



EDEN

**High Energy density Mg-Based metal
hydrides storage system**

Dr. Crema Luigi

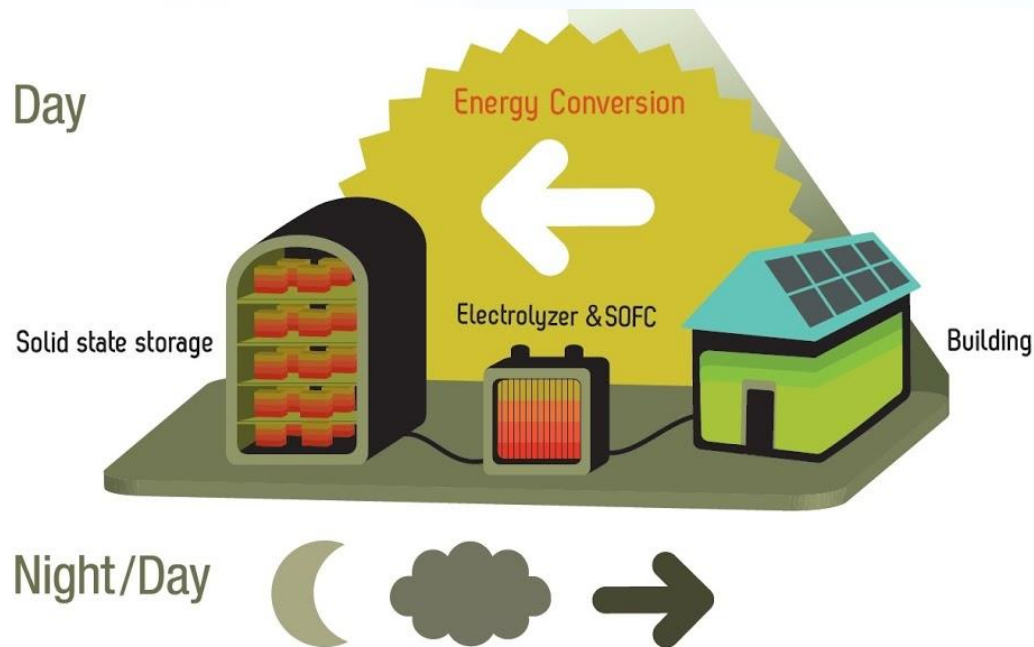
Head of unit ARES, Foundation Bruno Kessler

<http://www.h2eden.eu/>

Email Coordinator: crema@fbk.eu

***Programme Review Days 2017
Brussels, 23-24 November***

- Call year: 2012
- Call topic: SP1-JTI-FCH.2011.2.4 - Novel H2 Storage materials for stationary and portable applications
- Project dates: 2012-10-01 to 2016-06-30
- % stage of implementation 01/11/2017: 100 %
- Total project budget: 2.653.574 €
- FCH JU max. contribution: 1.254.900 €
- Other financial contribution: none
- Partners: FBK, PANCO, ULL, Cidete, MBN Nanomaterialia, MATRES and JRC



HYDROGEN STORAGE SOLUTION

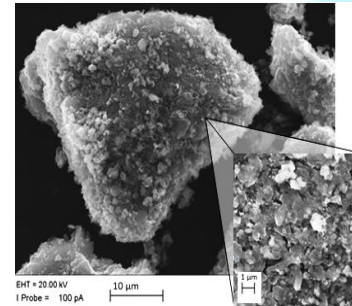
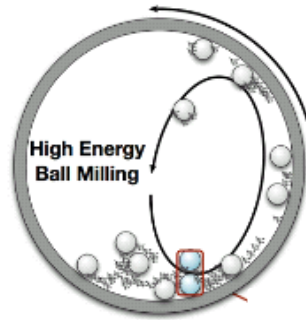
EDEN aims at research, development and validation of a solid-state hydrogen storage technology for specific sector of stationary applications and at support of distributed grid level applications. The main objectives of this research project address the development of a new storage material with high hydrogen storage capacity, loaded into a specifically designed storage tank and able to be managed in real-time. The technology was demonstrated in Barcelona, installed in a facility of the Energy Agency of the City. The final net cycle efficiency of the system was 25%.

PROJECT SUMMARY-Objectives

TARGET 1. HYDROGEN STORAGE MATERIAL

develop a *new storage material* with high hydrogen storage capacity.

- Gravimetric capacity 7.1%
- Operating Temp. 320° C
- Delivery Pressure min 2 Bar
- Charging Pressure min 3 Bar



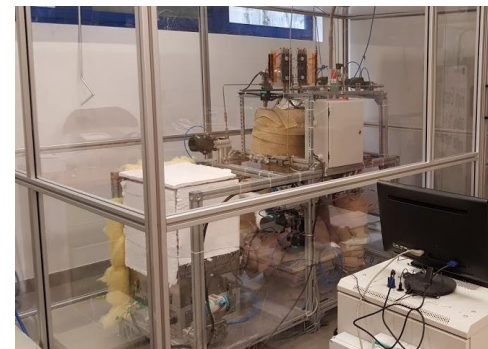
TARGET 2. STORAGE TANK

- Full innovative design (patent under application)
- Highly homogeneous temperature gradient
- High tank fuel utilization



TARGET 3. INTEGRATED SYSTEM

- Power input (Electrolyzer mode): 2,5 kW_{el}
- Power output (FC mode): 1,5 kW_{el}
- Hydrogen consumption (25NL/min)
- Thermal integration Fuel Cell-Tank
- Tank prototype: effective Volume: 20 l



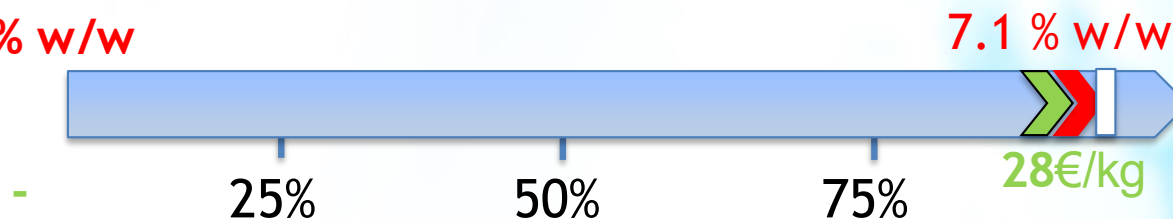
PROJECT PROGRESS/ACTIONS – Storage Material



Status at end project at date 01/11/2017 (stage of implement. = 100%)

Achievement to-date
100% stage of implement.

5.5 % w/w



6 % w/w

30€/kg

Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
Hydrogen Storage	Gravimetric density	% w/w	7.1	6	-	-
	Density density	g/l	130	60	-	-
Storage cost	Material cost	€/kg	28	-	-	-

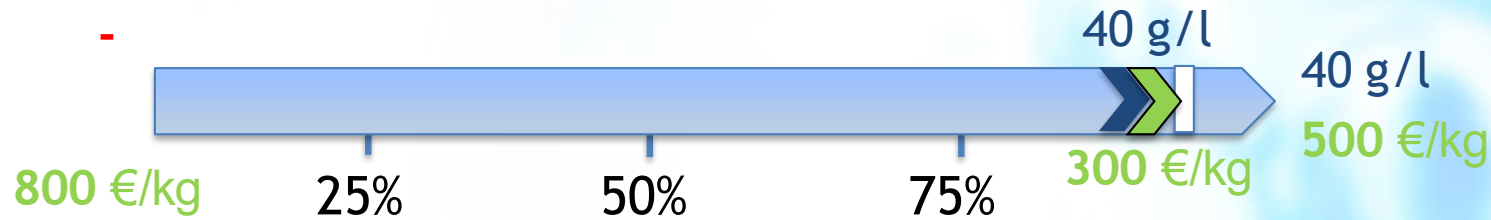
Future steps:

Future targets are including testing of a hybrid solid state storage combining the proper ration between Mg and other lower temperature storage materials

PROJECT PROGRESS/ACTIONS - Tank

Status at end project at date 01/11/2017 (stage of implement. = 100%)

Achievement to-date
100% stage of implement.



Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
H2 Storage	Density density	g/l	40	40	-	-
Storage Cost	System cost	€/kg	300	500	-	-

Future steps:

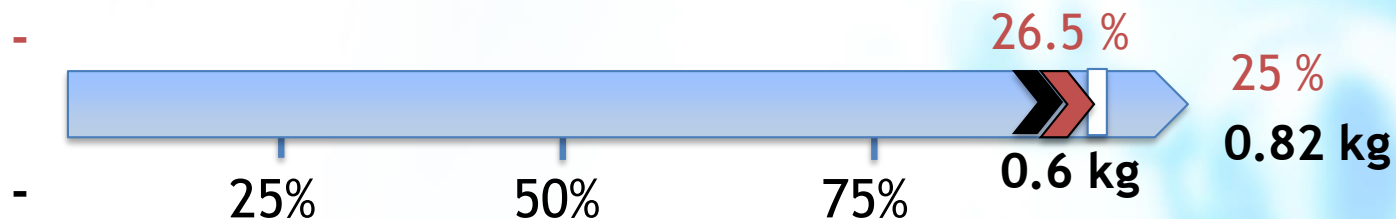
Optimization of the overall gravimetric storage density at the level of tank.
Optimization of heat exchange between tank and system.

PROJECT PROGRESS/ACTIONS – Integrated system



Status at end project at date 01/11/2017 (stage of implement. = 100%)

Achievement to-date
100% stage of implement.



Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
Heat recovery	Absorption heat recovery	%	26.5	25	-	-
H2 Capacity	Total H2 stored	kg	0.6	0.82	-	-

Future steps:

The storage capacity is combined with other targets of the hydrogen storage system, such as reaction kinetic, costs, fuel and heat management.

Risk 1: the overall tank can't reach 4%, but 1,3% gravimetric density

NATURE of RISK: oversizing of metallic structures for security reasons

Mitigation 1: 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%

Risk 2: 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

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



- Interactions with projects funded under EU programmes
 - HYPER, SSH2S and BORE4STORE (including final event)
 - FET FLAGSHIP GRAPHENE, FP7 - H2020
 - COST ACTION: Nanostructured materials for solid-state hydrogen storage

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

DISSEMINATION ACTIVITIES



Public deliverables

- D4.3 Full Scale Demonstration of EDEN System
- D5.3 Setting up of project website
- D6.3 Final Progress report

Conferences/Workshops

- 1 organised by the project
- 8 in which the project has participated (but not organised)
- 1 panel session organized "HYDROGEN STORAGE: a key element for Future Energy Systems"

Social media



Publications: 11

- R. Bartali et Al., "Nb2O5 deposition on Mg by plasma technique for hydrogen storage applications", NANOENERGY 2015 - International Conference on Nanotechnology, Nanomaterials & Thin Films for Energy Applications, June 1-3, 2015, Manchester, United Kingdom.
- L. Crema et Al, "EDEN: NOVEL POWER-TO-POWER SYSTEM FOR ENHANCED HYDROGEN STORAGE IN SOLID STATE", EFC2015 - European Fuel Cell Technology & Applications Piero Lunghi Conference, December 16-18, 2015, Naples, Italy.

Patents: 3 under evaluation for application

Thank You!

Coordinator: Dr. Crema Luigi, crema@fbk.eu