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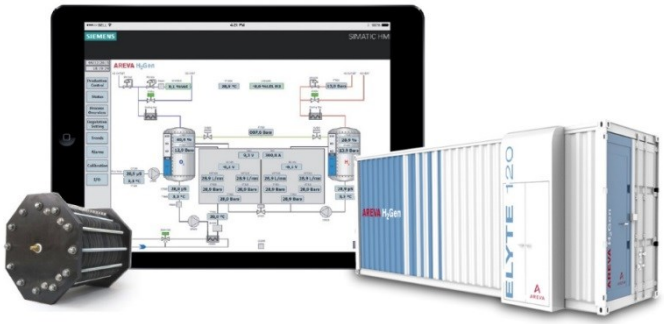
“Water PEM electrolysis: used of GD-OES for fast characterization of innovative coating”



GD-Days 15-16 september 2016

Nicolas Quéromès
Test Manager

NOVEL

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AREVA H_2Gen company overview

- **2014 : The merge of :**
  - **An industrial start-up** CETH2 **(owned by** smart energies **)**
  - **The electrolysis division of former** AREVA / HELION HYDROGEN POWER
- **And venture capital funds from the French State**

ADEME – Agence de l'Environnement et de la Maîtrise de l'Energie

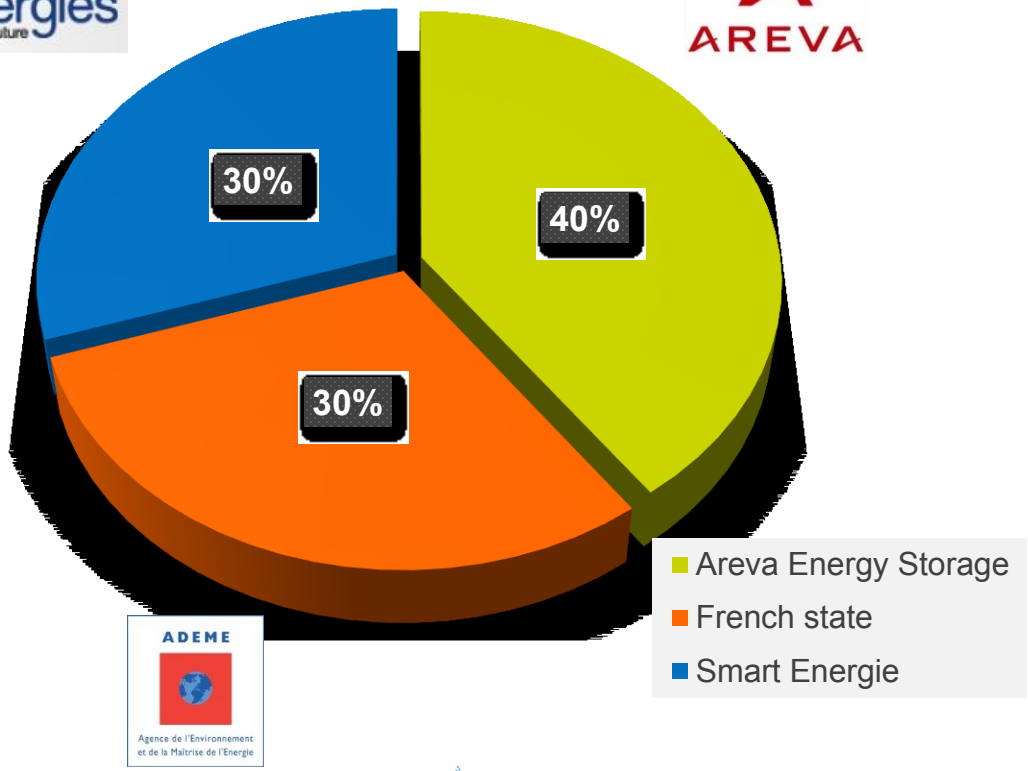
Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

INVESTISSEMENTS D'AVENIR

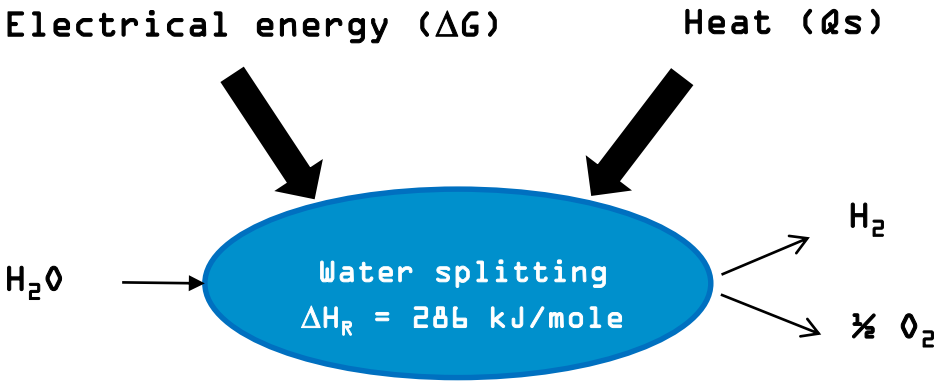
A PEM electrolyser division within the AREVA Group

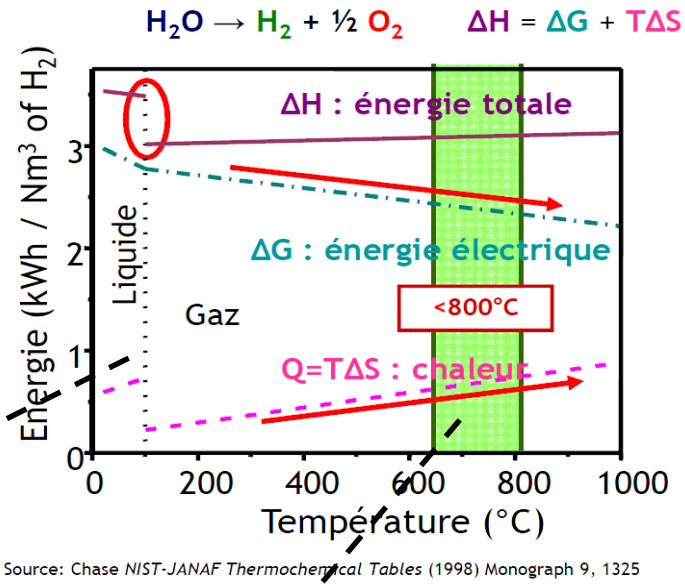
Capital Structure

- **3 shareholders :**



Water electrolysis





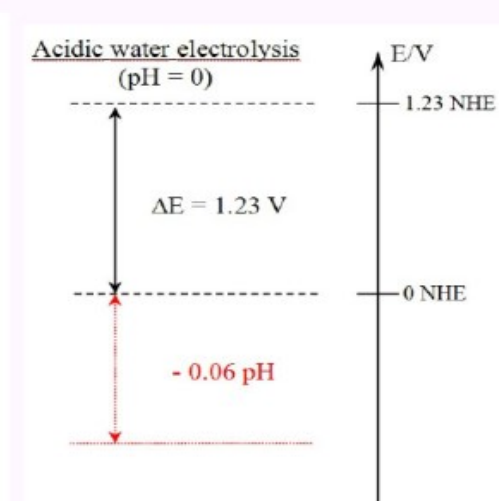
Source: Chase *NIST-JANAF Thermochemical Tables* (1998) Monograph 9, 1325

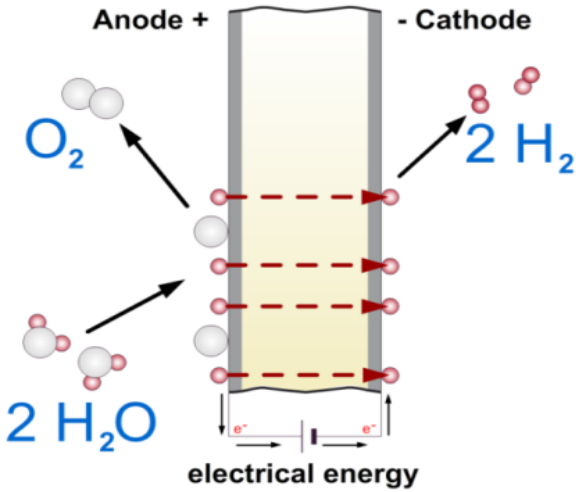
Low temperature electrolysis	High temperature electrolysis
- Alkaline electrolysis (liquid electrolyte) - Acid electrolysis (solid polymer electrolyte – PEM)	- Vapor electrolysis (EVHT)

Background

- 1962-66 : Programme Gemini-Apollo space program and first polymer cell
- 1966 : First SPE electrolyzer by GE
- 1987 : Frst 100 kW electrolyzer by BBC (ABB)

PEM Water Electrolysis





Compare to other electrolysis technology, PEM electrolysis advantage are fast dynamic response times, high pressure operation ability, large operational ranges, high efficiencies, and very high gas purities (99.999%)

Anode : $H_2O \rightarrow ½\ O_2 + 2H^+ + 2e^-$

Cathode : $2\ H^+ + 2\ e^- \rightarrow H_2$

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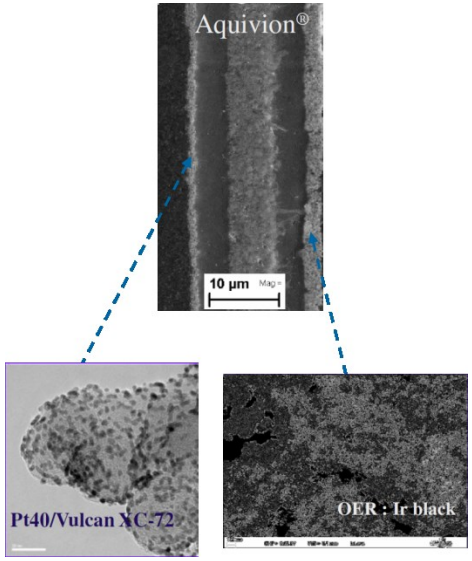
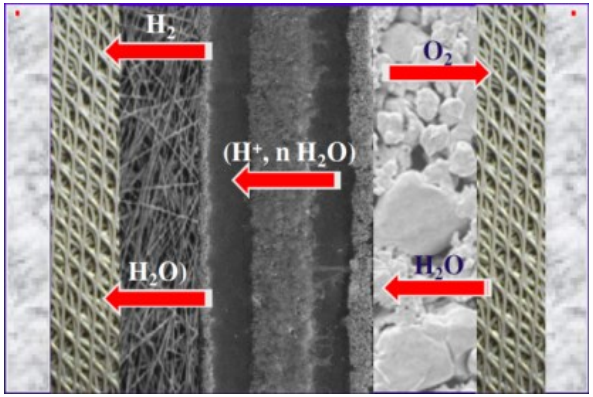
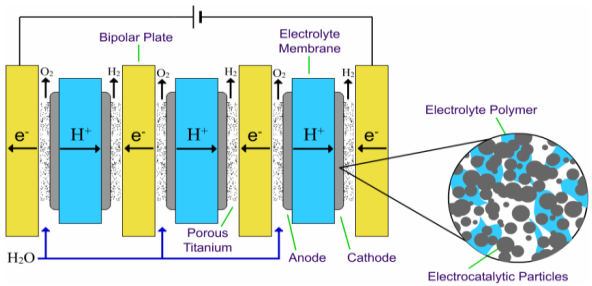
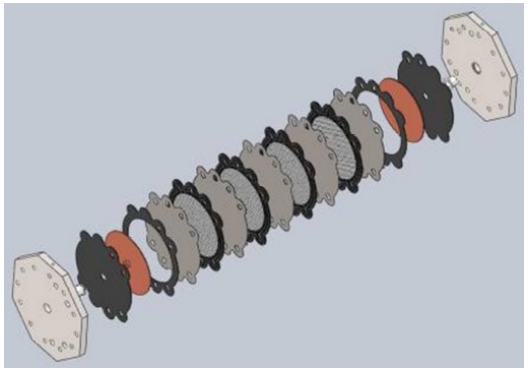
PEM Cell & Stack









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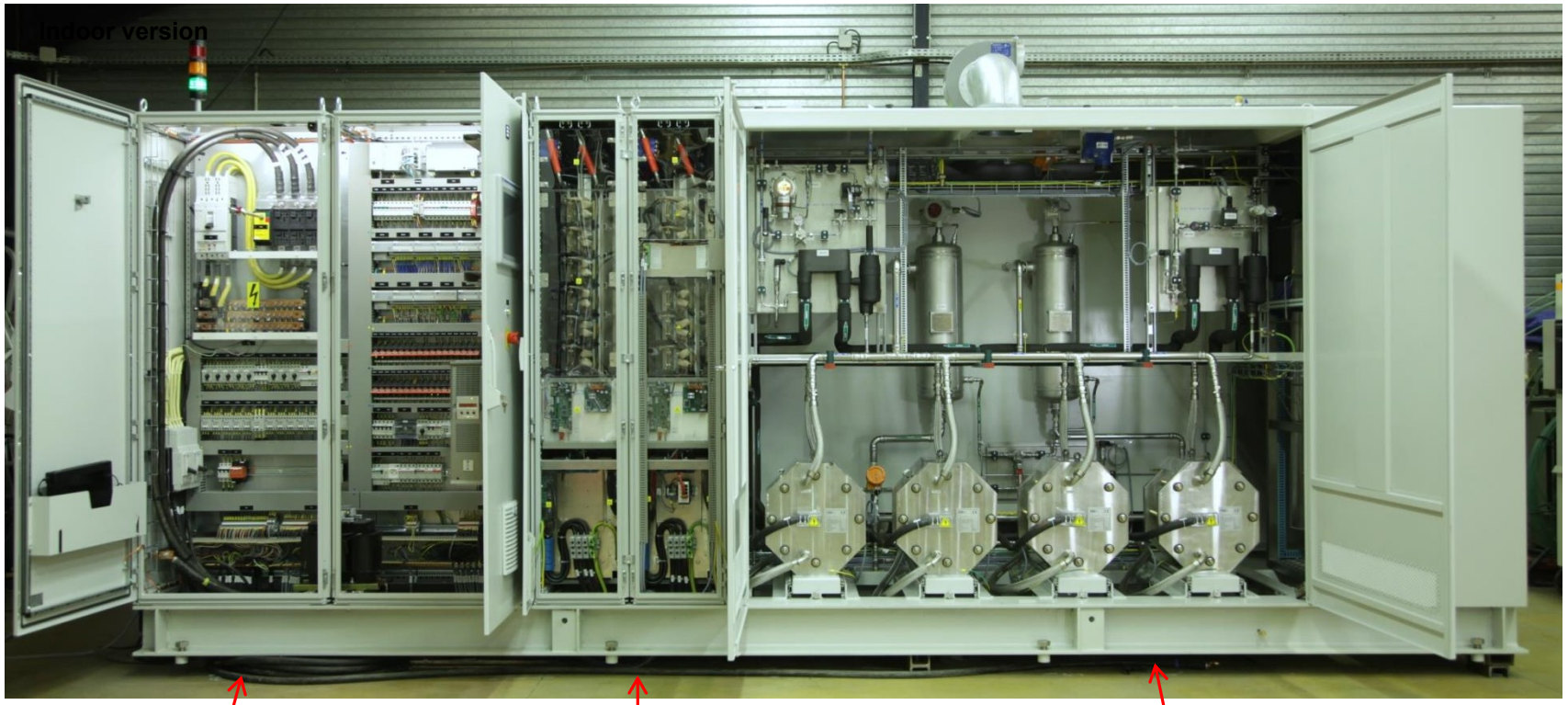
Products, view of a complete PEM electrolyser

Indoor version



Electrical cabinet

- SIL 1 PLC : Allen Bradley
- UPS : for proper shutdown

Rectifier

- 2 cabinets
- 95 kW each
- 300A / 350 V

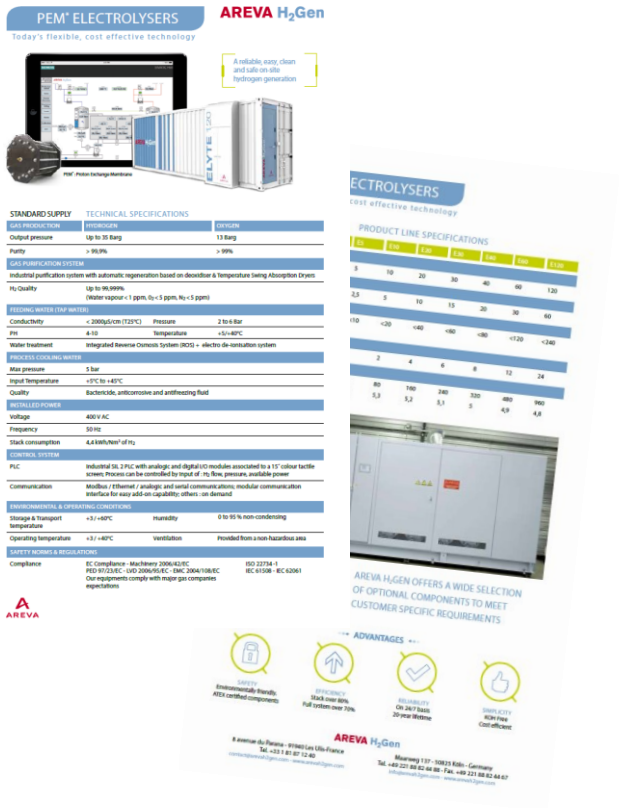
Gas Skid

- 4 stacks of 8 Nm^3/h each
- Stacks are CE certified
- 2 separator tanks SS316L CE certified

Areva H2Gen Product Line

- A commercial product line from 5 to 120 Nm^3/h at 15 Bar and up to 240 Nm^3/h at 35 Bar

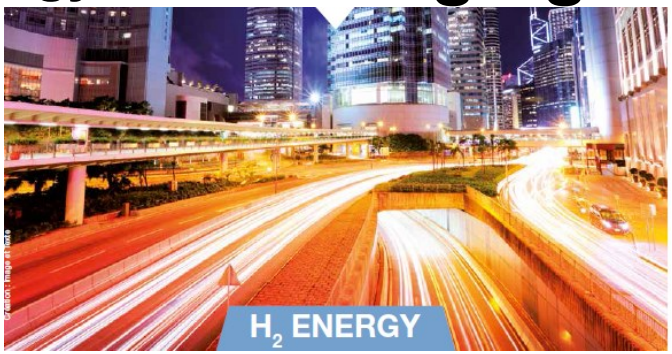
- Customs solutions multi MW projects :
  - Grid balancing services
  - Renewable hydrogen for petro-chemicals



Two Major markets

- Hydrogen for Industry : **a mature market**

- Hydrogen for Energy : **an emerging market**



NOVEL Project

Novel Materials and System Designs for Low Cost, Efficient and Durable PEM Electrolysers

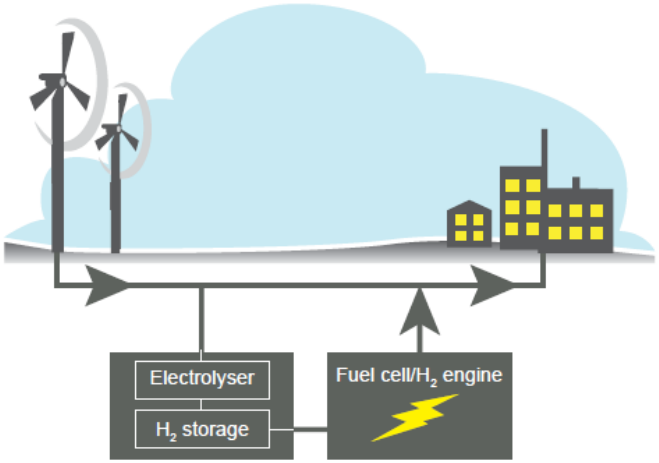
NOVEL

The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for the Fuel Cells and Hydrogen Joint Technology Initiative under grant agreement n°303484.

Novel Main objectives

Develop and demonstrate a PEM water electrolyser using beyond state of the art materials.

75% Efficiency (LHV), electrolyser stack cost < €2,500 / Nm^3h^{-1}, target lifetime of 40,000 h (< 15 μVh^{-1})



Novel Consortium

PAUL SCHERRER INSTITUT PSI

Johnson Matthey Fuel Cells — the power within

Fraunhofer ISE

New Materials Development (Electrocatalysts & Membranes) → Component development and testing → Increased understanding of lifetime and degradation → Stack and system design

SINTEF

TEER COATINGS LTD — innovation and experience

DE LA RECHERCHE À L'INDUSTRIE cea

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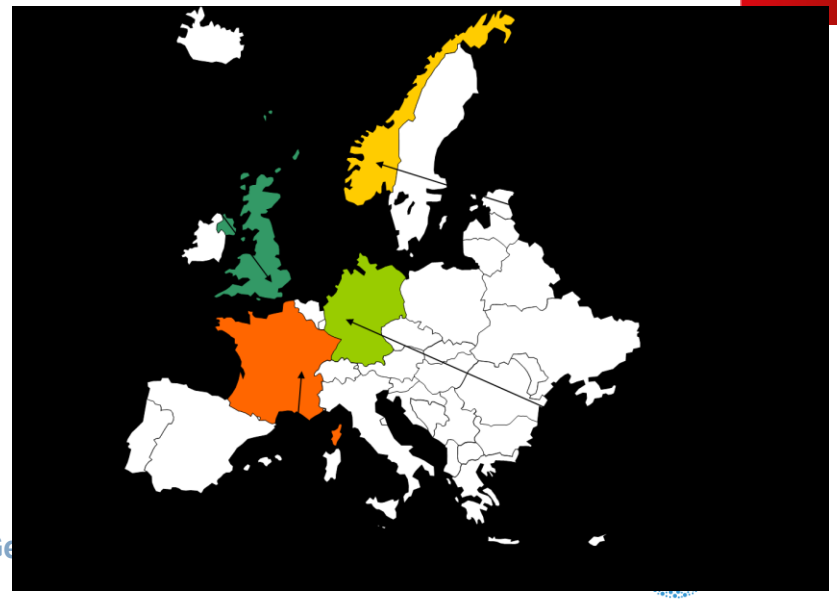
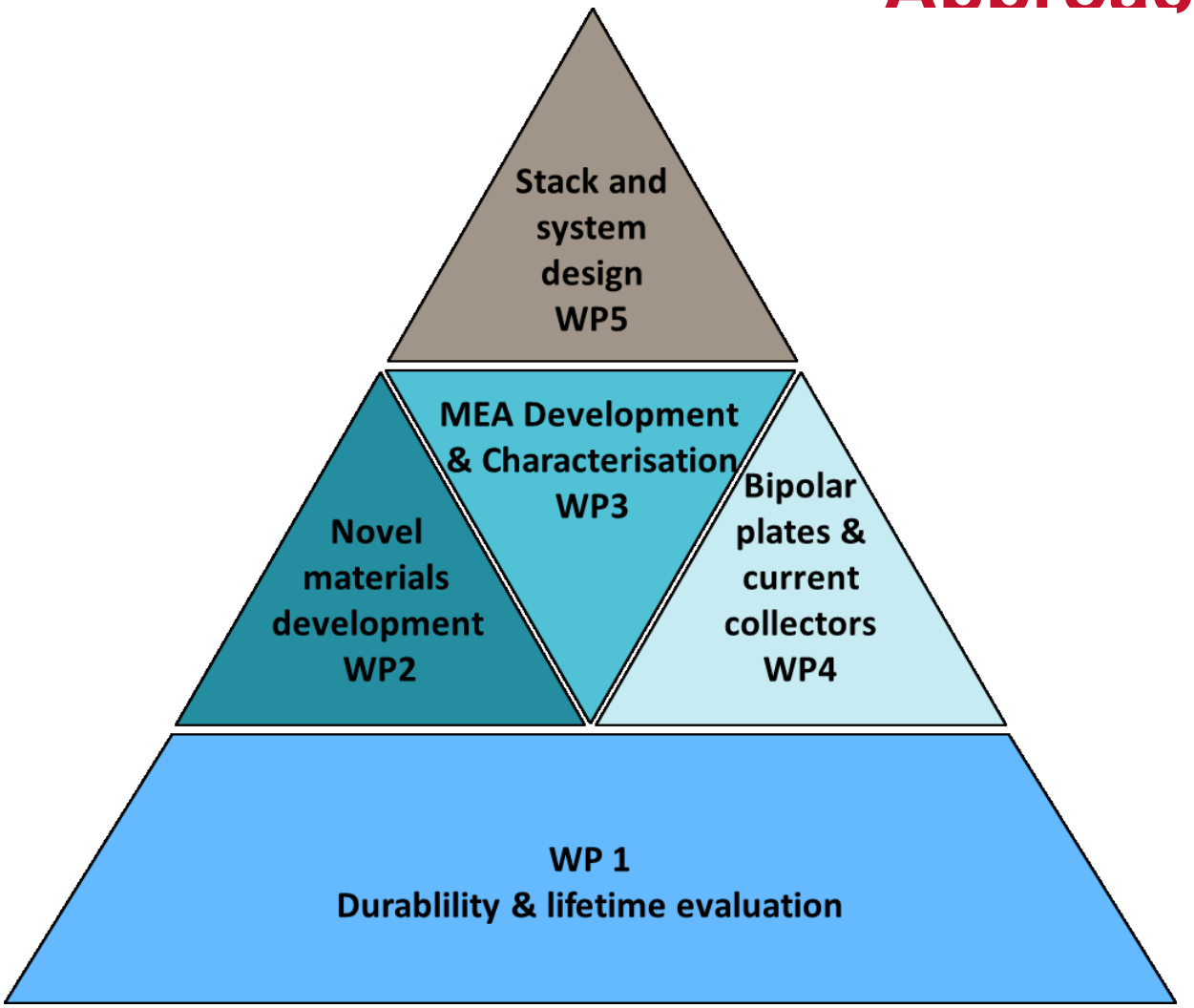


Approach


Stack and system design WP5
MEA Development & Characterisation WP3
Novel materials development WP2
Bipolar plates & current collectors WP4
WP 1
Durablility & lifetime evaluation

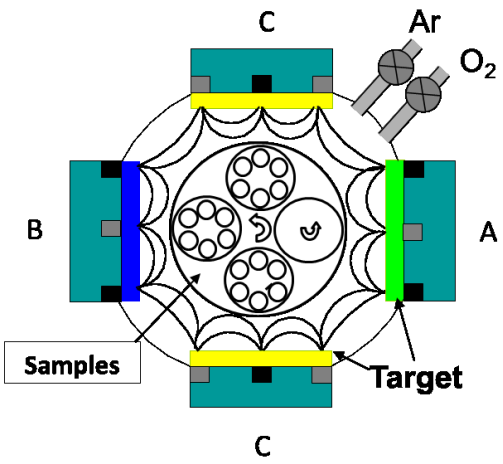
TEER COATINGS LTD
innovation and experience

Fraunhofer ISE

Coating for bipolar plate

Closed field unbalanced magnetron sputter ion plating (CFUBMSIP) technology has been used as a primary procedure for coating development

More than 75 different coatings h
been investigated



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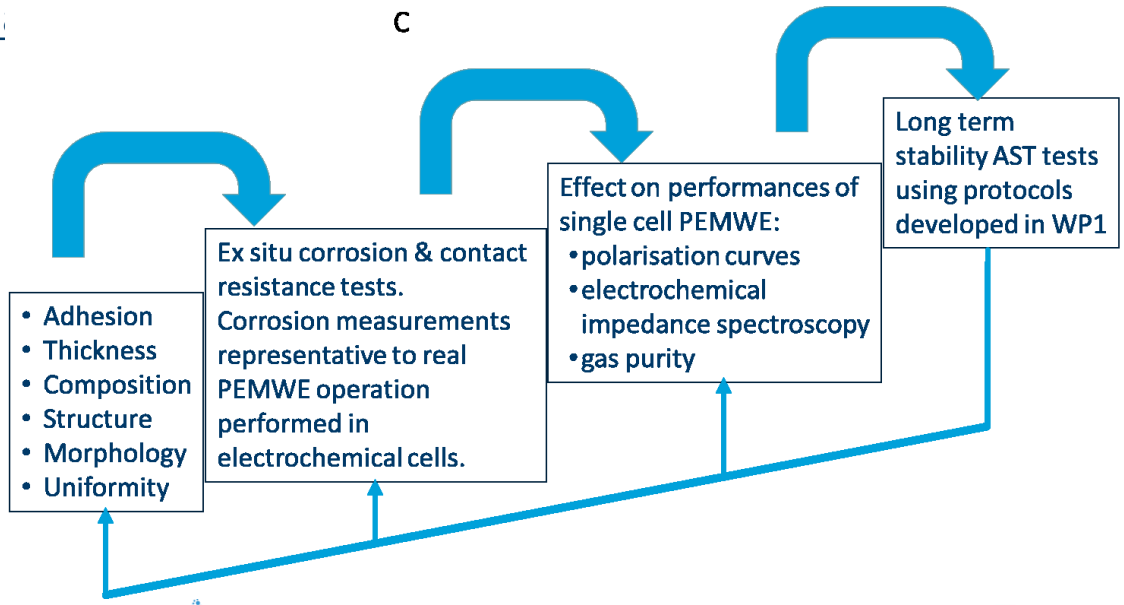

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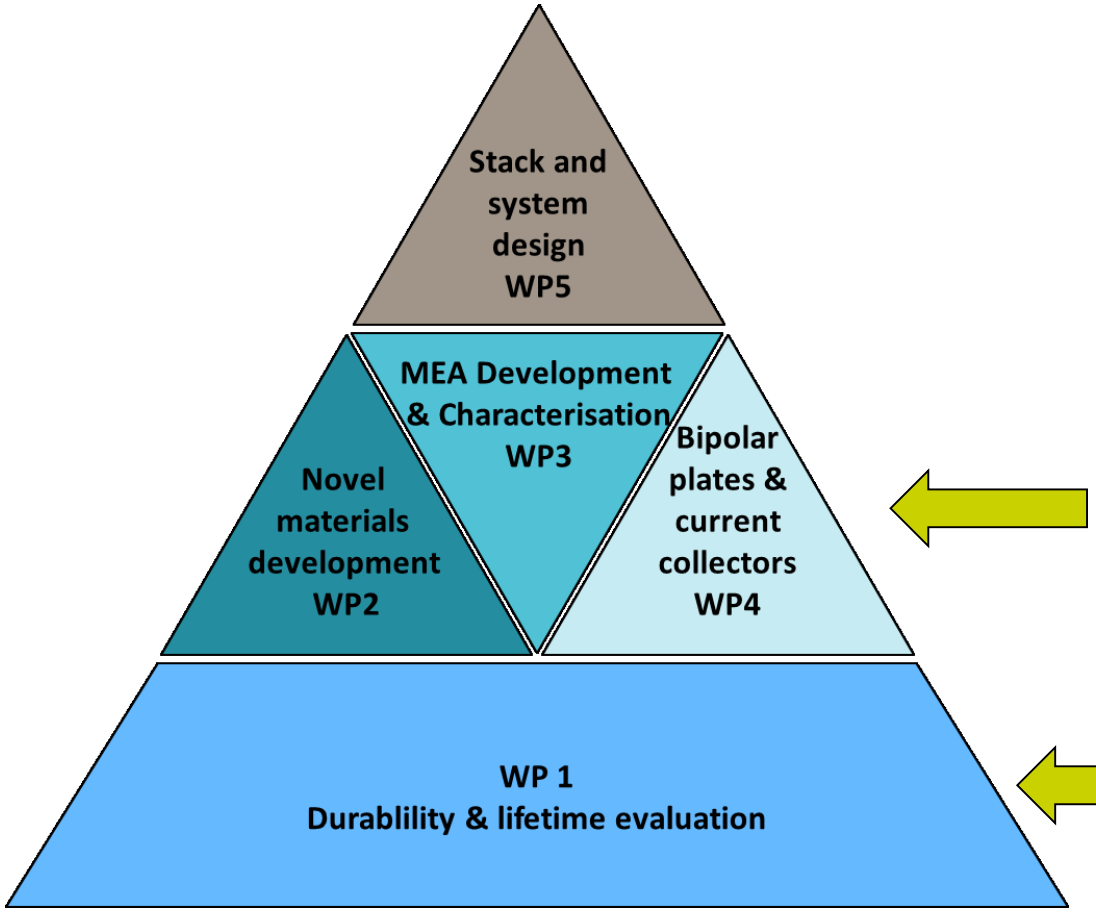
Where GD is used ?



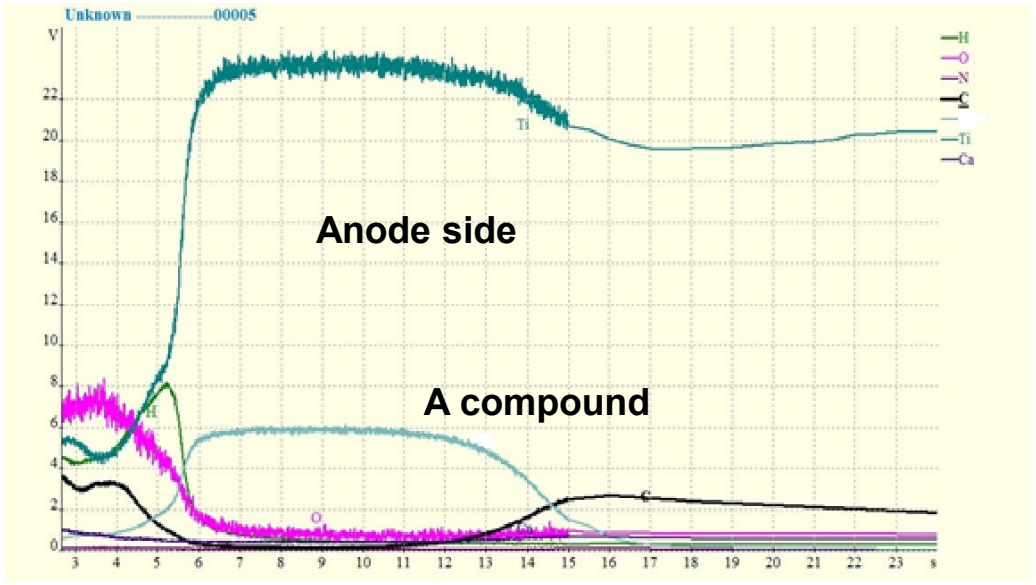
Determination of coating stability

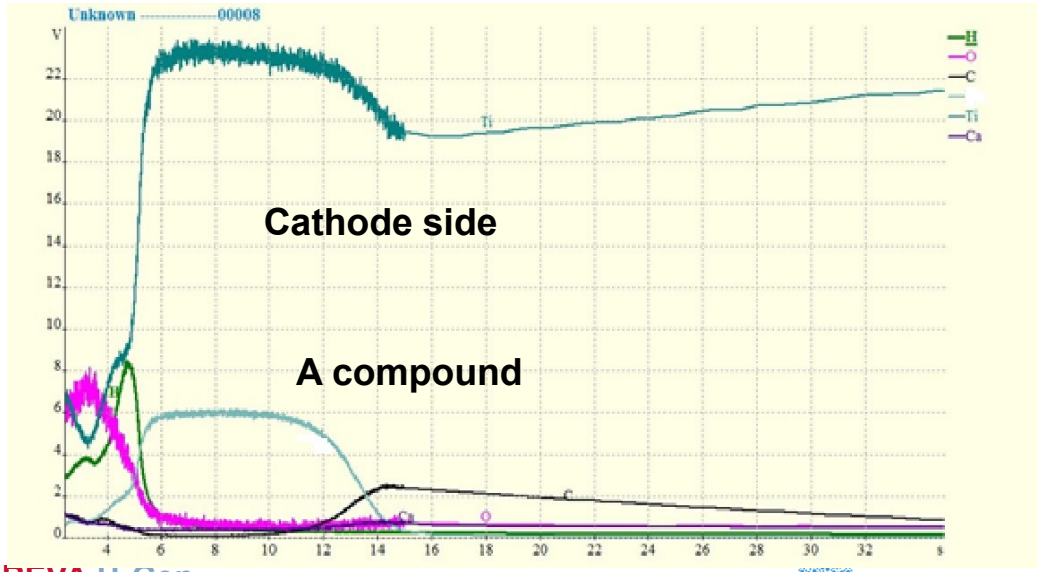
Measurement of Hydrogen insertion (help to predict durability)

Why GD is used ?

- Ability for hydrogen detection
- Detection of element in surface and bulk
- Fast results and no preparation

GD results: BPP end of life





Investigation of Bimetallic compound: Ti + A (confidential)

Substrate in Titanium

Coating act as a diffusion barrier for hydrogen → suppresion of hydrogen embrittlment

Coating act as a diffusion barrier for oxygen.

At the end of life, on both side coating is still present and had the same thickness for cathode and anode

Acknowledgements and project member

Many thanks to Patrick Chapon and Sofia Gaiaschi for performing GD analysis

Many thanks for FCHJU to support the NOVEL Project

Project members

SINTEF – Magnus thomasson (coordinator), Tommy Mokkelbost, Alejandro Oyarce,

PSI - Lorenz Gubler, Albert Alber

Johnson Matthey - Emily Price, Jonathan Sharman, Ed Wright

TEER Coatings - Kevin Cooke, Xiaoling Zhang

Fraunhofer ISE - Tom Smolinka, Thomas Lickert, Patricia Gese, Andreas Georg

CEA - Frederic Fouda-Onana

AREVA H2GEN - Fabien Auprêtre, Nicolas Quéromès

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