METPROCELL
(n° 277916)

Dr.-Ing. Maria Parco
TECNALIA RESEARCH & INNOVATION

0. Project & Partnership description

METPROCELL

Project full title: Innovative fabrication routes and materials for METal and anode supported PROton conducting fuel CELLs

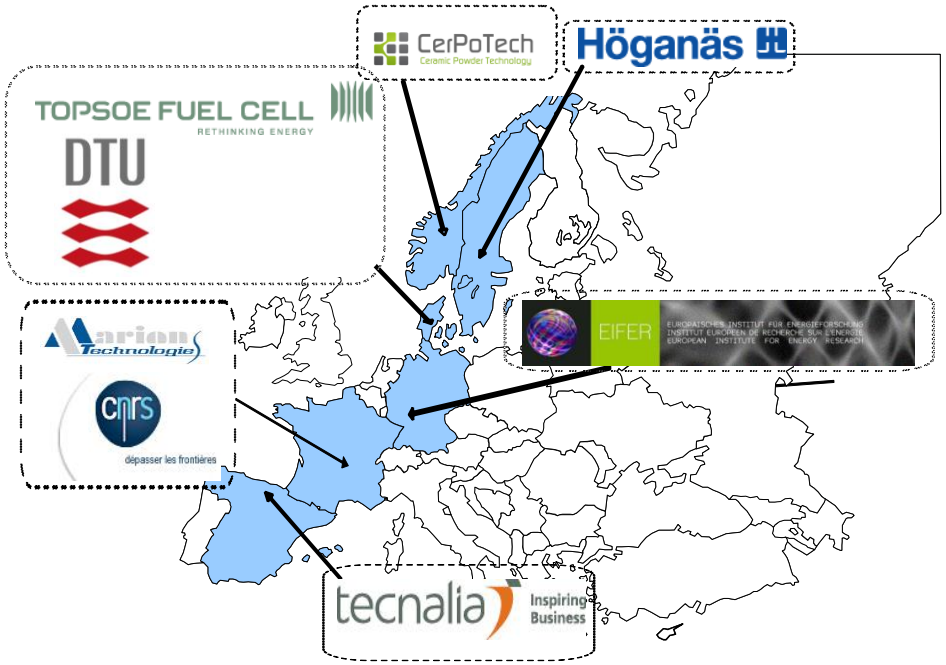
Duration: 01/12/2011 – 30/11/2014

Total budget: 3.4 MEUR (FCH contribution: EUR 1,822,255.00)

Consortium:

TECNALIA RESEARCH & INNOVATION
European Institute for Energy Research
Centre National de la Recherche Scientifique
Technical University of Denmark - DTU

Ceramic Powder Technology AS – (SME)
Marion Technologies – (SME)
TOPSOE FUEL CELL A/S –(Industry)
Höganäs AB – HOGANAS (Industry)



1. Project achievements/ project concept

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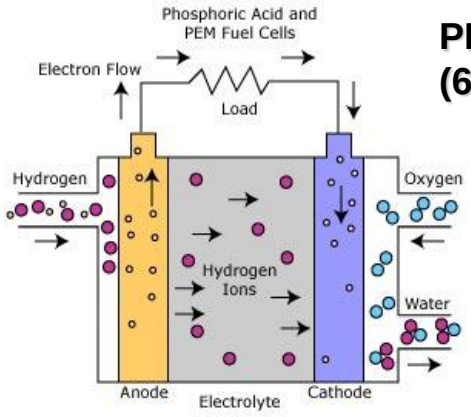
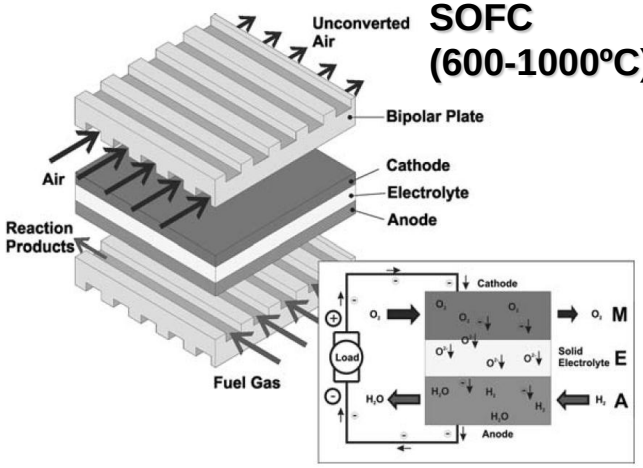
Today's solutions



PEMFC (60-120ºC)



SOFC (600-1000ºC)

METPROCELL concept

PC dense electrolyte
CO_2 tolerance
High H^+ concentration and diffusion (e.g. $BaCe_{0.9}Y_{0.1}O_{3-\delta}$)

H_2O tolerance
High performance cathode
(e.g. LSCF, BSCF, Pr_2NiO_{4+d})

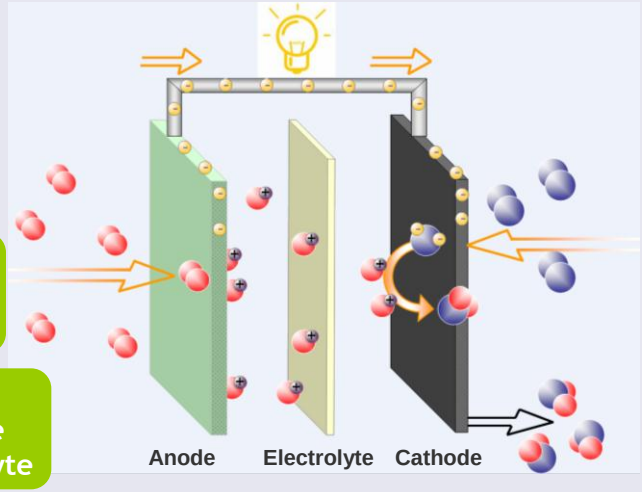
H_2 fuel sources (g)
(CH_4, NG, biogas…)

Protonic conducting solid oxide fuel cell (SOFC-H^+)

(Operating temperature : 400°C < T < 600°C)

Hydrogen oxidation
$H_2 \rightarrow 2\ H^+ + 2\ e^-$

Oxygen reduction
$O_2 + 2\ H^+ + 2\ e^- \rightarrow H_2O$



H_2 electrode (anode)
Porous material
(metallic or Ni)

Sulfur tolerance
High performance anode
Ref: Cermet NiO-electrolyte

Improved characteristics (higher thermal cycling resistance, better heat transfer, current collection..), real simplification and reduced cost of industrial working processes (proof of concept on APU/gas-micro CHP)

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Project objectives

- Development of new electrolyte and electrode materials with enhanced properties for improved PCFCs dedicated to 500-600°C.
- Suppress the post- sintering steps using alternative manufacturing routes based on thermal spray technologies and plasma EVD.
- Assess the potential of both metal and anode supported cell architectures to obtain the next generation of PCFCs.
- Bring the *proof of concept* of PCFCs by the set-up and validation of short stacks for APU and gas/micro-CHP (first complete PCFC stack units).
- Assess the PCFC technology as electrolyser.

1. Project achievements/ project approach

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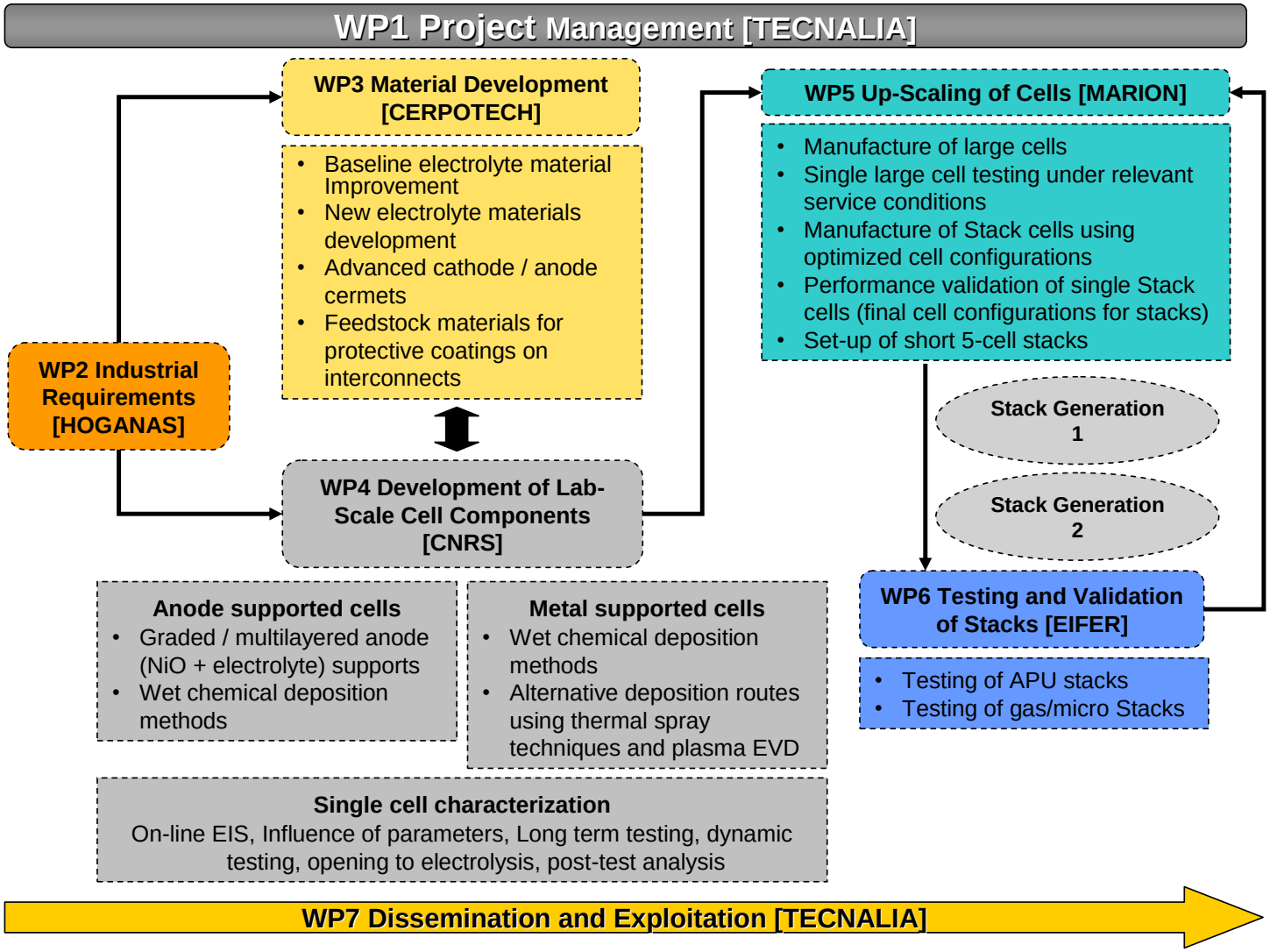

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Key milestones

	Delivery date
❑ Single cells in comparison with literature: At least: 200 mW.cm-² @ 0.65V, 600°C (target: 400 mW.cm-² at 600°C as maximum Power density)	M24
❑ Elaboration of at least 22 stack cells (2 stacks/system)	M28
❑ Performance validation of single stack cells in terms of degradation rate (2% or less over 500 hour long term cell testing under fuel cell and electrolysis mode)	M30
❑ Manufacture of short stacks (5 cells/stack x 2 stacks/system x 2 systems, i.e. APU and gas/micro-CHP)	M30
❑ Validation of stacks under relevant industrial conditions	M36

Testing procedures

Non-standardized test procedure shared by all project participants for:

- Start-up, anode reduction and fuel cell operation steps at both single cell level and stack level.
- Long term operation of PCFCs at single cell and stack level (endurance test at single cell level).
- EHT operation step of SOECs (single cell level).
- Long term operation of button SOECs (endurance test at single cell level).

Correlation of the project with the corresponding Application Area:

- Solutions to specific identified failure mechanisms:
  - New generation of PC electrolytes more tolerant in CO_2 and dedicated to 500-600°C.
  - New electrode compositions with enhanced electrochemical performances (lower concentration/activation polarization) and compatible with the new PC electrolytes.
  - Reduction of the service temperature under 600 ºC to prolong the service life of metal supported cells potentially beyond current benchmarks of 40.000 hours.

Correlation of the project with the corresponding Application Area:

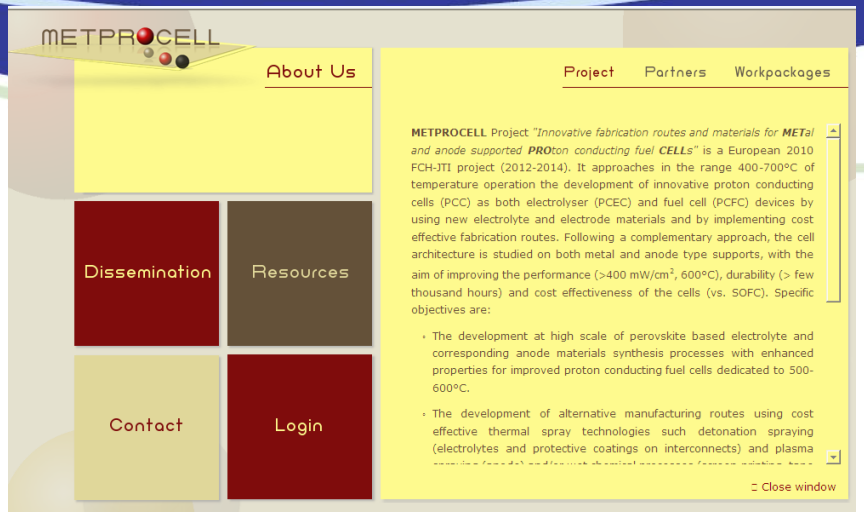
- Proof of improved performance for existing design of cells, stacks and BoP
  - Assessment of the long-term (>500h) performance of recently developed PCFC designs
  - Increase of system efficiency, through:
    - a better utilization of the heat produced and a better BoP,
    - a lower operating temperatures down to 600 ºC,
    - a reduction of the energy consumption of at least 7- 10% and the elimination of the fuel dilution (since water is formed at the cathode).

Correlation of the project with the corresponding Application Area:

- New material production techniques/Cost reductions (€ 5000 for domestic micro CHP)
  - Reduction of the manufacturing steps, through the implementation of alternative fabrication routs with none post-sintering needs, i.e. thermal spray deposition techniques.
  - Enabling the manufacture of new (low cost) metal supported cell designs.
- Recommendations for use of materials in specific stack
  - Testing and validation of novel PCFCs in existing stack design (standard SOFC technology).
  - Set-up of specifications for the construction of Stacks dedicated to the SOFC H^+ technology.

3. Cross-cutting issues

- Dissemination & public awareness
  - o Public web site
    (http://www.metprocell.eu/about.html)
  - o Six monthly dissemination newsletter
  - o Common dissemination actions with other national/international projects



- *2013:* International Workshop n°2 « Prospects Protonic Ceramic Cells », Montpellier (F)

→ Organizer: EIFER (M. Marrony, J. Dailly)

→ Topics: PCC in applied research (Fuel cell, Electrolysis, Ammonia synthesis, H_2 pumping)

- Publications:

20-22/06/2012: European Fuel Cell Forum Conference, Lucerne (CH)

→ Poster Communication on METPROCELL project by CERPOTECH (R.A. Strom)

Link: http://www.efcf.com/

10-14/09/2012: Solid State Proton Conductors Conference, Grenoble (F)

→ Invited speaker: EIFER on “Status and prospects in Proton conducting ceramic cells” (M. Marrony)

Link: http://sspc16.weebly.com/

4. Enhancing cooperation and future perspectives

- Technology Transfer / Collaborations (*Interaction with other national/international projects):*
  - *Other FCH JU projects: TOPSOE FUEL CELL will use stack design developed in other projects, especially in the frame of METSAPP, to test the developed PCFCs.*
  - *CONDOR (national project-France): The European Institute for Energy Research (EIFER) and the involved CNRS´s laboratories have provided electrode and electrolyte compositions developed in the frame of CONDOR to be used in METPROCELL as reference solutions.*

- Project Future Perspectives
  - *With METPROCELL, TOPSOE FUEL CELL wish to establish state of the are knowledge concerning a new generation of high temperature fuel cells based on proton conduction. If the conclusion of the project is positive, a continued R&D is to be expected.*