CoMETHy
Compact Multifuel-Energy To Hydrogen converter

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PROJECT OVERVIEW

Project Information	
Call topic	SP1-JTI-FCH.2010.2.2 - Development of fuel processing catalyst, modules and systems
Grant agreement number	279075
Application area (FP7)	Hydrogen production and distribution
Start date	01/12/2011
End date	31/12/2015
Total budget (€)	4,933,250
FCH JU contribution (€)	2,484,095
Stage of implementation	100%
Partners	ENEA (I); Processi Innovativi (I); Acktar (IL); Technion (IL); Fraunhofer Institute IKTS (D); Univ. of Salerno (I); CERTH (GR); Aristotle Univ. of Thessaloniki (GR); Univ. “La Sapienza” (I); ECN (NL); GKN (D); Univ. “Campus Bio Medico” (I)

PROJECT SUMMARY

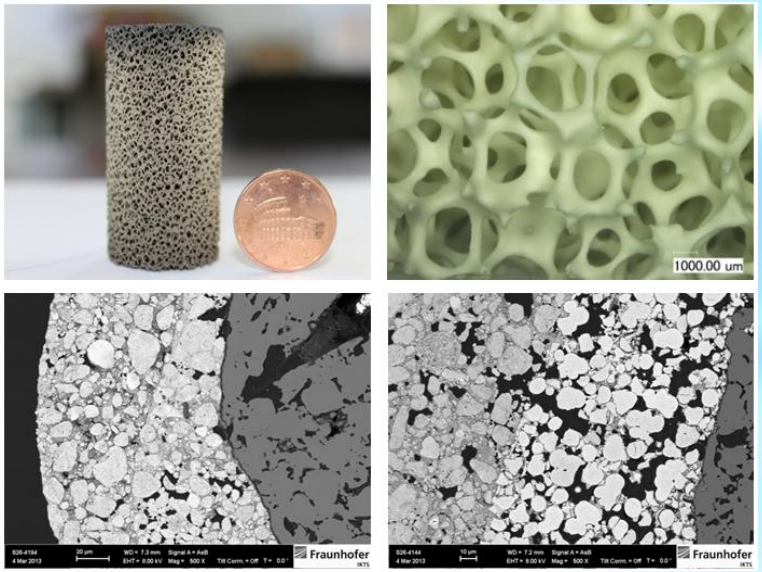
CoMETHy's objective is to develop a "low-temperature" (< 550° C) steam reformer, based on a membrane reactor, to flexibly convert different fuels (methane, ethanol, etc.) to pure H_2, driven by Concentrating Solar plants using molten salts as heat transfer fluid and storage medium.

MAIP 2008-13 aims at introducing up to 50% RES in H_2 production.

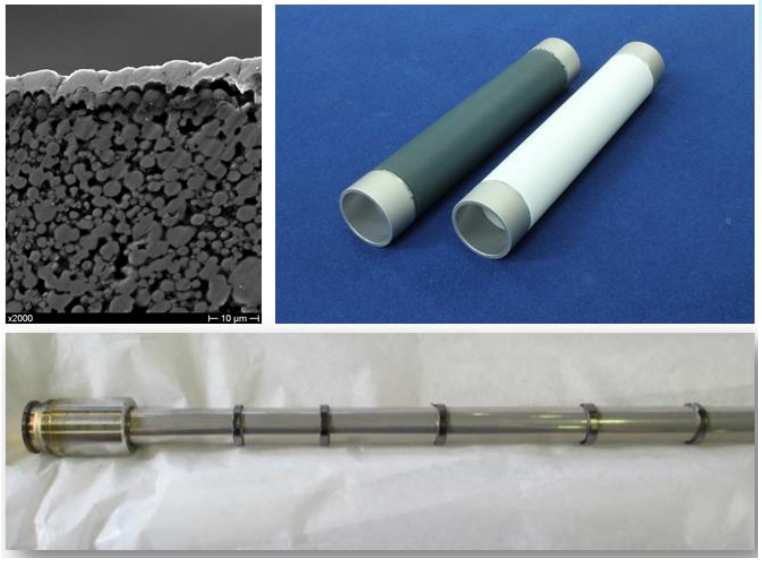
CoMETHy provides a thermochemical alternative option to water electrolysis (powered by RES) for short term H_2 production, leading from 38% to 100% CO_2 emissions reduction compared to traditional NG SR.

PROJECT PROGRESS - Low-T SR catalysts and H_2 separation membranes

- Fuel-flexible catalysts developed for methane (NG or biogas-like mixtures) and bioethanol SR at 400-550° C
- Enhanced heat transfer and low pressure drops
- Developed catalysts proved stable (> 250 hr) with shift activity (outlet CO concentration < 5 %vol.)



- Pd-based composite membranes evaluated and best options identified for the reformer
- Project objectives about permeability (> 10 $Nm^3/m^2/h/bar^{0.5}$) and durability (< 20% selectivity loss over 1,000 hr) met
- Nevertheless, further optimization and qualification required



PROJECT PROGRESS - Proof-of-concept

- Different membrane reformer designs conceived
- Designs are easily scalable from 2 Nm^3/h (pilot) to > 1,500 Nm^3/h (H_2 production rate) (AIP 2010 target)
- Integrated membrane reactor prototypes successfully tested and modelled
- The multi-fuel approach successfully proved (reformer flexibility for CH_4 and bioethanol)
- Reactors' stability proved for hundreds operation hours
- Pilot plant built and successfully tested for CH_4 SR over several hours and conditions
- Catalysts and membranes replaced in < 4 hr (AIP 2010 target)

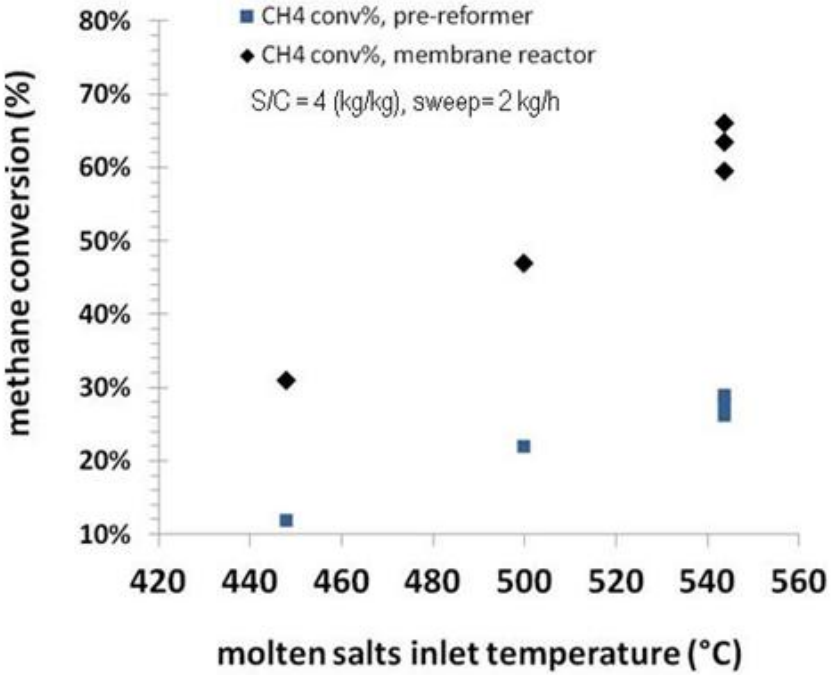
membrane reformer

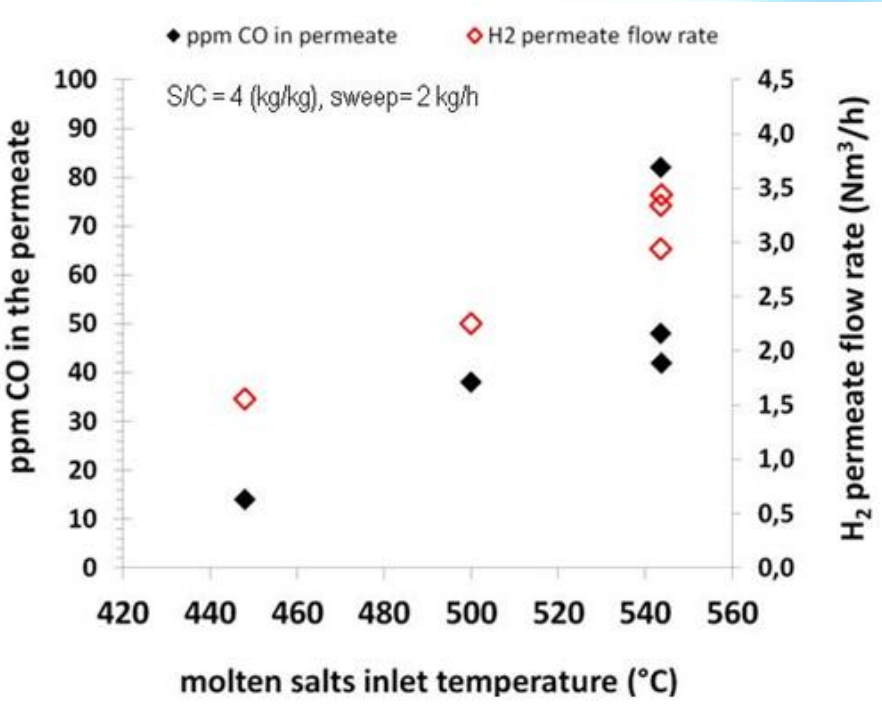

molten salts loop


pilot plant overview

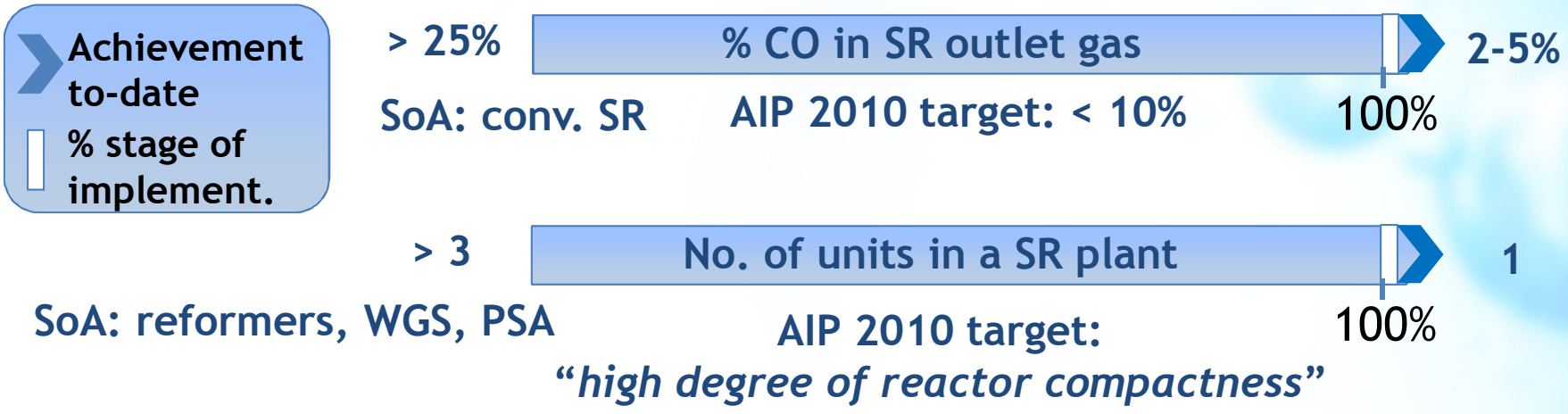
PROJECT PROGRESS - Proof-of-concept

- > 60% conversion obtained driving the membrane reformer with molten salts at ca. 550° C
- up to 3.5 Nm^3/h H_2 permeate obtained (project target: 2 Nm^3/h)
- produced H_2 relatively pure (> 99.8 %vol.) with < 100 ppm CO





PROJECT PROGRESS - achievements vs. KPI in FCH JU MAIP/AIP 2010



Aspect addressed	Parameter (KPI)	Unit	SoA 2016	FCH JU Targets		
				Call topic	2017	2020
Reforming catalysts with shift activity	% CO in outlet gas	%vol.	> 25 %vol	< 10 %vol.		
Plant compactness	Number of basic units in a SR plant (reactors, separators)	No. of units	> 3	"high degree"		

PROJECT PROGRESS - Techno-economic evaluations

- Different process schemes and scenarios investigated for solar SMR in the scale of 1,500 and 5,000 Nm^3/h

Plant capacity	Solar SMR – CoMETHy (incl. CO_2 recovery)	Conventional SMR (incl. CO_2 recovery)
5,000 Nm^3/h	1.09 – 1.22 €/kg (HPC) 5,000 solar hrs/year	1.19 €/kg (HPC) "zero" solar
1,500 Nm^3/h	2.02 – 3.36 €/kg (HPC) 2,000 – 4,500 solar hrs/year	1.74 €/kg (HPC) "zero" solar

Aspect addressed	Parameter (KPI)	Unit	SoA 2016	FCH JU Targets		
				Call topic	2017	2020
Production Cost	H_2 Production Cost (HPC)	€/kg	1.19-1.74	< SoA value		

SYNERGIES WITH OTHER PROJECTS AND PROGRAMMES

Interactions with projects funded under EU programmes	
CARENA (FP7)	Organization of technical Workshops and share/exchange information for the development and up-scale of Palladium Membrane Reactors technology
CACHET-II (FP7)	
ReforCELL (FCH JU)	
DEMCAMER (FP7)	
MATS (FP7)	Data supply about the concentrating solar plant for the techno-economic assessment solar reforming process
Interactions with national and international-level projects and initiatives	
IEA/SolarPACES - Task II "Solar Chemistry Research"	Interactions with expert groups and presentations at annual meetings of the SolarPACES annual meetings

DISSEMINATION ACTIVITIES

Public deliverables

- Mid-Term Project Summary Report
- Project Summary Report

Conferences/Workshops

- 4 organised/co-organized by the project
- 63 in which the project has participated (but not organised)

Publications: 42 (22 peer reviewed international journals + 6 books + 14 proceedings)

- "Multi-fuelled Solar Steam Reforming for Pure Hydrogen Production Using Solar Salts as Heat Transfer Fluid". Energy Procedia. 2015, Vol. 69, 1750-1758.
- "Enhancement of pure hydrogen production through the use of a membrane reactor". Int. Journal Hydrogen Energy. 2014, Vol. 39, 4749-4760.

Patents: 1

- Method and system for the production of hydrogen, European Patent. Application n. EP12159998.9, Application Date: 16 March 2012.

EXPLOITATION PLAN/EXPECTED IMPACT

Exploitation

- Application of CoMETHy solar SMR process for centralized H_2 production in chemical industry, e.g. ammonia synthesis in sun belt countries.
- Application of CoMETHy multi-fuel reformer in an "autothermal" scheme for decentralized hydrogen production, e.g. in refueling stations: the reformer can be applied to H_2 production from NG, biogas or bioethanol. This small reformer would be the first commercial product of this kind in Europe.

Impact

- Technological impact on H_2 production processes from RES, providing an alternative (thermochemical) option to water electrolysis in the short term and including CO_2 capture.
- Socio-economic impact: CoMETHy proposes new products and solutions well aligned with the common strategies on sustainable development in the worldwide growth of the "green economy", thus supporting job creation, energy safety and welfare.

Thank You!

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