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## Owner's Manual

### Dryer 2.1

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

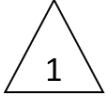
Rev. 06 – September 2023





## CHANGE HISTORY FOR DR2.1

A black triangle on the left side of the page indicates changes since the last revision. The number inside the triangle indicates the revision which includes the changes the first time. The product and specifications are subject to change without notice.



Rev.	Status	Date	Revision memo	Created/changed by
01	IFI	24/10/2022	First version	Philipp Endres
02	IFI	24/11/2022	Overall updates in safety, pictures and more	Philipp Endres
03	IFI	11/01/2023	Correcting spelling errors and improving formatting	Philipp Endres
04	IFI	15/02/2023	Correcting spelling errors and improving formatting	Philipp Endres
05	IFI	12/05/2023	Update H <sub>2</sub> purge line	Philipp Endres
06	IFI	21/09/2023	Hydrogen detection mandatory, ETL requirements	Philipp Endres



## PREFACE

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 identifying 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 conditions. 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 is not guaranteeing efficiency, safety, and functionality in case of modifications not described in this document.





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DR2.1 – Owner’s Manual

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- ⇒ Enapter is not responsible for any damage caused by the device or to the device based on wrong 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 contained materials and substances. It also includes directly attached tubes, pipes, and other equipment from Enapter if not stated differently.
- ⇒ **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 a safe operation of the device.



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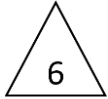
# 1. OVERVIEW OF THE DRYER

Enapter's hydrogen dryer is a standardised, stackable, and flexible device to dry 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 specifications of the dryer can be found in the datasheet. It can be downloaded here: [Datasheet of the dryer](#). See the battery limits for more detailed information about the interfaces and connections of the device: [Battery limits of the dryer](#).

	DRY2.1
Nominal Hydrogen Drying Rate	35 bar version: 2.5 Nm <sup>3</sup> /h (2.0 Nm <sup>3</sup> /h <sup>4</sup> ) 8 bar version: 1.0 Nm <sup>3</sup> /h
Output Pressure	Up to 35 barg / 8 barg
Hydrogen Output Purity	~99.999 % in molar fraction compliant with ISO14687
Average Dewpoint and Impurities	< -70 °C, (H <sub>2</sub> O < 5 ppm, O <sub>2</sub> < 5 ppm)
Minimum Input Purity	35 bar version: > 99.8 % 8 bar version: > 98.0 %
Operative Power Consumption	200 W
Nominal Power Consumption	35 bar version: 0.045 kWh/Nm <sup>3</sup> of H <sub>2</sub> 8 bar version: 0.14 kWh/Nm <sup>3</sup> of H <sub>2</sub>
Stand-by Power Consumption	10 W
Power Supply	200 – 240 V (AC), 50/60 Hz
Dimensions (W x H x D)	482 mm x 176 mm x 634 mm
Space inside cabinet	4 U
Weight	23 kg
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
Remote Control	Enapter Cloud Service, Enapter App
Safety	
Maximum H <sub>2</sub> contained within device	47 NL
Conformity	CE certified according to the machine directive 2006/42/CE Category I Classified as per 2014/68/EU PED ISO 12100 IEC 61000-6-3 IEC 61000-6-2 ISO 13849

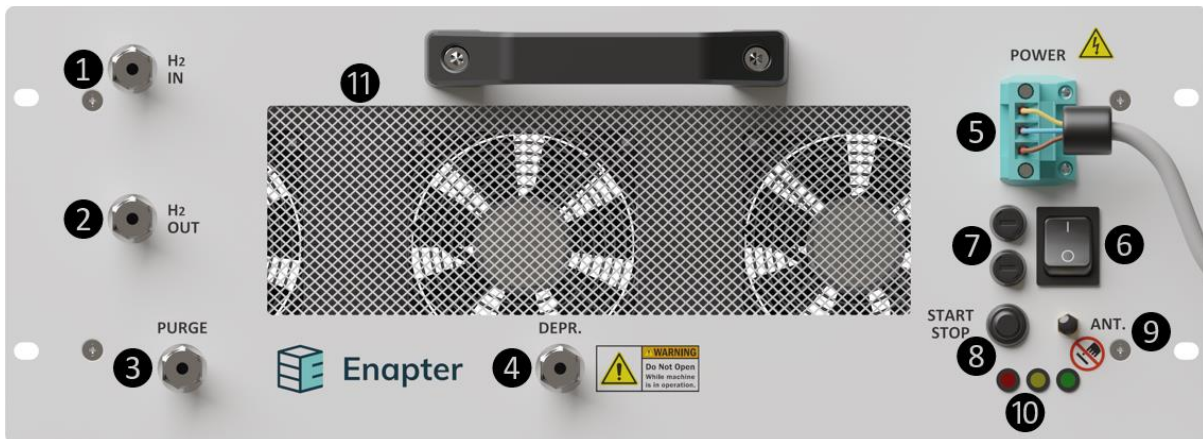


	IEC 61010-1 ASME B31:12
Noise level at 1 m	< 60 dB
Ventilation and Safety Recommendation	Indoor: Ventilation depends on the room size. A hydrogen detection system with a safety circuit is mandatory. Outdoor: Protect from outside environmental influences, if integrated into a cabinet. Ensure the safety 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
IP Rating	IP 20
Interfaces	
H <sub>2</sub> Inlet	¼" Swagelok Tube Fitting
H <sub>2</sub> Outlet	¼" Swagelok Tube Fitting
Purge Outlet	¼" Swagelok Tube Fitting
Depressurising Line	¼" Swagelok Tube Fitting



<sup>4</sup> ETL certified dryer versions only

## 1.2 FRONT PANEL



DR2.1 front side

The front panel of the dryer includes all physical connections of the device.

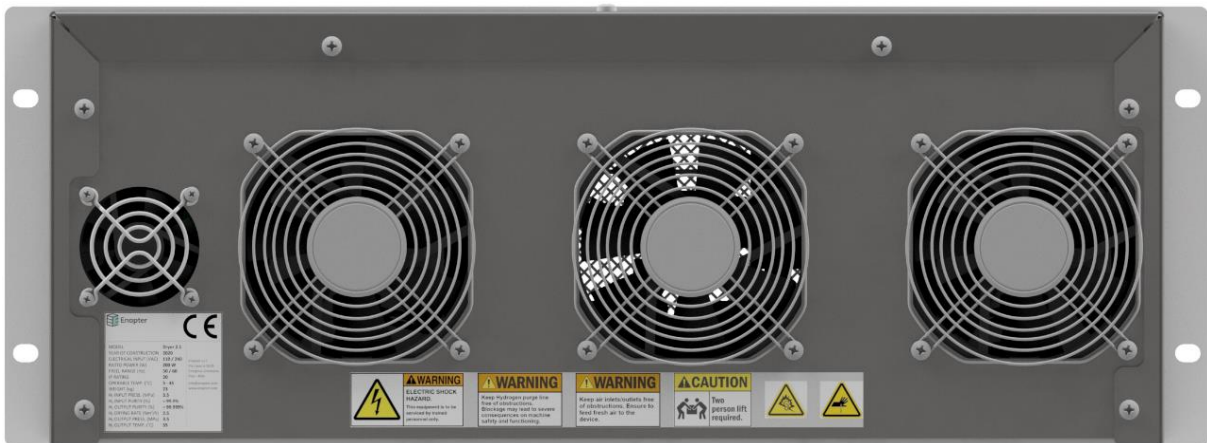
- H<sub>2</sub> IN – please refer to the [Hydrogen Inlet Connection Guide](#) below
  - ≡ ¼" double ferrule Swagelok tube fitting bulkhead (SS-400-61)
  - ≡ Input: max. 2.5 Nm<sup>3</sup>/h H<sub>2</sub> at 35 Bar, max. 2.0 Nm<sup>3</sup>/h H<sub>2</sub> at 35 Bar for ETL certified dryer versions, max. 1.0 Nm<sup>3</sup>/h H<sub>2</sub> at 8 Bar
- H<sub>2</sub> OUT – please refer to the [Hydrogen Outlet Connection Guide](#) below





- ≡ ¼" double ferrule Swagelok tube fitting bulkhead (SS-400-61)
  - ≡ Output: max. 2.5 Nm<sup>3</sup>/h H<sub>2</sub> at 35 Bar, max. 2.0 Nm<sup>3</sup>/h H<sub>2</sub> at 35 Bar for ETL certified dryer versions, max. 1.0 Nm<sup>3</sup>/h H<sub>2</sub> at 8 Bar
3. H<sub>2</sub> PURGE – please refer to the [Purge Connection Guide](#) below
    - ≡ ¼" double ferrule Swagelok tube fitting bulkhead (SS-400-61)
    - ≡ Output: Intermittent, up to 28 NL H<sub>2</sub>/h during some operational states + water vapor
    - ≡ Up to 47 NL H<sub>2</sub> is purged when the device is shut down.
  4. DEPR. – open this depressurisation line only before transportation of the dryer. Do not connect any pipe to this port.
  5. POWER – please refer to the [Electrical Connection Guide](#)
  6. On/Off Switch – Use this button to switch the device on and off
  7. Fuses – please refer to the [Electrical Connection Guide](#)
    - ≡ to protect the device against overcurrent
  8. START STOP – please refer to the [Manual Start/Stop](#) section below
    - ≡ Manual start and stop button to start and stop the device
  9. ANT. – Antenna port
    - ≡ 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!
  10. LEDs – please refer to the [Appendix IV](#)
    - ≡ Status LEDs to show device status
  11. Mesh – please refer to the [Routine Maintenance](#) section below
    - ≡ Keep the mesh free and clean it regularly

### 1.3 BACK PANEL



DR2.1 back side



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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 to block the inlets and outlets of the internal ventilation system.

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



## 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



## 2.2 GENERAL SAFETY



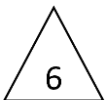
**Serious injuries and death as well as damages to the product or the environment possible! Follow the instructions in this manual carefully!**

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 wrong inputs
  - ≡ Caused by wrong 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**, as well as to **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, as well as to keep the air inlets/outlets 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 explosive atmospheres.** 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 ear muffs 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 be repaired only by qualified specialists who use original spare parts.
  13. Any maintenance activity, excluding the ones listed in the routine maintenance and installation sections, are 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.
  15. **Do not store the device at temperatures below 1°C.**

## 2.3 ADDITIONAL SAFETY FOR THE DRYER

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<sub>2</sub> outlet of the device.
2. Do not attach hydrogen sources other than the electrolyzers **specified by Enapter.**
3. Make sure that the H<sub>2</sub> purge line is **never obstructed.**



## 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.

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



Always ensure that the device is installed and operated in compliance with all relevant local safety guidelines, rules, directives and regulations. Do not install, operate, or maintain the device without explicit knowledge or help from experienced and licensed system integrators, the manufacturer, or external certifying 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 not 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 to use suitable tools when handling the device and packaging material.

A general training with regards to lifting heavy loads and general 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. In particular:

### **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 the head.

### **Caution! Handle the device with care!**



During handling of the device, be cautious and use the handles on the device to minimise 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 condition. 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.



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- ≡ 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 be always free of ignitable concentrations.

**Warning!**



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





### 3.4 CHEMICAL HAZARDS

Potassium Hydroxide is used in the electrolyser as the main process liquid (electrolyte). The electrolyte usually comes pre-mixed with the electrolyser but it can also be purchased as a powder to be diluted in purified water.



**Caution! The device contains chemicals!**

Refer to the Material Safety Data Sheet (MSDS) 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 electrolyser.



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

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 become very hot!**



- ≡ Never open the device unless being specially trained for service by Enapter.
- ≡ Do not touch the O<sub>2</sub> vent port or any attached pipes directly after operation. The O<sub>2</sub> is released with up to 225 °C. 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 has been designed for use in standard ambient conditions, respecting stability requirements (in the absence of 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 DRYER

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 has to 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. During transport, installation, packaging or unpacking, do not tilt, shake or turn the device by more than 50° to avoid damages. Do not install the device on an inclined position of more than 10°.

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 do not dispose the original shipping materials. Enapter will not accept devices if they are returned without the original shipping boxes or equivalents for a safe transport. If the shipping boxes cannot be kept, please recycle responsibly.

#### **Notice! Claim transport damages directly on arrival!**



If any damage has occurred during transport, please report this immediately to the shipping agent and supplier. Afterwards, 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 weights over 20 kg. Please see the datasheet 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 manoeuvre the box upon delivery.

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

### 4.2 TOOLS, MATERIAL AND ACCESSORIES REQUIRED

The following tools, equipment, and material are needed to connect the device successfully. Ensure the material chosen for this task is compatible with hydrogen operation.

#### 4.2.1 TOOLS

- ≡ 9/16” combination wrench
- ≡ 5/8” combination wrench
- ≡ Slotted screwdriver
- ≡ Stainless-steel pipe cutter
- ≡ ¼” tube bender



#### 4.2.2 MATERIAL

- ≡ Stainless-steel AISI 136- ASTM A269 ¼” outside diameter X 0,89 mm w.t.



#### 4.2.3 ACCESSORIES (INCLUDED IN THE BOX)

- ≡ Ferrite cylinder for power input cable
- ≡ Swagelok Nut and Ferrule set



### 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 utilised, all components used in this process must not be able to ignite the hazardous substances.



**Danger! The device produces 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 utilised, 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 VENT OUTLETS

Generally, there are two options. The extents of this safety area depend on different parameters, for example, the diameter and the length of piping leading to the safe area, the vent spout design, exit velocity and wind conditions.

Preferably, the operator:

1. calculates the measurements of the safety area based on the provided data for each specific output and applies industrial standards such as the following to their system design, safety concept and site documentation.
  - ≡ EIGA Doc 211/17: Hydrogen Vent Systems for Customer Applications
  - ≡ CGA G5.5: Hydrogen Vent Systems
  - ≡ ISO/TR 15916:2015: Basic considerations for the safety of hydrogen systems
2. Or follows the recommendations of Enapter for systems consisting of up to ten (eight<sup>4</sup>) electrolyser 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<sub>2</sub> vent outlet near the H<sub>2</sub> vent or H<sub>2</sub> purge outlet to minimise the risk of explosion. Leave at least 3 meters of space between the gas outlets.

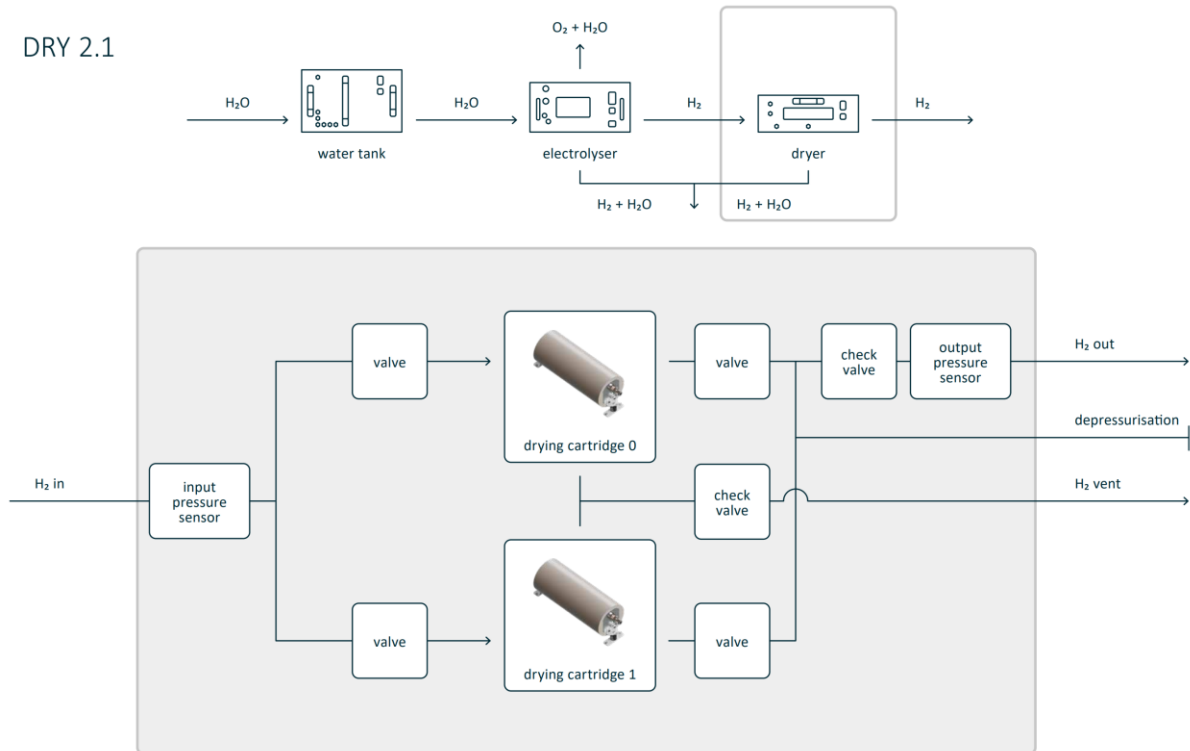
<sup>4</sup> ETL certified electrolyser versions only

## 4.4 PROCESS FLOW DIAGRAM (PFD)

The following diagram shows internal components of the device as well as how it interacts with the Enapter Electrolyser and the Enapter Water Tank. It is also available [here](#). Please note that the diagram is slightly simplified to be better understandable and to protect Enapter’s intellectual property.



DRY 2.1



PFD of the DR2.1

#### 4.5 INSTRUCTIONS FOR CONNECTING STAINLESS-STEEL TUBES

All pressurised hydrogen gas connections are Swagelok tube fittings for ¼” outside diameter (OD) tubes. The inlets/outlets to be connected according to these instructions are labelled “H<sub>2</sub> In”, “H<sub>2</sub> Out” and “H<sub>2</sub> Purge” 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 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. Contaminations inside the pipes may damage the device and connected components.

Always check each connection for leaks! For more information, please refer to Appendix I below.



#### 4.5.1 HYDROGEN INLET CONNECTION GUIDE (H<sub>2</sub> IN)



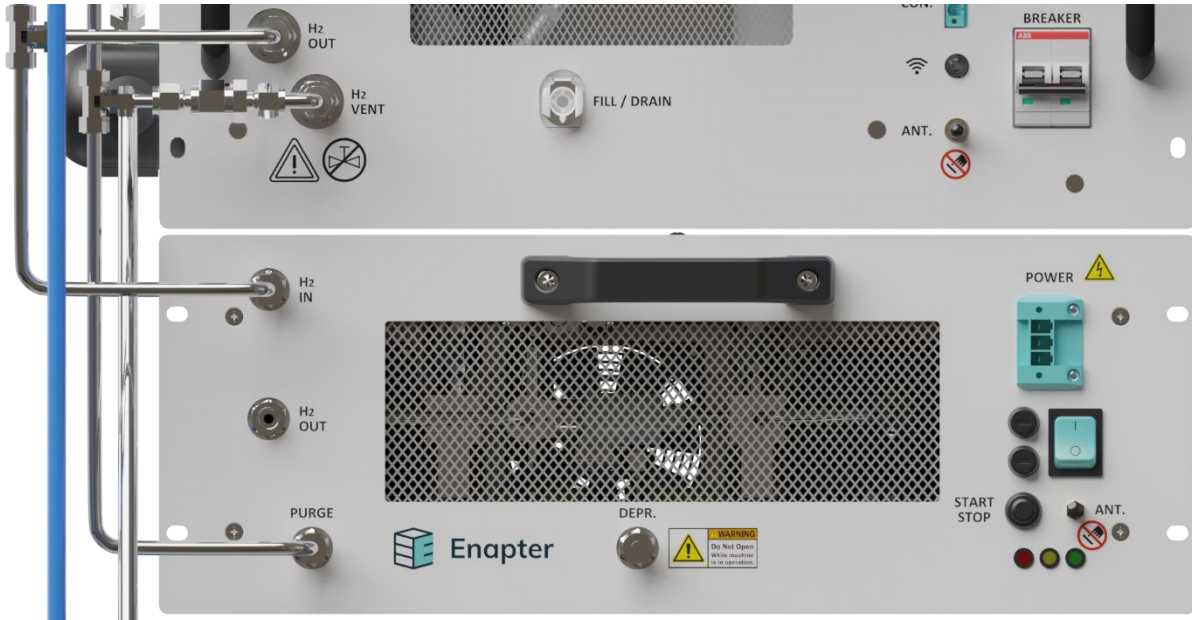
*DR H<sub>2</sub> IN*

Following the steps outlined above, connect the hydrogen output line of the electrolyzers to the “H<sub>2</sub> IN” port, located at the top left of the front panel. Make sure that the connected electrolyzers combined do not exceed the maximum allowable flow rate of the dryer.

#### **Danger! Risk of explosion!**



All pressurised connections must be inspected and checked for leakages. Failure to do so significantly increases the risk of explosion. After operation, this pipe might stay under pressure. First release the pressure carefully before opening the connection. Enapter is not responsible for any damage caused by improperly installed equipment.



*EL H<sub>2</sub> OUT connected to DR H<sub>2</sub> IN*



#### 4.5.2 HYDROGEN OUTLET CONNECTION GUIDE (H<sub>2</sub> OUT)



*DR H<sub>2</sub> OUT port*

Connect the H<sub>2</sub> Out port, located at the left of the front panel, to a hydrogen storage. It is recommended to fit a shut-off valve between the tank and the dryer to be able to isolate each component during maintenance.



#### **Danger! Explosive gases in pressurised pipes!**

All pressurised connections must be inspected and checked for leakages.

Failure to do so significantly increases the risk of explosion.

All pressurised pipes must be free of metal swarfs, obstructions and other particles as they might cause injuries and damage. Especially when the pressure inside the pipe is released too quickly.

Make sure to install a pressure relief device between the device’s H<sub>2</sub> Out port and the H<sub>2</sub> storage or other downstream equipment to protect the devices from overpressure.

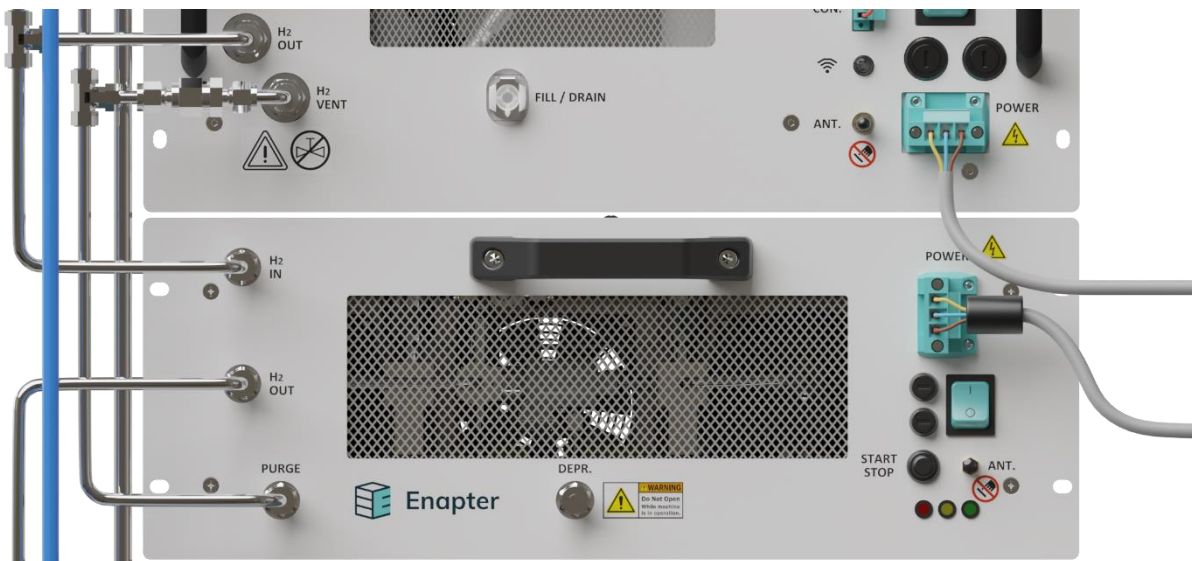
Enapter is not responsible for any damage caused by improperly installed equipment.

Please be aware that when larger hydrogen systems are created by putting together several modules, the piping downstream may have to be sized accordingly. It is the operator’s responsibility to ensure adequately sized piping is selected, which does not limit the air flow. The operator must ensure that the outlet satisfies all relevant local safety guidelines, rules, directives, and regulations, in terms of the safe handling of the produced gas, noise emission, risk assessments, maintenance, a satisfactory safety concept being utilised, and all other relevant areas.

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

Please contact the Enapter customer support team for questions regarding the piping.





*DR H<sub>2</sub> OUT connected*

#### 4.5.3 PURGE CONNECTION GUIDE (PURGE)



*DR PURGE port*

Connect the H<sub>2</sub> purge port, located at the bottom left of the front panel, to the hydrogen purge outlet.

After ramp down, the device depressurises and releases up to 47 litres (35 barg version) or 11 litres (8 barg version) of hydrogen within 2 seconds. The result is a momentary flow rate of up to 85 Nm<sup>3</sup>/h which comes out of the H<sub>2</sub> Purge outlet. Please wear PPE earplugs when being close to the device. Purging is necessary to release the water which has been extracted from the hydrogen.

Additionally, when operational in some device states, a regeneration flow of up to 30 NI/h is released through the purge line together with water vapour.

The released hydrogen will pose a risk of explosion – therefore, it must be led into a safe area at a height of at least 3 m, without any source of possible ignitions. For more information, see the section [Safety areas around the vent outlets](#). If this is not possible, manage the purge in other ways, such as using a flare stack, burn box or forced dilution.

Up to five electrolyzers (35 bar)/ two electrolyzers (8 bar) and one dryer can be connected safely together in a 19” rack by using a common purge line.



### Danger! Risk of explosion!

Never mix the output of the H<sub>2</sub> purge line with the output of the O<sub>2</sub> vent line.

The H<sub>2</sub> purge line can be combined with the H<sub>2</sub> purge line of the Enapter DR2.1.

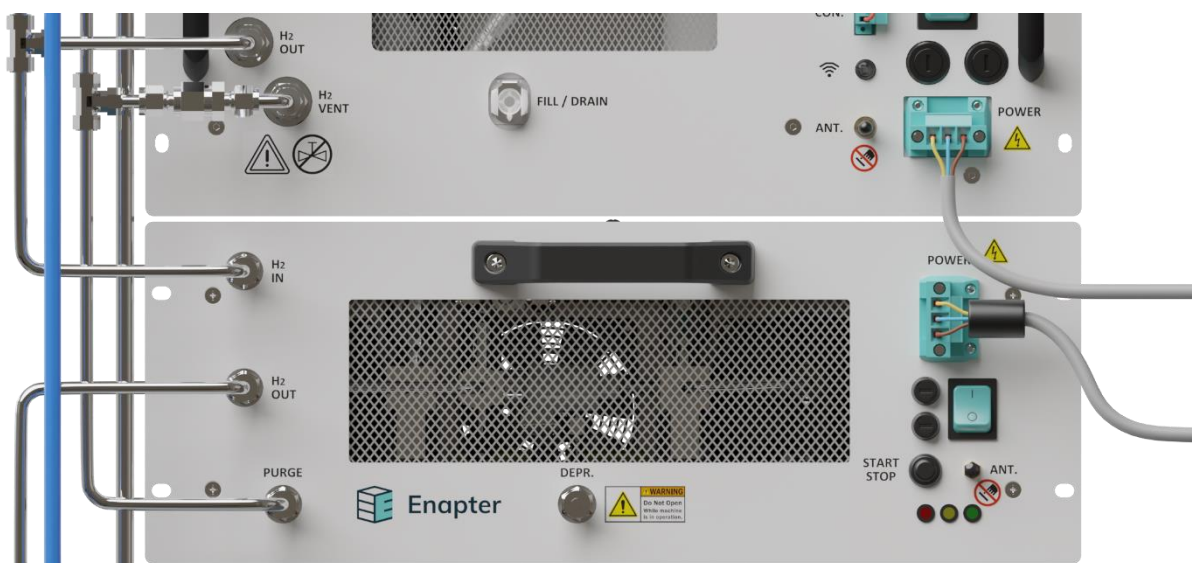
Make sure, that there is never building up pressure of more than 0.2 barg inside the pipe and that it is always open to the atmosphere! Otherwise, the device will get permanently damaged. The line contains water steam and liquid water which is able to freeze and block the pipe. The pipe of each device 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 utilised, 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.



*EL and DR Purge line connected*



To connect the port labelled “H<sub>2</sub> Purge”, use H<sub>2</sub>, KOH and pressure resistant pipes, sealings and connectors only. If connecting several devices to a common vent line, make sure the diameter of the line is sufficient and that it always runs declining. As water is condensing inside the vent lines, there must not be any horizontal or sagging sections. The condensing water would block the pipe. Pipes outside of the container or rack or far away from it are often facing colder temperatures and therefore more condensation which leads to a higher amount of liquid water. The lowest point of the vent line should therefore be located where the condensed water is accumulating. Bigger pipe diameters and low flow velocities help to drain condensed water safely.



At this lowest point with low flowrates where the condensed water is trapped, a drain trap or similar device must be installed to separate the condensed water from the hydrogen.

Remember that each local lowest point, sagging or horizontal section requires an additional drain trap or similar device.

Make sure that water will not flow back to the devices. The vent outputs must not be the lowest points of the pipe.

#### 4.5.4 INSTRUCTIONS FOR THE DEPRESSURISATION LINE (DEPR)

Do not open the cap of the depressurisation line unless instructed by Enapter. This line is to release pressure in case of an emergency or error. It is not relevant for normal usage.

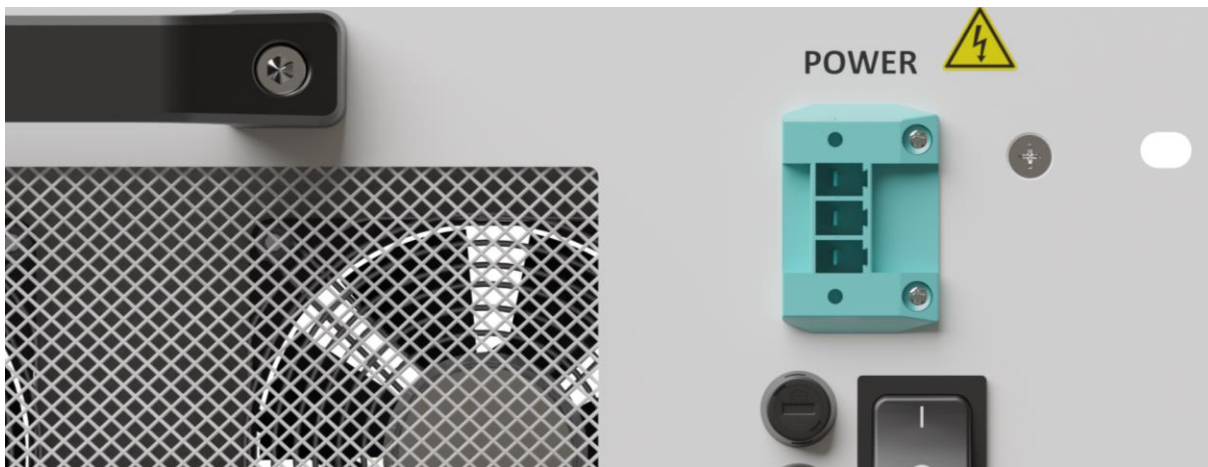


#### **Danger! Risk of explosion!**

If this cap is not completely closed or even removed during operation, hydrogen will be released to the surrounding and create an explosive atmosphere. Therefore, it is important to keep the depressurisation line closed.

#### 4.6 ELECTRICAL CONNECTION GUIDE

Before mounting the power input cable to the male connector, ensure the cable is passed twice through the ferrite (included with each dryer) as shown in the pictures below. The ferrite has an internal diameter of 13.77 mm (307 Ohm, 100 MHz).



*DR Power Connector*



**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 be always free of ignitable concentrations.

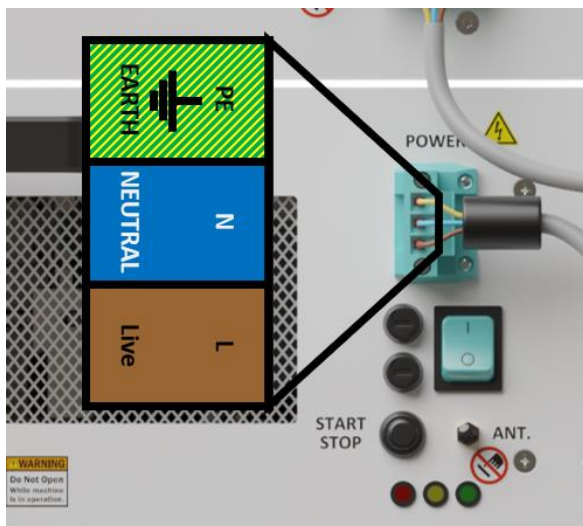
**Warning! Risk of electrical shocks!**



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 the electrical connections with wet hands!**

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](#). Follow the relevant safety standards and ensure that all relevant local safety guidelines, rules, directives, and regulations are adhered to. The minimum cable cross-section diameter for each connection is 1 mm<sup>2</sup>. Ensure to use the male connector in the correct orientation, as shown below.



*DR Power Connector*



*DR Power Connector*

Enapter recommends installing a protective device against overload and short circuits on the power supply line; this 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 dryer, 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.

The device must be connected to protective earth connection to prevent people from contact with dangerous voltage and to allow the correct functioning of the device. The earthing must comply with all relevant local safety guidelines, rules, directives, and regulations.



In case the fuses blow, open the slots on the front panel to replace them. The fuses to be used are the following: Two fuses each with 250 V, 1.5 A, Ø5 x 20mm.



**Warning! Explosion hazard. Do not remove or replace fuse when energised!**

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.

It is the operator’s responsibility to check all connections (pipes, tubes, wires) before starting the device. This applies especially if modifications have been executed on the device. During the initial start-up and in regular time intervals all connections must be checked for leakages and damages as well. Please see the maintenance chapter for more information.

## 4.7 INITIAL OPERATION OF THE DRYER

### 4.7.1 PREPARING FOR H<sub>2</sub> DRYING

Now that the device is connected, here is what to do next to get it running.

### 4.7.2 PAIRING THE DEVICE TO THE CLOUD

It is time to power on the device for the first time. Put the switch at the top of the front panel in the upper position to switch the device on.

Download the Enapter app from the Apple App Store or the Google Play Store. After installing, open the app. For detailed information about the app, please refer to the [mobile application handbook](#).

1. If you use 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 of 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, also 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. The device will start drying hydrogen automatically as soon as sufficient inlet pressure is detected on the “H<sub>2</sub> IN” port.

After the pairing, the device will ask for a firmware update (if outdated). We recommend to always use 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](#).



## 5. OPERATION OF THE DRYER

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

### 5.1 MANUAL START/STOP

When the device is in standby mode, push the start/stop button, this will start the device if sufficient inlet pressure is present.

To stop the device, simply push the start/stop button again. The device then ramps down and vents the contained H<sub>2</sub> to return itself to a safe state.

#### **Notice! Properly shut down the device to avoid damages!**



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

Please be aware that in the first 20 h of operation, the hydrogen purity might not reach the maximum yet as the internal parts might contain some remaining humidity from the assembly.

### 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.

The device can be controlled automatically by setting up a rule-based engine. If this is in place, it will start automatically from standby once it detects incoming pressure in the hydrogen inlet pipe. A stop command should be sent when the electrolyzers stop supplying the dryer with hydrogen. This can be done manually via the app, or it can be performed by the rule-based control system built upon the Enapter EMS. Otherwise, the dryer will go into standby, waiting for inlet pressure to start operation again. To find out more about how to set up the rule-based controls for automatic stopping of the dryer, please consult the [Enapter Handbook](#).

The device is equipped with two cartridges which are alternately operating (see chapter [Process Flow Diagram \(PFD\)](#)). While one cartridge is drying the hydrogen, the other cartridge is recovering. One cycle of drying and recovering takes 10 h, so 20 h in total for both cartridges until the first cartridge starts drying hydrogen again. The different device states are described in the following.

### 5.3 DRYING

In this state, the saturated cartridge in block 0/1 is heated to 150 °C so that the moisture inside evaporates and can exit through the purge line, pushed by a small regeneration flow of hydrogen at atmospheric pressure. This regenerates the cartridge in block 0/1 so it later can absorb humidity from the hydrogen again. Meanwhile, the other cartridge in block 1/0 is dehumidifying the hydrogen that



passes through it. Depending on the device configuration and pressure, this process can take about 5 h (35 barg version) or 4.5 h (8 barg version).

## 5.4 COOLING

Since the saturated cartridge in block 0/1 was heated up to 150 °C, it needs to be cooled down to absorb humidity again. The heater is turned off, and a small amount of hydrogen flows through the cartridge to cool it down for about 2 h (for both 35 barg and 8 barg version). Meanwhile, the other cartridge in block 1/0 is still dehumidifying the hydrogen that passes through it.

## 5.5 SWITCHING

This process slowly allows pressure to build back up in the newly regenerated cartridge in block 0/1. Meanwhile, the other cartridge in block 1/0 continues to dehumidify the hydrogen passing through it. This process lasts 2:28 h (35 barg version) or 28 min (8 barg version). No gas is being vented.

## 5.6 PRESSURIZING

This quick, 1 min process pressurises the cartridge that was previously heated and then cooled. An equal amount of hydrogen flows through both cartridges, and they both dehumidify the hydrogen. No gas is being vented.

## 5.7 FINALIZING

The hydrogen now flows through the newly regenerated and dried cartridge in block 0/1 while the saturated cartridge in block 1/0 is depressurised for 1 min so it can be regenerated in the next step.

## 5.8 DRYER CONTROL NETWORK

If the Dryer Control Network is enabled, the dryer will start only when at least one electrolyser is in “steady state”. In all other cases the dryer will be automatically turned off. To avoid the dryer from being started automatically, the button on the front panel or the stop button in the cloud can be used.

Find more information about the [Dryer Control Network](#) in the handbook.

## 5.9 TROUBLESHOOTING

The device can be continuously monitored and controlled remotely. This allows a quick and easy detection of warnings and errors. The device will automatically stop the operation in case of a fatal error. For troubleshooting please visit [handbook.enapter.com](http://handbook.enapter.com).



## 6. ENAPTER MONITORING TOOLS

The device can be monitored and controlled remotely by authorised 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 visualisation of collected data on customisable 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 customisable 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 DRYER

This device is designed to provide many hours of service with minimal and easy maintenance. Proper care and maintenance by qualified personnel help to maximise the operating life of the device. Leave enough space around the device to allow proper inspection, maintenance and cleaning. This section shall be read carefully and understood, in conjunction with prescriptions given in 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 damages 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 UPDATES

Enapter provides firmware updates to include new functionality and to fix and improve system stability and performance. It is recommended to check for updates using mobile phone app or the cloud web interface regularly and install them. In some cases, interfaces or compatibility with other devices might change due to an update. To make sure, that an update is not negatively affecting the overall setup, please read the release notes beforehand and inform the Enapter customer support team in case of doubts.

### 7.2 ROUTINE MAINTENANCE

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; it is recommended to use one of the techniques listed in the [Hydrogen Leak Testing](#).



**Caution! Only authorised 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, fuses, 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 be always 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.



Wear PPE always 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.

### 7.3 CLEANING

When performing the routine maintenance processes and checks, the device should be inspected and cleaned. Start by carefully using a vacuum cleaner (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 reconnecting the power supply.



**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 authorised personnel is allowed to open and inspect the device for maintenance reasons.

### 7.4 DISPOSAL

Enapter is fully committed to recycling the devices and its components.



Please return the device to Enapter at the end of life, where it 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.

### 7.5 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 completely cooled down and that the dryer has been depressurised by temporarily opening the cap from the depressurisation line. Place the plastic caps on the remaining connections. 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 20 kg. Use lifting aids if available.



Due to their weight and size, it is recommended to use a pallet cart or similar devices to manoeuvre the box upon delivery. If the box must be lifted, always lift it with at least two persons.



**Notice! Do not exceed the allowed temperatures!**

During winter, or when outside conditions are below freezing temperature as well as for very hot environments, the shipping box must be additionally marked with a label informing the shipping agent that the package may not be exposed to temperatures outside of the given storage temperatures stated in the datasheet.



## 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<sub>2</sub> 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

##### CONS

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

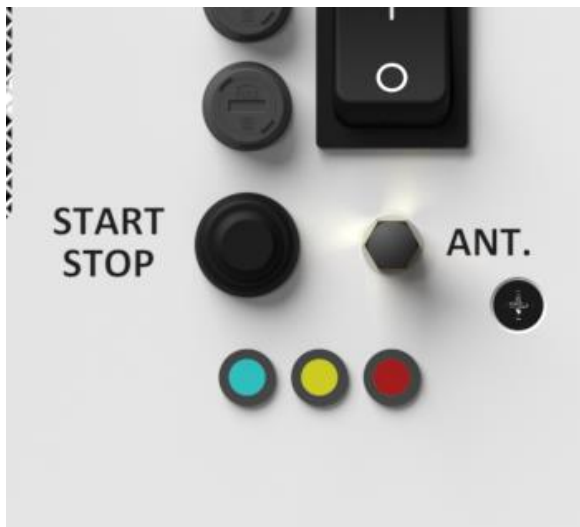


- Can verify several connections at the same time

### Appendix II. LED States



EL4.0 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 status LED indication of the [electrolyser](#) and the [dryer](#).

### Appendix III. Error Codes

[Here](#) you can find a list of all the warnings and errors that can be triggered while using the electrolyser. 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 chose “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 electrolyser’s firmware [can be found here](#).



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06

DOCUMENT TITLE  
DR2.1 – Owner’s Manual

RELEASE DATE  
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