



MATISSE

**Manufacturing improved stack with textured
surface electrodes for stationary and CHP
applications (GA 621195)**

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

- Call year: 2013
- Call topic: SP1-JTI-FCH.2013.3.2 - Improved cell and stack design and manufacturability for application-specific requirements for Stationary Fuel Cell power and CHP systems
- Project dates: 01/10/2014 - 31/12/2017 (+3M)
- % stage of implementation 01/11/2017: 90%
- Total project budget: 2 983 291€
- FCH JU max. contribution: 1 684 717€
- Other financial contribution:
- Partners: CEA, ZSW, Nedstack, inhouse, Areva SE



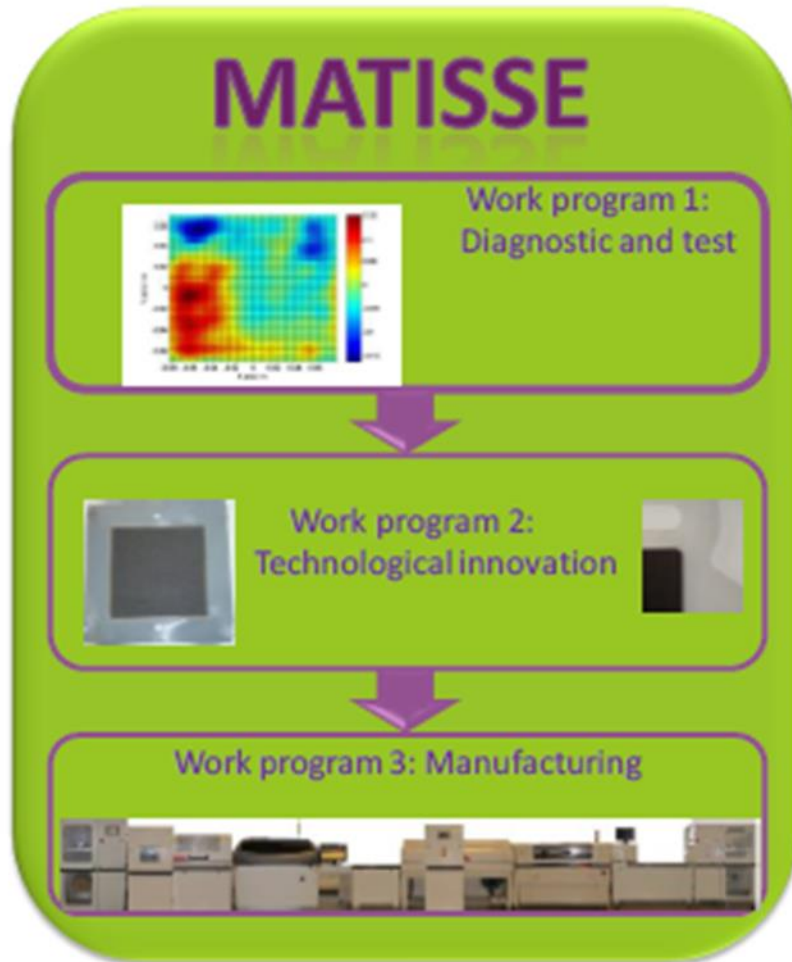
Delivery of PEMFC advanced cells and stacks for stationary applications

→ 3 specific stack designs & operating conditions:

- | | |
|----------------------------------|------------------------------|
| - H ₂ /O ₂ | Areva SE (smart grid) |
| - H ₂ /air | Nedstack (large power plant) |
| - Reformate H ₂ /air | inhouse (micro-CHP) |

Approach based on the assessment of stacks with textured surface electrodes

→ Improvement of robustness, lifetime, performance and reduction of system cost (thanks to local optimisation)



→ **Understanding** of fuel cell operation with specific characterizations

→ **Development and optimisation** of components for improved operation

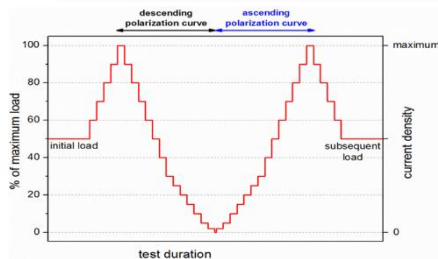
→ **Demonstration** of fuel cell components manufacturing using automated processes

PROJECT SUMMARY

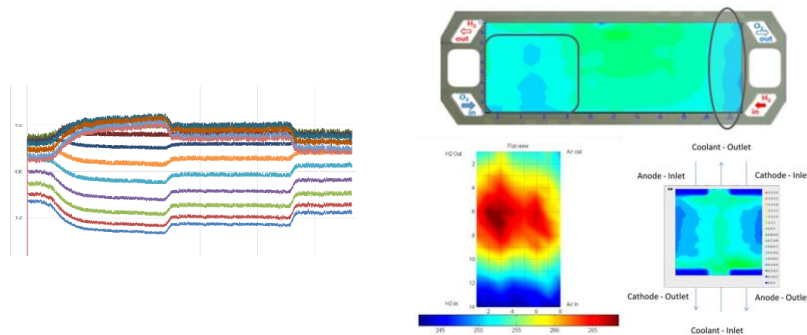
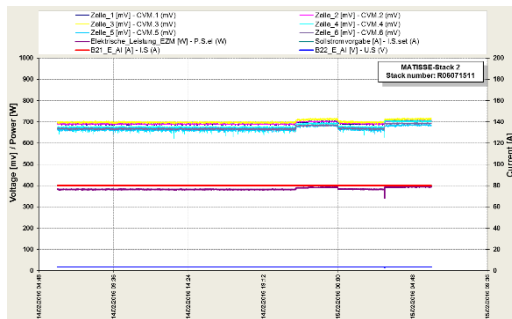
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Starting point:

- reference MEAs for the 3 stack designs and applications
- + cell and stack testing



- Investigation of local behaviour
Segmented cells & Current Density Distribution Mapping (CDDM) + Thermal mapping
- Investigation of overall behaviour & validation
Performance & stability in specific conditions



Data analysis
Inputs for electrodes
& MEAs formulation

PROJECT SUMMARY

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Development and improvement of electrodes and Membrane Electrode Assemblies (MEAs)

- Development of integration technologies
 - Anti-wicking / Gasket deposition
- Identification of catalyst layers formulations and inks for specific conditions
- Definition of textured electrodes
(according to CDDM, cell design and working conditions)



Enhancement of manufacturing automation for each stack design

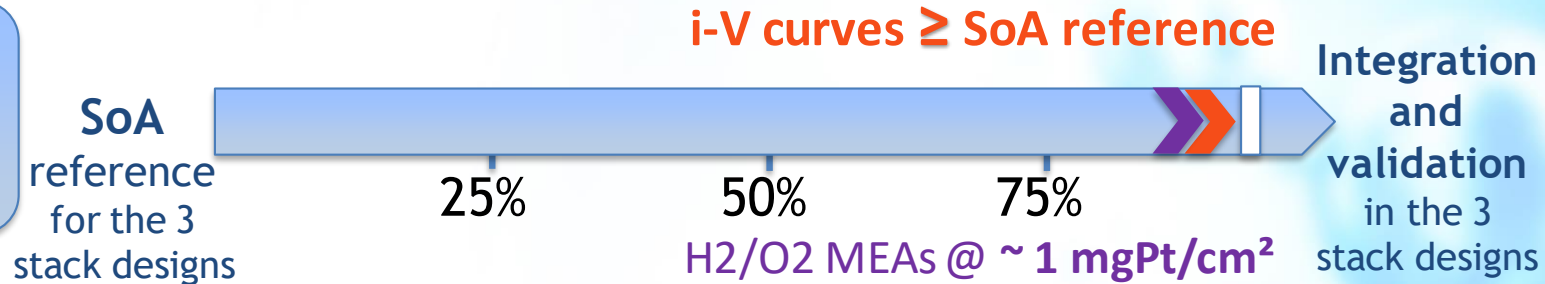
- Electrodes fabrication
→ Homogeneous and textured
- MEA assembling



PROJECT PROGRESS/ACTIONS - Integration and performance validation of MEAs in stacks



 Achievement to-date
 % stage of implement.



Aspect addressed	Parameter (KPI)	Unit	SoA 2017	MATISSE Partners Targets	
				2017	2020
Performance of Matisse MEAs in 3 specific stack designs	Electrical efficiency for power unit H₂/Air or Reformate /Air Cell voltage @ nominal I	V@A Nominal conditions	0,65V@120A 0,7V@80A	=	>
	Reduced stack components costs H₂/O₂ case - Pt loading	mgPt/cm ²	4	<4	<1

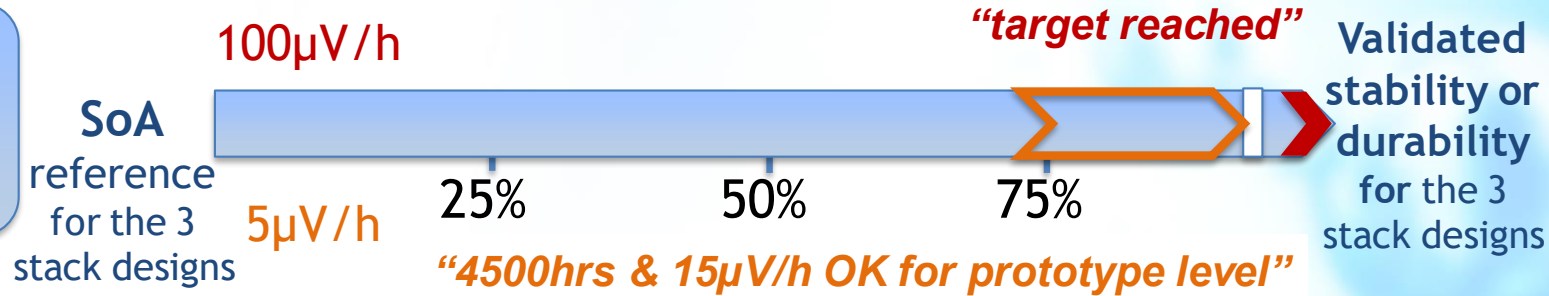
Future steps:

Performance tests in full power stacks to be finalized for final conclusion about the automated aspects of MEAs manufacturing (cells voltage and distribution)

PROJECT PROGRESS/ACTIONS - Durability and stability validation of MEAs in stacks



 Achievement to-date
 % stage of implement.



Aspect addressed	Parameter (KPI)	Unit	SoA 2017	MATISSE Partners Targets	
				2017	2020
Durability and stability of Matisse MEAs in 2 specific stack designs	H2 /Air case Degradation rate vs. specific AST	$\mu\text{V/h}$	100	≤ 100	
	Reformate /Air case Degradation rate vs. specific load cycles protocol	$\mu\text{V/h}$ (duration)	5	15 (4500h)	< 5

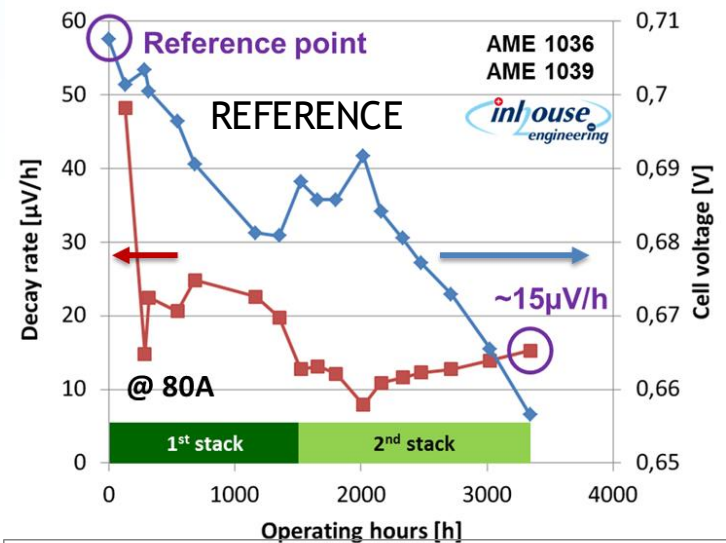
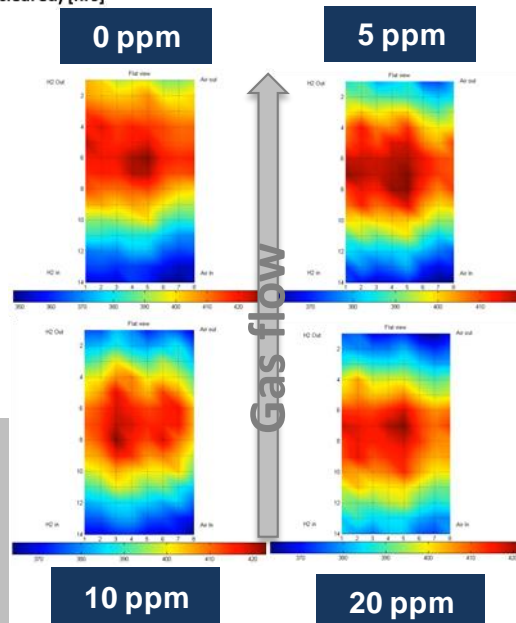
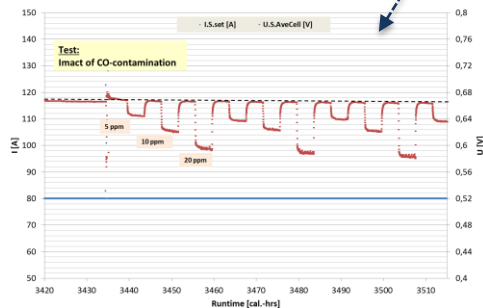
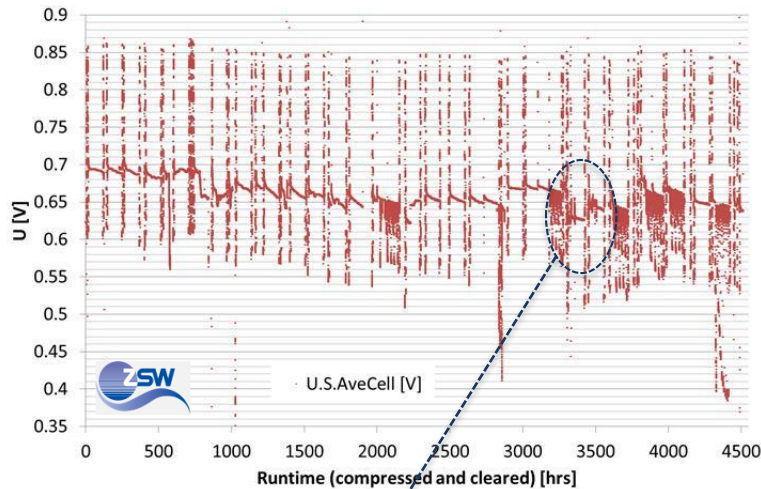
Future steps:

Durability evaluation still on-going with textured MEAs for Reformate/Air case (2000 hrs completed)

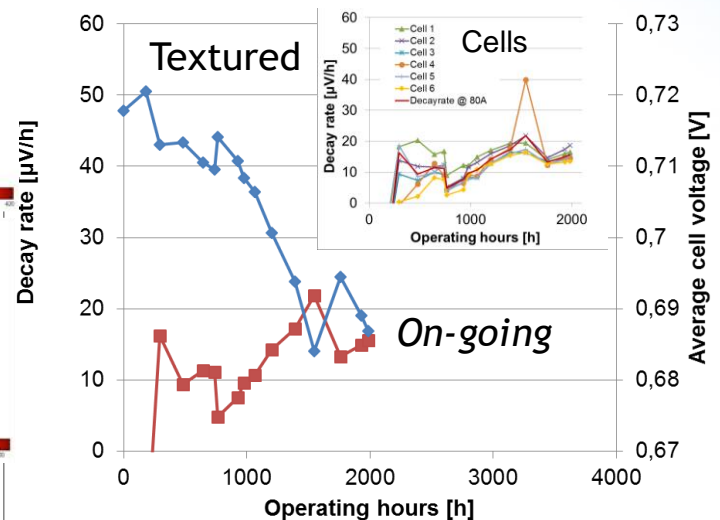
PROJECT PROGRESS/ACTIONS - Validation of Matisse MEAs under Reformate/Air



Durability tests on reference and textured MEAs



Average decay rate based on BoL curves

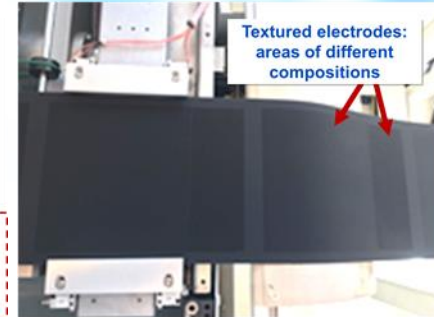
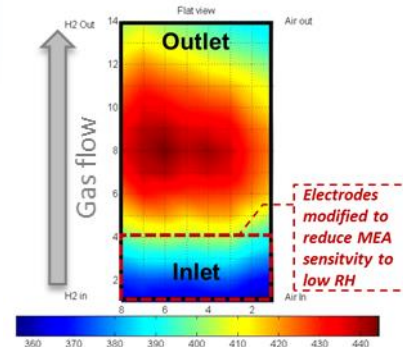
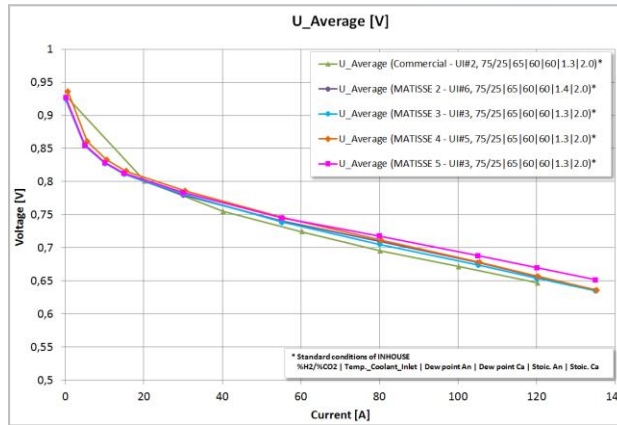


Reformate (75% H_2 /25% CO_2) / Air
 Λ_{An} : 1.4
 Λ_{Ca} : 2.4
 Stack temperature Inlet: 65° C
 Dew points IN: 60° C

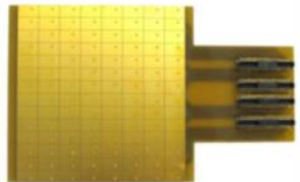
PROJECT PROGRESS/ACTIONS - Impact of textured electrodes on MEAs' behaviour

MATISSE

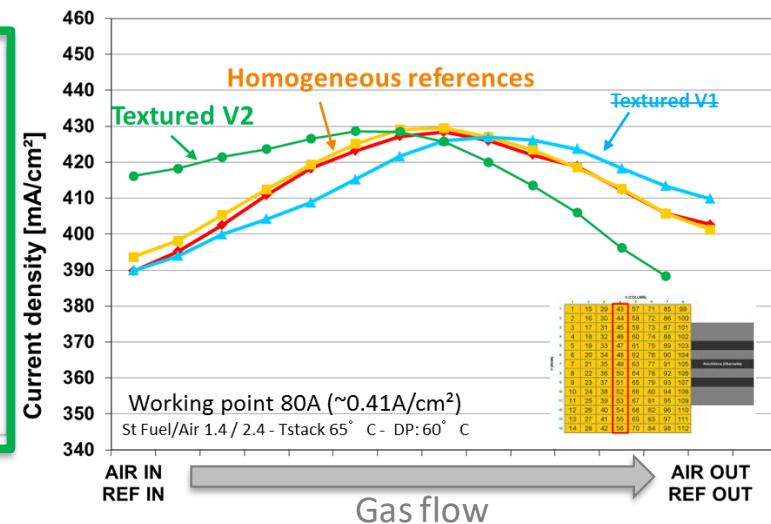
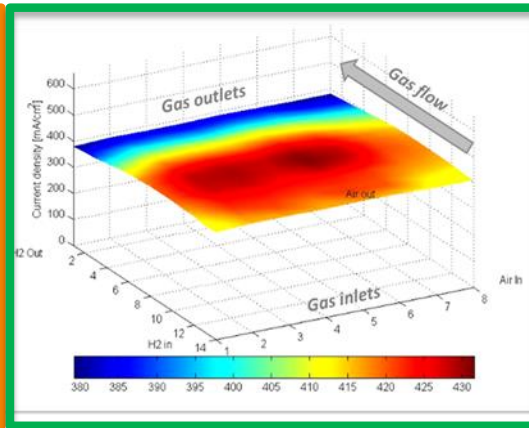
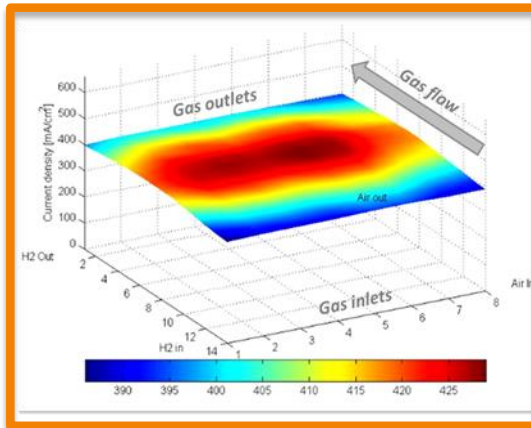
Current density distribution modified by texturation of anodes and cathodes on inhouse stack design



Textured active layers made on the screen-printing pilot line



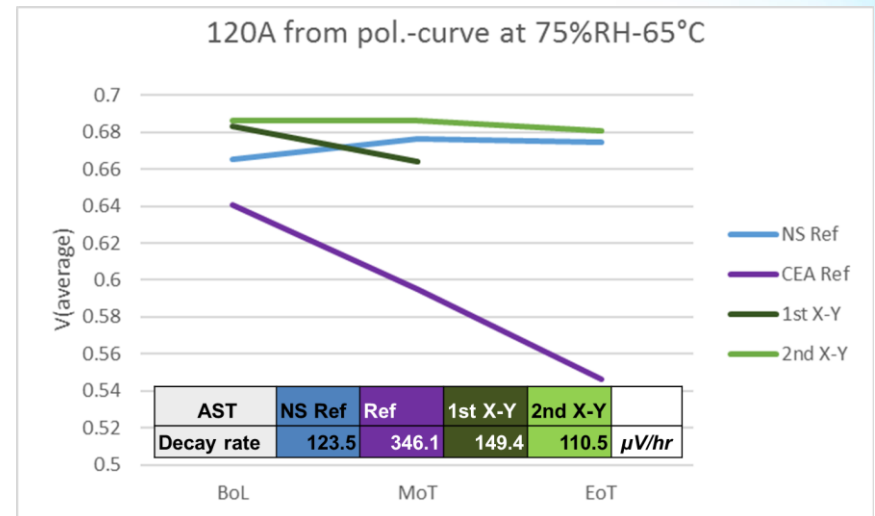
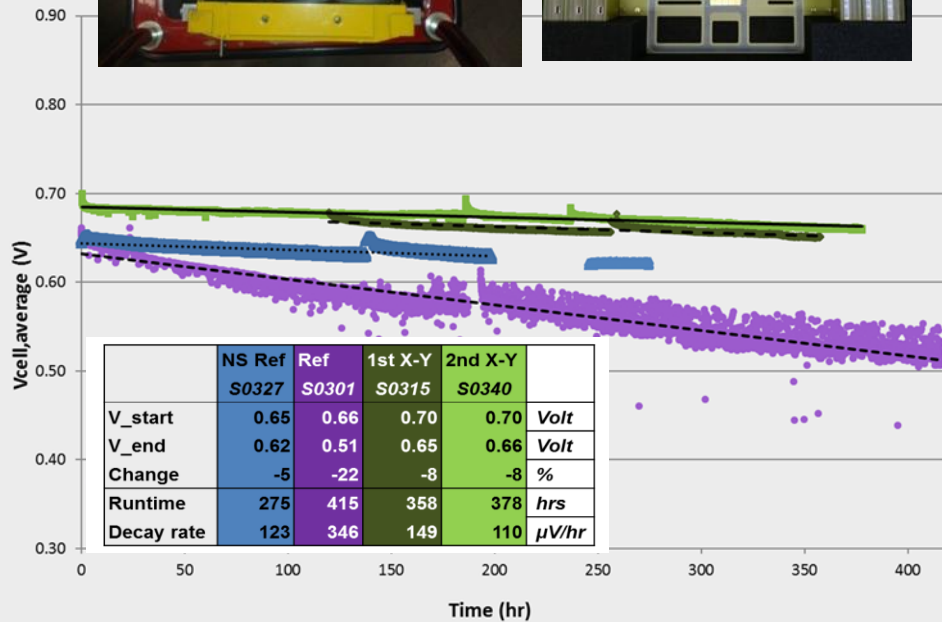
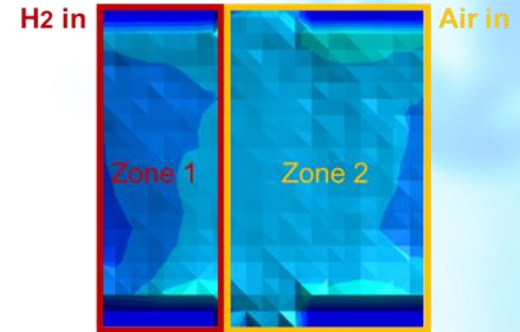
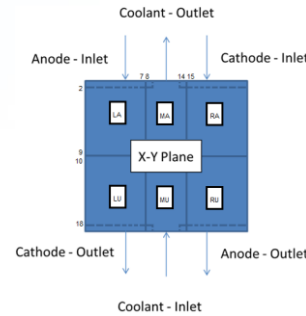
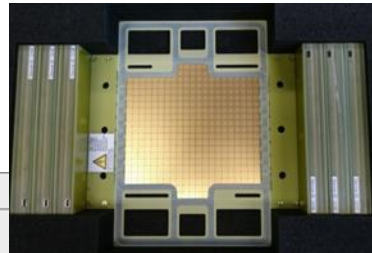
Top side of sensor plate



PROJECT PROGRESS/ACTIONS - Impact of textured electrodes on MEAs' behaviour



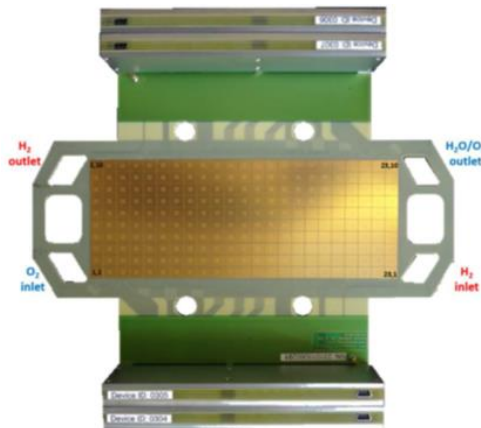
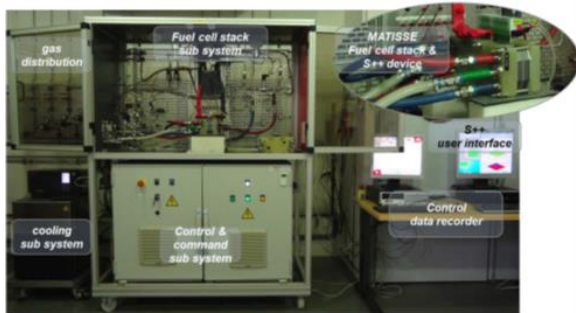
Performance and durability improvement with Nedstack operating conditions (@ fixed load or AST)



PROJECT PROGRESS/ACTIONS - Impact of textured electrodes on MEAs' behaviour

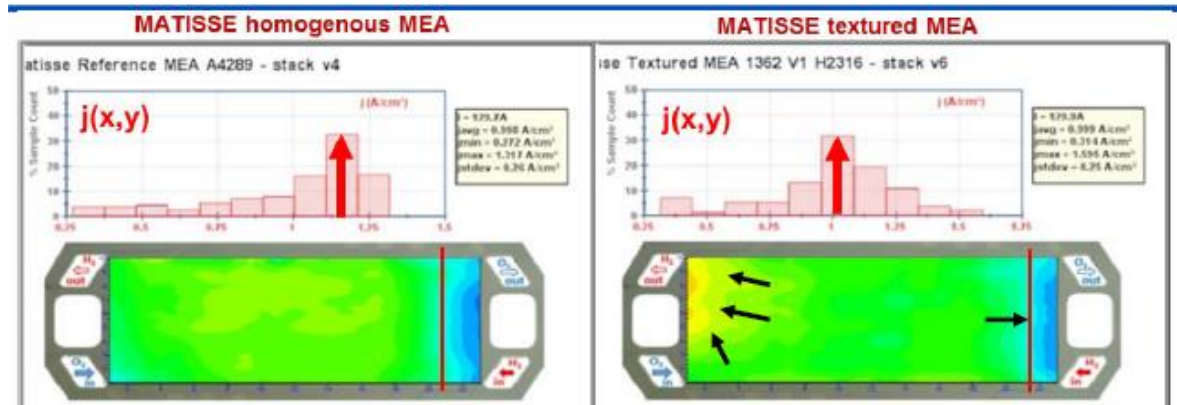
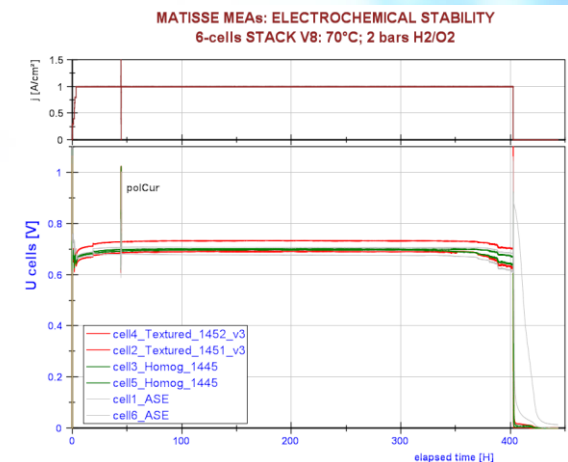
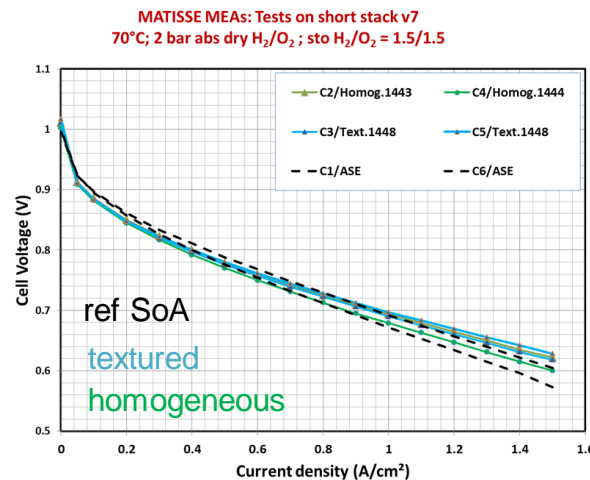


Current density distribution modified by texturation of cathodes on Areva SE stack design



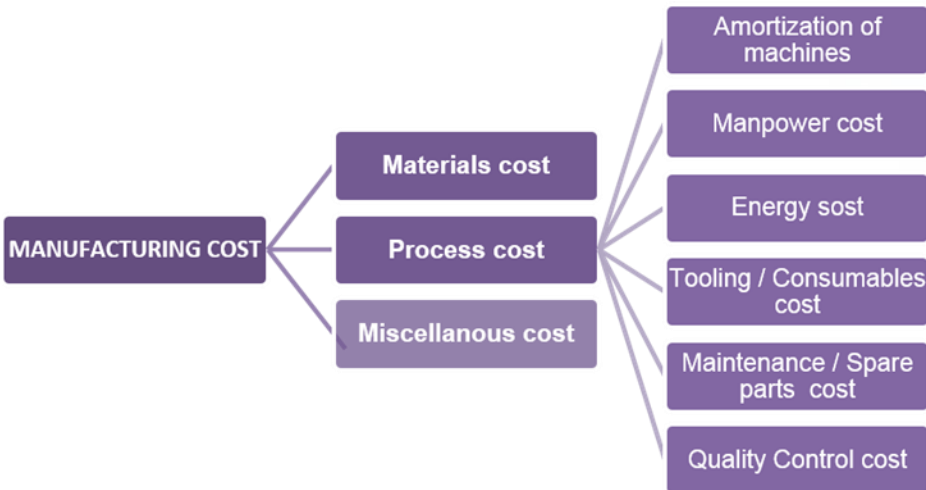
AREVA

H2/O2

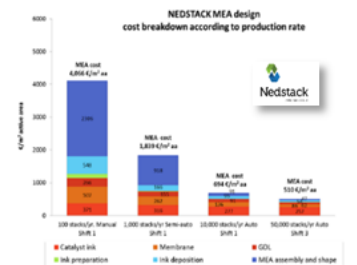
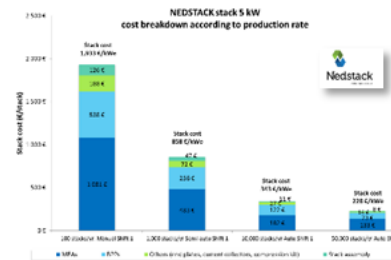
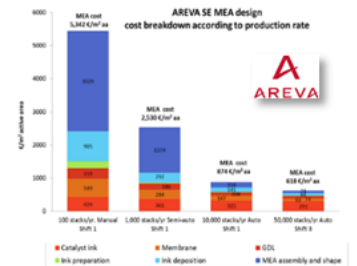
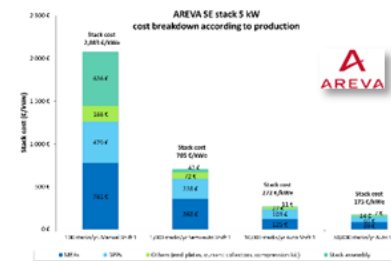
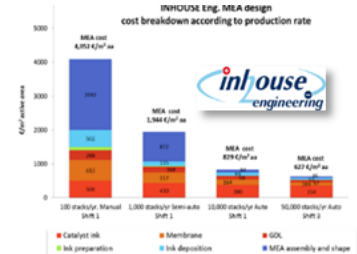
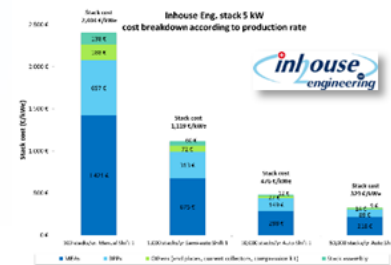


Cost assessment for each stack design and MEA type

Stack & MEAs cost breakdown according to production rate



Investigate the financial & technical impact of the cells and stack developed on the BoP
 ➔ recommendations



- **Interactions with projects funded under EU programmes**
 - EURECA: similar design stack design for inhouse
 - SECOND ACT: similar stack design for Nedstack and joint development for segmented cell implementation and data analyses
 - STACK TEST: recommendations on tests and data processing
- **Interactions with national and international-level projects and initiatives**
 - Experience gained on the manufacturing of electrodes and MEAs can be used for other projects

Public deliverables

- D3.1 - Characterization protocol
- *D3.10 - Impact of textured electrode on stack performances*
- *D5.4 - Study of stack manufacturing*
- *D5.5 - Study of electrode manufacturing*

Conferences/Workshops

- 0 planned within the project
- 4 in which the project has participated (but not organised)

Social media

<http://matisse.zsw-bw.de/general-information.html>

Publications and Patents: 0

- *MANUFACTURING of Improved Stack with textured Surface Electrodes for Stationary and CHP applications* - Oral Communication at EFCF 2017 (Ext. abstract) S. Escribano, C. Nayoze, J. Cren (CEA), J. Hunger, F. Wilhelm, A. Kabza (ZSW), A. Rakotondrainibe, S. Besse (ArevaSE), S. Theuring, C. Hildebrandt (inhouse), C. VanAken (Nedstack)
- *Identification of dissemination subjects → segmented cells results, impact of textured active layers on current distribution, durability tests and processes, cost assessment method and results*

Thank You!

Coordinator: sylvie.escribano@cea.fr



You can use any of the following slides and insert them inside the presentation, otherwise delete them

Risk 1

Mitigation 1

Risk 2

Mitigation 2

Risk 3

Mitigation 3

EXPLOITATION PLAN/EXPECTED IMPACT



Exploitation

Explain

Impact

Explain

Free slide illustrating activities on training, RCS (Regulations, Codes and Standards), public awareness, etc.