GKN HYDROGEN

A Langley Holdings Company


# De-Risk by Design | The World´s safest hydrogen storage

Company Presentation as of August 22, 2024

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# Who we are

GREEN. SAFE. COMPACT.

# Our Shareholder Langley Holdings plc

Langley Holdings plc is a diverse, globally operating engineering Group headquartered in the United Kingdom. GKN Hydrogen is part of Langley 's Power Solutions Division.

| | | |
|---|---|---|
| 3<br>Principal Divisions | 90+<br>Subsidiaries | €1.2bn<br>Revenues |
| 18<br>Manufacturing Sites | 5,000+<br>Employees | €125m<br>PBT |

**Anthony Langley, Chairman & CEO, Langley Holdings plc:**
"The acquisition of GKN Hydrogen underscores Langley Holdings' strategic focus on sustainable energy solutions and commitment to a greener future".

## Power Solutions

€574m
Revenues
2,257
Employees


## Print Technologies

€331m
Revenues
1,572
Employees


## Other Industrials

€301m
Revenues
1,355
Employees


Source: Langley Holdings plc - Annual Report 2023

## Our Mission: We transform the way energy is stored.

We decarbonize industrial and public infrastructures, utilities and buildingd by commercializing safe and compact hydrogen storage in solid-state metal hydrides.

# Who we are

GKN HYDROGEN

**Market launch**
May 2021

Spin off from
GKN Powder Metallurgy
World #1

Agile standalone
Business since
Aug 2022

- **Pioneer in Safe Storage of Green Hydrogen**
  - Metal Hydride Intellectual Property
  - Secure supply chain from leading powder metal producer
  - GKN Hydrogen's Technical Know-How
  - Digital integration capability
- **GKN Hydrogen operates in 3 locations**
  - Pfalzen, ITA (System Eng, Ops & Digital)
  - Bonn, Radevormwald, GER (Commercial, R&D)
  - Carlsbad, US (Commercial & Appl. Eng.)
- **Markets served:**
- **EU, US, AUS**


Business led by

**Gottfried Rier**
*CTO & MD Italy, Germany and the US*

**Jim Petrecky**
*CCO & MD US*

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# Hydrogen Timeline - From R&D to Industrial Scale

## 2013

R&D launch in partnership with GKN Powder Metallurgy

GKN POWDER METALLURGY

#1 Global Producer of Powder Metal Parts

#2 Global Producer of Metal Powder

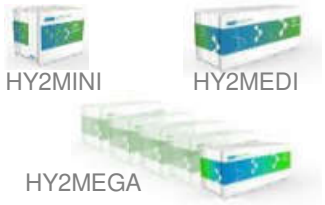
## 2019

Installation of initial proof of concept product

Power-2-Power

## 2021

Virtual launch of GKN Hydrogen and HY2 product suite HY2MINI, HY2MEDI & HY2MEGA storage



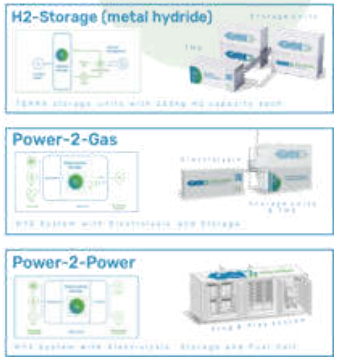

## 2022

Launch of digital monitoring platform

GKN Hydrogen becomes a separate legal entity

## 2023 & Beyond

New Commercial product groups




## 2024

Langley Holdings plc acquires GKN Hydrogen 1st August


**Launch of GKN HYDROGEN**

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# Metal Hydride - How it works

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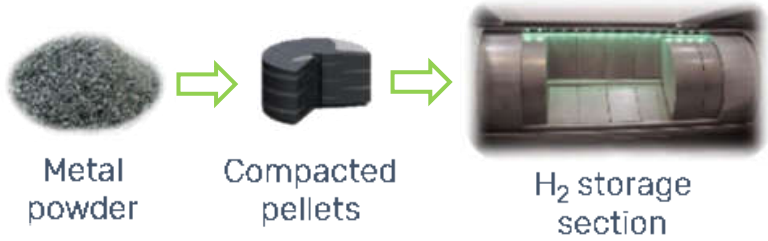
# Metal Hydride Storage = How it works

## Hydrogen Charge

- $H_2$ gas is fed to the metal alloy at pressure up to 40 bar
- Alloy reacts with hydrogen, creating a metal hydride and releases heat

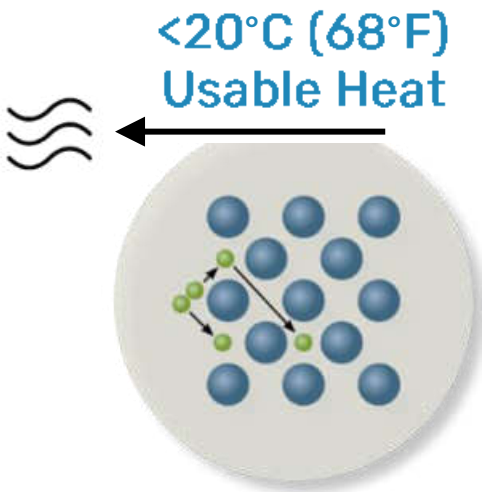


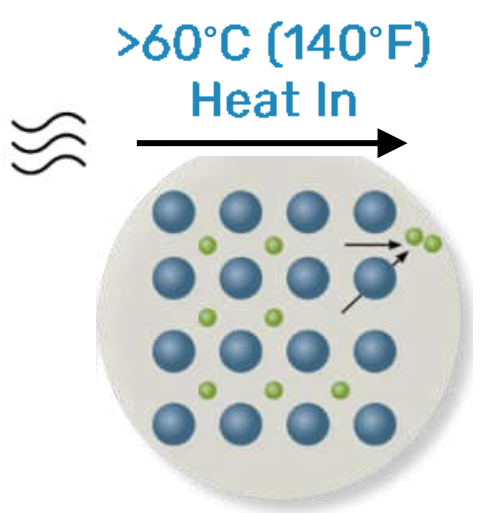

## LONG-DURATION STORAGE

- Stored without losses indefinitely until needed
- ~96% chemically bonded/ solid and safe, only 4% is gaseous H2

## Hydrogen Discharge

- Metal hydride is heated
- $H_2$ is released safely

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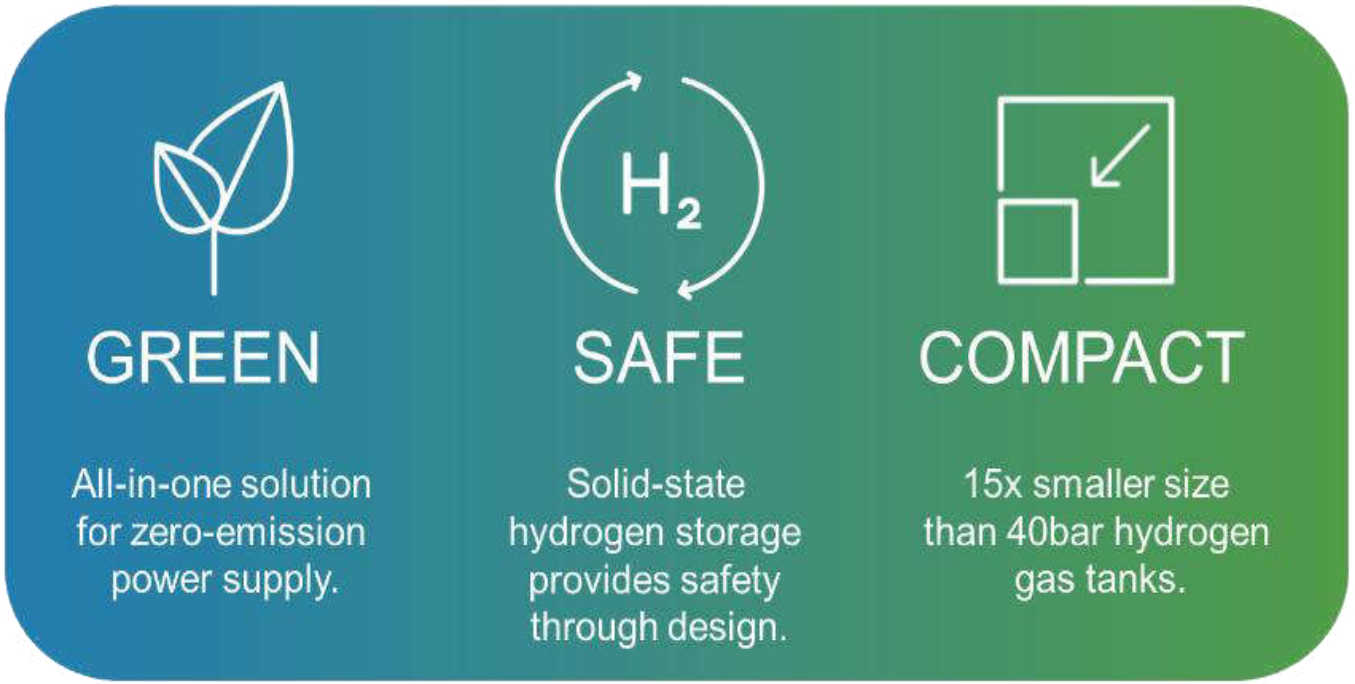
# Metal Hydride by GKN = The safest Hydrogen Storage




- Low Pressure <40 bar
- Low temperature <70 °C
- No compressor needed
- Long Life-time >25 years
- 99% capacity after 5,000 cycles

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# Safety behaviour of H2 charged Metal Hydrid (FeTi base)

## Water

Blistering (H2) as soon as in contact with H2O.

Oxidation of MH, exothermic reaction - minimal temperature increase of <5°C detected.

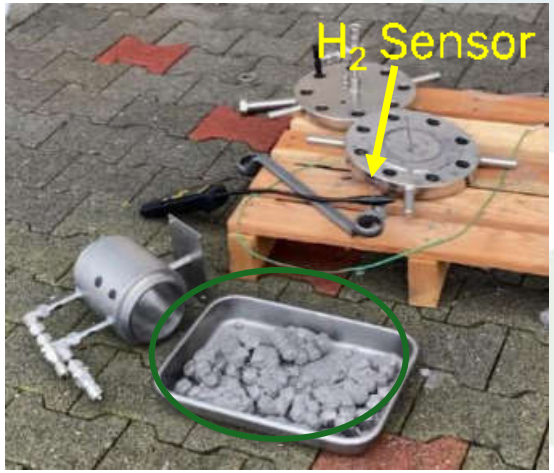
→ **No critical reaction** of the active MH material **with water.**

## Fire

After multiple firings with a propane burner - a flame is visible indicating that contained organic material is burning off.

No self-advancing flame.

→ **No critical reaction** of active MH material in contact **with an open flame.**




## Air

Scenario only possible when tank is unloaded.

No reaction visible when active MH material meets air. Only the release of hydrogen can be measured.

→ **No critical reaction** of the active MH material **in the air.**

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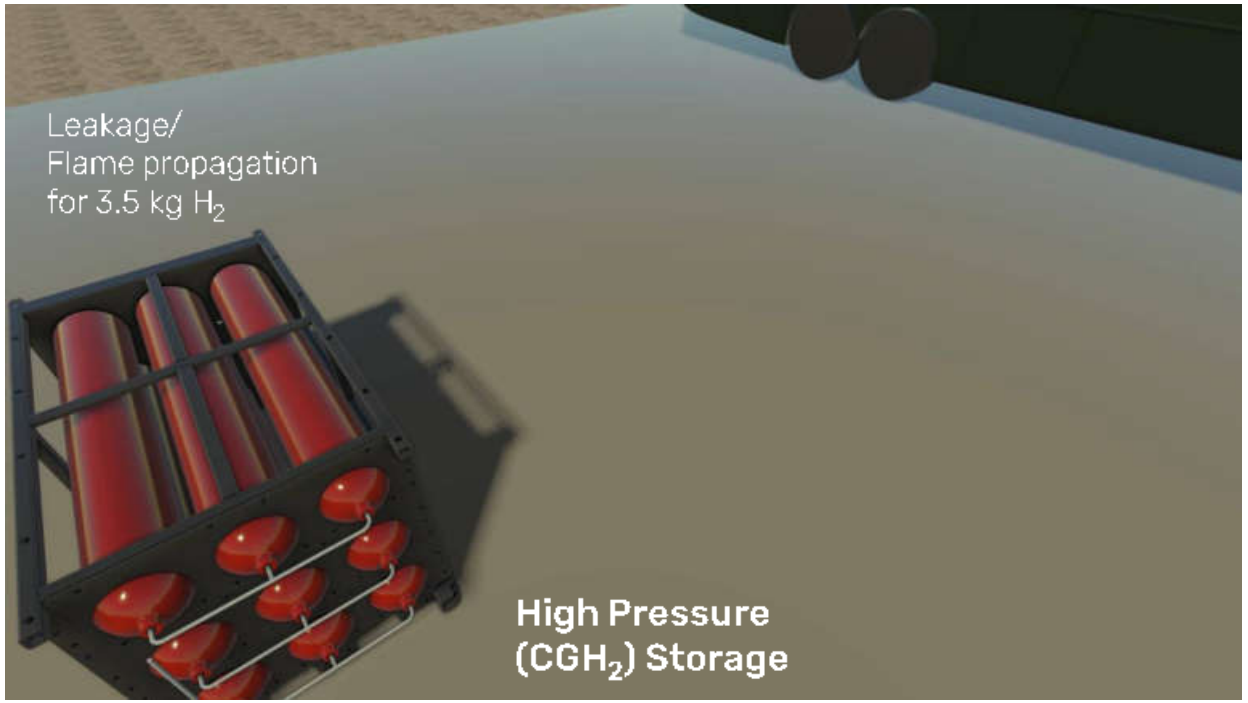
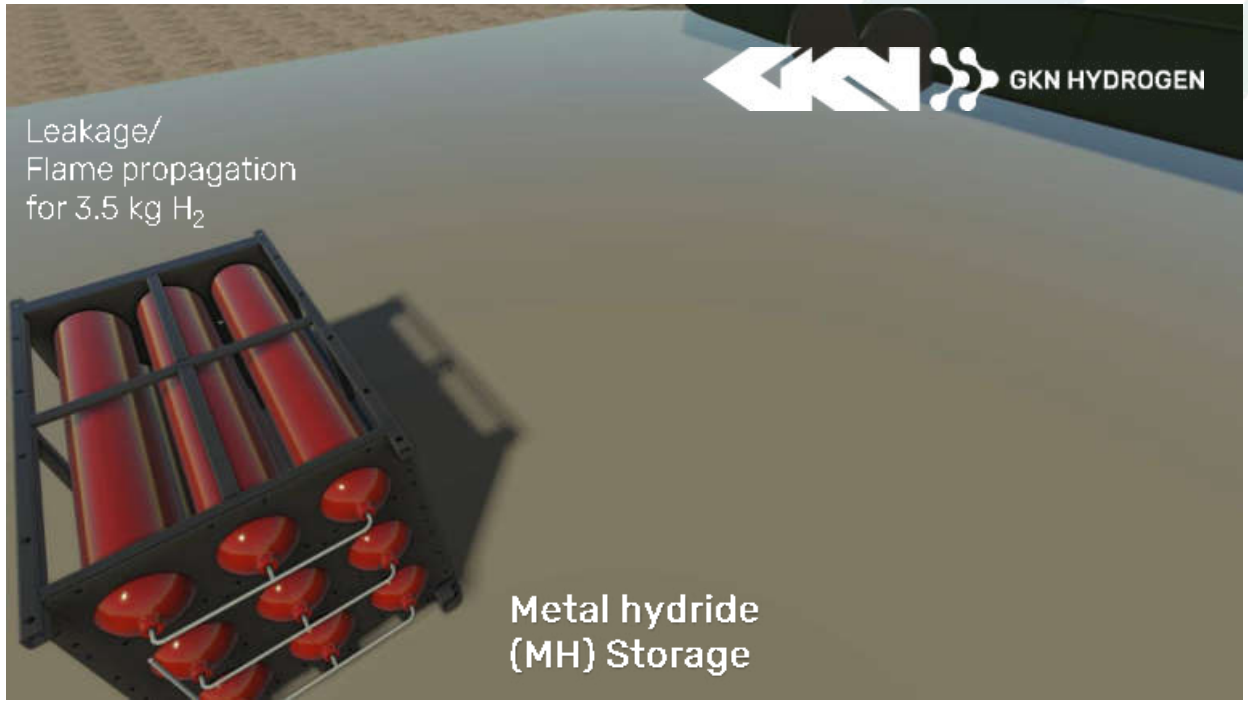
# Flame propagation in case of damaged H2 storage

## High pressure Hydrogen storage vs. Metal hydride hydrogen storage (GKN Hydrogen)




3.5 kg H2 stored in a 700bar high pressure storage




3.5 kg H2 stored in a 35 bar Metal Hydride storage

→ **20 times less flame energy**

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# What we offer

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# What we offer

## $H_2$ STORAGE IN METAL HYDRIDE


## CONTAINERIZED Systems

**Power-2-Power, Power-2-Gas, Gas-2-Power**


Stationary Power


Dispatchable Power

## MOBILE REFUELER


## SCALED UP TO MW

by modular engineering design

## METAL HYDRIDE STORAGE

**Hydrogen Storage**
Iron-Titanium Alloy

**Energy Storage**
250 kg per 20' container
8.325 MWh chem energy

**Fully integrated**
- Storage
- Thermal Mgmt
- Safeties
- Controls
- Balance of plant

**H2 Release Temp**
60 - 90 deg C

**Operating Pressure**
0.5bar(g) to 40bar(g) max
10 bar(g) nominal over discharge


Example layout
500 kg Storage + Thermal Mgmt

(Example)


**Electrolyzer**
4 MW
~850 kg H2 per 12h

**Energy Storage**
33.3 MWh chemical
1,000 kg H2 @ 35 bar
(or Multiple tons)

**Fuel Cell**
1 MW
~750 kg H2 per 12h

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# Industrial Scale Hydrogen Storage


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# Industrial Scale Hydrogen Storage

## HY2MEGA

TMS (optional)

HY2MEGA storage unit

Units stackable

### Dimensions / Weight

Container size: 6m x 2.5m x 2.6m
Weight: 32,000 kg

### Key Specifications

#### Hydrogen Storage Capacity

250 kg $H_2$/ Unit
Units can be clustered / stacked to Multiple tons of hydrogen

#### Nominal $H_2$ flow

60kg $H_2$ per hour per unit

#### Peak $H_2$ flow

Max. 100kg $H_2$ per unit (for 20min)

#### Transportable

By truck and train

#### Output Voltages

EU 120V / 230V / 400V – 50Hz
NA 120V / 240V / 480V – 60Hz

#### Pressure Range

40bar(g) to 0.5bar(g)
10bar(g) continous delivery pressure feasible

#### Hydrogen purity requirement

> 99.999%
< -70°C dew point

**Electrolysis, Fuel cell or CHP upon customer request / EPC support placeable**

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# Containerized Plug & Play Systems

Power-2-Gas

Power-2-Power

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# Power-2-Gas Systems I Technical Data

## HY2 Power-2-Gas System

NEW - available start of 2024

**Dimensions**

20foot container
40 foot container
or as integrated and modular multi-container design

**Key Specifications**

**Energy Storage Capacity**
1MWh up to several 100MWh
30kg up to several tons of H2

**Electrolyser**
20kg up to tons of H2 per 24h
24kW up to several MW power

**Nominal H2 flow**
7.2kg up to tons H2 per hour

**Peak H2 flow**
12kg up to several tons H2 (for 30min)

**Thermal management (TMS)**

Standard: Customer supplies cold <15°C and hot water >65°C
*Option: On-board autarch TMS system for cold and hot energy need*

## As All-in-One container solution

*1x 20foot container*

- up to 48 kW electrolysis (= 20 kg H2 per 24h)
- up to 75 kg H2 storage
- **up to 18 kg/h nominal H2 flow**

*1x 40foot container*

- up to 96 kW electrolysis (= 40 kg H2 per 24h)
- up to 150 kg H2 storage
- **up to 36 kg/h nominal H2 flow**

## As integrated modular multi-container approach

*Modular multi-container solution*

- from 120 kW up to several MW electrolysis (= 50 kg to several tons of H2 per 24h)
- from 250 kg to several tons of H2 storage capacity
- **up to several tons/h nominal H2 flow**

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# Power-2-Power Systems I Technical Data

## HY2MEDI


**Dimensions / Weight**
6 m x 2.5m x 2.6m /
13,000 – 23,000kg

### Key Specifications

**Energy Storage Capacity**
0.5 – 2 MWh electrical
30 – 120kg $H_2$ @ max. 40 bar

**Electrolyser**
Up to 10kg hydrogen per 24h
Up to 24 kW power

**Nominal Fuel Cell Load**
7-14 kW

**Peak Load**
19kW (15 min every 12h)

**Output Voltages**
EU 120V / 230V / 400V – 50Hz
NA 120V / 240V / 480V – 60Hz

**Power During Outage**
7kW up to 285h /
14kW up to 142h

## HY2 System 2.0

NEW - available 2024


**Dimensions / Weight**
12 m x 2.5m x 2.6m /
20,000 – 32,000kg

### Key Specifications

**Energy Storage Capacity**
0.6 – 2.5 MWh electrical
Up to 150kg $H_2$ @ max. 40 bar

**Electrolyser**
Up to 40kg hydrogen per 24h
Up to 96 kW power

**Nominal Fuel Cell Load**
Up to 48 kW

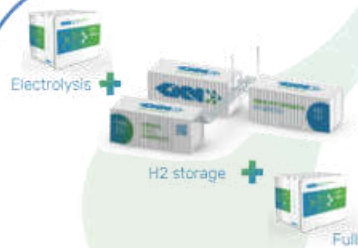
**Peak Load**
76 kW (15 min every 12h)

**Output Voltages**
EU 120V / 230V / 400V – 50Hz
NA 120V / 240V / 480V – 60Hz

**Power During Outage**
24kW up to 104h
48kW up to 52h

## HY2 System 2.0

NEW - available 2024




**Dimensions / Weight**
Modular multi-container solution/
utility performance scale

### Key Specifications

**Energy Storage Capacity**
4.2MWh up to several 100MWh
250kg up to several tons of H2

**Electrolyser**
up to several tons H2 per 24h
120 kW up to several MW

**Nominal Fuel Cell Load**
120kW up to MW-class

**Peak Load**
148kW (short term) up to MW

**Output Voltages**
EU 120V / 230V / 400V – 50Hz
NA 120V / 240V / 480V – 60Hz

**Power During Outage**
> 48h ongoing, depending
on storage size & loads

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# Digital Access

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# Enable Customers to Digitize their Storage Ecosystem

HY2Connect app and digital platform for remote control and monitoring of system operation and integration with other energy management control systems

## Adaptive Control System
Continuous control strategy optimisation based on production forecast and demand analysis

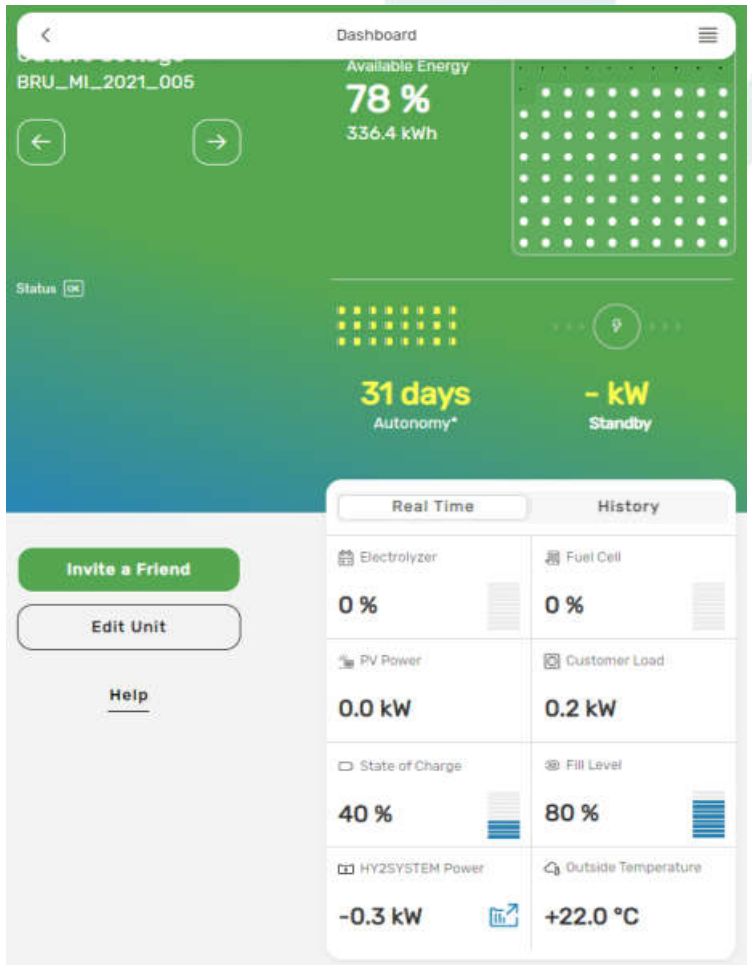
## Digital Cockpit
Fleet Management, Monitoring and Alerting

## Value Reports
Performance monitoring, usage summary, environmental data - Storage as a Service

## Advanced Analytics
System efficiency optimisation, error pattern recognition and anomaly detection

## Measurement and Verification
Artificial intelligence & machine learning techniques for performance guarantees – Storage as a Service

## Digital Twin Simulation
Replicates behavior of system for various demand/production profiles over long time periods

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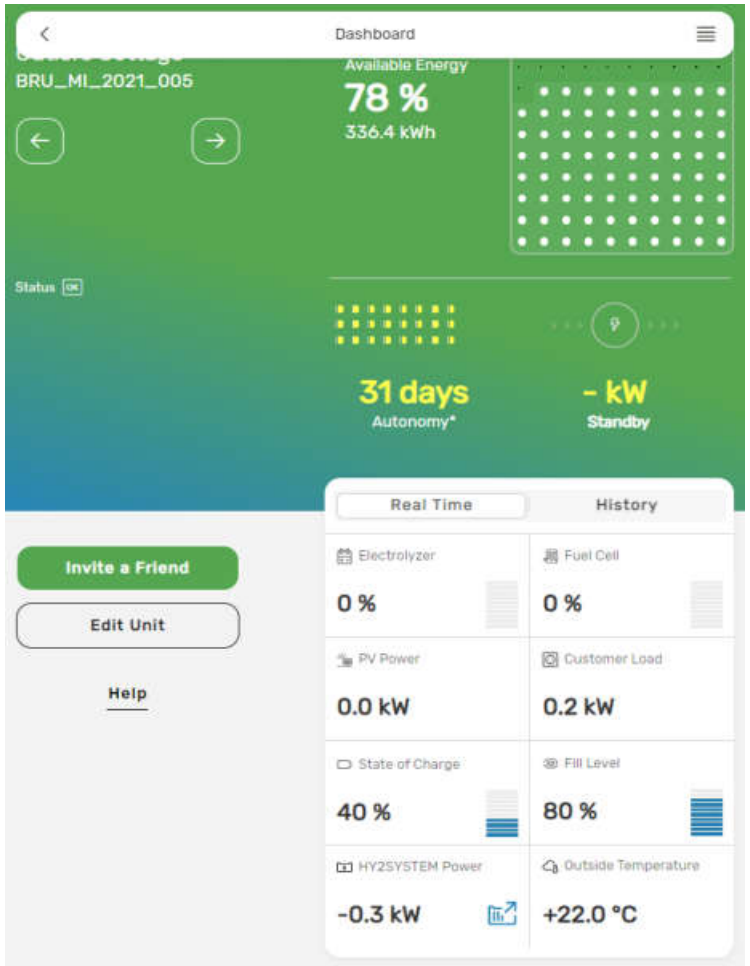
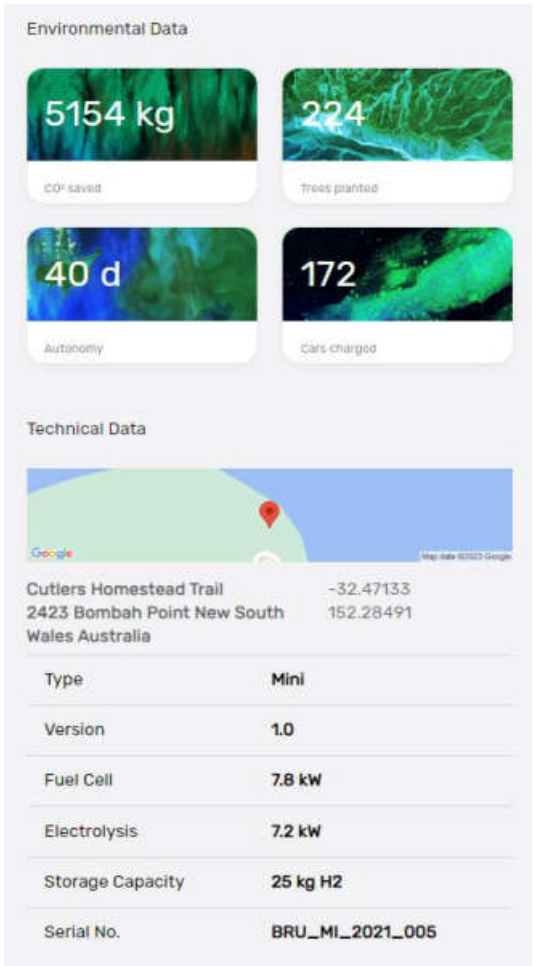
# HY2CONNECT Web App - Visualization

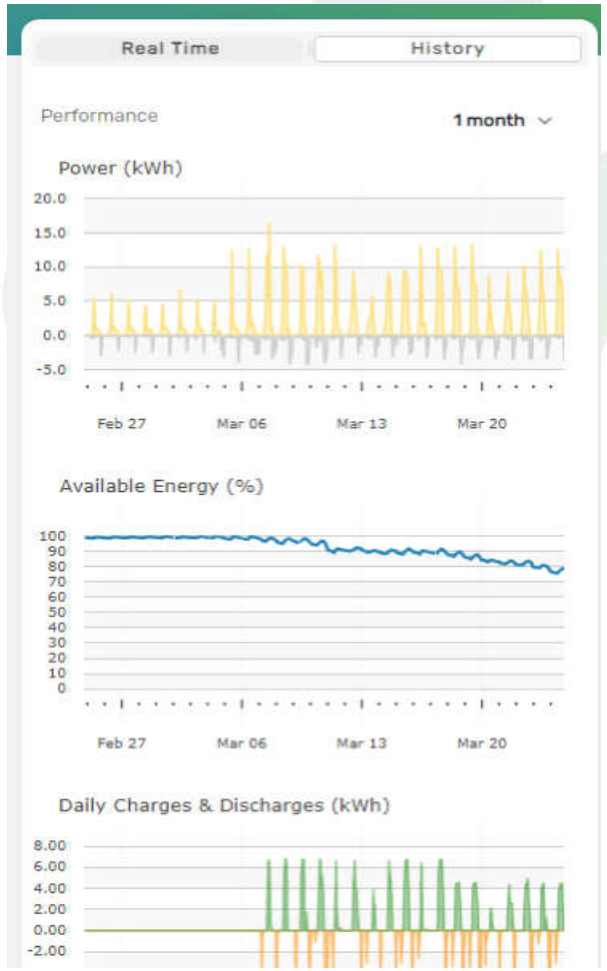
## Real-time Metrics




## General Metrics




## Historical Metrics

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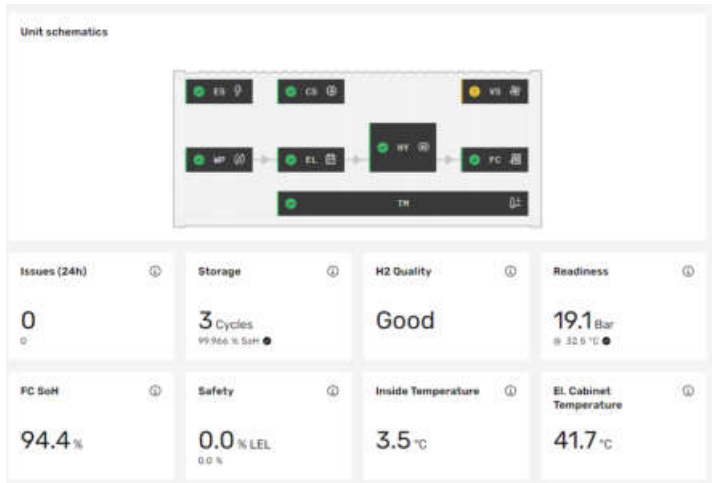
# DIGITAL PLATFORM - Visualization

## Dashboard Metrics




## Charts Metrics


## Forecast & Nowcast Metrics

| Unit | Temperature | Outside | Humidity | Radiation | Wind | Precipitation |
|---|---|---|---|---|---|---|
| Murcia | 28 °C | 31 °C | 50.2 % | 436 W/m² | 22.7 km/h | 0.0 mm/h |
| Duke Energy | 24 °C | 24 °C | 73.2 % | 339 W/m² | 7.6 km/h | 0.0 mm/h |
| CEC Phelan | 20 °C | 16 °C | 28.3 % | 129 W/m² | 5.8 km/h | 0.0 mm/h |

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# Project Experiences

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# More than 25 Global Installations

**Myall Lake / N-S-Wales**
P-2-P / Off-Grid
0.42 MWh / 25 kg $H_2$

**Mt Holly / Arkansas**
P-2-P / Micro Grid
0.42 MWh / 25 kg $H_2$

**Carlsbad / CA**
P-2-P / Micro Grid
0.42 MWh / 25 kg $H_2$

**Phelan Mojave Desert / CA**
P-2-P / Micro Grid
0.42 MWh / 25 kg $H_2$

**Boulder / CO**
MH Storage / Micro Grid
16.6 MWh / 500 kg $H_2$

**Carlsbad / CA**
P-2-P/ Mobile Demo
0.50 MWh / 30 kg $H_2$

**Prague, Commercial Hotel**
P-2-P / Micro Grid
0.50 MWh / 30 kg $H_2$

**Bonn, Plug-in E-Charging**
P-2-P / Auxiliary
0.33 MWh / 20 kg $H_2$

**Passau, Commercial Building**
P-2-P and CHP
0.81 MWh / 50 kg $H_2$

**Hanau, R&D Lab**
P-2-P and P-2-G
2.0 MWh / 120 kg $H_2$

**Braunschweig, R&D Lab**
MH Storage / $H_2$ Back up
16.6 MWh / 500 kg $H_2$

**59.80 MWh**
**Installed capacity**

**Customers served**

DUKE ENERGY
ACOM agrocomponentes
NREL
siz energieplus
essential energy
RUBNER haus
Fraunhofer IWKS
eRevo energy revolution
GKN SINTER METALS

**Bruneck, Manufacturing Site**
MH Storage
9.5 MWh / 286 kg $H_2$

P-2-P / IT Back up
0.42 MWh / 25 kg $H_2$

**Bruneck, Bio-Farm**
P-2-P / Axiliary Power
2 MWh / 120 kg $H_2$

**Residential Cottage, Prettau**
P-2-P / Off-Grid
0.17 MWh / 10 kg $H_2$

**Residential Building, Kiens**
P-2-P / Rebalancing
0.27 MWh / 16 kg $H_2$

**Mountain Hut, Sterzing**
P-2-P / Off-Grid
0.90 MWh /60 kg $H_2$

**Ratsberg, Telecom Tower**
P-2-P / Back up 96 hrs
1.5 MWh / 90 kg $H_2$

**Test Vessel, Naples**
P-2-P / Martime
0.70 MWh / 40 kg $H_2$

**Brittnau, Resid. Building**
P-2-P / Inhouse Solution
0.50 MWh / 30 kg $H_2$

**Zurich, Appartment Building**
P-2-P / Auxiliary Power
2.0 MWh / 120 kg $H_2$

**Eich, Residential Building**
P-2-P / Auxiliary Power
0.42 MWh / 25 kg $H_2$

**Spital/ Commercial Building**
P-2-P + CHP / Micro Grid
2.0 MWh / 120 kg $H_2$

**Balsicas, Greenhouse**
P-2-P / Auxiliary Power
0.20 MWh / 12 kg $H_2$

**Murcia, University**
P-2-P / Rebalancing
0.20 MWh / 12 kg $H_2$

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# HY2MEGA Storage Installation

## Power 2 Power-System, NREL – Colorado/ USA

**Application:** Micro-Grid I Utility scale

**System:** HY2MEGA


| 17MWh | **500kg $H_2$** | 1MW | 1.25MW |
|---|---|---|---|
| Stored Energy | **2x HY2MEGA Storage** ***GKN*** | Nominal Power Fuel Cell | Electrolyzer |

- Development of second generation of HY2MEGA
- **2x HY2MEGA** added to the mega-watt class hydrogen assets at the facility on NREL's Campus, CO
- Validate and simulate grid scale use-cases
- **Delivered Nov. 2023**
- Installation in Q1/2024







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# HY2MEGA Storage Installation

## Power 2 Gas-System, **H2 terminal SIZ-TU Braunschweig**

siz energieplus

- **Application:** Fuel Cell test center

**System:** HY2MEGA

| 17MWh | **500kg H2** | 1.0MW |
|---|---|---|
| Stored Energy | **2x HY2MEGA Storage** *GKN* | Electrolyzer *Customer* |

- Integration of **2x HY2MEGA and 1x TMS** in the local micro grid
- Validate of fuel cells on test riggs with $H_2$ from HY2MEGA
- **Delivered 12-2023**
- Site installation H1-2024

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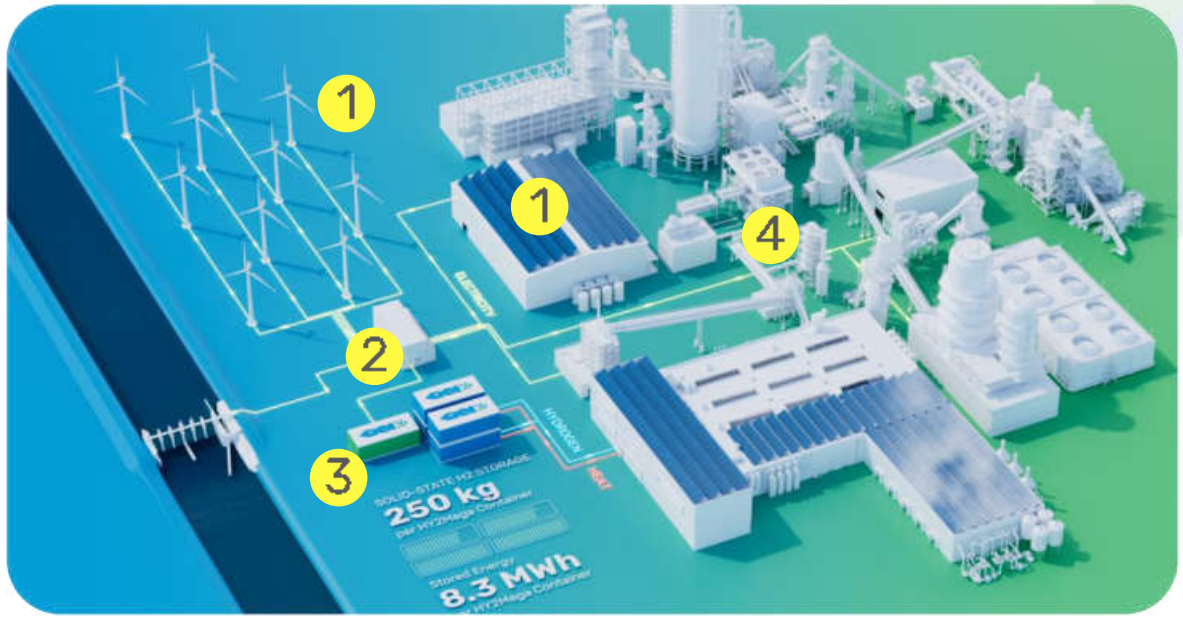
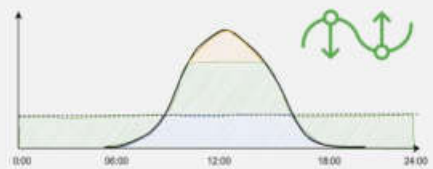
# Use of renewables in industry

**Industry:** high demand for methane → high CO2 emissions
**Solution:** replacement of CH4 by H2 and the safest method of storage at low pressures (max. 40 bar)
**USPs:** Planning the entire system integration to ensure the safe replacement of CH4 by H2
**Scalability:** A key solution (H2 mixing) in industry to reduce CO2 emissions





- Burning/Furnaces: steel, ceramic, glass
- Feedstock & Hydrogen Gas - direct use
- Blending / Mixing
- eFuels
- Energy Load Management



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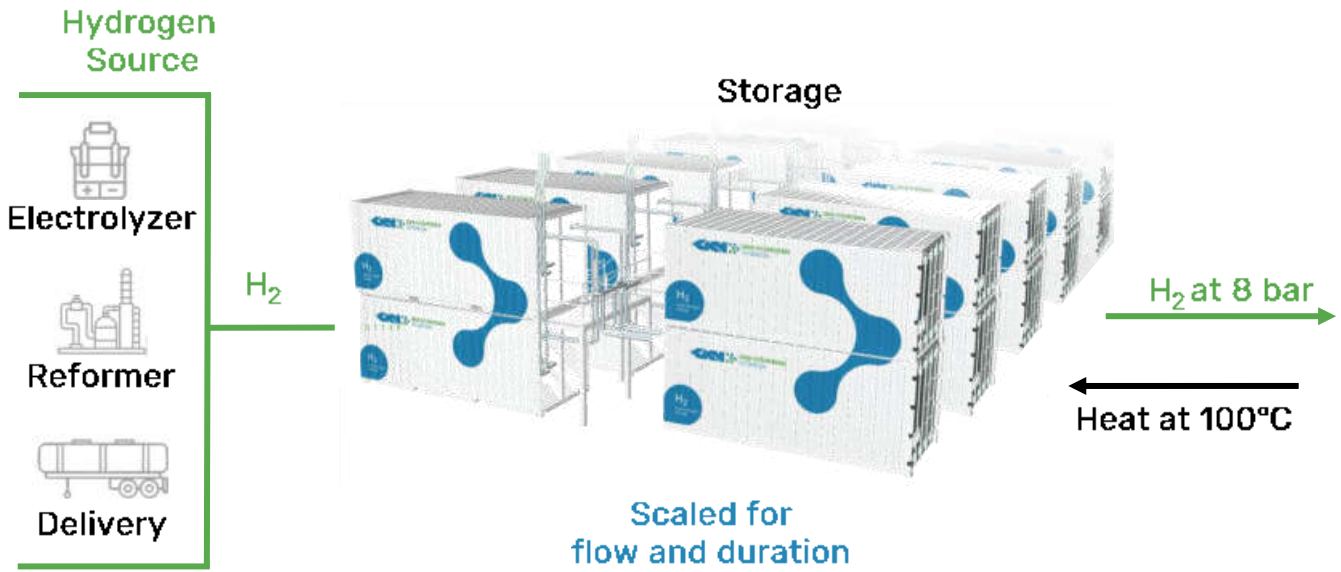
# Focus Use Case | H2 Engines




JENBACHER

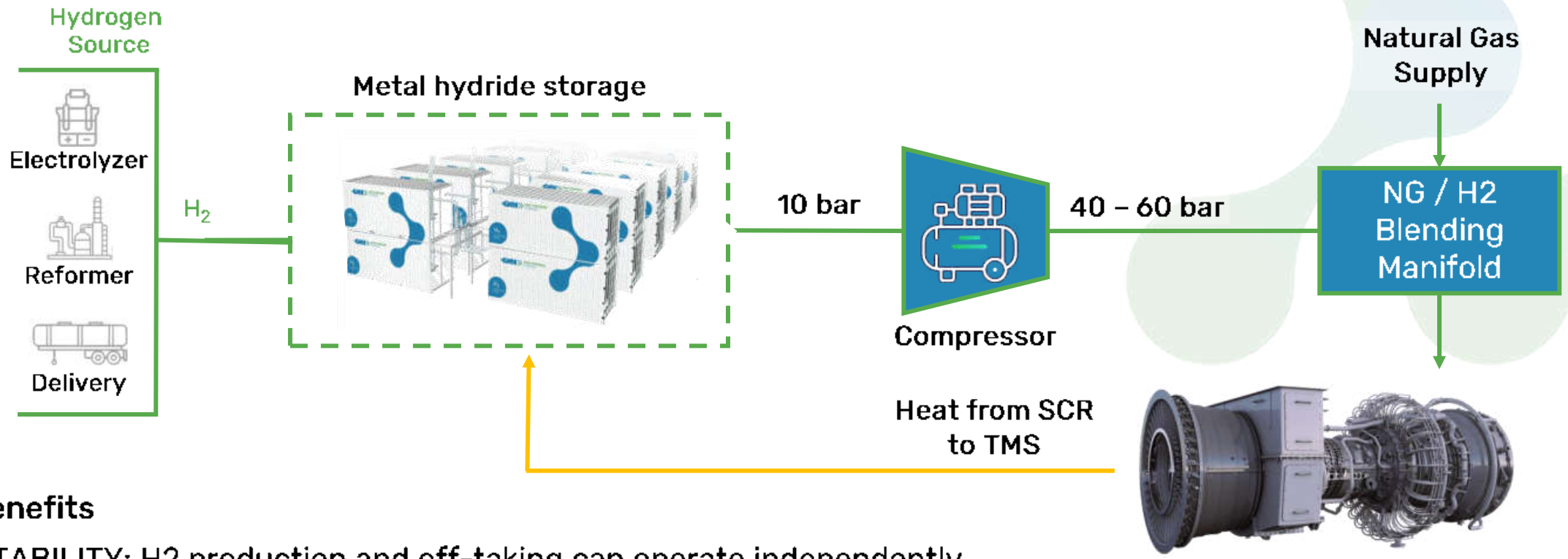
CAT

CAT DR250 System
w/ G3520H 2.5 MW generator

Use waste heat to:
- maximize efficiency and
- minimize infrastructure

- Uniquely fit for hydrogen-ready internal combustion engines. The ferrous-titanium metal hydride stores 96% of hydrogen as a metal, the safest form of hydrogen storage. The remaining 4% gas is sent to the engine instantly for power needs. The 100°C bi-product heat from the engine breaks the hydride bonds to sustain hydrogen flow.
- Safety, simplicity and efficiency. Storage sends 8 bar hydrogen to the engine. This eliminates high CapEx, energy, and maintenance associated with compressors and pumps used in other hydrogen storage solutions.

# Use Case | Peaker Plant

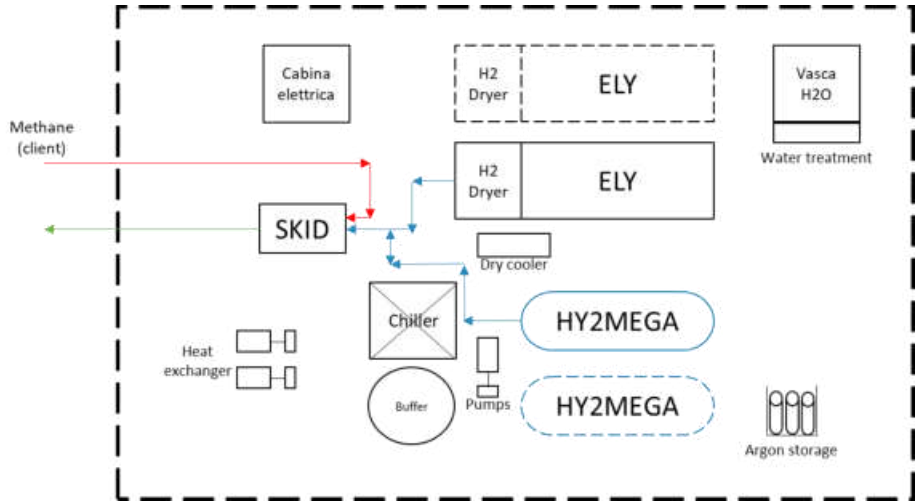



## MH Benefits

- STABILITY: H2 production and off-taking can operate independently
- UPTIME: Continued electrolizer operation with downstream failures
- SMALL FOOTPRINT: Fully containerized & stackable; smaller setbacks
- SCALE: Increased storage capacity without compressor
- OPEX: Low costs due to operation without compressor

# Italian Tile Manufacturer | Industrial Direct Use

**Market:** Industrial **Application:** H2-Blending **Function:** H2 direct use **System:** MEGA




GREEN

SAFE

COMPACT

LONG LIFETIME

Fotovoltaico
2566 kWp

1 MW EL

2x GKN Hydrogen storage

Gas mixer

Oven

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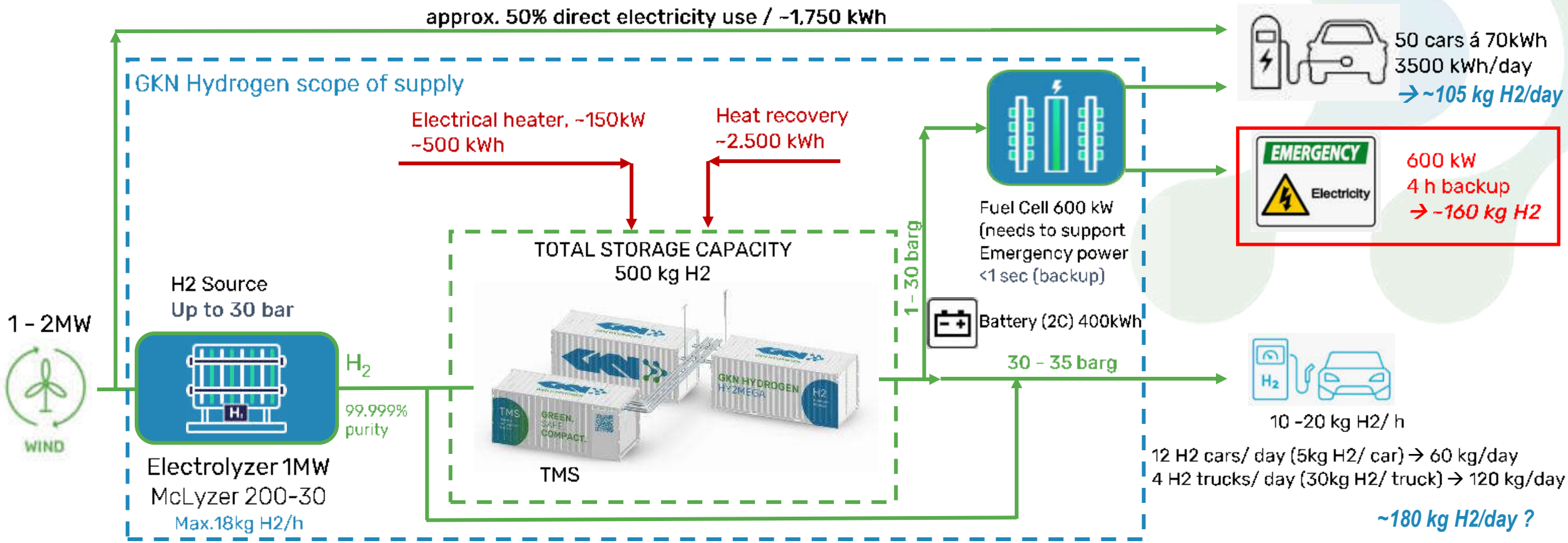
# Hybrid Green Mobility H2 Hub |




| | Fuel Cell (0,5 -30 barg) | Heating Energy for Fuel Cell mode** | H2 – Dispenser (30 – 35 barg) | Heating Energy for H2 Dispenser mode** | TOTAL (0,5 -30 barg) | TOTAL Heating energy* |
|---|---|---|---|---|---|---|
| Heat Generation ( ~95 °C) | ~315 kg H2 | ~2.300 kWh | ~185 kg H2 | ~1.700 kWh | ~500 kg H2 | ~3.000 kWh |

| Input H2/ day (ELY 1MW with 18 kg/h) | Demand H2 (kg)/ day (except emergency) |
|---|---|
| **285 kg** (means an ELY runtime of 16h/day at max. performance) | **105 kg** (e-Charging)<br>**180 kg** (HRS) |

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# HY2 System Certification

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# Hydrogen Timeline - From R&D to Industrial Scale

## Management System



qualityaustria
SYSTEM CERTIFIED

| | |
|---|---|
| ISO 9001:2015 | No.28283/0 |
| ISO 45001:2018 | No.01764/0 |
| ISO 14001:2015 | No.05000/0 |

IQNET
CERTIFIED MANAGEMENT SYSTEM

## Products / Applications

TÜV SÜD America

### US

Field Evaluation Report mit „TÜV Süd Amerika"

| | |
|---|---|
| • ANSI/CSA FC 1-2014 / IEC 62282-3-100 | Fuel Cell Technologies |
| • NFPA 79 | Electrical Standard |
| • NFPA 70 | National Electrical Code |
| • ASME B31.3 | Process Piping |
| • ASME B31.12 | Hydrogen Piping |
| • NFPA 2 | Hydrogen Technology Code |
| • UL 508A | Industrial Control Panels |
| • NEC 500 | Hazardous (Classified) Locations |

### EU

CE

CE-Kennzeichnung nach 2014/68/EU - Druckgeräterichtlinie

| | |
|---|---|
| • 2014/35/EE | Niederspannungsrichtlinie |
| • EN IEC 62282-3-100 | Brennstoffzellentechnologien |
| • EN 13480 | Industrielle Rohrleitungen |
| • EN 60204-1 | Elektrische Ausrüstung von Maschinen |
| • EN 61508-1 | Funktionale Sicherheit |
| • EN 301489-52 | EMV |
| • EN 62305-2 | Blitzschutz Risikomanagement |
| • EN 60079 | Explosionsgefährdete Bereiche |

**Our commercial experts, engineers, designers, and technicians** are dedicated to create value by providing a safe, compact and cost-effective storage solution seamlessly integrating hydrogen production and offtake assets.

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# Appendix

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