High energy density Mg-Based metal hydrides storage system EDEN

(303472)

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http://www.h2eden.eu/

PROJECT OVERVIEW

- SP1-JTI-FCH.2011.2.4 - **Novel H2 storage materials for stationary and portable applications**
- APPLICATION AREA SP1-JTI-FCH.2: *HYDROGEN PRODUCTION & DISTRIBUTION*
- From 2012-10-01 to 2016-01-31, **ongoing project**
- Total budget: EUR 2.653.574, EU FCH-JU contribution EUR 1.524.900
- EDEN aims at research, development and validation of a solid-state hydrogen storage technology for specific sector of stationary applications and at support of distributed grid level applications. The main objectives of this research project address the development of a new storage material with high hydrogen storage capacity, loaded into a specifically designed storage tank and able to be managed in real-time.
- Stage of implementation (95 % project duration passed)
- Project Consortium

FONDAZIONE BRUNO KESSLER

Coordinator

MBN nanomaterialia®

CIDETE EL ARTE DE REFRIGERAR TERMOELECTRICIDAD

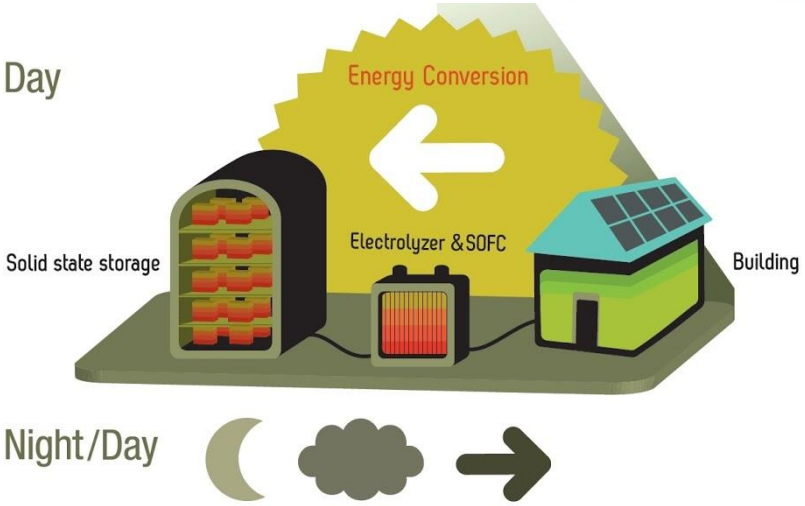
JRC EUROPEAN COMMISSION

PANCO GmbH PHYSIKALISCHE TECHNIK·ANLAGEN·ENTWICKLUNG & CONSULTING

ULL Universidad de La Laguna

MATRES material research & design

PROJECT TARGETS AND ACHIEVEMENTS



OVERALL TARGET

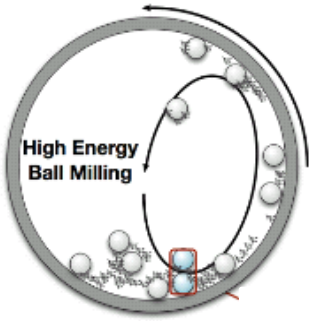
develop a *new storage material* with high hydrogen storage capacity, able to be managed in real-time for distributed level applications, included on a specifically designed storage tank and interlinked to an energy provision system able to match intermittent energy sources with local energy demand (buildings, small dwellings).

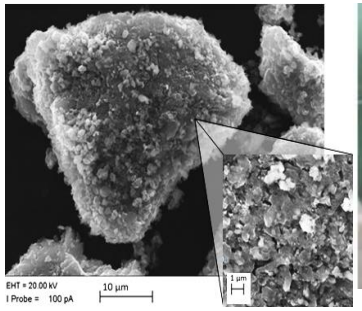
Storage Properties

	Unit	Value
Gravimetric Capacity	kgH_2/kg (%)	7.1
	kWh/kg	2.4
Volumetric Capacity	kgH_2/l	0.13
	kWh/l	4.4
Operating T	°C	320
Max Delivery pressure	bar	2
Min Charging Pressure	bar	3
Desorption rate*	gH_2/min	> 1

** For 1kg of material, at 320 °C and 1.2 bar (0.2 barG).*

TARGET 1. MATERIAL
Best candidate: ED011





PROJECT TARGETS AND ACHIEVEMENTS

TARGET 2. STORAGE TANK

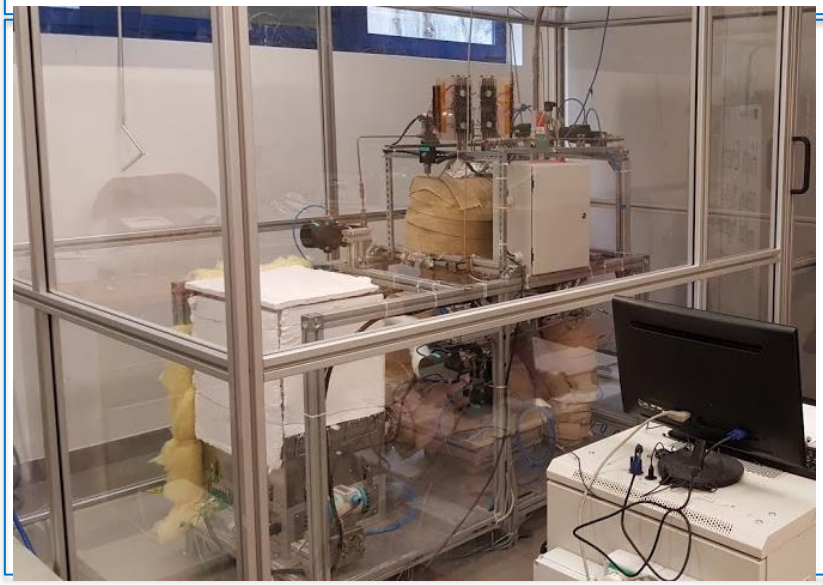
- Full innovative design (patent under application)
- Thermal management with rSOC
- Innovative design embedding HEAT PIPES, MATERIAL COMPACTION, VARIABLE DENSITY HEAT TRANSFER MEDIUM INSIDE

TOTAL MATERIAL: 10 kg

TEMPERATURE GRADIENT : ~ 1° C

REACTION KINETICS A/D: > 3 g/min

FUEL AVAILABILITY: 90%



TARGET 3. INTEGRATED SYSTEM

- Power input (Electrolyzer mode): 2,5 kW_{el}
- Power output (FC mode): 1,5 kW_{el}
- Delivery: 20Nl/min H_2 (about 1mol)
- Hourly consumption 240 mol (= 6000 g MgH_2)
- Tank prototype: effective Volume: 20 l => 720g H_2,
- About 8000 Nl H_2, lasts for about 10h (full load)

PROJECT TARGETS AND ACHIEVEMENTS

Programme objective/target	Project objective/target	Project achievements to-date	Expected final achievement
MAIP (Not applicable to solid state H2 storage system)			
AIP			
> 6% w Hydrogen storage capacity	> 6% w	**7,1 % w**	**7,1 % w**
> 4% w Tank system storage capacity	4% w	**5,9 % w** (storage internal geometry) **1,3 % w** (FULL TANK - weight optimization not addressed)	to be otimized
Any FC Compatibility with FC systems	SOFC	**rSOC**	100% to be otimized
< 500 €/kg Long term run cost of stored H2 – system level	300 €/kg	**570 €/kg** 4 year ÷ 1 year of system running	Set up a value chain for industrial production to reduce this cost

PROJECT TARGETS AND ACHIEVEMENTS

FINAL TECHNOLOGY TARGETS

- Reliable system, 4000 working hrs / year
- Embedded design: everything in 3 m^3 on the first prototype, target < 1 m^3
- Efficient P2P system: target 40% overall efficiency
- The estimated price for EDEN material of 45 €/kg considering an industrial production for the catalyzed best candidate material - ED011

WHAT'S LEFT?

- BoP improvement (pressurization, water management)
- Pre-commercial development: standardization and modularity
- Demo project to arrive at a pre-commercial development of the technology (TRL 7 / 8)

RISKS AND MITIGATION

- Gravimetric density, 4%:
  - **RISK**: the overall tank can't reach 4%, but 1,3% gravimetric density
  - **NATURE of RISK**: oversizing of metallic structures for security reasons
  - **MITIGATION**: for stationary applications, this is not a relevant target, within certain limits of system weight
  - **FUTURE PERSPECTIVE**: Gravimetric optimization has yet to be performed. Density can be leveraged to +100%
- System integration and In-field testing:
  - **RISK**: planning for 6 months in-field testing will be reduced
  - **NATURE of RISK**: Missing components from suppliers, additional time to have a new desiccant system to complete the prototype
  - **MITIGATION**: Prolonged validation of components in-lab, agreements with local authority in Trentino to run demo activity after the project will be closed
  - **FUTURE PERSPECTIVE**: long term tests will be performed, partly within the EDEN project and partly immediately after

SYNERGIES WITH OTHER PROJECTS AND INITIATIVES

FCH JU projects
on hydrogen storage

Joint Workshop

Santa Cruz, Tenerife (Spain)
October 2nd, 2013

More than 60 participants

TOPICS: MATERIALS, HYDROGEN TANK, SYSTEM INTEGRATION, CROSS CUTTING ISSUES

A BOOKLET SUMMARIZING MAIN OUTCOMES WAS REALIZED

- **IPHE Workshop**: *Hydrogen – A competitive Energy Storage Medium for large scale integration of renewable electricity (25 09 2012, Seville – SPAIN)*

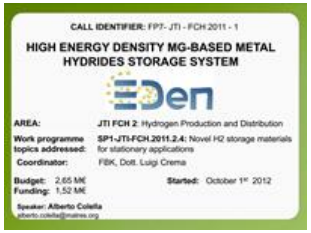
- Interactions with European-level projects
  - **HYPER, SSH2S and BORE4STORE (including final event)**
  - **FET FLAGSHIP GRAPHENE, FP7 – H2020**
  - **COST ACTION**: Nanostructured materials for solid-state hydrogen storage

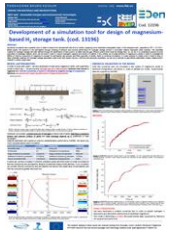
HORIZONTAL ACTIVITIES

- PhD education
  - Dr. Matteo Testi (FBK): modelling to design the solid state hydrogen tank, design of the integrated system, validation and tests
  - Mr. Hafeez Ullah (FBK): catalyst material and analysis
  - Mr. Pablo Acosta Mora (ULL): electrochemical characterization of SOFC units and physicochemical SOFC studies under the EDEN project.
- Project activities in safety, regulations, codes, standards
  - Validations in FBK following regulation Dlgs. TU 81/08, meeting with local authorities in Trento (PAT, APRIE), Involvement of the Barcelona Government, of the Energy Agency of Barcelona. Safety regulations for tests in Barcelona agreed with the Pompeers, following a Risk assessment analysis prepared by project partners.
- General public awareness
  - More than 10 national and international press releases on newspapers
  - 2 services on Italian National Television (RAI) and a report on TV DEDALO di ADA Channel - digital terrestrial channel
  - Press Release on BUILD UP , The European portal for energy efficiency
  - Final Dissemination Event – open event

DISSEMINATION ACTIVITIES

- **Website** and dissemination materials (leaflet, brochure, card)
- **1 workshop** *"FCH JU Joint Workshop on Hydrogen Storage"* organized
- **1 panel session** *"HYDROGEN STORAGE: a key element for Future Energy Systems"* organized
- **8 CONFERENCES** attended with presentation
- **11 SCIENTIFIC PUBLICATIONS**
- 3 PATENTS under evaluation for application
- WHITE PAPER on panel session results





EXPLOITATION PLAN/EXPECTED IMPACT

EDEN: 1st POWER TO POWER SYSTEM integrating a hydrogen solid-state Mg-based storage solution and a rSOC with full thermal and fuel management

- **MBN – ED011** storage material at catalogue with a technical datasheet
- Realization of an **industrial value chain** for production the material, technology development
- **Future plans**: **new DEMO project** to move EDEN system from TRL5 to TRL7, in parallel to specific developments from partners to optimize components and design

TECHNOLOGY TRANSFER BOARD

Precision Fluid Controls

IRS Ingegneria Ricerca Sistemi

DAEHONG Enterprise co.,ltd.

SOLID POWER

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Ein Mitglied der AST Gruppe

catator

AKS DASIS Industry

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sasAutomation Process Control & Industrial Automation

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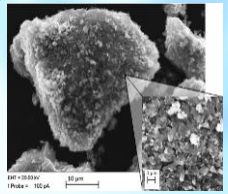
EXPLOITATION PLAN/EXPECTED IMPACT

TRL SCALE

MARKET

Design of medium size storage system
Demonstrated stable ciclability and performances for 30 days cycling,



Best candidate Mg Hydride
Material fully characterized and demonstrated at big scale

	Gravimetric capacity wt.% (H_2/MH)	Desorption rate wt.%/min	Hydrogen density g/l	Material cost €/kg
Achieved	7.1 (>95% st.)	0.11 (at 320°C)	109.9	≈ 80*
Target	> 6.0	> 0.02	> 80	< 30

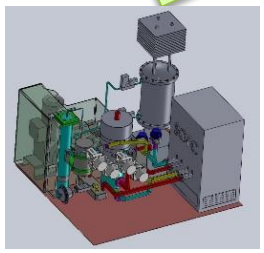
1 2 3 4 5 6 7 8 9

TANK

MATERIAL

SYSTEM

IDEA



Overall system prototype
Double acting engine for medium temperature applications, expected efficiency 16% @ 300° C.
Actually generation demonstrated up to 450 W @280° C

Acknowledgements & Contacts

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