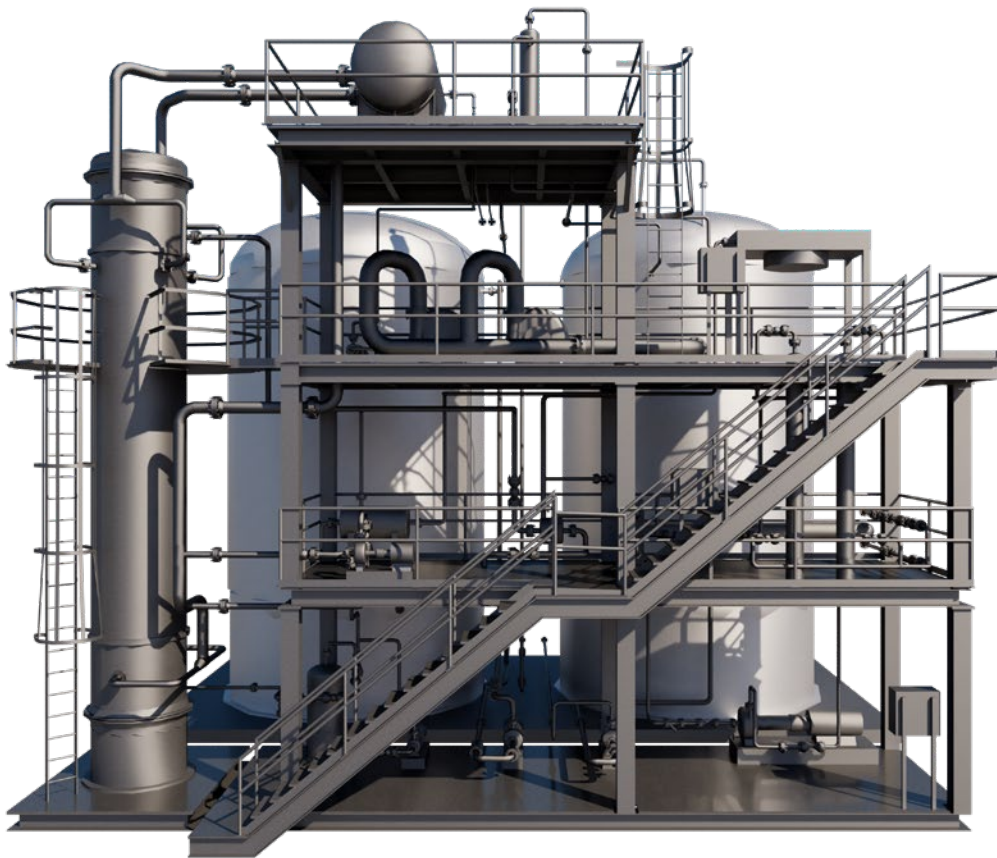


HYDROGEN INFRASTRUCTURE SOLUTIONS





A hydrogen fueled society
— truly sustainable and emission-free.

THE LOHC COMPANY

The Hydrogenious LOHC Technologies GmbH is a pioneer and global industry leader in the field of hydrogen storage in Liquid Organic Hydrogen Carrier (LOHC) materials. The patented technology enables safe and efficient storage of hydrogen in an easily transportable oil, thus eliminating the need for pressurized hydrogen tanks.



THE LOHC TECHNOLOGY

Hydrogen is a central vector in a future renewable energy system. But it is also the smallest and the lightest molecule, making its storage and transport difficult and inefficient.

The LOHC technology changes the way we handle hydrogen!

Liquid Organic Hydrogen Carriers (LOHC) are liquid oils that can chemically store hydrogen at high storage densities under ambient conditions. Our LOHC oil (dibenzyltoluene) enables high-capacity hydrogen transport in the existing infrastructure for fossil fuels. The LOHC oil is hardly flammable and non-explosive eliminating the risk of large-scale hydrogen storage and transport.



THE LOHC MATERIAL



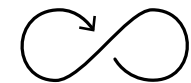
SAFE

- No molecular hydrogen
- Hardly flammable and non-explosive, even when loaded with hydrogen
- Non-toxic and not classified as hazardous good (ADR, etc.)



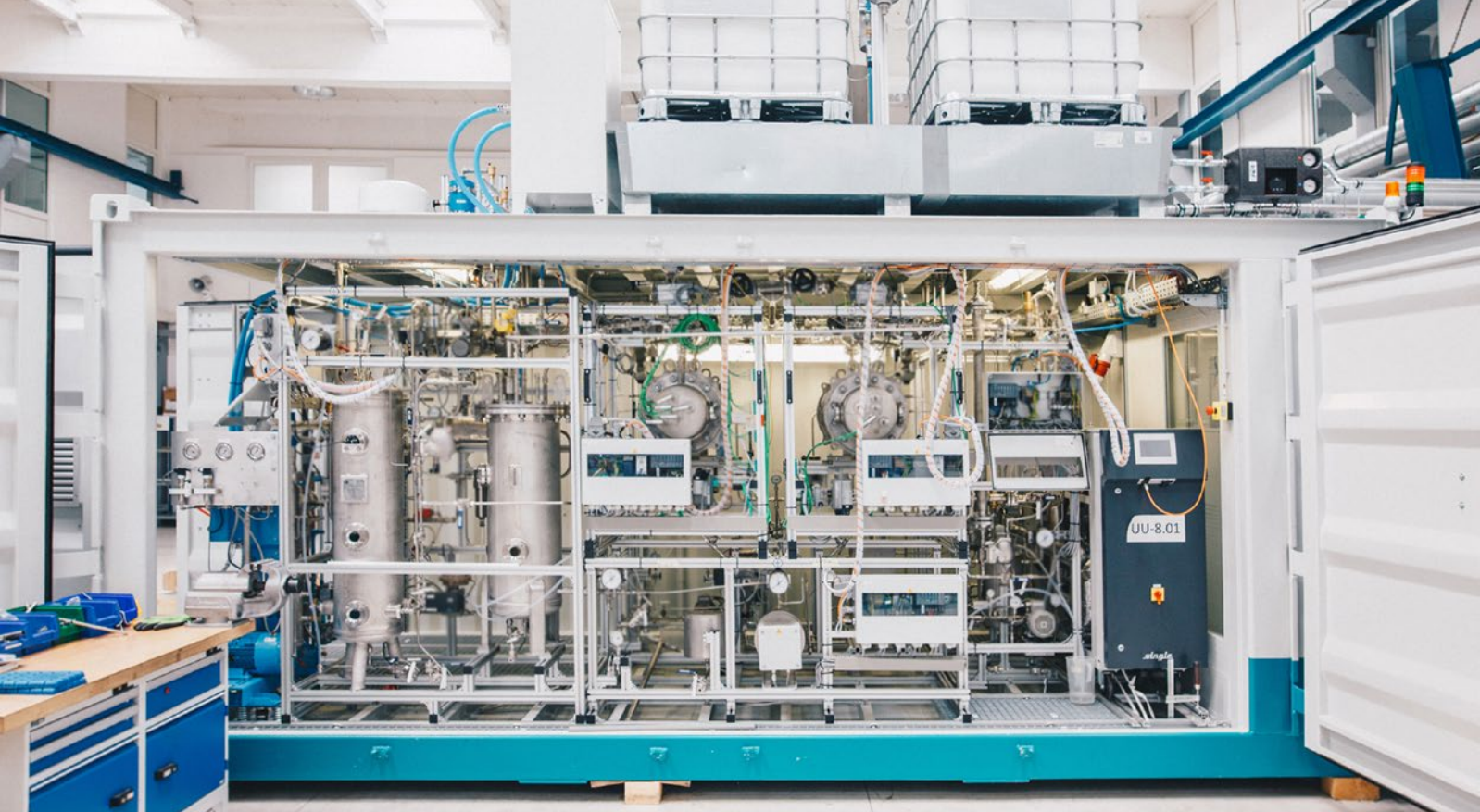
EASY

- Ambient storage conditions
- Handling of a liquid oil from -39 °C to 390 °C
- Transportable in existing infrastructure for fossil fuels



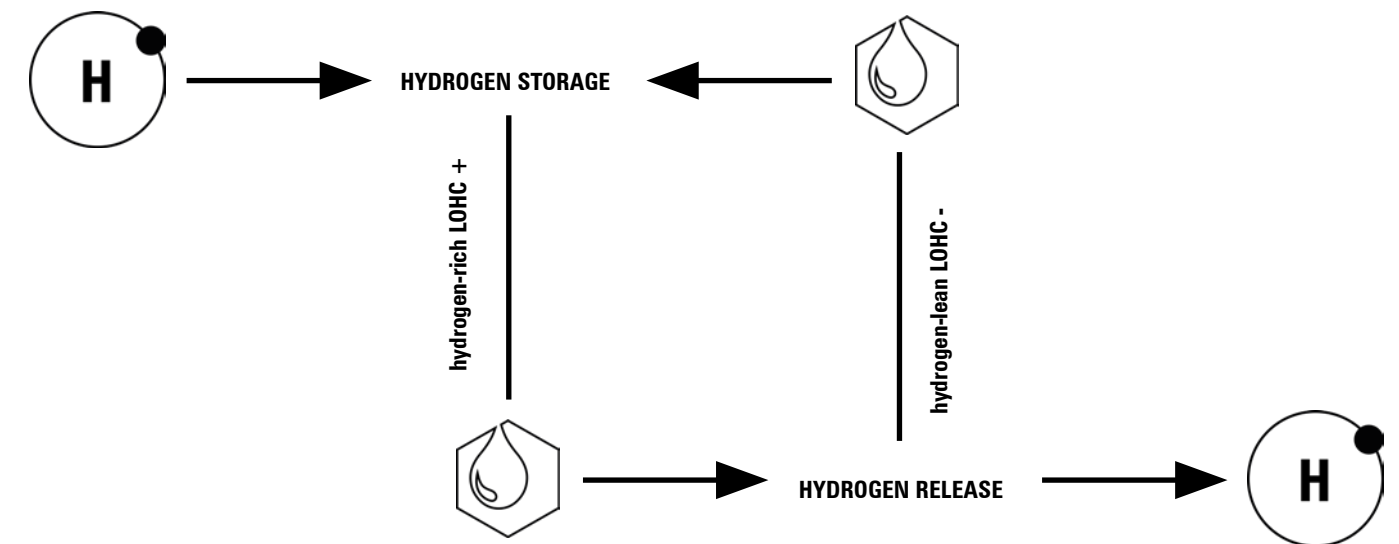
EFFICIENT

- High storage density of $630 \text{ Nm}^3_{\text{H}_2} / \text{m}^3_{\text{LOHC}}$
- No self-discharge over time
- High cycle stability of carrier liquid



THE LOHC CONCEPT

- Hydrogenation: Chemical bonding of hydrogen molecules to the LOHC via a catalytic reaction in a continuous process
- Exothermic reaction at 30 bar, generating about 9 kWh_{th} /kg_{H₂} heat at >200 °C



- Dehydrogenation: Chemical release of hydrogen molecules from the LOHC via a continuous catalytic process
- Endothermic reaction requires about 12 kWh_{th} /kg_{H₂} heat at ~300 °C
- On-demand hydrogen release with high hydrogen purity

HYDROGEN HANDLING MADE EASY

HYDROGEN GENERATION

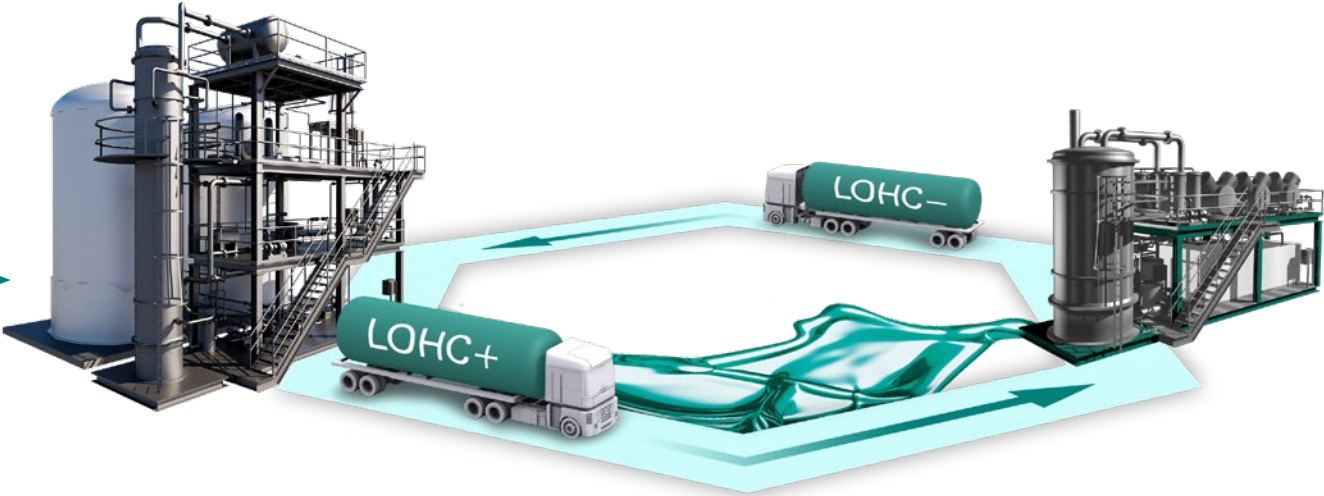
- Steam methane reforming
- Coal gasification
- By-product hydrogen
- Hydrogen-rich gases

INDUSTRIAL HYDROGEN

RENEWABLE ENERGIES

ELECTROLYSIS

- Wind
- Solar
- Hydro
- Biomass



HYDROGEN UTILIZATION

- Flat glass production
- Metal refining
- Chemical processes
- Fertilizer production

INDUSTRY SUPPLY

HYDROGEN REFUELING

- Large capacity hydrogen refueling stations
 - Bus depots
 - Captive fleets
 - Trains & Trams

- Optimized for continuous hydrogen storage in LOHC
- Ideal for large-scale hydrogen storage processes
- Easy hydrogen logistics and low operating costs

THE STORAGE UNIT

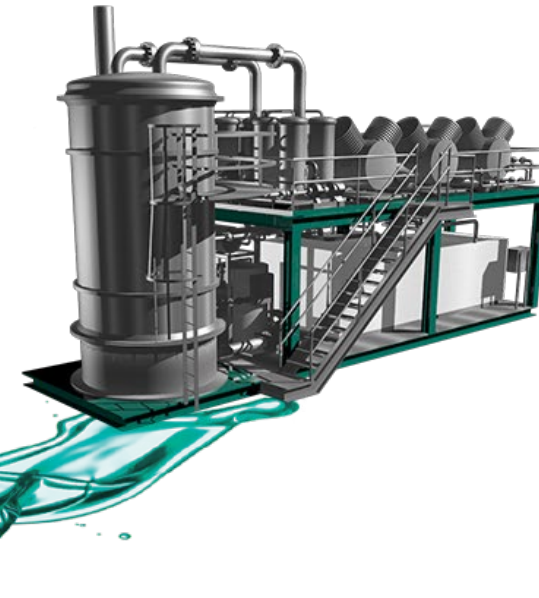
Mid - to - large scale hydrogen storage from industrial and renewable sources



- High safety and flexible hydrogen storage capacity
- Ideal for medium to large-scale hydrogen demand
- Reduced footprint and easy on-site installation

THE RELEASE UNIT

Hydrogen supply for H₂ refueling stations, chemicals, agriculture, metals, glass, electronics, pharmaceuticals, food, etc.





LOHC Hydrogenation

Chemical bonding of hydrogen molecules to the liquid carrier oil

THE STORAGE UNIT

The Storage Unit is designed to store hydrogen in the LOHC oil. The process is optimized for continuous operation and high efficiencies. During the exothermic storage reaction high-temperature heat is produced, which can be used on-site. Depending on the required storage capacity, the systems are available as containerized (C-Series) and skid-based (S-Series) solutions. From StorageBOX to StoragePLANT we have the right product to meet our customer's demands.

THE STORAGE UNIT

Key Benefits



Optimized for continuous hydrogen storage in LOHC



Ideal for large-scale hydrogen infrastructure



Designed for long-life operations and low maintenance



High safety and high hydrogen storage capacity



Low footprint and easy on-site installation

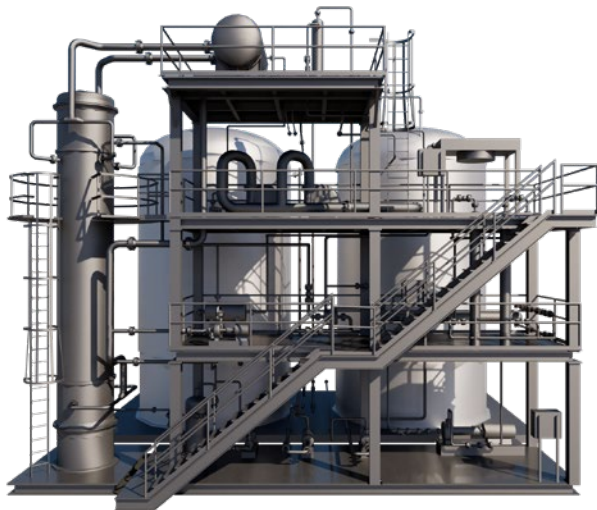


C-SERIES

Containerized systems for medium scale projects and application piloting

KEY FEATURES

- Easy on-site installation
- Predefined footprint
- Marginal site preparation



S-SERIES

Skid-mounted systems for large-scale hydrogen storage

KEY FEATURES

- Large-scale industrial design
- Designed for direct coupling with SMR or large-scale electrolysis

C-SERIES

The StorageBOX

BASIC CONFIGURATION

	StorageBOX 10	StorageBOX 120
Hydrogen capacity ^a	10 Nm ³ /h // 0.9 kg _{H₂} /h	120 Nm ³ /h // 11 kg _{H₂} /h
LOHC production ^a	20 l/h	240 l/h
Heat production ^a	9 kW _{th}	100 kW _{th}
Load range	50 – 100 %	
	^a under nominal load	
Footprint	20 foot container	
Inlet hydrogen stream	30 – 50 bar, 99.99 % purity	
Inlet LOHC stream	≥ 0.1 barg, T ≥ 15 °C	
Power connection	400 V AC, 3 phase, 50 Hz	

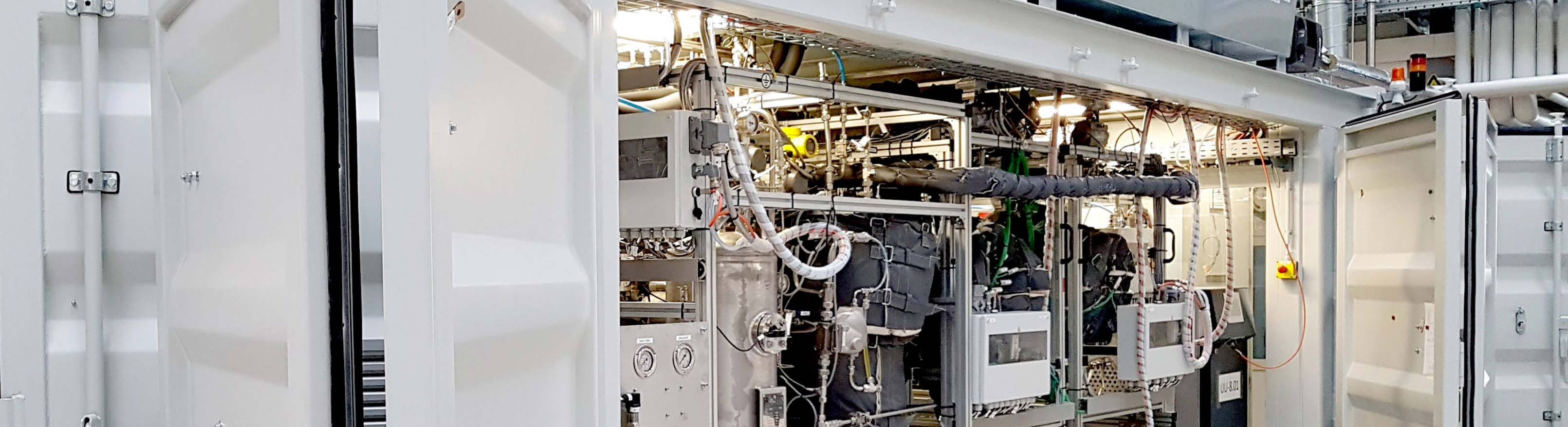
S-SERIES

The StoragePLANT

BASIC CONFIGURATION

	StoragePLANT 5tpd	StoragePLANT 12tpd
Hydrogen capacity ^a	5 t/d // 210 kg _{H₂} /h	12 t/d // 500 kg _{H₂} /h
LOHC production ^a	4500 l/h	11000 l/h
Heat production ^a	1900 kW _{th}	4500 kW _{th}
Load range	50 – 100 %	
	^a under nominal load	
Footprint	Skid-based	
Inlet hydrogen stream	30 – 50 bar, 99.99 % purity	
Inlet LOHC stream	≥ 0.1 barg, T ≥ 15 °C	
Power connection	400 V AC, 3 phase, 50 Hz	

CUSTOMIZED PLANT SIZES AVAILABLE FOR > 12 t/d



LOHC Dehydrogenation

Release of hydrogen molecules from the liquid carrier oil.

THE RELEASE UNIT

The Release Unit is designed to release hydrogen from the LOHC oil. The process is optimized for continuous operation and long-term stability. The endothermic hydrogen release process requires heat, which can be supplied by high-temperature waste-heat, natural gas, electricity or hydrogen. The systems are available as easy to install containerized systems (C-Series) and skid mounted solutions (S-Series), ideal for hydrogen refueling stations and industrial supply.

THE RELEASE UNIT

Key Benefits



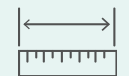
Optimized for continuous high purity hydrogen release from LOHC



Ideal for medium to large-scale hydrogen demand



High safety and high hydrogen storage capacity



Low footprint and easy on-site installation



Underground storage at hydrogen refueling stations possible

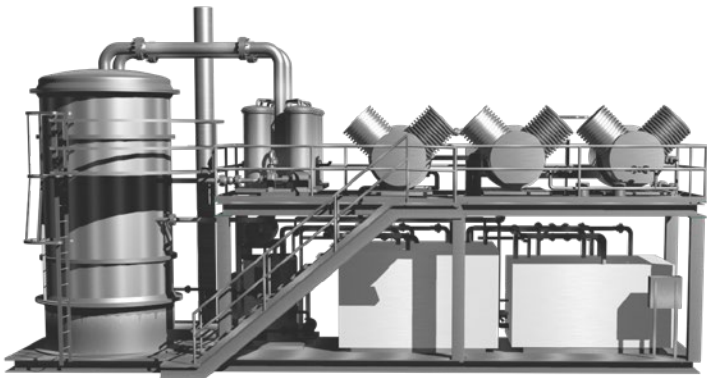


C-SERIES

Containerized systems for medium scale projects and application piloting

KEY FEATURES

- Easy on-site installation
- Predefined footprint
- Marginal site preparation



S-SERIES

Skid-mounted systems for large-scale hydrogen release

KEY FEATURES

- Large-scale skid mounted design
- Designed for industrial processes and large hydrogen refueling stations

C-SERIES

The ReleaseBOX

BASIC CONFIGURATION

	ReleaseBOX 10	ReleaseBOX 60	ReleaseBOX 120
Hydrogen outlet ^a	10 Nm ³ /h // 0.9 kg _{H2} /h	60 Nm ³ /h // 5.5 kg _{H2} /h	120 Nm ³ /h // 11 kg _{H2} /h
LOHC demand ^a	20 l/h	120 l/h	240 l/h
Heat demand ^a	12 kW _{th}	66 kW _{th}	130 kW _{th}
Load range	50 – 100 %		
^a under nominal load			
Footprint	30 foot container		40 foot container
Inlet LOHC stream	≥ 0.1 barg, T ≥ 15 °C		
Power connection	400 V AC, 3 phase, 50 Hz		

S-SERIES

The ReleasePLANT

BASIC CONFIGURATION

	ReleasePLANT 1.5tpd
Hydrogen outlet ^a	1.5 t/d // 65 kg _{H2} /h
LOHC demand ^a	1400 l/h
Heat demand ^a	780 kW _{th}
Load range	50 – 100 %
^a under nominal load	
Footprint	Skid-based
Inlet LOHC stream	≥ 0.1 barg, T ≥ 15 °C
Power connection	400 V AC, 3 phase, 50 Hz

CUSTOMIZED PLANT SIZES AVAILABLE FOR > 1.5 t/d

THE RELEASE UNIT OPTIONS //

HYDROGEN OUTLET purity

HYDROGEN 4.0

If the subsequent process or hydrogen consumer can handle a certain amount of impurities we can operate the Release Unit with a maximized hydrogen outlet stream. The **HYDROGEN 4.0** option ensures hydrogen quality of $\geq 99.99\%$.

HYDROGEN 5.0

In case of higher requirements regarding the hydrogen quality, we offer the **HYDROGEN 5.0** upgrade option with a hydrogen quality of $\geq 99.999\%$.

FUEL GRADE

In case of using the released hydrogen as a fuel, e.g. for fuel cell vehicles, we can deliver a fuel grade hydrogen according to ISO 14687:2-2012 and SAE J2719. This **FUEL GRADE** upgrade will be integrated into the Release Unit.

THE RELEASE UNIT OPTIONS //

HYDROGEN OUTLET pressure

LIGHT PRESSURE 10 bar

The Release Unit operates at low pressures. For pressure requirements of up to 10 bar at the terminal point we offer our **LIGHT PRESSURE** upgrade. This option will be fully integrated into our Release Unit.

MEDIUM PRESSURE 50 bar

If the requested pressure exceeds a level of 10 bar, you can choose the **MEDIUM PRESSURE** upgrade which ensures hydrogen pressures of up to 50 bar at the terminal point of our Release Unit.

HIGH PRESSURE 100 bar

In order to use the released hydrogen for refueling of vehicles, high hydrogen pressures at the HRS (e.g. 350 or 700 bar) are required. For these purposes, we can provide a **HIGH PRESSURE UPGRADE** which ensures a hydrogen pressure of 100 bar at the terminal point of our Release Unit.



LOHC TANK & LOGISTICS

Bound to LOHC, hydrogen is stored at ambient temperature and without the need of pressurized or cryogenic vessels. Due to the liquid state and the diesel-like properties of our LOHC, the material is stored and distributed with existing mineral oil fuel infrastructure. Our LOHC is hardly flammable and non-explosive. By using standard oil infrastructure solutions, LOHC entails a cost-effective way to store and transport particularly large amounts of hydrogen in a very safe and efficient way.

TANK SYSTEMS

On-Site Storage Tank

With our expertise in LOHC technology we will provide you with the perfect storage concept for your hydrogen storage or supply demand with fully flexible hydrogen storage capacities up to multi-ton hydrogen storage in standard oil tanks.

BASIC REQUIREMENTS

Wall	Double-walled or collecting tray
Shell material	No special requirements
Valves, gauges	PTFE, FFKM
Pressure	Atmospheric or slight overpressure (<0.5 barg)
Inertisation	Inert gas (e.g. nitrogen)
Mandatory meters	Continuous level indicator, thermometer
Configuration	Manlid, bottom outlet, top outlet, pressure relief valve, full drainability
Options	Heating, baffles, compartments, insulation



IBC Container
1 to 3 m³



Swap Body Container
10 to 24 m³



Stationary Tank
10 to 100 m³



Underground Storage
> 10 m³

Logistics and Refueling Options

The existing infrastructure of conventional fuel transportation concepts can be used to handle our LOHC material. If your on-site situation allows stationary storage tanks, you can use conventional tank trucks to deliver LOHC and refuel the on-site tanks. Alternatively we can supply you with swap body containers to transport the LOHC in batches and store it on-site.

Tank Truck
15 to 30 m³

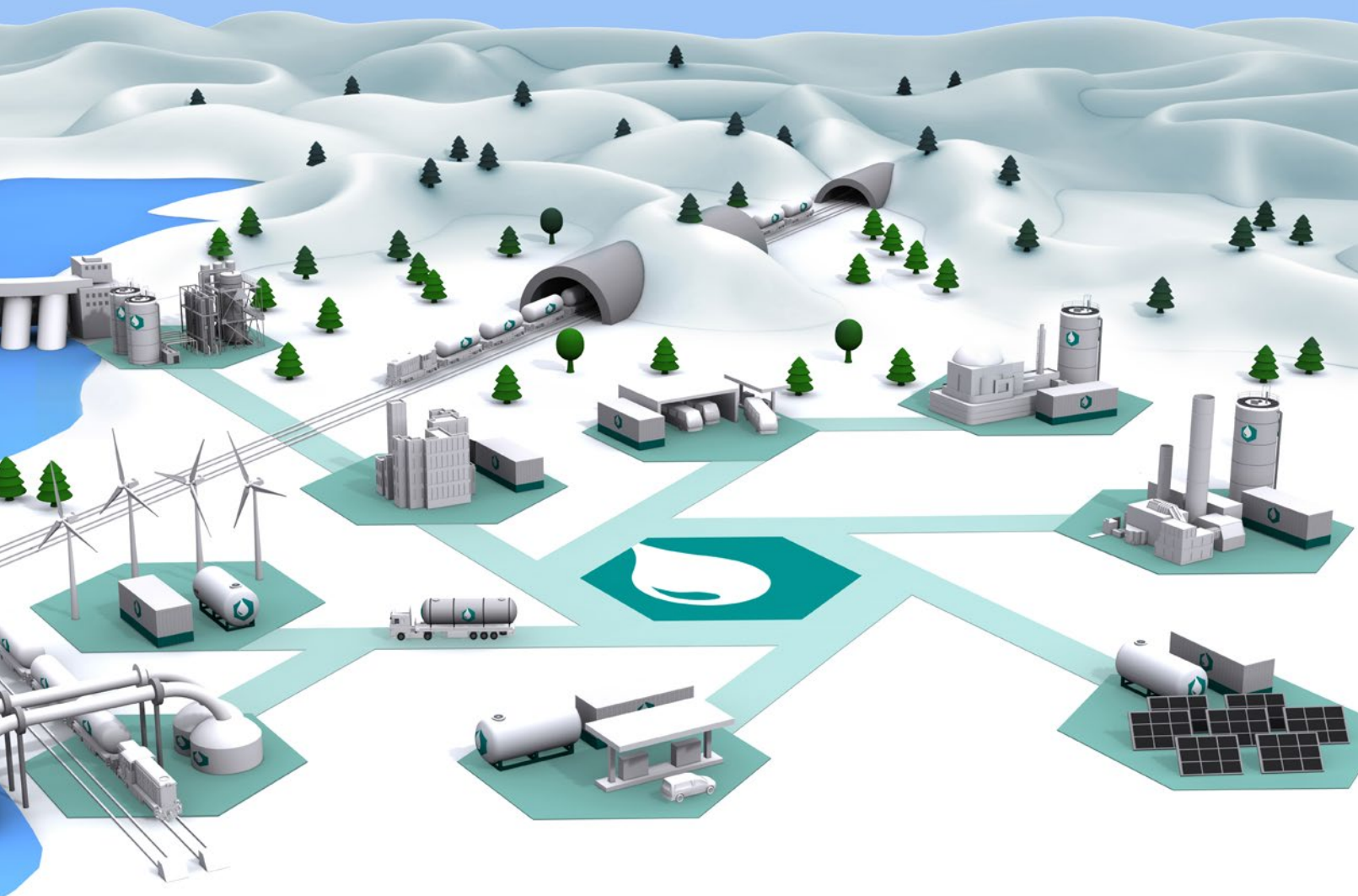


Tank Trailer
15 to 30 m³



Swap Body Container
10 to 24 m³





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