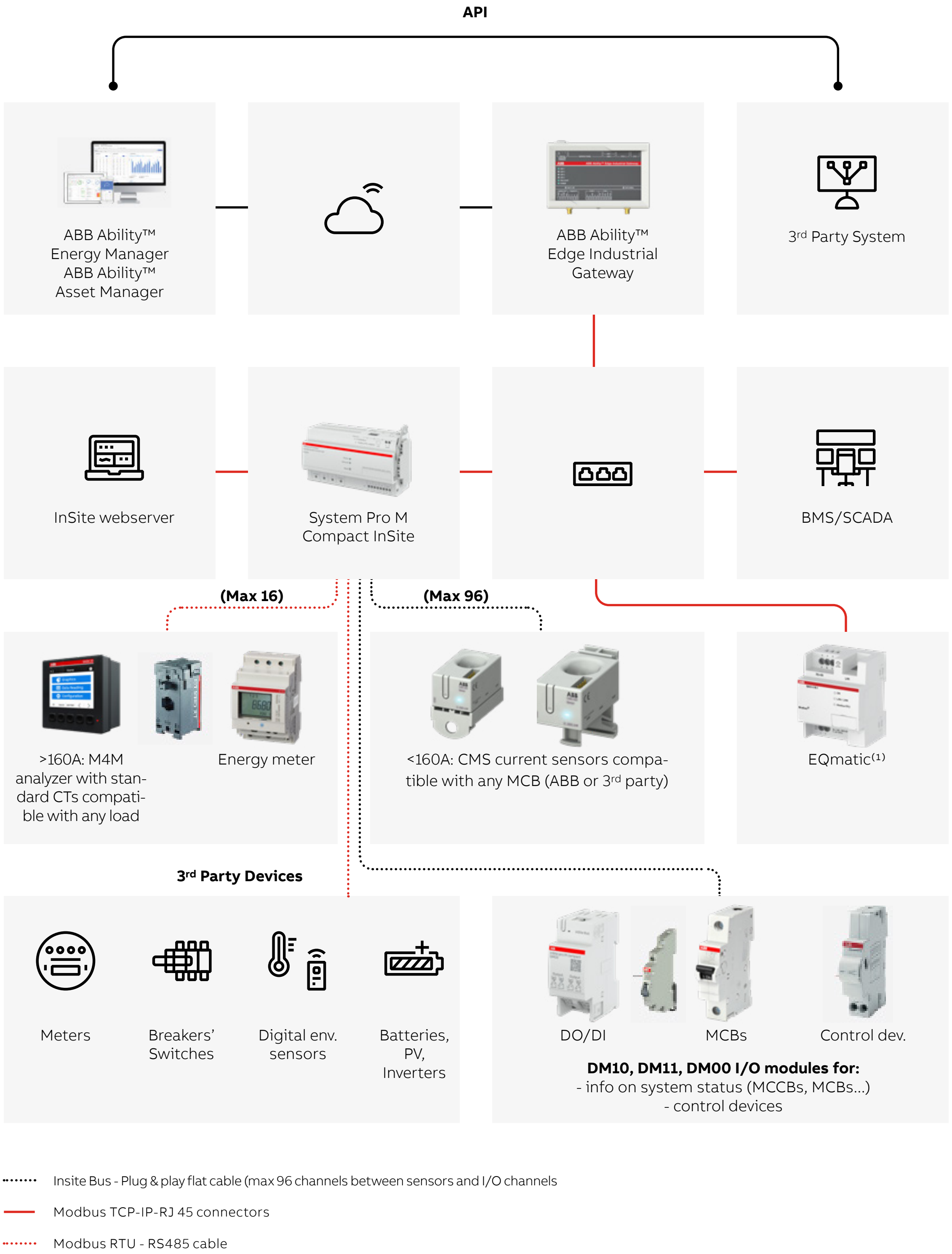
PSTX Soft
Starter

Manual
Operated
Switch Fuses

# Measuring & monitoring

Measuring voltage and current is crucial, particularly for monitoring the degradation of the stack and/or individual cells.

Moreover, it's vital to relay other key measurements to the control system, such as water consumption, energy use, and the status of various devices, among others.



(1) Connect 3rd Party devices for water or gas measurement, and view on in-site webserver

System Pro M Compact® InSite

M4M Network Analyzer

ABB EQmatic Energy Analyzer

ABB Ability™ Energy Manager

S200 Miniature Circuit Breaker

ABB Energy Meter

ABB Ability™ Edge Industrial Gateway

ABB Ability™ Asset Manager