GRZ Technologies
STS Sales, Technology & Services Ltd.

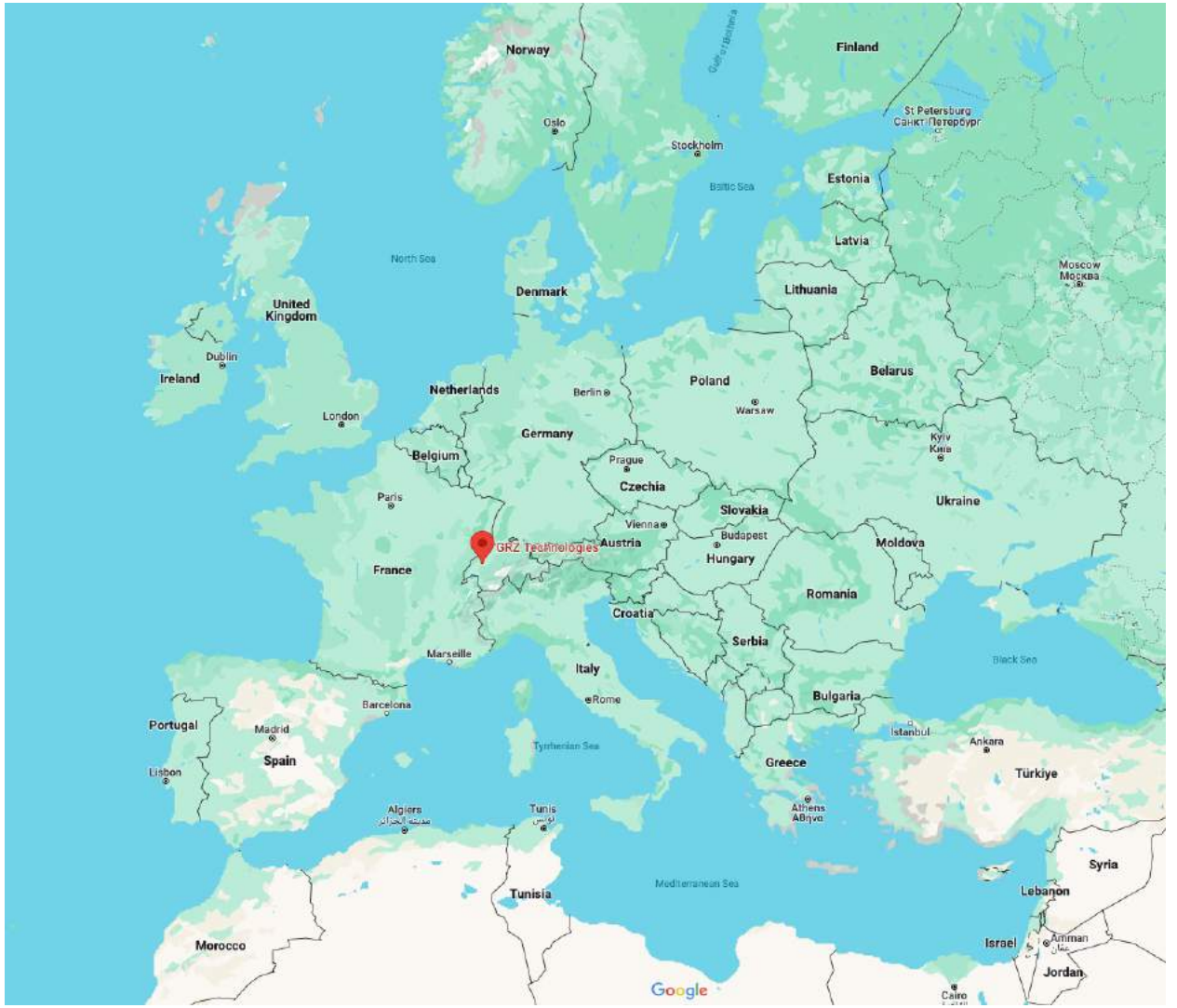
January 24

S.T.S – Sales, Technology & Services Ltd.

Burckhardt Compression	Reciprocating Compressorsd	World Leading OEM	Swiss Company
De Pretto Industrie	Steam Turbines Rotating Equipment	OEM and Service Providere	Italian Company
SULZER	Sulzer Pumps	Centrifugal pumps	Finish Company
	Sulzer Chemtech	Licensing, Engineering and Hardware for the chemical industry	Swiss Company (HQ)
grz TECHNOLOGIES	H2 Storage	Metal Hydrates Storage and Complete containarized solutions	Swiss Company

Management and Senior Organization Members

- GRZ was founded In 2017 by Noris **G**allandat, Claudio **R**uch and Prof. Andreas **Z**üttel (EPFL).
- GRZ and STS cooperation began late 2021.
- GRZ Technologies SA is a Swiss Company
  Avenches, Switzerland



Company Development

1990‘ Prof. Andreas Züttel initiates research activities on metal hydrides

2017 10. 3. 2017, Incorporation of GRZ Technologies Ltd.

2018 Market entry of the laboratory-scale HyCo

2019 Contract signed for first DASH Power project

2020 Establishment of new factory, Hyundai becomes a partner

2021 Regular shipment of goods – products in service on 4 continents

2022 Successful market entry of standardized DASH Power

2022 Strategic partnership with fischer group

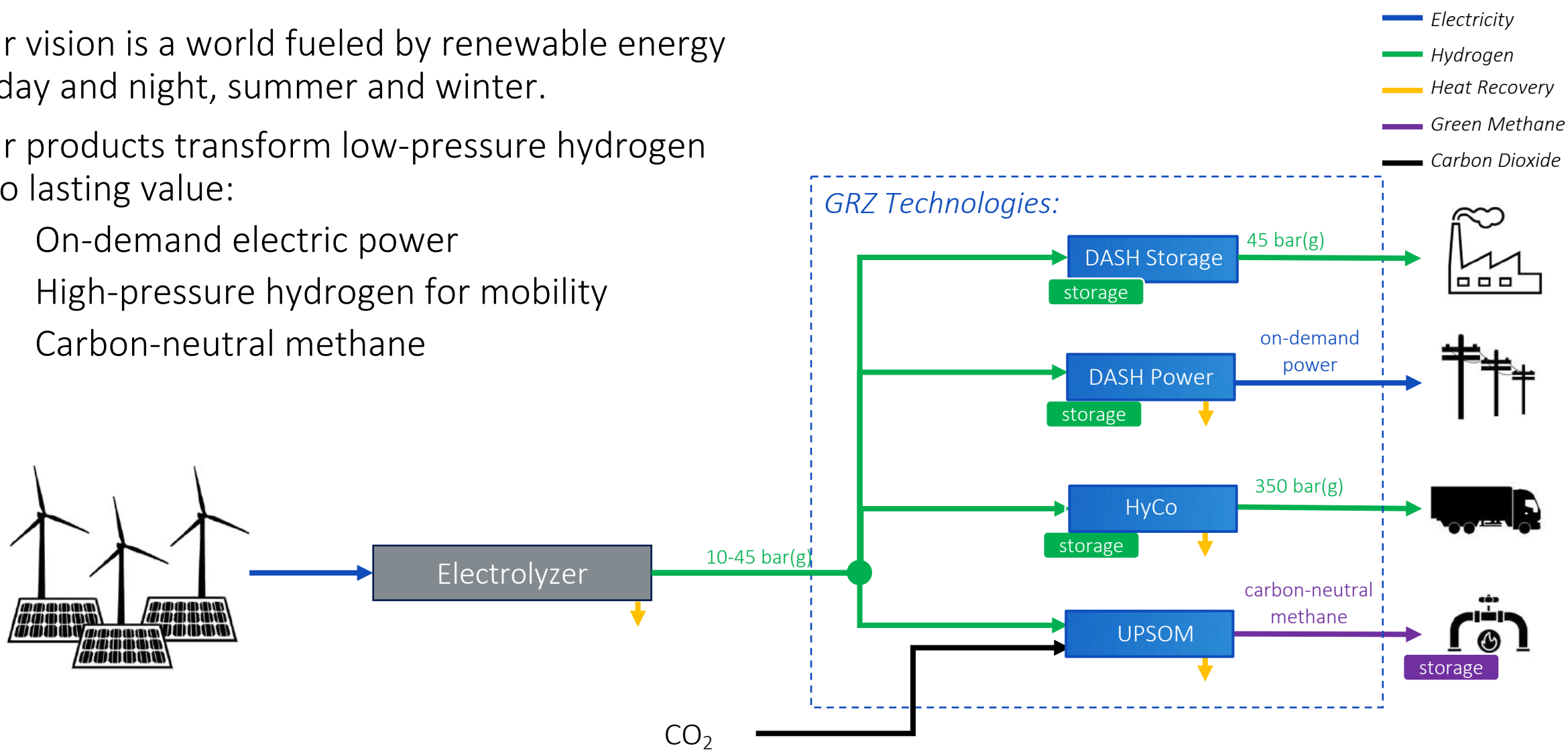
2023 Establishment of new factory

2023 Series production of standardized products

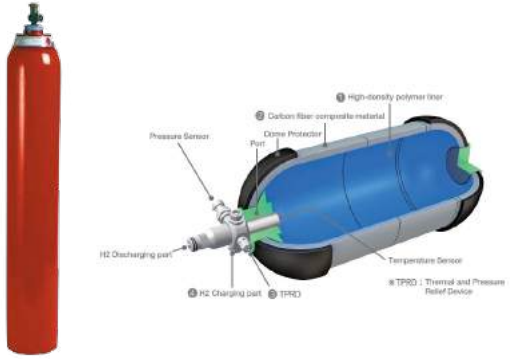
2023 Strategic partnership with AMPO and Sabanci

GRZ Technologies

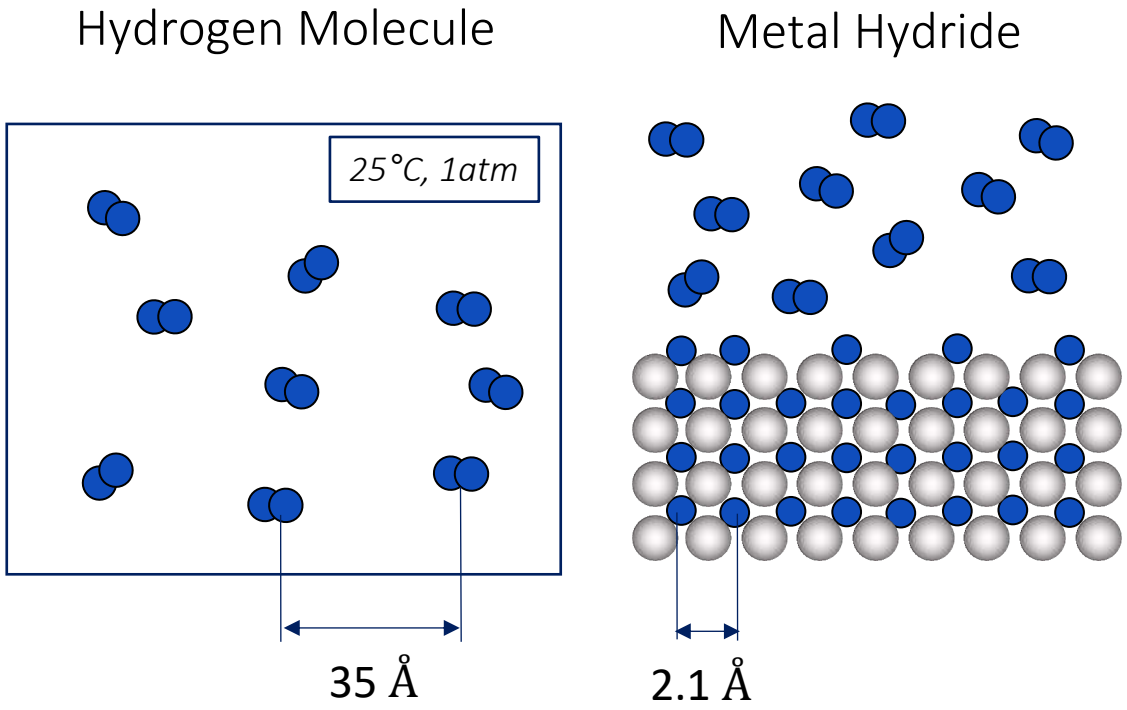
- Our vision is a world fueled by renewable energy – day and night, summer and winter.
- Our products transform low-pressure hydrogen into lasting value:
  - On-demand electric power
  - High-pressure hydrogen for mobility
  - Carbon-neutral methane



Forms of Hydrogen Storage

Pressurized (≈35 bar)	Pressurized (>200 bar)	Liquid	Solid state
			
Advantages: • No compression required • Widely available • Moderate pressures	Advantages: • Good volumetric density at high pressures (700 bar)	Advantages: • High volumetric density • Scalability	Advantages: • Very high volumetric density • Excellent safety characteristics • No compressor required • No energy losses due to compression /liquefaction
Disadvantages: • Large volume • Not entire capacity usable • Safety-related limitations	Disadvantages: • Energy losses due to compression • Safety concerns • Compressor required • Not entire capacity usable	Disadvantages: • Energy losses due to liquefaction • Technical complexity: boil-off, constant cooling, ... • Safety-related limitations	Disadvantages: • Lower gravimetric density

Solid-State Hydrogen Storages (Metal Hydrides)



Factor 16.6 in Distance = Factor 2300 in Volume

Ph. Mauron, M. Bielmann, A. Züttel EMPA, Switzerland

Hydrogen molecules are dissociated in hydrogen atoms, which are absorbed into a specific metallic material under favorable conditions. The hydrogen atoms occupy the interstitial sites of the metallic lattice, which enables a high volumetric density.

Metal Hydrides for Hydrogen Storage

Hydrogen (=Energy) Storage

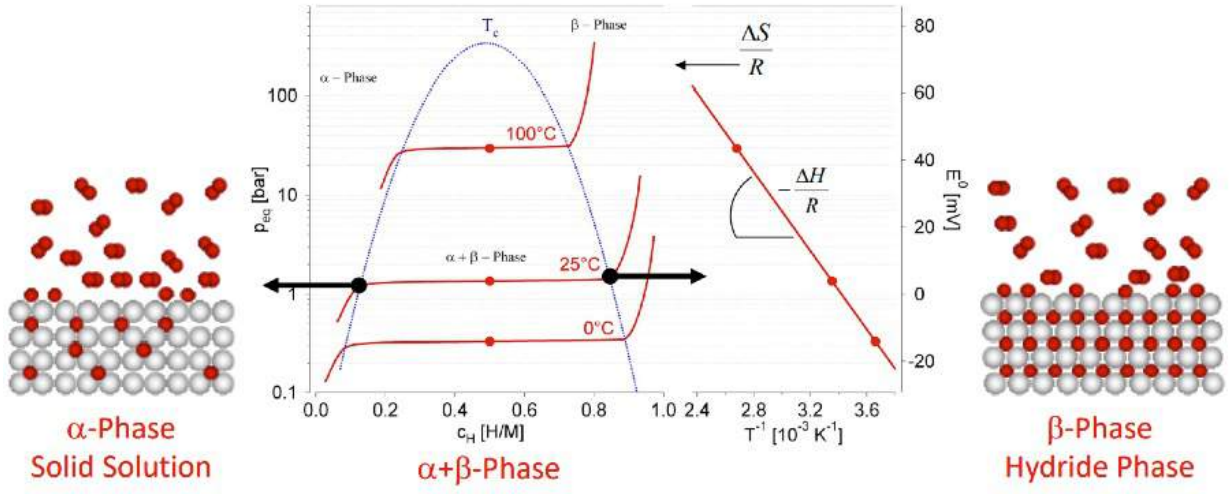
- Very high volumetric density
- Excellent safety properties
- Long lifetime, no degradation
- High round-trip efficiency
- Density correspond to compressed hydrogen at 1000 bar(g)
- Flow rates can be controlled with temperature

Thermal Behavior

When storing hydrogen in metal hydrides, the thermal behavior of the system is of great importance.

This is due to the basic physical properties of the compounds:

- The pressure in the system largely depends on the temperature. The relation between these variables is non-linear.
- When H2 is absorbed by a DASH storage, heat is released. It is therefore an exothermic process.
- Conversely, the removal of hydrogen is an endothermic process. Therefore, heat is required to desorb hydrogen from a storage.



Thermal Behavior (II)

- storage module from which the hydrogen was removed with a very high flow rate causing it to freeze and exemplifies the process described above.

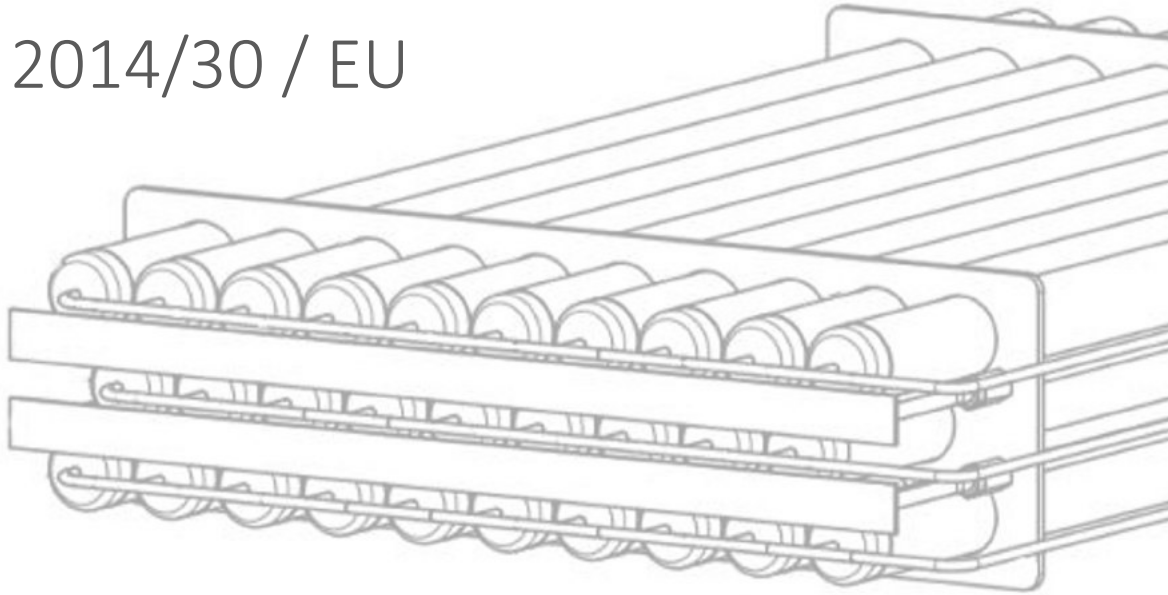
System Design and Manufacturing

- GRZ Technologies builds metal hydride storage modules according to a patented design on its production lines in Switzerland.
- The basic component of each storage module is the application-specific and optimized hydrogen carrier material.
- The storage material is then inserted into optimized stainless-steel containers (e.g., made of AISI 304L 3.1).
- The smallest unit in the modular design used for this is the cell.

Quality Standards

We manufacture equipment which is CE-conform with respect to the following directives:

- ATEX-Directive 2014/34/EU
- Machinery Directive 2006/42 / EC
- Pressure Equipment Directive 2014/68 / EU
- Electromagnetic Compatibility Directive 2014/30 / EU
- Low Voltage Directive 2014/35/EU
- Electrolyzers/Hydrogen ISO 22734:2019



DASH M-series Solid State Hydrogen Storage Modules

- Metal hydrides in optimized stainless steel pressure vessels
- 2 standard modules (M3 and M45)

DASH Storage	Unit	M3	M45
Storage capacity per module	kg_{H2}	3	45
Maximum charge flow (at 20°C)	kg_{H2}/h	0.08	1.2
Maximum discharge flow (at 20°C)	kg_{H2}/h	0.08	1.2
Outer dimensions (L x W x H)	mm	1051 x 651 x 217	2000 x 1090 x 680
Weight	kg	250	3'915
ATEX		None	
Preferred hydrogen charge pressure	bar(g)	30 to 45	
Hydrogen discharge pressure	bar(g)	1 to 45	
Hydrogen supply purity	%	99.995	
Outlet H_2 purity	%	99.995	
External cooling requirements		None	
Admissible ambient temperature	°C	-5 to 40	
Expected service life	years	> 30	

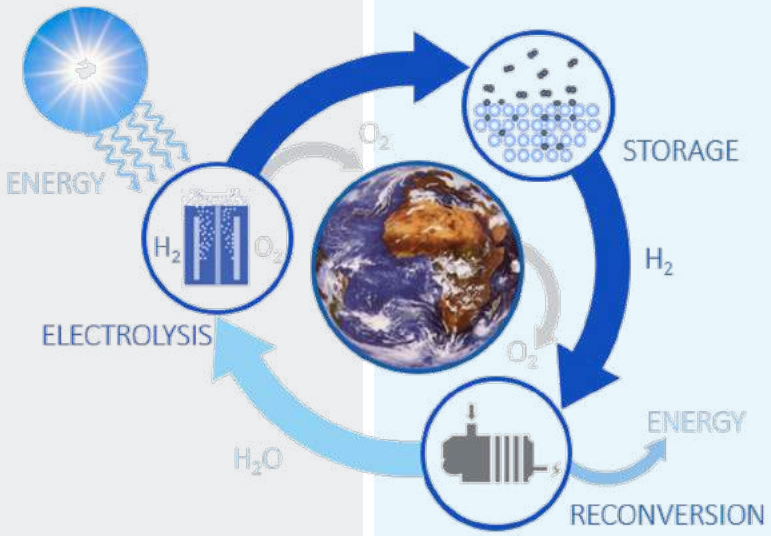
- Can be combined to build several tons of storage capacity
- Can be submerged in liquid for quick thermal management – for integration in bigger projects, and increase in flow rates

DASH C-series Solid State Hydrogen Storage Containerized

- Metal hydrides in optimized stainless steel pressure vessels integrated in a container, that can be stacked
- Plug & play modules with thermal management for rapid charge / discharge
- From 45 kg. to several tons.

DASH Storage	Unit	C45	C90	C135	C180
Storage capacity	kg_{H2}	45	90	135	180
Maximum charge flow	kg_{H2}/h	2	4	8	8
Maximum discharge flow	kg_{H2}/h	2	4	8	8
Preferred hydrogen charge pressure	bar(g)	30 to 45			
Hydrogen discharge pressure	bar(g)	1 to 45			
Required H_2 purity	%	99.995			
Outlet H_2 purity	%	99.995			
Dimensions	container	10ft	10 ft	20ft	20ft
Weight	tons	5.8	9.4	14.0	17.5
Noise	dB(A)	<70			
Electrical interface input	V AC	230	400 3-phase		
Ambient temperature	°C	-10 to 45			
Expected service life	Years	> 30			

DASH Power (I)



Standardized Electrolysis Units or delivered hydrogen via truck or pipeline – all depending on application

DASH Power

- Fully integrated hydrogen storage
- Charged with any hydrogen source
- Delivering electrical power

DASH Power (II)

DASH Power Systems:

- **On-demand power where you need it:** integrated automotive-grade fuel cell system (up to 500 kW_{el} per module)
- **Think MWh not kWh:** up to 4.5 MWh_{el} of electrical energy on a very small footprint.
- **Forget cycle limitations and capacity degradation:** fully reversible process without cycle limitations or degradation.
- **Safety without compromises:** our proven and patented solid-state hydrogen storage technology leads to excellent safety properties allowing for the installation in almost any environment, even indoors.
- **Environmentally friendly energy storage:** greatly reduced environmental footprint and long lifetime
- **Easy integration:** compact design in 20ft ISO -containers

DASH	175-900	260-1800	400-2700	500-3500	500-4500
Electrical power (Peak, kW_e)	175	260	400	500	500
Electrical power (Cont., kW_e)	75	160	240	320	320
Storage capacity (kg_{H2})	45	90	135	175	225
Total storage capacity (MWh_e)	0.9	1.8	2.7	3.5	4.5
Time to discharge at 100% load (h)	12.0	11.3	11.3	10.9	14.0
Electrical interface output	3-phase 400 V 50/60 Hz				
Communication interface	TCP/IP OPC UA and hardwired				
Ambient temperature (°C)	-10 to +38 (without degradation)				
Noise	< 59 dB(A) at 10 meters distance				
Hydrogen supply purity	4.5 (> 99.995 %)				
Hydrogen supply pressure (bar(g))	30 – 45				
Nominal power output (kWh/kg_{H2})	20				
Max. fuel cell efficiency (%)	62				
Max. efficiency (incl. waste heat, %)	84				
Dynamic operation	10-90% in 1s during operation				

HyCo - Metal Hydrides for Hydrogen Compression

Hydrogen Compression

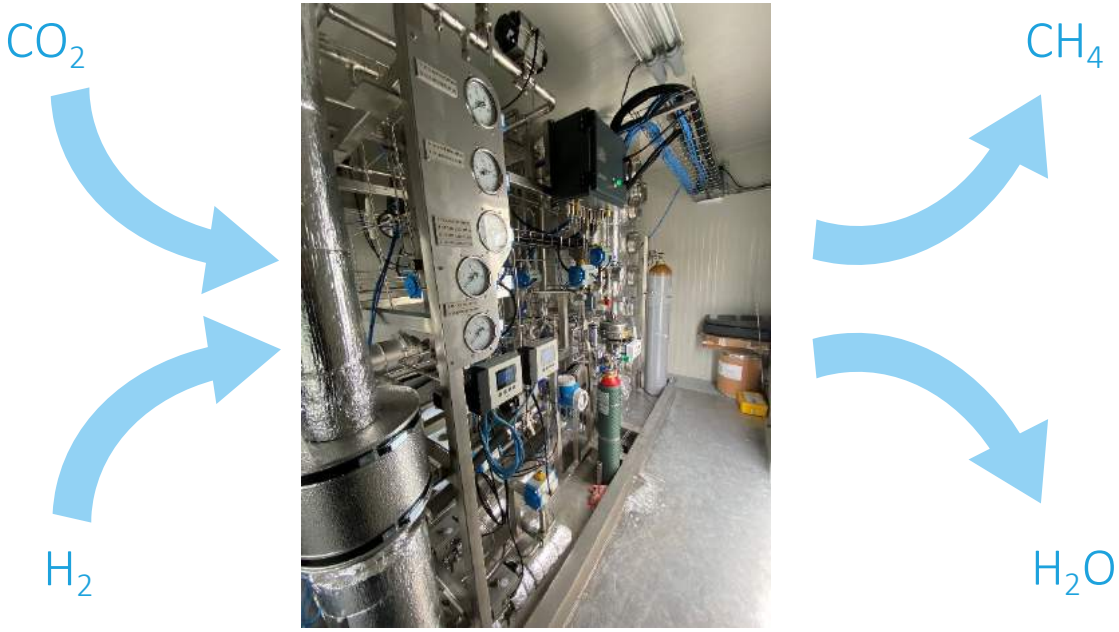
- Combined storage / compression units
- Thermally powered compression
- Silent, vibration-less, without leakage, and with minimal maintenance
- Many years experience with laboratory compressor deliveries delivered in 4 continents

UPSOM – Methanation Reactor

- A new methanation technology with improved efficiency and reduced costs.
- Directly convert CO_2 and H_2 into synthetic methane using the Sabatier process

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

- Synthetic methane is a 100% carbon-neutral replacement for fossil natural gas
- Over 99% conversion in a single stage thanks to novel catalyst and innovative reactor design
- Small scale system has been operational for 3 years
- Applications:
  1. Upgrade of raw biogas
  2. Use of CO_2 from flue gases
  3. Storage of excess energy in synthetic methane



UPSOM – Methanation Reactor

Hydrogen buffer storage (DASH technology)

Electrolyzer

UPSOM methanation reactor

Parameters	UPSOM-500	UPSOM-1000
Methane production (CH_4)	3.2 – 16.2 kg_{CH4}/h	7.4 – 37.5 kg_{CH4}/h
Hydrogen consumption (H_2)	1.6 – 8.1 kg_{H2}/h	3.7 – 18.75 kg_{H2}/h
Carbon dioxide consumption (CO_2)	8.9 – 44.4 kg_{CO2}/h	20.6 – 102.7 kg_{CO2}/h
Power (Eq. CH_4 HHV)	45 – 225 kW	104 – 520 kW
Input pressure of H_2 and CO_2 and operating pressure	10 bar(g)	
Average operating temperature	250°C	
Product shape	20ft-ISO Container	
Weight of complete containerized solution	9'800 kg	14'800 kg
Electrical power supply	32 A / 400V 3P	32 A / 400V 3P
Standby power consumption	500 W	
Dynamic operation	0% – 100% - 0% in seconds	
Start-up time from cold	15-30 minutes	
Compliance	ATEX Directive 2014/34/EU PED Directive 2014/68/EU LVD Directive 2014/35/EU	

Contact

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Newsletter

Thank you for your attention

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