Owner’s Manual

Electrolyzer 4.1

Please study this manual carefully before unpacking, installing, and operating the device.

Rev. 07– January 2026

CHANGE HISTORY FOR EL4.1

Rev.	Status	Date	Revision memo	Created/changed by
00	IFI	01/10/2023	First version	Philipp Endres
01	IFI	06/10/2023	Edited/Proofread for clarity	Beth De Felici
02	IFI	06/11/2023	Updated data and fixed formatting	Beth De Felici
03	IFI	16/04/2024	Updated voltage specs / Updated fuse info / Updated O2 safety specs/ Fixed external links	Beth De Felici
04	IFI	05/07/2024	Updated KOH information / Updated images /Safety Info	Beth De Felici
05	IFI	07/04/2025	Updated images / Updated appendix with Factory Setting Reset details / Removed DC version details / Updated storage conditions / Updated warranty conditions / Updated water specifications	Beth De Felici
06	IFI	28/07/2025	Updated info on KOH shipping and supply / Fixed hyperlinks / Nominal Use Conditions	Beth De Felici
07	IFI	27/01/2026	Updated dry contact build/ Updated included accessories/	Beth De Felici

Thank you for choosing Enapter. Please study this manual carefully before unpacking, installing, and operating the device.

If you have any further questions, please contact the Enapter customer support team. Quote the device serial number and hardware number on the back of the device to help identify your product quickly.

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SCOPE OF THE DOCUMENT

This manual provides information needed to carry out the installation and usage of your Enapter device safely and as intended.
Keep this document in a safe place and readily available. Always follow its instructions. It is the operator's responsibility to ensure that an installed device is always in proper condition. Please observe any additional local requirements applicable to the installation and operation of hydrogen devices.

APPROVED USE

This device must only be operated for its intended purpose, according to the specifications and instructions provided in this document.
Observance of this document is part of "normal use".

Danger! Improper use of the device can result in serious injuries and damage to the environment.

- Always use the device according to the specifications described in this document.
- Ensure that the manual is always accessible.
- Make sure you have read and understood this document in its entirety.
- Comply with all safety instructions and warnings.
- Store the manual and other documentation in a safe and accessible place and pass them on to future owners and operators of the device.
- Comply with all relevant local safety guidelines, rules, directives, and regulations.
- Enapter does not guarantee efficiency, safety, and functionality in case of modifications not described in this document.
- Enapter is not responsible for any damage caused by the device or to the device based on improper operation or setup.

TERMS

The following terms are used in this document:

- **Device**: Device means the unit, including its hardware and software as well as the contained materials and substances.
- **System**: System means the combination of devices, tubes, pipes, and equipment from Enapter and other manufacturers which are connected physically, logically, or in any other way to produce, store, use, transfer, or convert hydrogen and related substances.
- **Operator**: The operator is the responsible person in charge who operates, installs, connects, maintains, and/or owns the device, its subcomponents, and additional components. To simplify reading, this document only refers to the operator to distinguish from Enapter but may also include the user, customer, client, owner, installer, instructor, system integrator, or persons who are responsible for safe operation of the device.

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1. OVERVIEW OF THE ELECTROLYZER

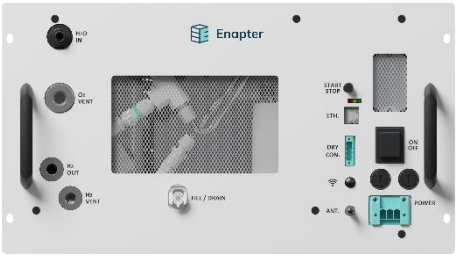
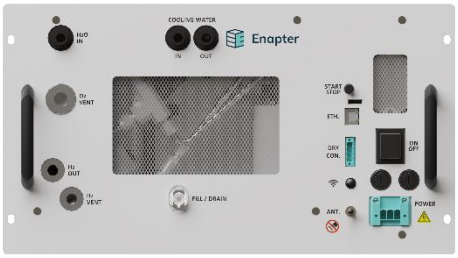
Enapter's patented anion exchange membrane (AEM) electrolyzer is a standardized, stackable, and flexible device to produce hydrogen. The modular, easily maintainable design – paired with advanced software integration – allows set up in minutes and remote control and management.

1.1 SPECIFICATIONS

The device operates on AC power and is available in two pressure variants: 35 barg and 8 barg. It is offered in both air-cooled and liquid-cooled configurations. The specifications of the electrolyzer can be found in the datasheet. <5>

It can be downloaded here: Datasheet of the electrolyzer.

See the battery limits for more detailed information about the interfaces and connections of the device: Battery limits of the electrolyzer.

Versions	Air Cooled:	Liquid Cooled:
AC-version:		

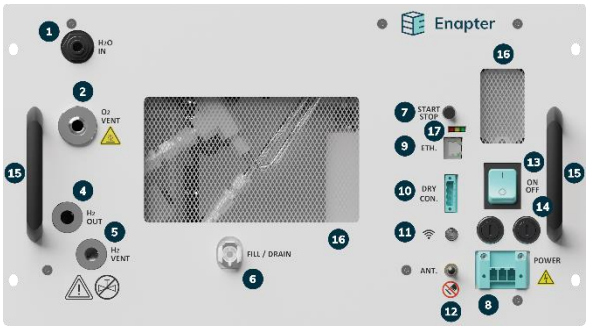
	EL4.1
Nominal Hydrogen Production Rate	0.3 Nm^3/h – 0.5 Nm^3/h Up to 1.0785 kg/24 h
Output Pressure	35bar **version**: Up to 35 barg 8 bar version: Up to 8 barg
Hydrogen Output Purity	35bar **version**: ~99.9 % (H_2O: 1000 ppm, O_2: <5ppm) at 25°C 8bar version: 98,8 % (H_2O: 12000 ppm, O_2: <5ppm) at 25°C
Water Consumption	0.42 L/h
Water Input Quality	Recommended Type II according to ASTM D1193-06 and required acidity < 0.1 meq/L according to ASTM D1067 Minimum conductivity of < 2 µS/cm <5>
Water Input Pressure Range	1 – 4 barg
Process Liquid	~1.5 % KOH solution <5>
Operative Power Consumption	2.4 kW (beginning of life)
Peak Power Consumption	3.0 kW
Nominal Power Consumption per Nm^3 of H_2 produced	4.8 kWh/Nm^3 (beginning of life)
Stand-by Power Consumption	0.03 kW

Power Supply	208 V – 240 V (AC), 50/60 Hz, <3>
Heat Dissipation	0.6 kW (beginning of life)
Maximum Heat Dissipation	0.9 kW (end of life)
Dimensions (W x D x H)	482 mm x 635 mm x 266 mm
Space inside cabinet	6 U
Weight	42 kg (empty) [1] 41 kg (empty) [2]
Control System Included	EMS
Communications	Wi-Fi - 802.11a/b/g/n (2.4 GHz only) - 802.12 WEP, WPA, WPA2 Personal (Pre-shared key) - Wi-Fi client isolation must be disabled Bluetooth Modbus TCP via Ethernet@
Remote Control	Enapter Cloud Service, Enapter App, Modbus TCP, Safety chain (dry contact)
Safety	
Maximum H_2 contained within	20 NL
Conformity	CE mark according to the machine directive 2006/42/CE UKCA mark according to Supply Machinery (Safety) Regulations 2008 CSA/ANSI B22734:2023 Ed.1 Hydrogen Generators Using Water Electrolysis - Industrial, Commercial, and Residential Applications [4]
Legislation and standards	Machinery Directive and relevant harmonized standards: 2006/42/CE; ISO 12100 Low Voltage Directive and relevant harmonized standards: LVD 2014/35/UE; EN IEC 61010-1 EMC directive and harmonized standards: EMC 2014/30/UE; IEC 61326-1 Radio equipment directive and harmonized standards: RED 2014/54/UE; EN 300 328 Restriction of hazardous substances directive RoHS II 2011/65/EU, delegate directive UE 2015/863 and directive 2017/2102
Noise level at 1 m	<85 dB
Ventilation and Safety Recommendation	To be installed in a safe (non-hazardous) area only. Indoor: Ventilation depends on the room size. A hydrogen detection system with a safety circuit is mandatory. Outdoor: Protect from outside environmental influences if integrated into a cabinet. Ensure the safety concept of each integrated module is respected.

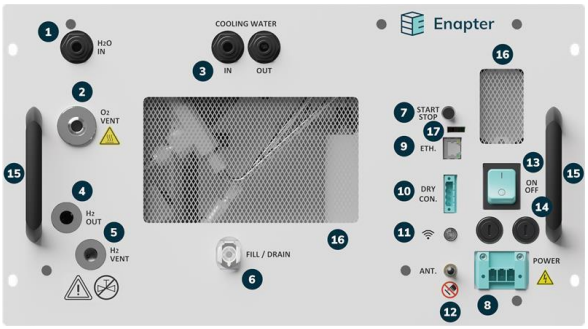
Environmental	
Operating Conditions	5 °C to 45 °C, up to 90% humidity, non-condensing.
Storage Conditions	2 °C to 55 °C, up to 90 % humidity, non-condensing <5>
IP Rating	IP 20
Interfaces	
H_2 Outlet	¼" bspp female port
O_2 Vent Outlet	⅜" bspp female port
H_2 Vent Outlet	¼" bspp female port
H_2O Inlet	10 mm push-fit female bulkhead connector
Fill / Drain Port	10 mm CPC quick connector
Cooling Water Inlet [2]	10 mm push-fit female bulkhead connector
Cooling Water Outlet [2]	10 mm push-fit female bulkhead connector
Warranty Conditions	Nominal use conditions
Nominal Use for Warranty and Warranty Extension	- Device commissioned[5] within three (3) months from date of delivery (DAP) - Device commissioned[5] within four (4) months from supplier's notification date of readiness (Ex-works) - Device is used for at least one (1) hour at a time, on average - At maximum, 8 cycles/day, 50 cycles/week. - Ensure Enapter has access to operational data and telemetry of the devices

[1] Air Cooled electrolyzers only (Liquid cooled versions excluded)
[2] Liquid Cooled electrolyzers only (Air cooled versions excluded)
[4] ETL certified electrolyzer versions only.
[5] Commissioning is defined as being filled with KOH solution and ran for at least one (1) hour <5>

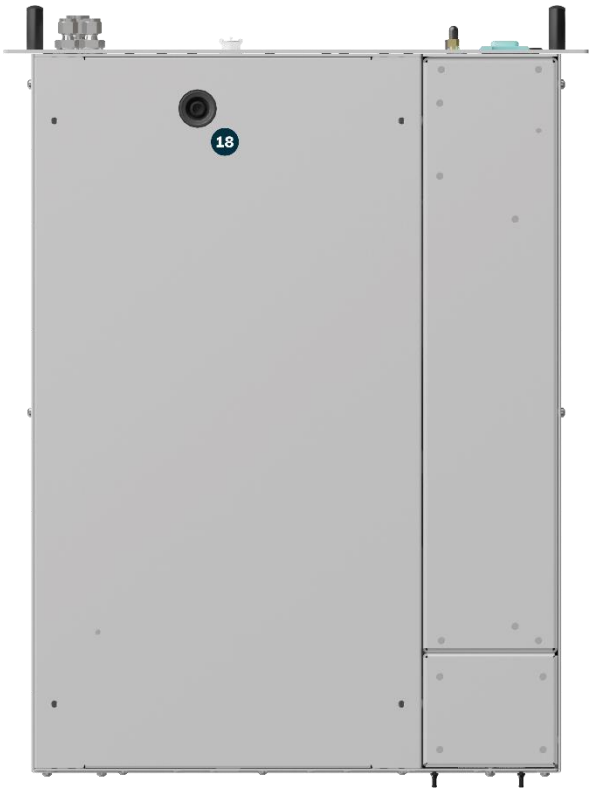
1.2 FRONT PANEL & BOTTOM



EL4.1 AC air cooled front side



EL4.1 AC liquid cooled front side. <5>



EL4.1 air cooled bottom view

The front panel includes most of the physical connections of the device. The leakage drain hole is positioned on the bottom of the device. For more information, please refer to the battery limits.

1. H_2O IN – please refer to the Water Inlet Connection Guide (H2O IN)
   - Push-fit female bulkhead connector (10 mm outer diameter pipes) POM (Polyoxymethylene)
   - Input: Filtered water (please refer to the Water Input Quality in chapter Specifications) input pressure between 1 and 4 bar
2. O_2 VENT – please refer to the Oxygen Vent Connection Guide (O2 VENT)
   - ⅜" bspp female port. Do not use NPT fittings.
   - Output: 0.25 Nm^3/h O_2 at up to 58 °C with 10-38 g/h water (H_2O) and traces of H_2

3. COOLING WATER IN/OUT – (only liquid cooled electrolyzers) please refer to the Cooling Loop Connection Guide (COOLING WATER IN/OUT)
   - Push-fit female bulkhead connector (10mm outer diameter pipes) POM (Polyoxymethylene)
   - Input/Output: cooling water to cool down the device.
4. H_2 OUT – please refer to the Hydrogen Outlet Connection Guide (H2 OUT)
   - ¼" bspp female port. Do not use NPT fittings.
   - Output: 0.5 Nm^3/h of H_2, up to 35 barg, 99.9% purity (35 barg version) or 98.8% (8 barg version)
5. H_2 VENT – please refer to the Hydrogen Vent Connection Guide (H2 VENT)
   - ¼" bspp female port. Do not use NPT fittings.
   - Output: Periodical vent of up to 20 NL (H_2 and water) every 6 h (35 barg version) or every 1.5 h (8 barg version)
6. FILL / DRAIN – please refer to the Electrolyte Filling section below.
   - 10 mm CPC quick connector. During maintenance routine for filling the electrolyte into the device or for draining and preparing it for transport. Before draining the device through its dedicated port, wear appropriate personal protective equipment (PPE). For more information, refer to Preparing fresh electrolyte III below. Collect the electrolyte in an appropriate container and place it in a chemical waste container. It contains 1.54 % of KOH if filled according to this manual.

     Please protect the environment: Do not flush into the sewer. Dispose of the liquid in compliance with all relevant local safety guidelines, rules, directives, and regulations.

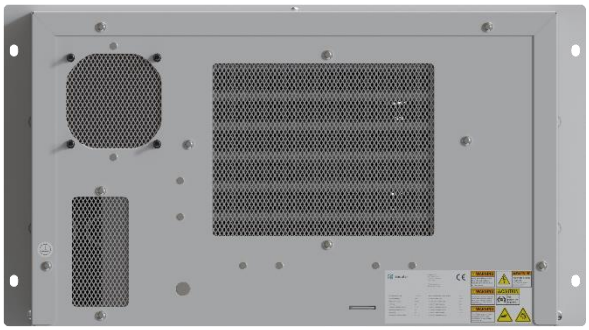
7. START STOP – please refer to the Manual Start/Stop section below.
   - Manual start and stop button to start and stop the device.
8. POWER – please refer to the Electrical Connection Guide (POWER)
   - Manual power button to switch device on and off.
9. ETH. – please refer to the Ethernet Port (ETH.) section below.
   - Interface to access external Modbus control features of the electrolyzer.
10. DRY CON. – please refer to the Dry Contact Connection Guide (Optional) (DRY CON.)
    - Interface to connect device to external sensors for emergency stops.
11. Wi-Fi Button – please refer to the Pairing the device to the cloud section below.
    - Manual button to activate/deactivate Wi-Fi.
12. ANT. – Antenna port SMA male – please refer to the Pairing the device to the cloud section below.
    - The device can be connected to the local network via Bluetooth and Wi-Fi, enabling real-time updates and monitoring for the operator via the Enapter App and cloud. A miniature antenna can be attached to this port to increase the amplification.
    - Do not touch the port when the device is powered on!
13. On/Off Button – please refer to the Electrical Connection Guide (POWER)
    - Integrated magnetothermal circuit breaker to protect the electrolyzer from overcurrent and short-circuits.
14. Thermal overcurrent circuit breakers – please refer to the Electrical Connection Guide (POWER) <3>
    - Integrated magnetothermal circuit breaker to protect the electrolyzer from overcurrent and short-circuits.

15. Handlebars – for easier transport
16. Air Inlets – please refer to the Routine Maintenance section below.
    - Keep the air inlets free of dust and dirt.
17. LEDs – please refer to the LED Status section below.
    - Status LEDs to show device status.

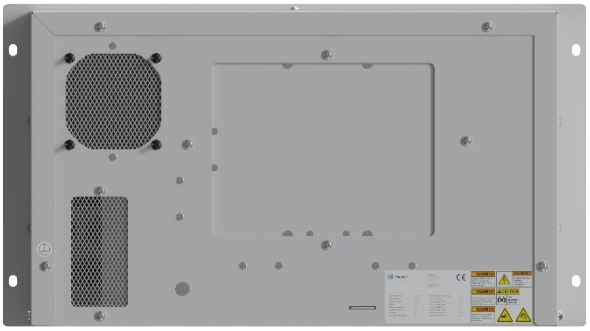
1.3 LEAKAGE DRAIN HOLE – PLEASE REFER TO THE TROUBLESHOOTING

18. section below.
    - The leakage drain hole allows the operator to drain the tray in case of electrolyte or water leakage.

1.4 BACK PANEL



EL4.1 air cooled back side



EL4.1 liquid cooled back side

The back panel of the device is used to blow out warm air. The stickers show the device specifications and serial number details.

Notice! Never obstruct the ventilation openings to avoid overheating!

Clean the ventilation openings regularly to avoid dust and bigger obstacles from blocking the inlets and outlets of the internal ventilation system.

Please leave at least 30 cm space behind the module to allow adequate airflow.

1.5 NOMINAL USE CONDITIONS

To ensure eligibility for warranty claims, the following nominal use conditions must be met <5>:

- The device must be commissioned within three (3) months from the delivery date (DAP), or within four (4) months from the supplier's notification of readiness (Ex-Works), whichever applies.
- Commissioning is defined as the device being connected and operated continuously for a minimum of one (1) hour.
- During regular operation, the device must be used for an average duration of at least one (1) hour per session to avoid accelerating stack degradation.
- The System may be cycled up to eight (8) times per day and fifty (50) times per week. Warrantied stack cycles are capped at five thousand (5000) cycles total.

We define a *stack cycle* as one complete event of power being applied to the electrolyzer stack and then removed again by the stack power supply unit (PSU). It is not linked to system pressure but purely to the electrical operation of the stack.

- The device must be operated within its specified parameters and protected from harmful environmental influences such as moisture, dust, and extreme temperatures.
- Enapter must be granted access to device operational data and telemetry upon request. This can be achieved either by maintaining a cloud connection with at least 95% uptime during system use, or by ensuring telemetry is reliably recorded via the Modbus interface in the case of non-cloud-connected systems. Enapter may ask for up to two (2) months of data to be transferred to check and verify operating conditions. More information about the required Modbus record can be found online on our handbook.
- Enapter must be provided with monitoring data for the DI water input – at minimum, measurements from a calibrated conductivity sensor – as well as the maintenance record and plan for the DI water supply system.
- Integrators or operators must perform the minimum required maintenance as specified in the Routine Maintenance section and maintain accurate records of all completed activities. <5>

	Recommended	Nominal Use Requirement
Perform regular maintenance (including electrolyte exchange)	Every 6 months	Every 12 months
Run device to minimize degradation	Produce H_2 for 1 hr/week (Minimum production rate allowed)	Produce H_2 for 1 hr / **13 weeks (3 months 1 week)** (Minimum production rate allowed)
Preventive maintenance: electrolyte exchange	Replace electrolyte after 1 month of inactivity, prior to recommissioning	Replace electrolyte after 3 months of inactivity (cumulative)

<6>

Failure to comply with these conditions – or to stay within the defined daily, weekly, or total stack cycle limits – may result in Enapter declining warranty claims. <6>

Notice!

To minimize stack cycles and extend stack lifetime, we recommend implementing intelligent production rate control strategies, and carefully monitoring automatic start/stop pressure thresholds. These allow the system to better

follow the available load curve across multiple, modular electrolyzer systems, whilst maximizing the use of available green energy for hydrogen production.

2. SAFETY INSTRUCTIONS

2.1 WARNINGS AND HAZARDS

The following terms and symbols are used in this manual to indicate important text passages which must be given particular attention:

Warns of fatal/serious injuries or death

Warns of injury

Warns of physical damage to the product

Warns of explosions

Do not open or dismantle

Keep away from sources of heat and ignition.
No naked flames

No smoking

Minimum two persons required to handle the item

Wear personal protective equipment (PPE)

Wear hearing protection

Button cell or coin battery safety warning <4>

Keep out of reach of children <4>

2.2 GENERAL SAFETY

Serious injuries and death as well as damage to the product or the environment possible! Follow the instructions in this manual carefully!

The operator must be aware of the following:

1. **The device is not intended to be used in a potentially explosive area.**
2. **Enapter is not responsible for improper use:**
   - Caused by inaccurate input.
   - Caused by inaccurate input pressures.
   - Caused by improper mounting or piping (e.g., leaking gas connections)
   - Caused by connecting the wrong power supply (e.g., wrong voltage)
   - Caused by improper installation.
3. Regarding design and installation, the operator must **follow Enapter's installation rules** and **ensure full compliance** with all relevant local safety guidelines, rules, directives, and regulations.
4. The operator must check the device for hydrogen, water, and KOH leakages regularly and ensure that all interfaces are connected correctly.
5. It is the operator's responsibility to **regularly check and maintain all outlet lines** and **keep the pipes free of ice, other obstructions, or overpressure.**
6. It is the operator's responsibility to **regularly check and clean the air intakes and outlets** of the device and to keep them free of obstructions.
7. If larger hydrogen systems are created by putting together several modules, it is the operator's responsibility to ensure full compliance of the final assembly with all relevant local safety guidelines, rules, directives, and regulations.

The following rules should always be observed:

1. **Keep the work area clean**. Clutter can create hazards around the device. Keep the work area well illuminated.
2. **Do not use the device in an explosive atmosphere**. Do not use the device near flammable substances.
3. **Handle the power supply cable and plug with care**. Do not pull the electric cable to disconnect it from the plug without removing power from it first. Keep the electric cable away from heat, oil, water, and sharp edges.
4. **Protect yourself from electric shocks.** Avoid any contact with earthing surfaces.
5. **Never expose the device to rain or damp conditions**.
6. **Keep children and people without explicit knowledge of the device and its function away** at a safe distance.
7. **Never operate the device in confined spaces** without additional safety infrastructures, such as active ventilation and hydrogen detection systems.
8. **Always protect yourself:**
   - **Wear protective goggles and nitrile gloves** when handling the electrolyte solution.
   - **Wear earmuffs or plugs** in noisy areas.
   - **Wear gloves** when handling the device.

- **Wear appropriate footwear** when handling the device.
- **Use lifting aids** if available when lifting the device. Never lift the device alone. Know your local and site-specific health and safety rules and act accordingly.

9. **Always disconnect the device from electricity before cleaning, disassembly, and transport.**
10. **Only use the device in the way and for the purposes mentioned in this manual.** If the device is employed for uses other than what is specified in this manual, unforeseen hazards may occur.
11. **Use the handles when lifting and moving the device.**
12. **Never attempt to repair the device** by yourself. The device must only be repaired by qualified specialists who use original spare parts.
13. Any maintenance activity, excluding the ones listed in the routine maintenance and installation sections, is only allowed to be performed by authorized **trained technicians**!
14. Any person working on the device **must be familiar and trained** with the hazards and risks associated with installing, commissioning, and running the device and attached devices.

Do not store or expose the device to temperatures below 2°C.

2.3 ADDITIONAL SAFETY FOR THE ELECTROLYZER

This device contains a SIL1 Safety Instrumented System (SIS) within, managing inner safety instrumented functions (SIF). The SIS is accompanied by a Safety Manual, an addendum to the Owner's Manual, to be used in conjunction with it. It provides all the functional safety-relevant information necessary for the operator to verify the required skills and instructions to install, verify, maintain, and periodically test the system, ensuring the respect for product safety requirements (item function, input/output interfaces etc.).

Serious injuries and death as well as damage to the product or the environment possible! Follow the instructions in this manual carefully!

Ignoring the Safety Manual instructions could impair the safety functions performance.

In addition, the following rules should always be observed. It is the operator's responsibility to ensure that every person working with the device is following these rules:

1. Do not attach filled tanks or other equipment with **pressures higher than the device's maximum outlet pressure** to the H_2 outlet of the device.
2. Do not provide water which does not meet the **minimum purity requirements**.
3. Do not provide water with a pressure higher than the **maximum allowed pressure**.
4. Make sure that the H_2 vent line and the O_2 vent line are **never obstructed and never combined**.
5. Do not combine the O_2 vent line of an EL 4.1 device with the O_2 vent line of any EL 4.0.

3. HAZARDS

The operator who operates, services, maintains, or installs this device must be aware of the potential dangers associated with its use and set up, the required materials, as well as the inputs and outputs, to implement sufficient countermeasures and processes to prevent accidents and act correctly in case of emergencies.

Risk of serious injury, death, and damage to the product or environment!

Follow the instructions in this manual carefully.

Always ensure that the device is installed and operated in compliance with all applicable local safety guidelines, rules, directives, and regulations.

Do not install, operate, or maintain the device without proper knowledge or the support of qualified and licensed system integrators, the manufacturer, or relevant certification bodies.

3.1 HYDROGEN HAZARD

It is the operator's responsibility to implement a safety system to manage the devices' inputs and outputs – more information about this is below.

Danger! Hydrogen is a highly explosive and volatile gas!

Hydrogen can explode! Do not mix hydrogen with oxygen or air! Prevent hydrogen from leaking! Even small leakages will create flammable and explosive environments!

Prevent electrostatic charging of the device. Hydrogen ignites very easily!

Do not inhale hydrogen!

Hydrogen can cause asphyxiation!

Hydrogen is very volatile. Still, it can accumulate in areas and materials that are unexpected. Do not handle hydrogen without a suitable ventilation and safety system!

Incorporate the device, especially the hydrogen and the vent lines, into the operational safety concept and comply with all relevant local safety guidelines, rules, directives, and regulations.

Avoid heat in the vicinity of the device.

Do not smoke and do have naked flames in the vicinity of the device.

Do not have hydrogen, not even in low concentrations, in the vicinity of the device.

The hydrogen which comes out of the device is under pressure! Comply with all relevant local safety guidelines, rules, directives, and regulations for the handling of compressed hydrogen.

In the case of escaping gas, stay away and keep inflammable materials away.

Ensure proper installation of the supply pipes.

Check the hydrogen lines and connectors regularly for leakages.

3.2 MECHANICAL HAZARDS

It is always necessary to wear appropriate personal protective equipment (PPE) and use suitable tools when handling the device and packaging material.

Some general training regarding lifting heavy loads and safety briefings are required to perform the tasks safely described in this manual.

Operators must comply with the general safety principles during the handling phases.

Caution! The device is heavy!

- Before handling, moving, and commissioning the device, assess the hazards of the operation and study the manual. Appropriate PPE must be worn, such as cut resistant gloves, safety shoes, protective goggles, etc. depending on the activity.
- Clear the area of work before starting to mount the device.
- The device is heavy and must be lifted by at least 2 people – plan around this and allow ample space to move around.
- Do not lift the device over your head.

Caution! Handle the device with care!

- During handling of the device, be cautious and use the handles on the device to minimize the mechanical risks, such as:
- Impacts and crushing injuries due to uncontrolled movements of the load.
- Dropping the device, causing crushing injuries
- Loss of stability, leading to entanglements and other injuries.
- The packaging/device must be handled by at least two people.

3.3 ELECTRICAL HAZARDS

The device poses no special electrical hazards if the following instructions on safety measures are followed, and the Electrical Connection Guide below is applied correctly:

Warning! The device requires an electrical power supply!

- Handle the electrical installation with care. Ensure that the power plug is fastened and fixed correctly into the socket to avoid any loosening of the wiring.
- The power plug is not double insulated. Therefore, it could become hazardous in single fault conditions. Make sure to disconnect the upstream power source before touching the power plug.
- Use only the supply voltage specified for the device.
- Do not short-circuit inputs and outputs.
- Do not reverse the polarity of inputs and outputs.
- Do not insert any mechanical parts, especially metal parts, into the device through the ventilation slots or other openings.
- Do not use liquids near the device.
- Never use the device if any part of it has been immersed in water.
- Do not touch the antenna when the device is powered on, ensure being electrostatically discharged when mounting/dismounting the antenna.

Warning! Explosion hazard! Do not remove or replace the power supply plug or fuses while circuit is live unless the area is free of ignitable concentrations.

- Always turn off the device, remove the power supply, and fully ventilate the room first before removing or replacing the fuses. Otherwise, electric sparks may occur. The area must always be free of ignitable concentrations.

Warning!

- Always turn off the power supply when the device is being cleaned, maintained, or transported. Any service, other than cleaning and routine user maintenance, must be performed by trained Enapter-endorsed technicians.

3.4 CHEMICAL HAZARDS

Dissolved Potassium Hydroxide is used in the electrolyzer as the process liquid (electrolyte). The chemical can be purchased as pellets or flakes, or directly in a concentrated solution to be diluted using purified water. An electrolyte-safe bag with pipe and connectors will be included in the shipment with the electrolyzer which can be used to fill and drain the units safely. <5>

Caution! The device contains chemicals!

Refer to the Safety Data Sheet (SDS) of all chemicals used before handling them. All persons mixing, draining, and handling the electrolyte must be informed about the chemicals and potential hazards.

Caution! Protect yourself!

Wear appropriate personal protective equipment (PPE). Avoid contact with eyes and skin.

If you got in contact with the solution, immediately wash the affected area and refer to the material safety data sheet of potassium hydroxide supplied with the electrolyzer. <4>

Ensure all material used to store the electrolyte solution is chemically compatible with it.

Caution! Contains button cell or coin battery! Warning of ingestion hazard!

INGESTION HAZARD: This product contains a button cell or coin battery.

DEATH or serious injury can occur if ingested. A swallowed button cell or coin battery can cause internal chemical burns in as little as 2 hours.

Keep new and used batteries OUT OF REACH of CHILDREN.

Seek immediate medical attention if a battery is suspected to be swallowed or inserted inside any part of the body. <4>

In the event of physical contact with the undiluted substance, refer to the material safety data sheet of potassium hydroxide and follow the instructions below.

First Aid Recommendations

- In the event of skin contact, take off contaminated clothing immediately. Wash off with soap and plentiful water. Consult a doctor.
- In the event of eye contact, rinse carefully with plentiful water for at least 15 minutes and consult a doctor.
- If ingested, do not administer anything to people that have fainted. Rinse mouth with water. Consult a doctor immediately.

3.5 CHEMICAL INFORMATION

Substance: Potassium Hydroxide

CAS no.: 1310-58-3

EC no.: 215-181-3

Classification: C.

R Phrases: R22, R36/38, R43, R42

S Phrases: S24-37, S39, S62

(see Safety Material Data Sheet included in the shipment)

3.6 THERMAL HAZARDS

Thermal hazards such as burns and scalds from contact with high temperature surfaces can be prevented by following these safety instructions:

Caution! Parts of the device and attached pipes and connectors can become very hot!

- Do not open the device unless you are specifically trained and authorized by Enapter to perform service operations.
- Do not touch the outlet ports or any attached pipes directly after operation. Switch off the device and wait until it is cooled down before servicing, transporting, or changing the piping of the device.

3.7 ENVIRONMENTAL HAZARDS

The device was designed for use in standard ambient conditions, respecting stability requirements (without seismic or hydrogeological events).

The device has not been designed for outdoor use. It is the operator's responsibility to protect the device and all its accessories against atmospheric phenomena such as direct sunlight, rain, snow, and lightning.

3.8 ACOUSTIC HAZARDS

According to the requirements stated into the Machine Directive 2006/42/EC, the following topics have been considered:

Caution! The device vents gases with a loud noise!

During regular operation, the device emits a noise level below the maximum acceptable threshold for long time exposure (80 dBA).

However, a sudden vent (either caused by device shut down or unforeseen error) can be louder than 85 dB, depending on the vent line installation. Due to this, Enapter recommends wearing PPE (earplugs) while working around the device.

4. INSTALLATION OF THE ELECTROLYZER

Any person working on the device must be familiar with the hazards and risks associated with installing, commissioning, and running it. The device is a non-portable device. It must be installed in a secured, fixed horizontal position to prevent accidental movement or dropping.

4.1 UNPACKING

The device has been carefully inspected and tested before shipping. Visual checks for damage and functional tests should be performed upon receipt. Please also check the yellow tilt watch stickers on both sides of each carton box. If one or both have been triggered at more than 50°, please contact the Enapter customer support team. During transport, installation, packaging, or unpackaging, do not tilt, shake, or turn the device by more than 50° to avoid damage. Do not install the device on an inclined position of more than 10°. The device must be installed on static ground, free of vibrations and shaking.

Please remove the thin foil that covers the chassis before mounting the device in its final position. Make sure to not remove the warranty labels on the backside when removing the foil.

Please retain the original shipping materials. Devices must be returned in their original packaging – or in equivalent protective packaging – to ensure safe transport. Enapter will accept returned devices; however, if a device is damaged during transit due to inadequate packaging, repair or replacement costs may be charged to the sender. If retaining the original shipping materials is not possible, please recycle them responsibly.

Notice! Claim transport damage directly on arrival!

If any damage has occurred during transport, please report this immediately to the shipping agent and supplier or do not accept the shipment (if possible). If damaged, the device should be returned according to the shipping instructions provided in this manual, in the section "Transport, Maintenance and Recycling".

Caution! The device is heavy!

Never lift the device out of the packaging alone. The device weighs over 40 kg. Please see the data sheet for more details.

Use lifting aids if available.

Due to their weight and size, it is recommended to use a pallet cart or similar devices to maneuver the box upon delivery.

If the box must be lifted somewhere, always lift with at least two people.

4.2 TOOLS, MATERIAL AND ACCESSORIES REQUIRED

The following tools, equipment, and material are typically needed to connect the device successfully. Verify your chosen materials are compatible with their operational requirements.

4.2.1 TOOLS

- Wrenches depending on the pipes and connectors.
- Plastic tube cutter (to cut H_2O tubing)
- Slotted screwdriver (to screw in the power supply plug)
- Stainless-steel pipe cutter (to cut the H_2 Out, H_2 vent, and O_2 vent pipe)
- Appropriately sized stainless steel pipe benders (to bend the H_2 Out, H_2 vent, and O_2 vent pipe)

4.2.2 MATERIALS

It is the responsibility of the operator or integrator to select appropriate materials and components for connecting the system based on their specific setup, and to ensure compliance with all applicable local safety guidelines, rules, directives, and regulations. Enapter recommends that integrators prepare for device integration in advance by selecting and procuring the necessary materials prior to delivery, so that the devices can be deployed promptly upon arrival. <5>

Note: It is the integrator's responsibility to **carefully select appropriate materials** that are compatible with their specific system design and operating environment. Materials must meet both **technical performance** and **local regulatory** requirements to ensure safe and reliable operation.

- Plastic tubing connections
  - **Tubing Material**: Enapter recommends using soft plastic tubing, such as LLDPE (Linear Low-Density Polyethylene), to ensure the push-fit collets can grab the tubing securely. Harder, or more slippery plastics could slide off, increasing the risk of leaks or disconnections. Avoid using tubing that is too soft without reinforcing the tubing.
    After insertion, always perform a pull test to verify that the tubing is properly secured. The tubing must be compatible with deionized (DI) water and non-leaching in order to prevent contamination of the DI water caused by prolonged contact with the material. This is critical for maintaining water purity and protecting system performance. <5>
  - **Fittings**: Use fittings that are specifically designed to be compatible with the selected plastic tubing. Enapter recommends POM (Polyoxymethylene) fittings, which are known for their chemical resistance, mechanical strength, and durability. These are widely available from multiple manufacturers, making them a reliable and accessible choice for most integration scenarios. Ensure that all fittings are rated for use with DI water and pressure conditions within the system.
- Stainless steel piping and components
  - For high-pressure hydrogen lines, Enapter recommends using stainless steel piping and fittings, specifically AISI 316L or materials equivalent to ASTM A269. These materials offer excellent performance in terms of tightness, corrosion resistance, and resistance to hydrogen embrittlement and fire conditions. Ensure that all components are rated for a minimum

operating pressure of 45 barg, matching or exceeding the system's requirements for safe and reliable operation.

- H_2 OUT/VENT:
  - ¼" stainless-steel tube fitting male BSPP (ISO parallel) thread connectors, with an appropriate gasket or O-ring.
  - Male BSPT (British standard pipe tapered) fittings are permissible to be mounted with Teflon tape but not recommended. **Do not use NPT fittings, they will damage the thread.**
  - We recommend connecting stainless-steel pipes with at least ¼" outside diameter to connect the pressurized hydrogen lines. When multiple systems are connected together, integrators should size their piping according to the instructions in 21
- O_2 VENT:
  - ⅜" stainless-steel tube fitting male BSPP (ISO parallel) thread connector, with an appropriate gasket or O-ring.
  - Male BSPT (British standard pipe tapered) fittings are permissible to be mounted with Teflon tape but not recommended. **Do not use NPT fittings, they will damage the thread.**
  - We recommend connecting stainless-steel pipes with at least ⅜" outside diameter to connect the low-pressure oxygen lines. When multiple systems are connected together, integrators should size their piping according to the instructions in 25.

4.2.3 ACCESSORIES (INCLUDED IN THE BOX)

- Green AC male connector for electricity
- Draining pipe with connectors (2 m)
- Green DRY CON (dry contact) jumpers
- Antenna for increased amplification of Wi-Fi signal
- Black ferrite cylinder for the Dry Contact output cable
- Check valve[1] for the H_2 vent line. <5>
- Filter for the water inlet pipe, 10 mm pipe diameter
- M4x16 Torx countersunk screw - for daisy chain grounding
- Crimped ring terminal

<7>

[1] Only specific versions of the EL4.1 will have the check valve included in the shipment and must be installed according to the Owner's manual. Please verify if your system requires its installation. If unsure, please contact Enapter support.

4.3 IMPLEMENTING SYSTEM SAFETY

Each connection to and from the device must be inspected and tested. Additional system engineering might be required to ensure safe operation.

Always follow best practices, apply local codes of regulation (if applicable), and follow industry standards for the implementation of safety systems to manage the risks of producing and storing hydrogen.

Gas containing pipes must be properly connected to the specific ports, tested by the operator, and directed to separate safe areas. If this is not possible, the operator must find another safe solution, such as using a flare stack, burn box, or forced dilution. When forced dilution is utilized, all components used in this process must not be able to ignite the hazardous substances.

Danger! The device contains explosive and highly volatile gases!

It is the operator's responsibility to ensure good engineering practices are applied to the hazardous substances which are released during the operation of the device!

The operator must ensure that the outlet satisfies all relevant local safety guidelines, rules, directives, and regulations, in terms of the safe dispersion of the vented gas, noise emission, risk assessments, maintenance, a satisfactory safety concept being utilized, and all other relevant areas.

It is the operator's responsibility to regularly check and maintain all pipes.

4.3.1 SAFETY AREAS AROUND THE O_2 VENT AND H_2 VENT OUTLET

In general, there are two options for defining a safe area. The extent of this area depends on several factors, including the diameter and length of the piping leading to it, the design of the vent outlet, exit gas velocity, and prevailing wind conditions.

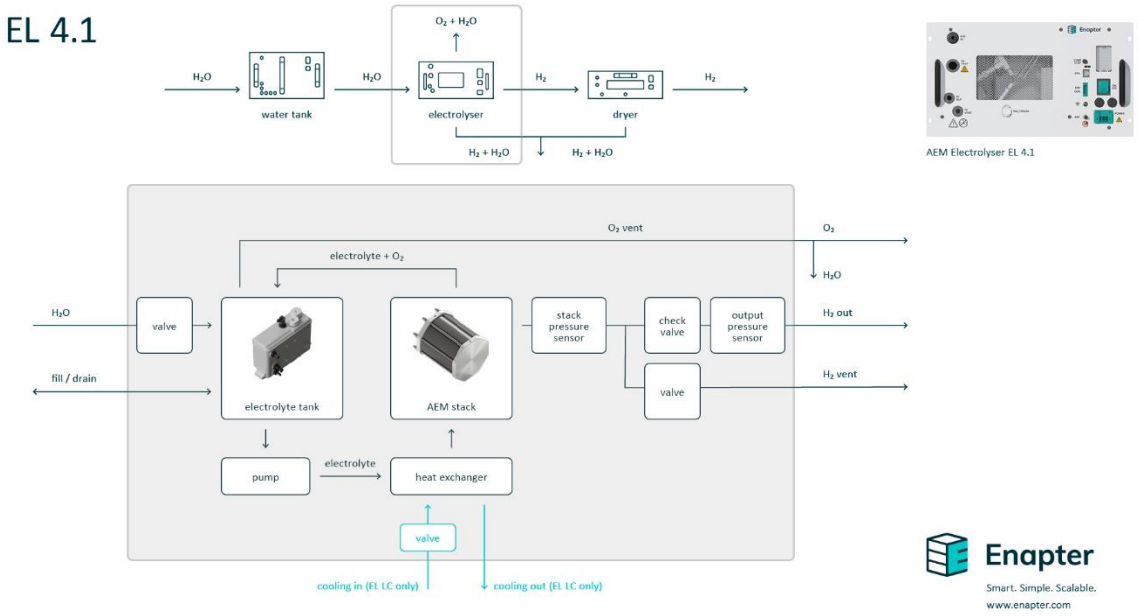
Preferably, the operator should:

1. Calculate the measurements of the safety area based on the provided data for each specific output and apply industrial standards such as following their system design, safety concept, and site documentation.
   - EIGA Doc 211/17: Hydrogen Vent Systems for Customer Applications
   - CGA G5.5: Hydrogen Vent Systems
   - EIGA Doc 154/16: Safe location of oxygen and inert gas vents
   - ISO/TR 15916:2015: Basic considerations for the safety of hydrogen systems
2. Or follow the recommendations of Enapter for systems consisting of up to ten (eight[2]) electrolyzers and two dryers. The safety area is cylindrical and has a height of 10 meters and a radius of 5 meters. Note that depending on the design of the vent piping and exit velocity, this area also extends in the direction of the ground by at least 1 meter. Never place the O_2 vent outlet near the H_2 vent or H_2 purge outlet to minimize the risk of explosion. Leave at least 3 meters of space between the gas outlets.

[2] ETL certified electrolyzer versions only

4.4 SIMPLIFIED PROCESS FLOW DIAGRAM (PFD)

The following diagram shows internal components of the device as well as how it interacts with the Enapter Dryer and the Enapter Water Tank. It is also available here. Please note that this diagram has been simplified to enhance clarity while safeguarding Enapter's intellectual property.



PFD of the EL4.1

4.5 INSTRUCTIONS FOR CONNECTING STAINLESS-STEEL PIPES

Attach all pipes first before starting the hydrogen production.

The stainless-steel connections need tube fittings with ¼" outside diameter for the H_2 pipes and ⅜" outside diameter for the O_2 pipe. The outlets to be connected according to these instructions are labelled "H_2 OUT" and "H_2 VENT", as well as "O_2 VENT" on the front panel of the device.

Follow the instructions of the fittings manufacturer carefully to install leak-tight connections. Cut the pipes perpendicular to the required length. Make sure that the pipes are not under tension. Ensure the pipe is free of score marks, the cut is perpendicular across the tube and remove sharp edges. Properly clean and flush the pipes, especially if they have been in contact with dust, dirt, or cutting particles. Make sure that the pipes are not getting in contact with oil or other liquids before or during the installation. Contamination inside the pipes may damage the device and connected components.

Always check each connection for leaks! Metal to metal fittings can be used but remounting them is not recommended due to possible leakages. For more information, please refer to Appendix I below.

4.5.1 HYDROGEN OUTLET CONNECTION GUIDE (H_2 OUT)

Connect the H_2 Out port, located at the bottom left of the front panel, to a hydrogen storage tank or the Enapter Dryer. It is recommended to fit a shut-off valve between the tank and the dryer to be able to isolate each string of modules during maintenance.

Multiple electrolyzers can be connected to a common line by combining the electrolyzers in a 19" rack via a common output line to the left of the devices and then connecting this H_2 line with the lines of other racks. Adapting the pipe diameters to the maximum output is required.

Three EL4.1 with common H_2 OUT connected to a DR2.1 <5>

Details

Danger! Explosive gases in pressurized pipes!

All pressurized connections must be carefully inspected and checked for leaks.

Failure to do so significantly increases the risk of explosion.

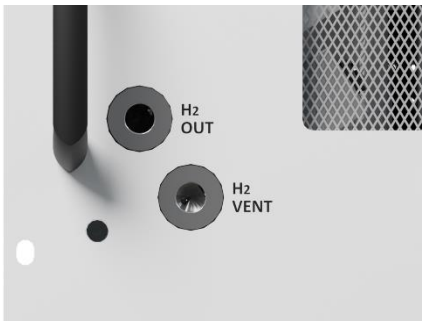
Ensure that all pressurized piping is clean and free from metal swarf, obstructions, or other particles, as these may cause injury or equipment damage—especially during rapid depressurization.

A pressure relief device must be installed between the H_2 Out port and any downstream equipment or hydrogen storage to prevent overpressure and protect connected systems.

Enapter is not liable for damage resulting from improper installation.

When assembling larger hydrogen systems using multiple modules, ensure that the downstream piping is correctly sized. Undersized piping can restrict flow and create operational hazards. It is the operator's responsibility to select suitable piping and ensure that the entire outlet system complies with all relevant local guidelines, rules, directives, and regulations - particularly those related to gas handling, noise emissions, risk assessment, maintenance, and safety. All piping must be regularly inspected and maintained by the operator. For any questions regarding piping configuration or installation, please contact Enapter Customer Support.

4.5.2 HYDROGEN VENT CONNECTION GUIDE (H_2 VENT)



H_2 OUT and H_2 VENT

Connect the H_2 vent port, located at the bottom left of the front panel, to your hydrogen vent outlet.

During ramp-up, after ramp down and every 6 h (35 barg version)/every 1.5 h (8 barg version) during operation, the electrolyzer depressurizes and releases up to 20 NL (35 barg version)/5 NL (8 barg version) of hydrogen within 2 seconds with a loud noise through the vent line. Please wear PPE earplugs when close to the devices. Venting is necessary to release the water which has been extracted from the hydrogen.

The released hydrogen will pose a risk of explosion – therefore, it must be led into a safe area, typically elevated to a height of at least 3 m, without any source of ignitions. For more information, see the section Safety areas around the O2 vent and H2 vent outlet. If this is not possible, please contact Enapter support, as managing the purge in other ways, such as using a flare stack, burn box or forced dilution is possible, but requires careful consideration.

Starting from May 2025, most EL4.1 systems will be shipped with an integrated check valve. For units delivered before this date, or for 8 bar versions, a check valve[3] is included in the packaging and must be installed downstream of the electrolyzer's vent output and replaced if defective. Please contact Enapter support if you are unsure if your system has an integrated check valve or not. <5>

[3] Only specific versions of the EL4.1 will have the check valve included in the shipment and must be installed according to the Owner's manual. Please verify if your system requires its installation. If unsure, please contact Enapter support.

Three EL4.1 and a DR2.1 with common H_2 VENT <5>

Details

Danger! Risk of explosion!

Never mix the output of the H_2 purge line with the output of the O_2 vent line.

The H2 vent line can be combined with the H2 purge line of the Enapter DR2.1 using the provided check valve[4] downstream from the electrolyzer's H2 vent port.

Ensure that the line always remains open to the atmosphere and that no pressure build-up exceeding 0.2 barg occurs inside the line. **All purge and vent lines must be installed with a consistent downward slope, as** any overpressure or blockage may lead to permanent damage to the device. It is critical to prevent any conditions that could result in the pipe being closed off or subjected to backpressure. The lowest point of the vent line should be where condensation is expected to accumulate and should be fitted with a water trap, unless the piping is designed in a way that allows condensed water to drain or be pushed out effectively, without causing an excessive pressure drop.

The line contains water steam and liquid water which can freeze and block the pipe. The pipe of each device and the common pipes for several devices must be sized appropriately and managed with an appropriate drainage system and good engineering practices to always allow the gas to flow while still draining the water safely.

The operator must ensure that the outlet satisfies all relevant local safety guidelines, rules, directives, and regulations, in terms of the safe dispersion of the vented gas, noise emission, risk assessments, maintenance, a satisfactory safety concept being utilized, and all other relevant areas.

It is the operator's responsibility to regularly check and maintain all pipes.

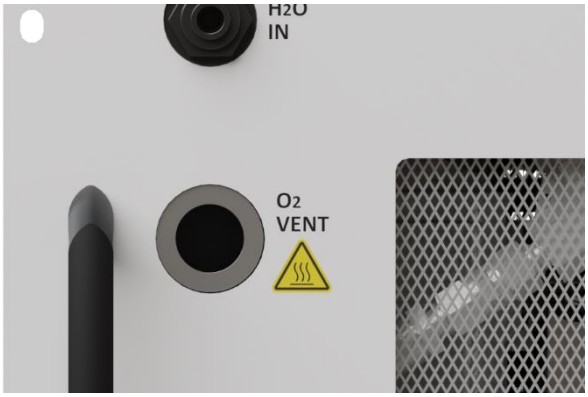
Enapter is not responsible for any damage caused to the device from mismanaged piping arrangements.

Important: When connecting to the port labeled "H_2 Vent", always use piping, connectors, and sealants that are resistant to H_2, KOH, and pressure.

[4]We recommend contacting Enapter to make sure that the purchased product is compatible (support@enapter.com)

4.5.3 OXYGEN VENT CONNECTION GUIDE (O_2 VENT)

Connect the "O_2 Vent" port, located at the top left of the front panel to your oxygen vent outlet.



EL4.1H_2O IN and O_2 VENT

The O_2 vent line requires the most demanding line management. Please study this section carefully. The oxygen vent line carries around 0.25 Nm³/h of oxygen at up to 58 °C out of the electrolyzer. Crossover in normal operation is under 3%, in the production range 60%÷100%, up to 30 barg (at the beginning of life). In transient conditions (such as ramp-up and ramp-down) and in the event of stack failure, a flammable mixture shall be expected and managed accordingly (venting to a safe area without ignition sources along/around the vent system).

Danger! Risk of explosion!

- Never mix the output of the hydrogen (H_2) vent line with the output of the oxygen (O_2) vent line.
- Do not combine the O_2 vent line of an EL 4.1 device with the O_2 vent line of any EL 4.0. The EL 4.0's O_2 vent releases hot gases.

Ensure that no overpressure or underpressure greater than ±0.1 barg occurs within the vent line. The line must remain open to the atmosphere at all times. Failure to comply may result in permanent damage to the device.

The vent line contains both water steam and liquid water, which can freeze and block the pipe. Each device's pipe – and any shared (common) piping across multiple devices – must be properly sized and designed using good engineering practices. A suitable drainage system must be implemented to allow for safe removal of condensate while ensuring unobstructed, bidirectional gas exchange.

The operator is responsible for ensuring that the outlet system complies with all applicable local safety guidelines, rules, directives, and regulations. This includes aspects such as the safe dispersion of vented gases, noise emissions, risk assessments, regular maintenance, and the implementation of a robust safety concept.

All pipes must be regularly inspected and maintained by the operator.

Enapter is not liable for any damage caused by incorrect or mismanaged piping configurations.

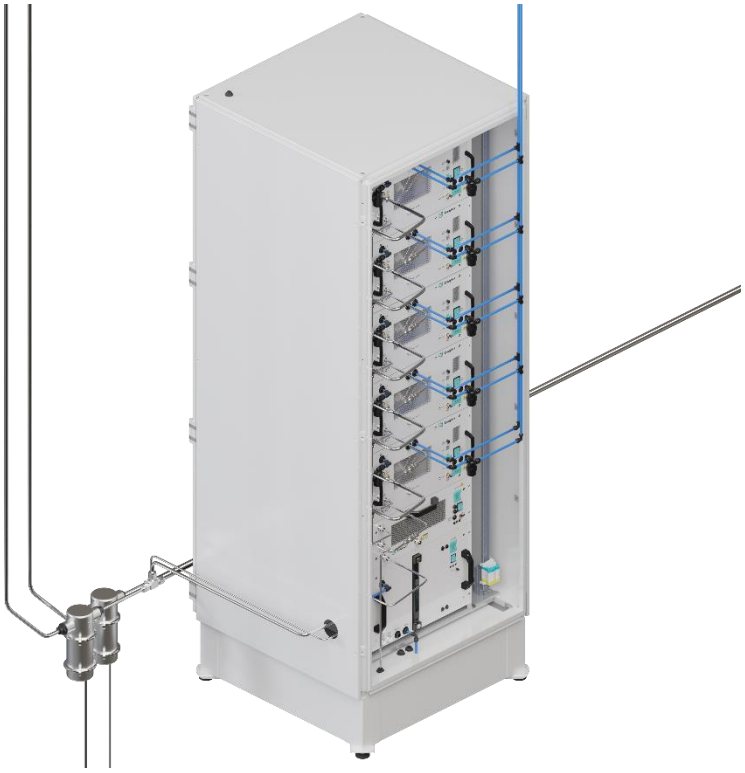
Important: When connecting to the port labeled "Vent", always use piping, connectors, and sealants that are H_2, O_2, KOH, and pressure resistant .

The oxygen vent outlet must lead to a safe area with appropriate ventilation. For more information, see the section Safety areas around the O2 vent and H2 vent outlet. The water from the water drainage system must be drained according to all relevant local safety guidelines, rules, directives, and regulations as it may contain KOH in case of overfills.

We recommend leading the gaseous outputs from the oxygen vent to a safe area, described in the section "Implementing System Safety". If this is not possible, please contact Enapter support, as managing the purge in other ways, such as using forced dilution, is possible, but requires careful consideration. <3>

Three EL4.1 and a DR2.1 with common O2 VENT <5>

Details



Example of an O_2 Vent line and water trap

Warning! Risk of explosion!

The gaseous outputs from the oxygen vent and the hydrogen vent must be kept separated. Mixing these outputs result in an explosive atmosphere.

4.6 INSTRUCTIONS FOR CONNECTING PLASTIC TUBES

The device uses simple push-fit connectors, allowing plastic tubing to be quickly and easily installed without the need for additional tools.

To prevent accidental disconnection during operation, especially on the H_2O and liquid cooling loops located on the front panel of the electrolyzers, it is strongly recommended to use collet locking clips.

1. Cut the pipe perpendicular to the required length. Make sure that the pipes are not under tension. Ensure the pipe is free of score marks, the cut is perpendicular across the tube and remove sharp edges. **Properly clean and flush the pipes, especially if they have been in contact with dust, dirt, cutting particles, or liquids like oil.** Fully insert the tube into the fitting. The inserted pipe diameter must match the fitting.
2. Pull the tube to check it is firmly held in place, then secure the connection by inserting a red fastening clip.
3. To disconnect, ensure that the line is depressurized. Then, remove the red fastening clip and push the collet against the fitting, while simultaneously pushing the tube into the fitting. Holding the collet in this position, pull the tube out of the fitting in one smooth motion.

4.6.1 WATER INLET CONNECTION GUIDE (H_2O IN)

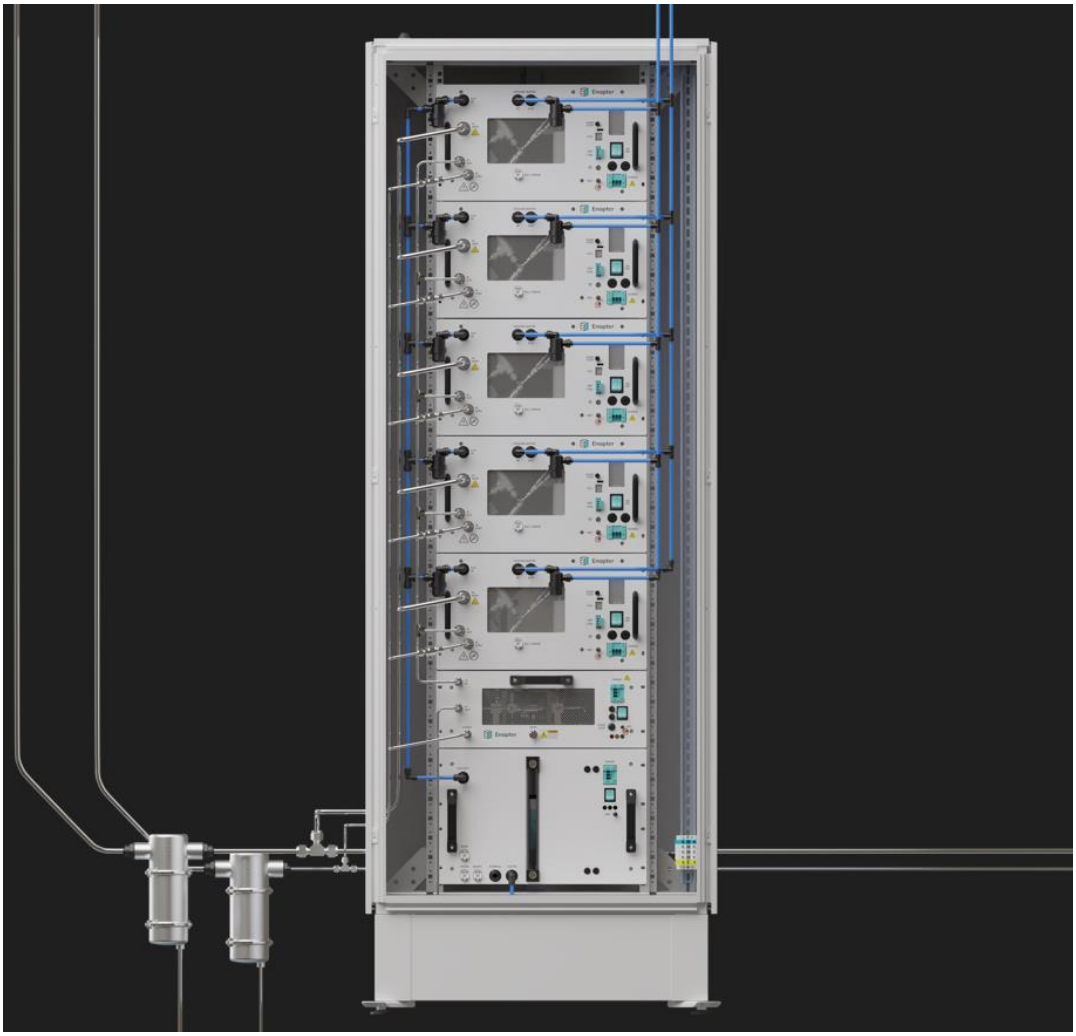
EL4.1A H2O IN and O2 VENT

The water inlet connector is a push-fit bulkhead for an outside pipe diameter of 10 mm. This inlet port is used for the automatic refilling of demineralized water from a pressurized source.

Notice! Overpressure can damage the device!
Ensure water pressure on the input line never exceeds the maximum allowed pressure. This can cause irreparable damage to the device and create significant leakages. Enapter is not responsible for any damage or injury resulting from the misuse of the device.

Notice! Insufficient water quality harms the device!
Ensure the water input quality is sufficient. Water with a high conductivity will irreparably damage the stack. The same applies for particles and debris in the demineralized water. It is recommended to install a filter at the water inlet of the device (included in shipment) and inspect it regularly to ensure that the water is free of particles. This filter does not affect the conductivity and cannot be used to replace the water purification system.
Ensure that the conductivity is always as low as possible. Otherwise change the cartridges of the water purification system immediately.
To minimize the number of required electrolyte exchanges, please follow the Water Input Quality recommendations in chapter 1.1 using ASTM D1193-06 Type I or II, with an acidity <0.1 meq/L, or adhere to the minimum system specifications for conductivity and acidity.
If a device is damaged from using water with insufficient conductivity or debris, Enapter is not responsible for any damage caused.

Flush all water pipes with demineralized water before connecting the device to ensure no debris is in the lines. Then connect your water supply to the "H_2O IN" port located at the top left of the front panel. Install the filter, which is included in the shipment, close to the "H_2O IN" port to avoid debris from entering the device.



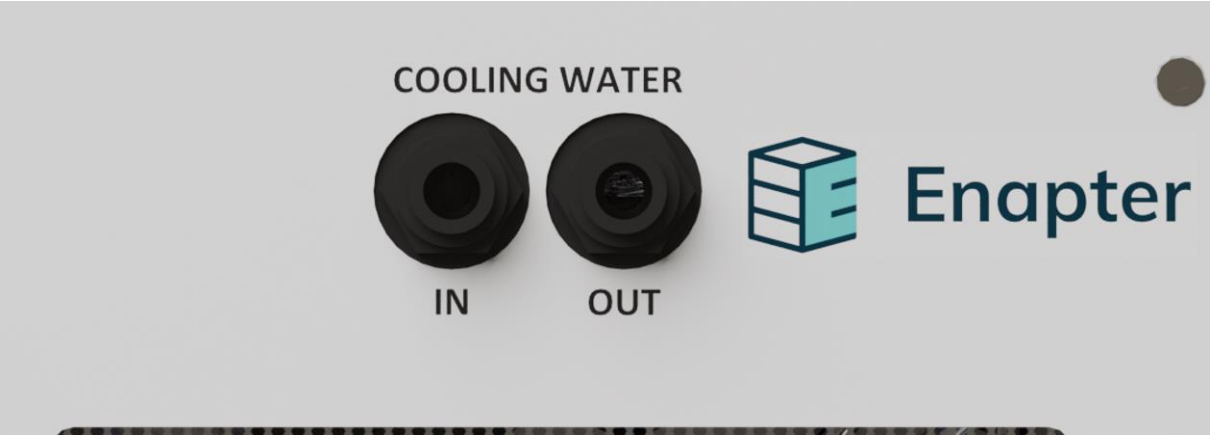
EL4.1 all pipes connected.

After performing the first Electrolyte Filling (filling the device with the electrolyte solution), the device will consume water during operation at a rate of around 0.42 L/h. The refilling is triggered automatically from the "H_2O IN" port. This occurs periodically during operation, or directly after ramp down.

4.6.2 COOLING LOOP CONNECTION GUIDE (COOLING WATER IN/OUT)

For connecting the cooling loop of the liquid cooled electrolyzer please consider the following instructions. For air-cooled devices, these instructions are not relevant.

Flush all water pipes with clean water before connecting the device to ensure no debris is in the lines. Only use components and materials which are compatible with the used cooling agent and with temperatures up to 60 °C.

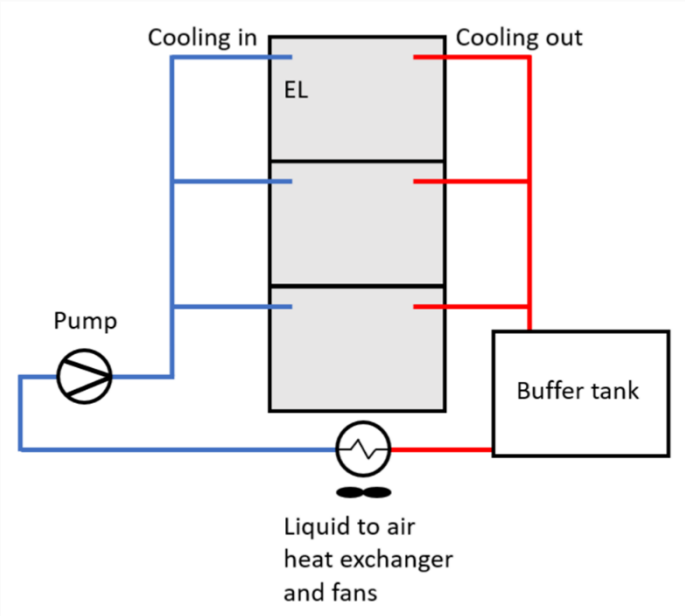


EL LC COOLING WATER IN and OUT

For the cooling of the device, Enapter recommends setting up a closed cooling loop using water or a water glycol mixture as a cooling agent. The cooling agent must be compatible with all the materials utilized in the cooling loop piping (as well as 1.4301 stainless steel, LLDPE, POM and EPDM) and be free of particles and be usable at up to 60°C. To further increase device reliability, install the filter supplied by Enapter on the cooling line inlet of the device. When the cooling agent is no longer showing the necessary physical and chemical requirements, is diluted, or shows any other form of degradation, it must be exchanged. At an external heat exchanger, the waste heat can either be transferred to another medium for further use or be dissipated to the ambient air by a fan. An external pump is needed to circulate the cooling agent. Please consider that the normally closed valve inside the device only opens when cooling is required.

The "COOLING IN" and "COOLING OUT" connectors are push-fit bulkheads for an external pipe diameter of 10 mm.

Connect the ports located at the top of the front panel to your cooling circuit. When integrating multiple electrolyzers into the same cooling loop, they must be connected in parallel to ensure consistent cooling performance. Enapter recommends connecting no more than five electrolyzers to a single cooling agent feed pipe to avoid excessive pressure drops and to maintain balanced water flow across all units. For larger setups, multiple cooling agent feed pipes should be connected in parallel, with an appropriately sized pump to circulate the cooling agent. Each device includes built-in flow restrictors (2 L/min) to help balance the cooling liquid distribution when multiple electrolyzers are connected in parallel.



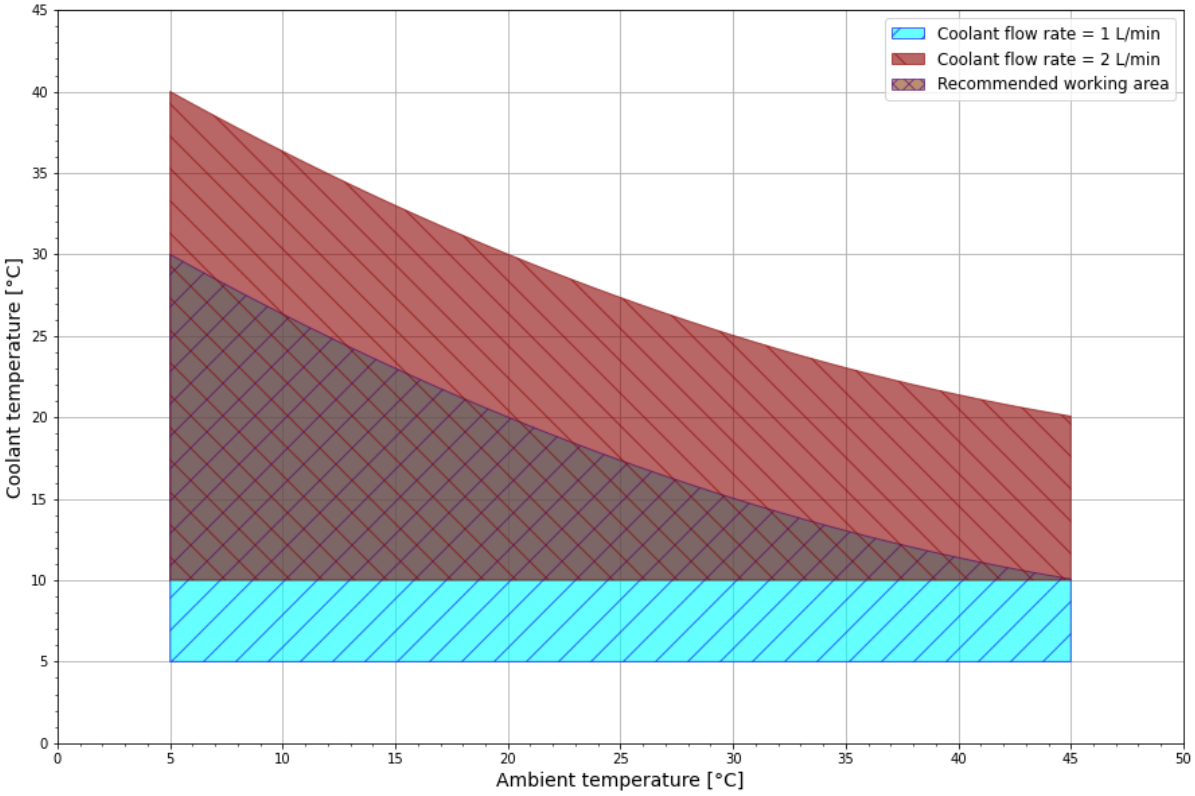
Cooling loop schematic

It is recommended to set up the cooling loop according to the schematic on the left. The return line (from the "COOLING OUT" port) should be connected to a non-pressurized coolant tank. This reduces back-pressure stresses on the valve inside the device and will prolong its lifetime. Connect the pump downstream of the external heat exchanger. When positioning it lower than the buffer tank, gravity can be used to feed the pump with cooling agent.

EL LC with filter

The external heat exchanger must be sized to be able to transfer up to 1000 W out of each electrolyzer connected to the cooling loop.

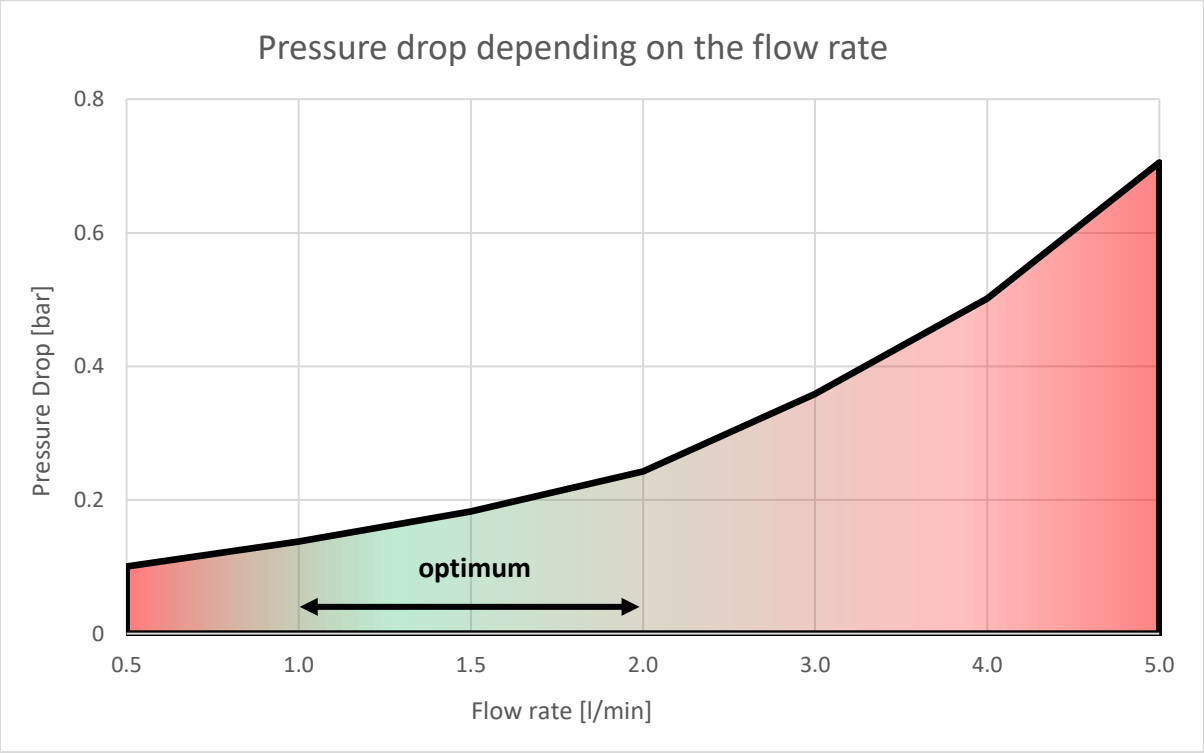
The graph below indicates the operating range of the cooling circuit in terms of allowable inlet temperature of the cooling agent and the ambient temperature depending on the flow rate.



Possible cooling agent temperatures depending on the flow rate and ambient temperature.

The x-axis shows the environmental temperature, while the y-axis shows the coolant temperature. The graph differentiates between the following three sections: the top red one represents the possible working conditions if the coolant flow rate is at the maximum allowed 2 L/min; the light blue area instead shows the possible working conditions if the flow rate is at the minimum allowed value of 1 L/min. The section between the two areas is defined as the recommended working area.

The flow rates shown refer to the instant flow rate per electrolyzer. The cooling operation of the devices is intermittent so the average flow rate will be lower. Keep in mind that these values are based on water. When using another cooling agent with a different heat capacity, the required flow rate needs to be adapted accordingly. The pump used must be suitable for intermittent operation and able to build up pressure against the normally closed valve inside the device. The pump must be correctly sized to provide the necessary flow rate against the pressure drop induced by the piping and electrolyzers. The maximum flow rate through one device is limited to 2 l/min by a flow restrictor. The pressure drop inside the device is around 0.25 barg for water and up to 0.35 barg for a glycol water mixture at 2 l/min. It is the operator's responsibility to correctly size the liquid-liquid/liquid-air heat exchanger and the cooling agent pump.

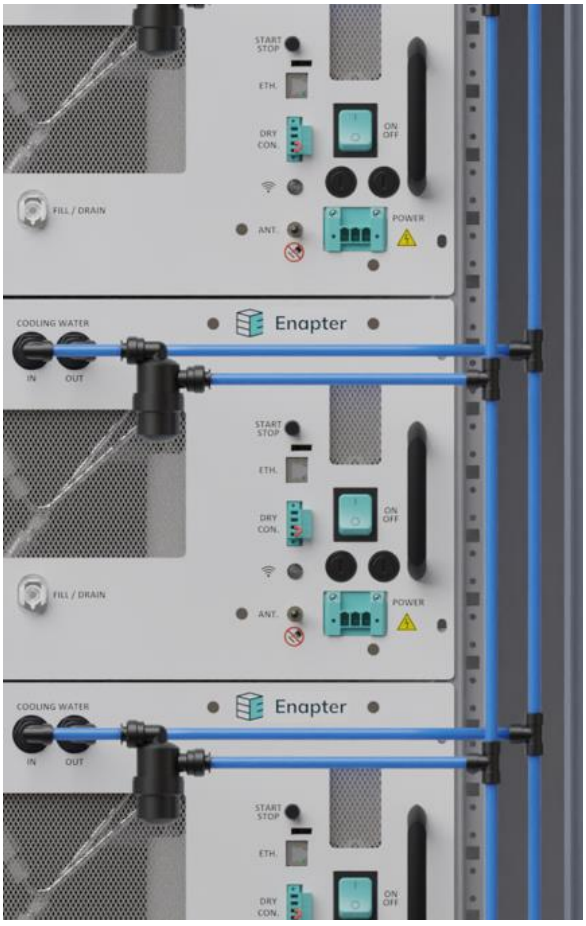


Pressure drop depending on the flow rate.

Please be aware that the device generates more heat as it degrades. At the beginning of life, a maximum of 600W per electrolyzer can be extracted from the electrolyte. At the end of life, this value increases to ca. 900 W per electrolyzer. This waste heat can be available at up to 45 °C and can then be used for any customer-specific heating purposes <5>.

Notice! Impurities can damage the device!
Ensure that the cooling agent pressure on the input line never exceeds 4 barg. Make sure that the cooling agent is filtered and free of particles. This can cause irreparable damage to the device and create significant leakages. Enapter is not responsible for any damage or injury resulting from the misuse of Enapter products.
Ensure the cooling agent pump can supply at least the minimum required flow rate. Shortage of cooling can cause irreparable damage to the device.

Three EL4.1 and a DR2.1 with common Cooling pipes <5>

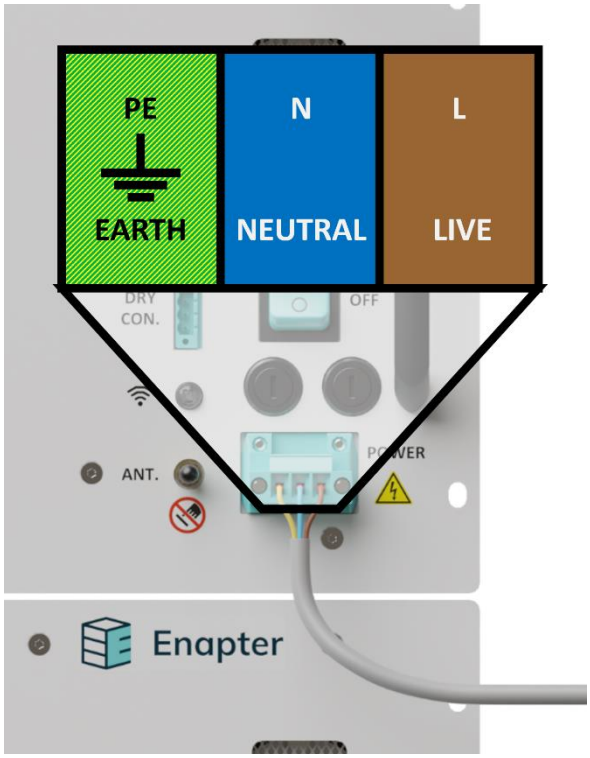


Details

4.7 ELECTRICAL CONNECTION GUIDE (POWER)

Warning! Explosion hazard. Do not remove or replace the power connector while circuit is live unless the area is free of ignitable concentrations!
Always turn off the device and fully ventilate the room first before removing the power supply. Otherwise, electric sparks may occur. The area must always be free of ignitable concentrations.

Warning! Risk of electrical shocks!
Double-check all the wiring connections before supplying power to the device. Failure to adhere to the following instructions can damage the device and lead to hazardous conditions in and around the device! Make sure that the power supply male connector is always fixed with screws to the female connector to avoid any accidental removal of the plug.
Never handle connections with wet hands!



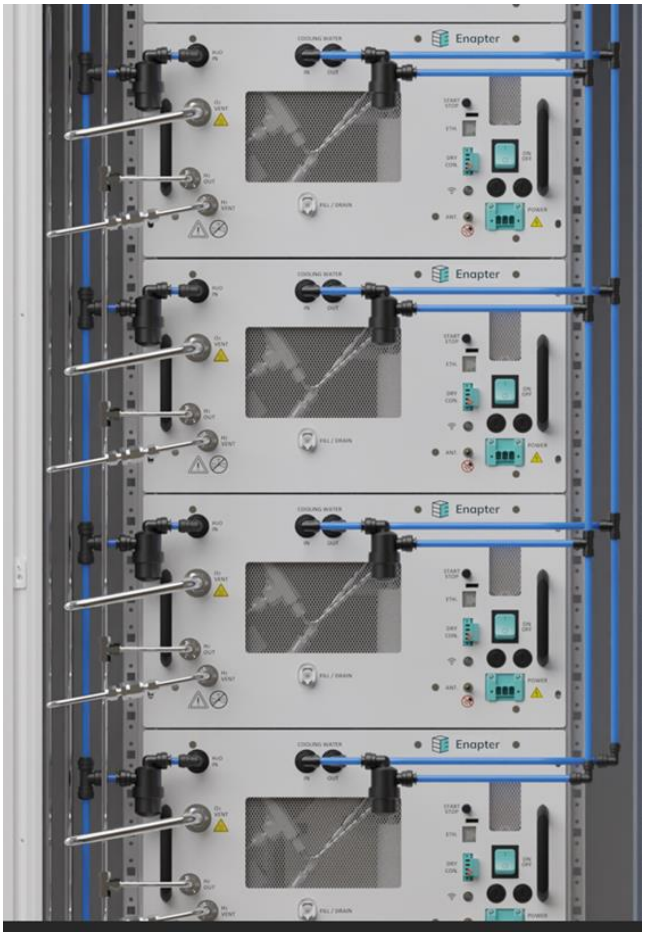
EL4.1 AC version power connector

Follow the relevant safety standards and ensure compliance with all relevant local safety guidelines, rules, directives, and regulations. Ensure that the connector is used in the correct orientation, as shown in the picture. Do not exceed the specified voltage and amperage (see battery limits for more details). Enapter recommends installing a protective device against overload and short circuits for all device versions on the power supply line. It must be selected in relation to the device's maximum power consumption and in compliance with all local and national safety requirements. To further increase electrical safety of the device, it is recommended to install an SPD (Surge Protection Device) to protect the device from potential over-voltages generated by lightning strikes, as well as an appropriately sized differential breaker for the installation.

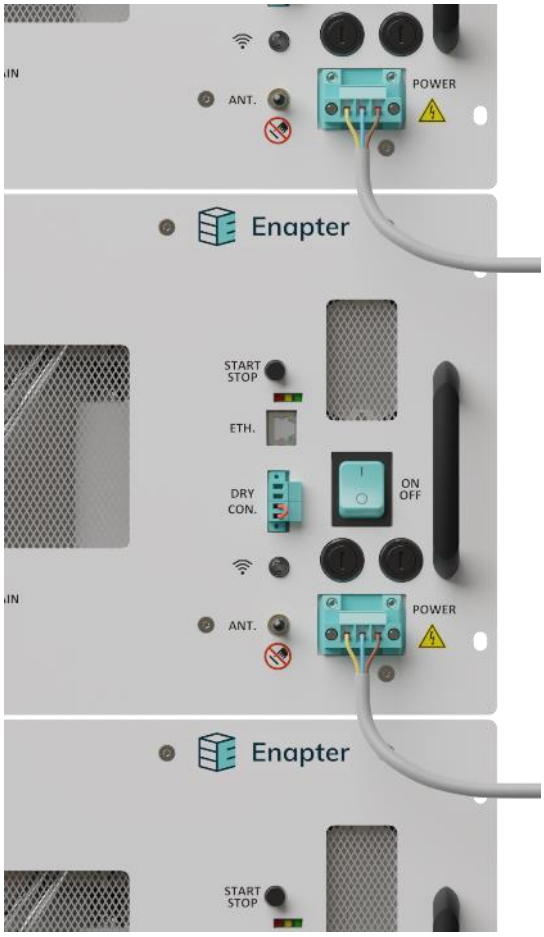
4.7.1 AC VERSION

Connect the device to the socket labelled "Power". Brown is live, blue is neutral, and yellow/green is the protective earth connection. The datasheet of the power supply plug can be found here. See the battery limits for more details. In the latest versions of the device (AC model), two thermal overcurrent switches are mounted on the front panel. Older versions use two 420 V, 16 A, Ø5 × 20 mm fuses, which must be replaced if blown. <3>

In case the thermal switch opens the circuit, you can manually reset them by pressing the integrated button.



Three EL4.1 and a DR2.1



Details

4.8 DRY CONTACT CONNECTION GUIDE (OPTIONAL) (DRY CON.)

The device has integrated dry contact sockets to allow emergency stops triggered by external devices e.g., a hydrogen sniffer or emergency stop switch. It is recommended to place this switch close to the devices so it can be identified that it will stop the system but not in a way that it is difficult to reach or be blocked by other devices or components. If no dry con chain needs to be integrated, please jump to the section below.

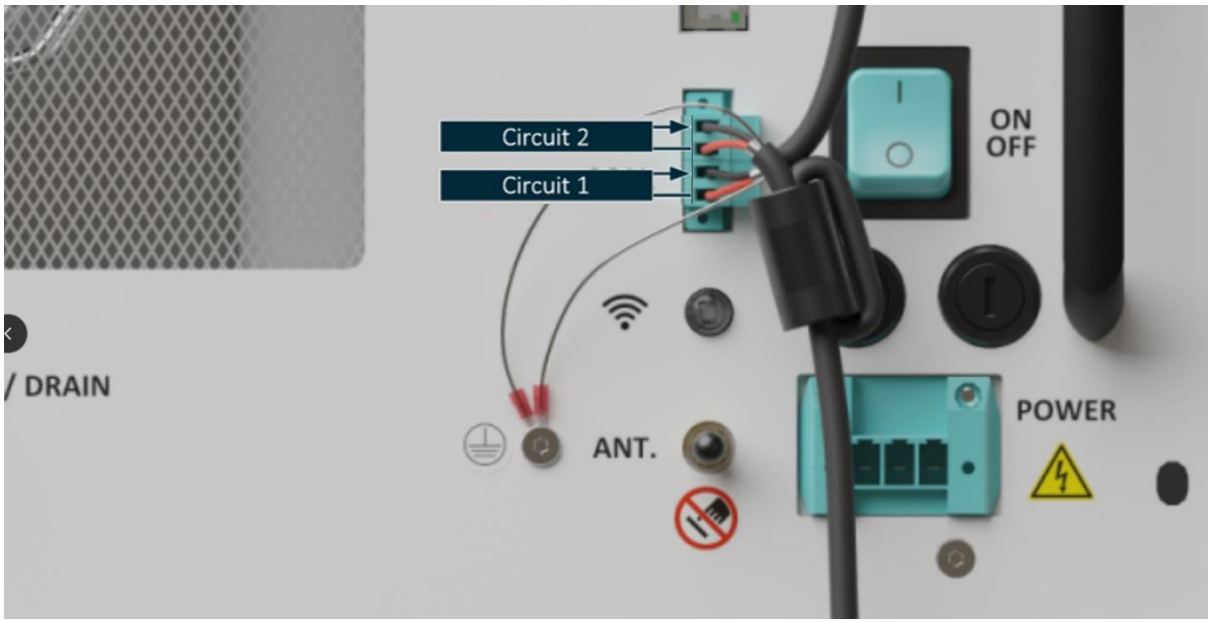
The cables of the input and the output (not part of the shipment) must be two-wire shielded cable with grounding (instruction on how to implement them below) <7>. The ferrite provided with the device should be placed as close as possible to the output connection (upper slot) with a double turn, as shown in the picture.

Connect the male connector of the dry contact chain to the female port on the device, labelled "DRY CON". The dry contact chain is closed during normal operation and opens in case of emergency.

The External safety device must be NO (normally open). Commonly, this could be a Hydrogen sensor.

The logic sample below:

External safety device on → internal contacts close → dry contact chain is closed → Normal operation
External safety device off → internal contacts open → dry contact chain is open → Alarm triggered, and operation is stopped. <7>



DRY CON circuit <7>

The pins are, from top to bottom, S2, COM2, S1, COM1. This allows the device to not only receive a dry contact signal but also to pass it on to the next Enapter device. The operator can daisy chain as many Enapter devices as wanted to a common loop, with the circuit length not exceeding 4 meters. To do that, connect a dry contact circuit to Circuit 1 (as shown in the picture), using the specially supplied plug. If the circuit is interrupted (i.e., the dry contact is opened), the device will immediately go into fatal error, stopping the hydrogen production, and release the internal hydrogen by venting it through the H_2 vent line.

Caution! The dry contact signal will not cut the power from the whole devices!
If the DRY CON is triggered, it will cut the power from the stack but not from the whole device. That means that the hydrogen production will be interrupted, but the device continues running.
If one electrolyzer within the DRY CON daisy chain is switched off, the chain is interrupted, and the emergency stop signal will not be transferred to the downstream devices

To implement the dry contact daisy chain, connect the two free contacts (Circuit 2) to the Circuit 1 of the nearest Enapter device When an external device triggers the dry contact, every electrolyzer connected in the chain will halt hydrogen production simultaneously. If one unit in the chain is switched/powered off, it must be isolated from the loop, so the other units that remain on can continue to operate under the daisy-chain safety system.

Note: A powered-off electrolyzer still connected to the daisy chain interrupts the safety loop. Always isolate inactive devices. **Dry contacts should not be used for normal start and stop operation.** Unexpected power cuts to the stack without normal ramp downs can shorten the device's lifetime and damage the device!

Additional Grounding Requirement

For installations where one or more electrolyzers are connected in a dry contact daisy chain, a two-wire shielded cable must be used.

The cable shield must be grounded at both ends:

At the external device side (e.g., hydrogen sensor)

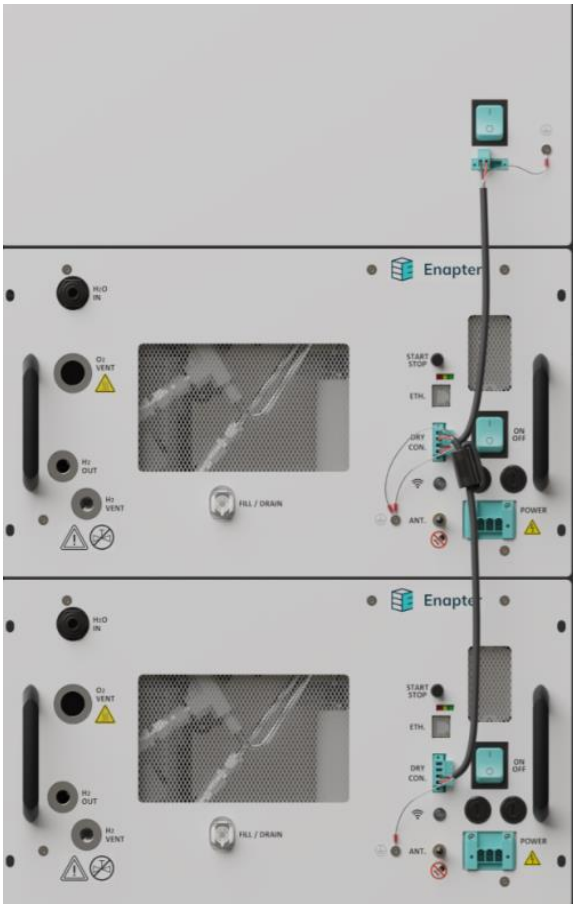
And at the electrolyzer side.

When multiple electrolyzers are connected in a series (daisy-chained), the shield grounding must be continuous and consistent between the input and output of each electrolyzer.

This is necessary to ensure system reliability and safety.

A dedicated grounding screw is supplied with each device to enable secure connection of the protective earth (PE) wire directly to the electrolyzer housing. The grounding screw can be installed in the designated threaded hole on the front panel of the device, and the wire connected using the supplied crimped ring terminal.
Other grounding methods may be used, provided they meet the grounding requirements (shielded cable and earthing on both ends of the chain for each connected EL).

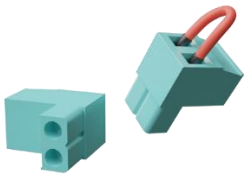
All conductive extremities and metallic surfaces within the electrolyzer cabinet, including those of adjacent units, must be bonded to a common ground point. Failure to maintain continuous grounding between chained devices can result in electrical hazards, potential equipment damage, or loss of warranty coverage. <7>



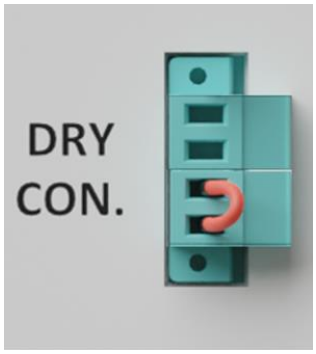
Dry Con daisy chain with two electrolyzer <7>

4.8.1 DRY CONTACT CONNECTION BYPASS

To disable the dry con chain functionality, insert the dry con jumper with the red connection cable in the lower part of the socket labelled with "DRY CON" like shown in the picture.

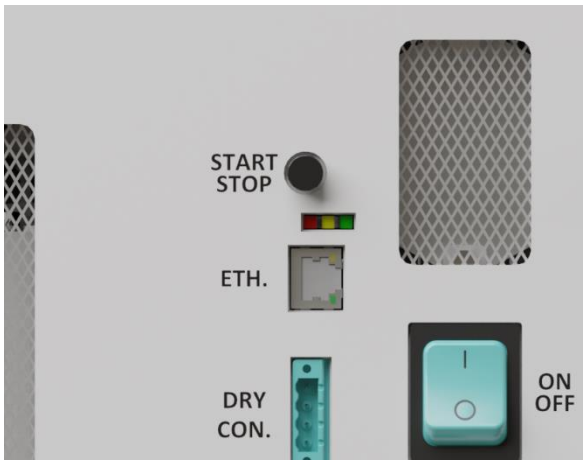


DRY CON jumpers



DRY CON connector with installed jumper

4.9 ETHERNET PORT (ETH.)



EL4.1 AC version Ethernet Connector

The front panel features an ethernet port.

This Ethernet port allows Modbus TCP/IP access. The device cannot be directly connected to a Local Area Network (LAN) to access it via the cloud or app. To access the device via the cloud or app, Wi-Fi and Bluetooth must be used. Please find more information in the chapter Pairing the device to the cloud. The Modbus command interface table can be accessed online via Enapter handbook. The Ethernet cable must be shielded.

4.10 ISO 22734 REQUIREMENTS

The device is ISO 22734 ready. To reach full conformity to ISO 22734 it is the operator's responsibility to additionally fulfil the following requirements from ISO 22734 which cannot be covered by Enapter.

ISO 22734 chapter	Title	Deviation from the requirement and necessary changes from the operator
4.3.9 / by 4.3.3.2	Environmental tolerance of enclosure	The IP rating of this device is IP20. However, the ISO22734 requires: Where a hazard from ingress of solid foreign objects and/or ingress of water exists, as a minimum the hydrogen generator shall: a) meet the IP22 rating as defined in IEC 60529 for indoor, industrial use b) meet the IP34 rating as defined in IEC 60529 for indoor, residential use
4.4.1.4	Protection methods to prevent the accumulation	Detection of hydrogen/air mixtures exceeding the maximum volume fraction of 1 % hydrogen shall cause hydrogen generation to stop and de-energization of non-classified electrical equipment. <4>

	of ignitable mixtures	
4.4.1.10	Venting system	H_2 and O_2 venting systems are not provided with the device and shall be designed and installed by the operator according to ISO 22734 requirements.

4.11 INITIAL OPERATION OF THE ELECTROLYZER

4.11.1 PREPARING FOR H_2 PRODUCTION

Now that the pipes and cables are connected, here is what to do next to get it running.

4.11.2 PAIRING THE DEVICE TO THE CLOUD

It is time to power on the device for the first time. Make sure that the antenna is installed on the device for a more reliable Wi-Fi connection . Push the On/Off button to switch the device on. Press the Wi-Fi button and ensure that the blue LED is steady, which indicates that it is turned on.

Download the Enapter app from most major app stores.. After installing, open the app. For detailed information about the app, please refer to the mobile application handbook.

1. If you are using the application for the first time, you will need to register. If you already have an account, please skip this step.
   - To create an account, click on the create account button on the first screen.
2. After logging in on the Enapter app, create a site – a virtual environment which will show all the telemetries collected from the devices connected to the cloud via UCMs (Universal Communication Modules). UCMs for additional Enapter-external devices can be purchased via Enapter.
3. Add all your devices to the newly created site by clicking on "Add device" and scanning the QR code which is located on the front panel of each device.

4.11.3 ELECTROLYTE FILLING

When the device is connected to a water supply and to the Web GUI or Enapter app, it is now ready to be commissioned for its first use. Once it is successfully paired to the cloud, it starts in maintenance mode and gives prompts to perform the first-time filling.

If refilling the device during regular maintenance, it might be necessary to repeat the steps of draining and filling the electrolyte a few times. This ensures that contamination inside the tank is kept at a minimum, especially if the device has not been used for a long time. The Enapter app will automatically guide you through the process. Make sure to not overfill the device as this will cause irreparable damage. If the electrolyte does not fully drain, please contact the Enapter customer support team.

Time required	5 minutes
Materials required	Safety Glasses
	Nitrile Gloves
	2 L of KOH solution

To prepare the device for operation, before demineralized water is added automatically, it must be filled with electrolyte. As it is not included in the shipment, it can be procured or purchased locally. Please refer to Preparing fresh electrolyte Preparing fresh electrolyte. <6>

Caution! Chemicals can cause injuries!
Refer to the Safety Data Sheet (SDS) of all chemicals used before handling them. All persons using, preparing, and filling the electrolyte into the device must be informed about any potential hazards involved with their activities.
Follow industrial hygiene and safety practice and wear appropriate personal protective equipment (PPE). Avoid any contact with eyes and skin.

Notice! Ensure material compatibility.
Ensure all material used to store and contain the electrolyte solution is chemically compatible with its contents.
Notice! Overfilling the device will lead to irreparable damage inside the device!
Enapter is not responsible for any damage caused by the operator.

Push CPC connector in to connect

Push clip on top of socket and pull connector to disconnect

Filling instructions:

1. Make sure that the device is online to follow the Enapter App or use the Web GUI instructions to fill the device.
2. Put on PPE. The minimum required equipment are safety goggles to protect from splashes and nitrile gloves. Ensure the working area is clean to avoid chemical contamination and potential exposure hazards.
3. Temporarily remove the "O_2 VENT" pipe.
4. Make sure that the device is fully drained, otherwise it might get overfilled and damaged.
5. Prepare an electrolyte bag with 2 L of KOH solution as well as the refilling pipes.
6. Switch the device to the Maintenance Mode and ensure that the internal electrolyte tank is empty. If the device is not in Maintenance Mode, it will try to refill while draining the device. To check if the device is in maintenance mode, please check the device status. Do not leave the device powered on and unattended while in Maintenance Mode.

7. If you purchased the KOH kit, place the Vitop connector over the cap on the reusable electrolyte bag with the red cap pieces facing the same direction. Push the Vitop connector down over the cap on the electrolyte bag and secure it by turning the red cap clockwise <5>.
8. Fully insert the supplied male CPC quick connector into the "FILL/DRAIN" port as shown in the left picture above.
9. If using the mobile app, press "Start refilling" now.
10. Carefully raise the electrolyte bag above the device so that gravity lets the 2 L of electrolyte flow into the device. Never lift the electrolyte above eye level. The solution will start filling immediately, if this does not occur, ensure the vent line is open to the atmosphere. Follow the steps provided by the app: pour the requested amount (2 L) until the app shows a pop-up to stop the filling process. This is roughly the size of the electrolyte bag.
11. If the app prompts you to stop, stop filling by lowering the bag below the electrolyzer and unplugging the connector by pushing the button on top of the CPC connector.
    Do not overfill the device.
12. Confirm the successful refilling by pressing the button "Exit Maintenance Mode" in the app.
13. After the filling, the water supplied via the H_2O IN port will match the required KOH concentration of 1 % during the filling procedure. Make sure a water supply source is attached to the "H_2O In" port when filling up electrolyte. If there is no water supply source available yet, the device will show a warning that no water supply source is attached. However, it is still possible to produce hydrogen for a few hours until the automatic refilling is triggered.

After the successful filling, the device will ask for a firmware update (if outdated). We recommend always using the latest firmware version to ensure all features are available and all bugs have been fixed. For questions regarding the firmware, please visit the firmware section in the handbook.

The device will automatically refill water via the H_2O In port during hydrogen production. This happens periodically but not continuously. Do not leave the device powered on and unattended while in Maintenance Mode.

5. OPERATION OF THE ELECTROLYZER

Before powering on the device, ensure the power cable and all pipes are properly connected and secured as described in this manual. Then, press the 'ON' button.

5.1 MANUAL START/STOP

When the device is in standby mode, push the start/stop button, this will start the device. Remember that it may take several minutes to warm up, purging the humidity and ramping up before hydrogen flows out of the H_2 outlet.

To stop the device, simply push the start/stop button again. The device then ramps down and vents the contained H_2 to return itself to a safe state.

Notice! Properly shut down the device to avoid damage!
Do not unplug/disconnect the power to the device without, either manually or via software control, shutting it down safely first. Unexpected power cuts can shorten the device's lifetime and damage it!

The device works most efficiently and is most durable when operating continuously. As with all electrochemical devices, the stack's lifetime is shortened with frequent start/stops. Enapter recommends limiting the device's operative cycles to a maximum of eight on/off cycles per day or 50 cycles per week, with a minimum runtime average of one hour. This helps ensure the longevity of the device.

Enapter counts a stack cycle whenever power is applied to the stack and is removed again.

5.2 REMOTE START/STOP

The device can be started/stopped remotely using the Enapter app or cloud as well as remotely via the Modbus interface. For more information on this, please refer to the online Enapter handbook.

5.3 AUTOMATIC START/STOP

Once the device is started it will produce hydrogen until it measures 35 barg at the output of the H_2 Out port. The device will then go into standby (MAX_PRESSURE). If the pressure then drops again below 29 barg, the device automatically restarts the hydrogen production until 35 barg is reached again at the output. The maximum pressure of 35 barg and the restart pressure of 29 barg are the default values and can be adapted according to the operator's needs.

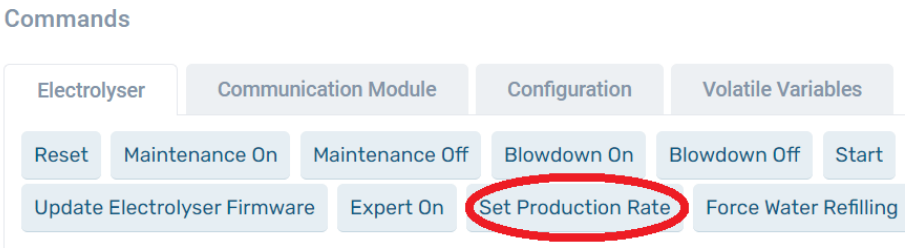
To increase the lifetime of the device, it is strongly recommended to use an intelligent control system which automatically increases and decreases the production rate to keep steady pressure at the output or to adapt the production rate to the available power supply. Like this, the hydrogen production will be steadier, and the number of ramp ups and ramp downs will be reduced.

5.4 MAINTENANCE MODE

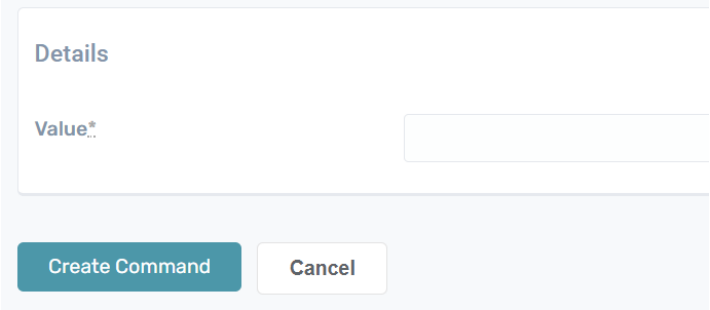
Maintenance mode can be manually enabled using the Enapter App. It is used to safely fill and drain the device, as well as to guide through inspection and other routine maintenance tasks. Please see the chapter Routine Maintenance to know more.

5.5 SET PRODUCTION RATE

Setting the production rate on the Cloud can be done in a very simple way on the main page of the electrolyzer. On the "Commands" section click on the button "Set Production rate".



Enter a number between 60 and 100 to set the production rate to a desired percentage (60 % - 100 %). Then click on the button "Create Command". The production can be adapted in 1 % steps.



Notice! The production rate will also be adapted with values outside of the range! Please note that if a lower value is set (for example 50), the production rate will be set at the smallest possible value (60 %). Accordingly, higher numbers than 100 will result in 100 % production rate.

5.6 RAMP UP

The ramp up time of the device depends on the electrolyte temperature (the ramp up is slower at low ambient temperatures). Typically, the device will start with a hydration period of 60 seconds, and then ramp up to the nominal production rate with the following values:

- Warm-up time (time taken for the electrolyte to heat up to 55 °C):
  The electrolyzer can reach a heating ratio of 1 °C/min. If starting the device with an electrolyte temperature of e.g., 25 °C it will take about 30 min to be fully operational and perform at its maximum efficiency at 55 °C.

- Ramp up time (time to reach nominal production rate):
  Usually, the 0.5 Nm^3/h production rate is reached in about ⅔ of the total warm-up time (the warm-up time is 30 min, so if starting at 25 °C, it will need 20 min to reach max production rate).
- Time to build up internal pressure:
  With standard set-points, the pressure is completely built in approximately a sixth of the total warm up time (if starting at 25 °C, the warm-up time is 30 min, so it will need 5 min to build pressure) <5>.

During ramp up, the device performs periodical venting to guarantee high purity H_2 on the outlet, as well as to release condensed water from the produced H_2

5.7 RAMP DOWN

Like the Ramp Up, the Ramp Down slowly switches off the stack and the other components and moves the device into a safe state. The device should always be ramped down via the start/stop button or via the app/cloud to preserve the components. Switching it off via the breaker, the Dry-Con or switching off the power supply should be performed in cases of emergency only.

5.8 ANTI-FREEZING ROUTINE

The anti-freezing routine is an automatic routine which will check the temperature on the internal electrolyte tank to prevent the electrolyte from freezing. If the temperature is below 6 °C, the heater and circulation pump will be turned on. It switches off once the electrolyte reaches 10 °C again. This routine also checks the flow of the circulation pump and verifies that there are no obstructions in the inner piping system. The anti-freezing routine will not be active when the tank is empty.

5.9 PREHEAT FUNCTION

The preheat function allows the device to heat up in advance and therefore allow a faster ramp up. When activated, the device will automatically heat up the electrolyte to 45 °C. Once reached, it can immediately start hydrogen production.

5.10 SAFETY HEARTBEAT

The Safety Heartbeat functionality is a periodic signal transmitted between the device and the gateway to detect if the device is still connected to the cloud. If the device does not receive the signal anymore, it will undergo a normal ramp down. This allows the operator to always access the cloud data if the device is running. This feature is optional and can be switched off as well. Find further information on the Safety Heartbeat in the handbook.

To activate the Safety Heartbeat via Gateway:

1. Connect the device to the Gateway
2. Configure Safety Heartbeat on the Gateway

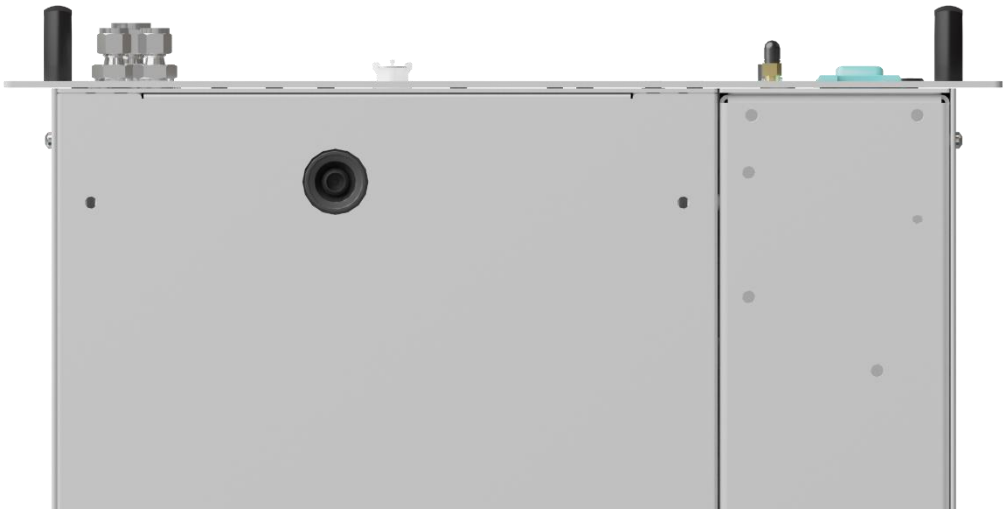
To activate the Safety Heartbeat via Modbus, follow the heartbeat instructions for Modbus.

5.11 TROUBLESHOOTING

The device can be continuously monitored and controlled remotely. This allows quick and easy detection of warnings and errors. The device will automatically stop the operation in case of a fatal error. For further troubleshooting, please visit handbook.enapter.com.

5.12 DRAINING THE CHASSIS

In the event of a water leak, please contact Enapter Support and follow the instructions below to safely drain the water from the device. If water has entered the chassis from external sources, the system may still be safe to operate; however, a full system check, and factory reset must be performed before resuming operation. In some cases, the device may require repair.



Drain Hole on the bottom of the device (view from the bottom)

Caution! The device contains chemicals!

Refer to the Safety Data Sheet (SDS) of all chemicals used before handling them. All persons using, preparing, and filling the electrolyte into the devices must be informed about any potential hazards involved with their activities.

Caution! Protect yourself from splashes!

Mix the electrolyte solution in accordance with good industrial hygiene and safety practice and wear appropriate personal protective equipment (PPE) as specified by the relevant Safety Data Sheet (SDS). Avoid any contact with eyes and skin.

1. The hole at the bottom of the device allows water and electrolyte inside the device to drain. To drain accumulated fluids, prepare a KOH resistant bucket of 3 L.
2. Put on personal protective equipment. The minimum required equipment are safety goggles to protect from splashes and rubber gloves.
3. Then carefully pull the device 10 cm out of the cabinet so that the hole can be easily reached.
4. Hold the bucket below the hole.
5. Push up the cap carefully. The fluid will drain immediately.
6. Finally, make sure that the hole at the bottom of the device is properly closed again.

6. ENAPTER MONITORING TOOLS

The device can be monitored and controlled remotely by authorized people by logging into Enapter's cloud services on a web browser (https://cloud.enapter.com/login).

The device comes with a preinstalled UCM (Universal Communication Module) to monitor and manage the device. Various sensor data from the devices is stored in the Enapter Cloud in a time-series database and provides real-time or on-demand visualization of collected data on customizable dashboards. To support the latest protocols and security fixes, the UCM can be updated over-the-air.

Every device can be directly integrated with the Enapter Software-Defined EMS (Energy Management System). The UCM inside the device connects either directly to the Enapter Cloud, or via an Enapter Gateway which readies the device for Industry 4.0 – to find out more, please visit the Enapter handbook.

Any operator of Enapter products can now integrate a wide range of devices and analogue inputs into the hydrogen production environment. System data of integrated devices is read continuously and is then securely transmitted to the cloud, which can be accessed from anywhere in the world via the web interface or with the Enapter mobile application.

After the setup of the device is finished, it can be managed via the mobile or web dashboard, which includes Automated Control and Monitoring functionality by customizable logic of the Enapter Rule Engine (requires an Enapter Gateway on the site).

6.1 MOBILE APPLICATION

Enapter's mobile application makes the installation, monitoring and controlling of any energy system quick and easy. If any part of the hydrogen system encounters an issue, the mobile app can send push notifications to alert the operator. This functionality is available via Wi-Fi or mobile network, all over the world.

To find out more, please refer to the Enapter handbook.

7. MAINTENANCE OF THE ELECTROLYZER

This device is designed for long service life with minimal, easy maintenance. Proper care by qualified personnel will help maximize its operating lifespan. This section should be read carefully and understood alongside the Safety Manual provided with the device. Leave enough space around the device to allow proper inspection, maintenance, and cleaning.

Serious injuries and death as well as damage to the product or the environment possible! Follow the instructions in this manual carefully!

Ignoring the Safety Manual instructions could impair the safety functions performances.

7.1 FIRMWARE UPDATES

Enapter periodically provides firmware updates to add new features, fix issues, and improve system stability and performance. We recommend regularly checking for updates via the mobile app or cloud web interface and installing them to ensure optimal operation. In some cases, updates may change interfaces or compatibility with other devices. To ensure an update does not negatively impact your setup, please review the release notes beforehand and contact Enapter customer support if you have any questions. If any known changes could affect your system, a service bulletin will also be issued to inform you in advance.

7.2 ROUTINE MAINTENANCE

To simplify the warranty process, please maintain a record of all routine maintenance performed on each system. Enapter support requires proof that the minimum required maintenance has been carried out in order to process warranty claims. **It is recommended to establish a maintenance plan for any installation prior to deployment**. If more information or clarification is required on any of the activities listed in this section, please contact Enapter Support; an example maintenance record is shown in Tracking routine maintenance and electrolyte swaps. <5>

The device should be inspected at least once a year for apparent signs of physical deterioration. **All hydrogen connections must be tested for leakages regularly**; Enapter recommends using one of the techniques listed in the Hydrogen Leak Testing.

Additionally, the **proof-tests described in the Safety Manual must be executed successfully once per year**. For more information, please look at the Safety Manual or contact the Enapter customer support team.

After commissioning, the process tank must be emptied at least once a year and new electrolyte filled into the device. For more information, please refer to Draining the electrolyte, which details the draining process of the device, and then follow the instructions for the Electrolyte Filling. It is recommended to clean the device at the same time as described in the chapter Cleaning <6>.

Depending on usage frequency and input water quality, the process tank may need to be emptied and refilled more frequently than once per year. To avoid accelerated degradation during periods of

inactivity, it is recommended to operate the system for at least one hour per week. This can be done at a reduced production rate to minimize power consumption.

- If the system has been idle for more than one month, it is **recommended** to replace the electrolyte before restarting hydrogen production.
- As stated in the section "Nominal use conditions ", if the system has been idle for more than three months (cumulatively), an electrolyte replacement is **required**, prior to restarting production.

When the device is connected to the cloud, it can send alerts when stack voltages begin to rise — typically an early indication that an electrolyte change is needed. Replacing the electrolyte can help restore performance by lowering stack operating voltages, improving system efficiency, and extending the service life of the electrolytic stack. In general, more frequent electrolyte changes contribute to longer overall system lifetimes. <5>

During routine maintenance or electrolyte swaps, operators are able to perform tests to assess the electrolyte health:

- Using high pH litmus paper, it is possible to test the drained electrolyte. Even if an electrolyte swap is not planned, a small sample (<5 ml) can be safely drained into a clean sampling vessel to assess the condition of the electrolyte.
  - **If the pH is decreased and approaches 12, the electrolyte must be replaced immediately.** Additionally, verify that the water purification system is properly maintained and that the input water meets the required specifications. The drained electrolyte can also be further analyzed by measuring its conductivity. Please report these findings to Enapter support.
- Using a portable conductivity meter, the conductivity of the drained (undiluted) electrolyte can be measured. To ensure the sample accurately represents the internal electrolyte volume and allows for repeatable measurements, please make sure a "Force Refill" command has been completed on the electrolyzer prior to draining.

Caution! Only authorized maintenance!
Any maintenance activities, excluding the ones listed in the Routine Maintenance and installation sections, are only allowed to be performed by trained technicians!
Warning! Explosion hazard. Do not remove or replace antennas, lamps, plug-in modules (as applicable) or other components unless the power has been disconnected, or the area is free of ignitable concentrations!

Always turn off the device and fully ventilate the room first before removing the power supply. Otherwise, electric sparks may occur. The area must always be free of ignitable concentrations.

Shut down the device, remove the power, and wait until the device is cooled down before working on it in any way.
Always wear PPE during the maintenance of the device.
Do not open the device!
During maintenance, avoid heat in the vicinity of the device and the hydrogen source. No smoking, no naked flames.
Prevent electrostatic charging of the device.

Before starting to work on the device, ensure being aware of all relevant local health and safety guidelines, rules, directives, and regulations, as well as action plans if an accident occurs.

7.2.1 FLUSHING THE ELECTROLYTE TANK

When the device has been drained during maintenance, it might request a flushing process via the Enapter App. Keep the device in maintenance mode while observing it in the Enapter App or the Web GUI. The flushing process will use purified water from the H_2O In port to flush the internal tank. Once the process is finished, the internal tank must be filled with fresh electrolyte. Follow the instructions below to flush the internal tank, remove the remaining old electrolyte, and therefore increase the lifetime of the device.

1. Put on PPE. Minimum Equipment Requirements are nitrile gloves and safety goggles to protect yourself from splashes. Ensure your working area is clean to avoid chemical contamination and potential hazard exposure.
2. Connect the device to the Enapter App and open its dashboard (or access the Web GUI).
3. Enable the Maintenance mode using the Enapter App or Web GUI.
4. Prepare a container and insert the end of the draining pipe into it.
5. Fully insert the other end of the draining pipe into the FILL/DRAIN port. The drained electrolyte will start pouring out immediately.
6. Disconnect the draining pipe from the FILL/DRAIN port by pressing down the button on the port once the app shows an empty tank. Then follow the steps in the app to initiate the flushing process (filling) of the device.
7. Once the internal tank is filled, prepare a second container and insert the end of the draining pipe into it.
8. Fully insert the other end of the draining pipe into the FILL/DRAIN port. The water which is now mixed with the remaining electrolyte will start pouring out immediately.
9. Disconnect the draining pipe from the FILL/DRAIN port by pressing down the button on the port.
10. Confirm that the flushing has been finished (draining) by pressing the "Continue" button in the app or Web GUI.
11. The device now is ready to be filled with fresh electrolyte. Please see the chapter Electrolyte Filling for more information.

7.2.2 CLEANING

When performing the routine maintenance processes and checks, the device should be inspected and cleaned. Start by carefully using a vacuum cleaner, or brush, (not included) to clean out the ventilation openings/grills. Afterwards, use a damp cloth (no acids, aggressive, or abrasive substances) to clean the outside of the device.

Caution! Unplug device before cleaning!
Remove the supply of power before cleaning the device. Never handle the electrical connections with wet hands. Ensure the device is dry before returning the supply of power to it.

Notice! No internal cleaning necessary!
The internal components of the device do not need to be cleaned and must not be accessed by the operator for cleaning.
Only trained and authorized personnel is allowed to open and inspect the device for maintenance reasons.

7.3 5-YEAR MAJOR MAINTENANCE

The device contains a safety system which allows advanced monitoring of safety critical components and further improves the safe operation of the device. To ensure that the safety system works properly, the device needs to be inspected by Enapter or one of its authorized service partners every five years (mission time) for major maintenance. More details can be found in the Safety Manual.

It's the operator's responsibility to request the major maintenance within the mission time and to book a time slot for the inspection. For more information as well as for requesting the major maintenance, please contact the Enapter customer support team.

Caution! Only authorized maintenance!
The 5-year major maintenance activities described in this section are only allowed to be performed by Enapter or authorized service partners!
Warning! Explosion hazard. Do not remove or replace antennas, lamps, plug-in modules (as applicable), or other components unless the power has been disconnected, or the area is free of ignitable concentrations!

7.4 TRANSPORT

For returns within warranty, repairs, or recycling, please report your device issue to the Enapter customer support team to receive the Return Material Authorization form and the packaging instructions.
Before transport, verify that the device is completely cooled down and that the electrolyte tank has been emptied according to Draining the electrolyte. Seal the connections on the front panel by inserting the red plugs that were supplied with the device into their respective bulkheads and place the plastic caps on the hydrogen outlet and vent lines. Ensure the device is transported in an upright position, and that an indicator for this is clearly visible on the outside of the packaging.

Notice! Use original shipping material only!
Enapter may not accept the device if returned without the original shipping boxes, or equivalent, for safe transport. If damage occurs during the return of a device under warranty, Enapter will not cover the costs of repair.
Caution! The device is heavy!
Never lift a device alone, as it weighs over 40 kg. Use lifting aids if available.
Due to their weight and size, it is recommended to use a pallet cart or similar devices to maneuver the box upon delivery. If the box must be lifted, always lift it with at least two people.

Notice! Do not expose the package to temperatures outside its specified storage conditions!
In environments with very low or very high temperatures, the shipping box must be clearly marked with a label informing the shipping agent that the package must not be exposed to temperatures outside the storage range specified in the datasheet.

7.5 STORAGE

Electrochemical devices can be sensitive to their environments. Therefore, it's important to follow the following storage instructions in order to ensure the device stays protected and performs as expected when in use. <5>

- For storage prior to first time commissioning:
  - Environmental conditions: 2 °C to 55 °C, up to 90 % humidity, non-condensing
- For storage after use:
  - Environmental conditions: 2 °C to 55 °C, up to 90 % humidity, non-condensing
  - Drain the ELE, but do not flush the device until it is recommissioned.
- For deployed devices not in use
  - Do not drain the unit
  - Environmental conditions: 2 °C to 55 °C, up to 90 % humidity, non-condensing
  - Electrolyte change after three months is strongly required prior to re-commissioning
  - Long-term storage requires you to pack up your device as if for transport. You can find instructions in the Transport section

7.6 DISPOSAL

Enapter is fully committed to recycling the devices and their components.
Please return the device to Enapter at the end of life when the device will be fully recycled.
By ensuring this product is correctly recycled, you will help to further reduce your impact on the environment and aid us in making the world cleaner and greener.

7.6.1 DRAINED ELECTROLYTE

Before draining the device through its dedicated port, wear appropriate personal protective equipment (PPE). For more information, refer to Appendix IV below. Collect the electrolyte in an appropriate container and place it in a chemical waste container. It contains up to 3 % of KOH <4> if filled according to this manual, depending on the electrolyte level when draining.

Please protect the environment: Do not flush into the sewer. Dispose of the liquid in compliance with all relevant local safety guidelines, rules, directives, and regulations.

7.6.2 BUTTON CELL OR COIN BATTERY

The electrolyzer contains a non-replaceable battery.

- Battery type: Lithium battery, CR2032
- Nominal Voltage: 3V

Please observe the following:

a) Remove used batteries immediately and recycle or dispose of them according to local regulations. Keep batteries out of reach of children. **Do not dispose of in household trash or incinerate.**
b) Even used batteries may cause severe injury or death
c) In case of exposure or ingestion, contact a local poison control center for treatment advice.
d) Do not attempt to recharge non-rechargeable batteries.
e) **Do not force discharge, recharge, disassemble, heat above 85°C (the manufacturer's temperature rating), or incinerate.** Doing so may cause venting, leakage, or explosion, leading to chemical burns or other serious injury. <4>

8. APPENDIX

Appendix I. Hydrogen Leak Testing

As part of a hydrogen device, it is of vital importance to check every connection made for leaks. For more information on this matter, please refer to the appendix of ASME B31.12.

There are three main ways recommended to check for leaks:

1. Surface hydrogen detection
2. Soap bubble testing
3. Pressure drops testing.

Surface hydrogen testing

Using a calibrated hydrogen sniffer, slowly check for leaks around each connection.

PROS

- Precise, it can pinpoint even small leakages.
- Can grade leakages according to leakage rates

CONS

- Does not work when there are elevated levels of hydrogen in the atmosphere

Soap bubble testing

Using a mixture of soap and water (please ensure the soap used is compatible with the device and the materials used), the solution is dropped on individual connections using a small pipette. If the connection bubbles, a leak is present.

PROS

- Can be fast for larger leaks on small parts when testing multiple at one time.
- Low cost
- Best method for detecting exact leak location detection.
- Accurate, it works even with elevated background H_2 levels

CONS

- Cannot detect tiny leakages.
- No leak rate or test result information
- Slow: Detecting small bubbles on typical parts can take much longer than other methods.
- Risky: An extremely operator dependent technique with a high possibility of passing actual failures.

Pressure drop testing

This test is performed by isolating individual sections of a pipe while monitoring the pressure contained within over time and should be performed at the maximum operating pressure of the device. If a drop in pressure is observed, which cannot be attributed to changes in temperature, a leak exists.

PROS

- Useful for final verification during device commissioning
- Can verify several connections at the same time

CONS

- Cannot detect exact leakage source.
- Cannot grade leakage rates accurately

Appendix II. Tracking routine maintenance and electrolyte swaps

To ensure proper maintenance and traceability, each electrolyte change must be recorded for every deployed system. This serves as evidence of meeting the minimum routine maintenance requirements. Recording this information can be easily integrated into standard maintenance planning processes, which are a common and expected practice in industrial project management. Customers may track this in their preferred format; however, an example of the minimum required data is provided below. <5>

System S/N	Date	Electrolyte swapped	H2 leaks checked	Inspected & cleaned	Performed by
QQXXXXXXXXZZZ	DD/MM/YYYY	☐ Yes | ☐ No	☐ Yes | ☐ No	☐ Yes | ☐ No	*Operator Name*
QQXXXXXXXXZZZ	DD/MM/YYYY	☐ Yes | ☐ No	☐ Yes | ☐ No	☐ Yes | ☐ No	*Operator Name*
QQXXXXXXXXZZZ	DD/MM/YYYY	☐ Yes | ☐ No	☐ Yes | ☐ No	☐ Yes | ☐ No	*Operator Name*
QQXXXXXXXXZZZ	DD/MM/YYYY	☐ Yes | ☐ No	☐ Yes | ☐ No	☐ Yes | ☐ No	*Operator Name*
QQXXXXXXXXZZZ	DD/MM/YYYY	☐ Yes | ☐ No	☐ Yes | ☐ No	☐ Yes | ☐ No	*Operator Name*
QQXXXXXXXXZZZ	DD/MM/YYYY	☐ Yes | ☐ No	☐ Yes | ☐ No	☐ Yes | ☐ No	*Operator Name*
QQXXXXXXXXZZZ	DD/MM/YYYY	☐ Yes | ☐ No	☐ Yes | ☐ No	☐ Yes | ☐ No	*Operator Name*
QQXXXXXXXXZZZ	DD/MM/YYYY	☐ Yes | ☐ No	☐ Yes | ☐ No	☐ Yes | ☐ No	*Operator Name*
QQXXXXXXXXZZZ	DD/MM/YYYY	☐ Yes | ☐ No	☐ Yes | ☐ No	☐ Yes | ☐ No	*Operator Name*
QQXXXXXXXXZZZ	DD/MM/YYYY	☐ Yes | ☐ No	☐ Yes | ☐ No	☐ Yes | ☐ No	*Operator Name*

Appendix III. Preparing fresh electrolyte

Time required	5-10 minutes
Materials required	Safety Glasses Nitrile Gloves Clean 5L container 2 L of demineralized water (please refer to the Water Input Quality in chapter 1.1) Chemical scales 40 g (+/-0.3 g) of KOH (85% purity) (CAS-N°:1310-58-3[5])





For routine maintenance, a new electrolyte solution must be prepared. Regular changing of the electrolyte in the electrolyzer helps to prolong the lifetime of the device. If the device has been filled with water which did not fulfill the required purity, the electrolyte must be exchanged as well. Fresh electrolyte or the necessary KOH granulate can usually be purchased locally.

We recommend contacting Enapter to make sure that the purchased product is compatible (support@enapter.com)

Caution! The device contains chemicals!

Refer to the Safety Data Sheet (SDS) of all chemicals used, before handling them. All persons using, preparing, and filling the electrolyte into the devices must be informed about any potential hazards involved with their activities.

Caution! Protect yourself!

Mix the electrolyte solution in accordance with good industrial hygiene and safety practice and wear appropriate personal protective equipment (PPE) as specified by the relevant Safety Data Sheet (SDS). Avoid any contact with eyes and skin.

Notice! Chemicals might damage the device!

Carefully read the instructions below before starting. Follow the instructions carefully and contact the Enapter customer support team in case of questions.

Ensure all material used to store and contain the electrolyte solution is chemically compatible with its contents.

1. Put on PPE. The minimum required equipment are safety goggles to protect from splashes and nitrile gloves. Ensure the working area is clean to avoid chemical contamination and potential exposure hazards.
2. Ensure the selected KOH resistant container is large enough to contain the solution entirely. Verify the container is clean, and no debris is visible inside. If you are unsure – go to step 3, otherwise, skip to step 4.
   - If you are preparing the solution in advance – clearly mark and label the solution. Keep out of the reach of children and untrained people. Never store chemicals above eye-level.
3. Thoroughly rinse the container with demineralized water, at a minimum of three times. Before continuing to step 4, perform another visual check to see if any other debris may be visible.
4. Fill 2 L of demineralized water into the KOH resistant container (please refer to the Water Input Quality in the chapter Specifications).
5. Carefully weigh the required amount of KOH. Add 40 g (+/-0.3 g) of KOH (with 85 % purity) into 2 L of demineralized water to create the KOH solution.
   - **Attention:** Do not use KOH with less than 85 % purity. Adjust the amount of KOH pellets according to the KOH purity.
6. Fill the KOH into the container with the demineralized water. **The solution will get warm!** Immediately stir the solution or mix it around the container with the lid firmly closed.

Appendix IV. Draining the electrolyte

Time required	5-10 minutes
Materials required	Safety Glasses Nitrile Gloves Clean 5L container



The module must be drained for transport, installation, and before the routine changing of the electrolyte in the device to prolong its lifetime. To do this, the device must be first switched into Maintenance Mode using Enapter mobile app or cloud. Follow the steps outlined in the app or use the instructions below.

Collect the liquid in an appropriate container and place it in a chemical waste container. Do not flush into the sewer! Dispose of the liquid in compliance with all relevant local safety guidelines, rules, directives, and regulations.

Caution! The device contains chemicals!

Refer to the Safety Data Sheet (SDS) of all chemicals used before handling them. All persons draining and handling the electrolyte from the devices must be informed about any potential hazards involved with their activities.

Caution! Protect yourself!

Wear appropriate personal protective equipment (PPE). Avoid any contact with eyes and skin.

If you got in contact with the drained solution, immediately wash the affected area and refer to the material safety data sheet of potassium hydroxide and potassium carbonate.

Notice! Chemicals might damage the device!

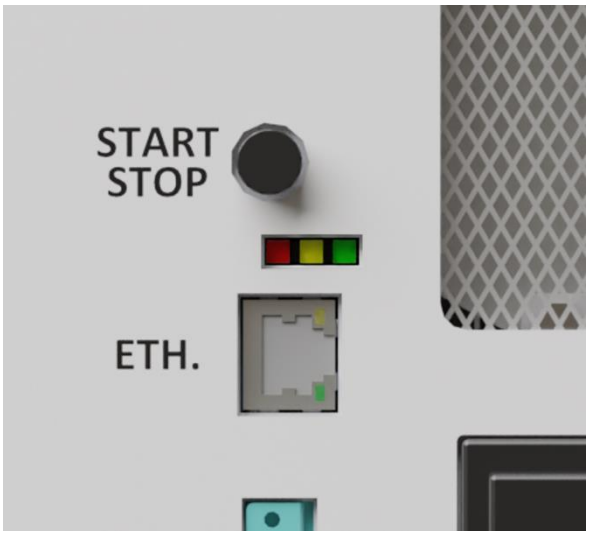
Carefully read the instructions below before starting. Follow the instructions carefully and contact the Enapter customer support team in case of questions.

Ensure all material used to store and contain the electrolyte solution is chemically compatible with its contents.

1. Put on PPE. The minimum required equipment are safety goggles to protect from splashes and nitrile gloves. Ensure the working area is clean to avoid chemical contamination and potential exposure hazards. Enable maintenance mode using the Enapter App.
2. Attention: the device should be kept powered on, if possible.
3. Prepare the container to catch the drained liquid and insert the end of the drainpipe into it.
4. Take out any tube or fitting attached to the "O_2 VENT" to let the air fill into the tank when the solution is drained.

5. Fully insert the supplied male CPC quick connector into the valve bulkhead labelled "FILL/DRAIN". The solution will start pouring out immediately. Place the container below the port to fully drain the electrolyte.
6. Collect the drained liquid in an appropriate container and place it in a chemical waste container. Do not flush into the sewer. Dispose of the liquid in compliance with all relevant local safety guidelines, rules, directives, and regulations.
7. Once the electrolyte stops pouring, safely remove the drain connector. To disconnect, push the button and pull the connector out of the bulkhead.
8. If the electrolyte is drained for maintenance, be aware that fresh water will be filled up via the "H_2O IN" port. The app guides you through the necessary steps. After the refill, more drains and refills will be needed until the electrolyzer can be filled up again with electrolyte.

Appendix V. LED Status



EL4.1 AC version LEDs

DR2.1 LEDs

The three LEDs on the front panel help to indicate the device status and operating condition.
During normal operation, the LEDs indicate the status of the device. Please visit the Handbook for the LED status indication of the electrolyzer and the dryer.

Appendix VI. Error Codes

Here you can find a list of all the warnings and errors that can be triggered while using the electrolyzer. The list covers all firmware versions.
The warning and error codes for the DR21 can be found here.
Check which firmware is installed on the device and then choose "Modbus TCP Communication Interface" and then "Warning, Error and Fatal Error Codes" to access all warning and errors. E.g. the warnings and errors for the electrolyzer's firmware can be found here.

Appendix VII. Factory Setting Reset

After an automatic emergency shutdown (Fatal Error), the system can only be restored through a Factory Setting Reset. It is not possible to restore the system without doing a Factory Setting Reset, even if the fatal error is no longer present.

To enable Factory Settings Reset:

- Depressurize the Stack. Inner Hydrogen Pressure must be < 2 barg.
- Press the Wi-Fi button to turn it off.
- Turn off the device.
- Press and hold the Start/Stop button and turn on the device (do not let go of the Start/Stop button).
- Keep holding the Start/Stop button and wait for the LEDs to start blinking in sequence 3 times.
- Release the Start/Stop button. All LEDs will blink once.
- Factory Settings Reset started. The device will be automatically rebooted. All LEDs will blink thrice.
- Press the Wi-Fi button to turn it back on.
- There will be a warning if the Start/Stop button has not been released: WARNING WP_04: STICKY BUTTON.

After the Factory Settings Reset your Electrolyzer will move to Maintenance Mode if the water level is lower than the low level. If the water level is higher than the low level, the Electrolyzer will remain in Operation Mode. <5>

You can find a step-by-step video guide here.