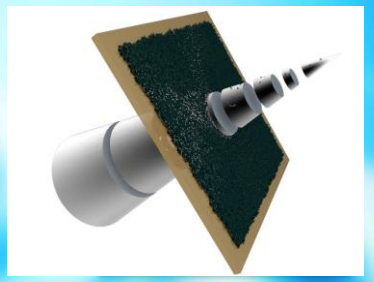

IMPACT

Improved Lifetime of Automotive Application Fuel Cells with Ultra-Low Pt-Loading

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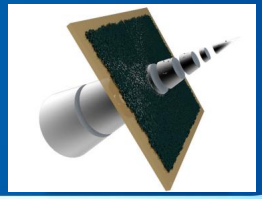
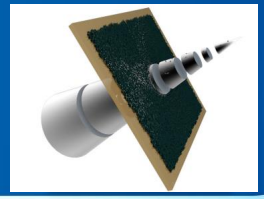
Programme Review Days 2017
Brussels, 23-24 November

PROJECT OVERVIEW



- Call year: 2011
- Call topic:
  SP1-JTI-FCH.2011.1.6 Investigation of degradation phenomena;
  SP1-JTI-FCH.2011.1.5 Next generation European MEAs for transport applications
- Project dates: 11/2012 – 10/2016
- % stage of implementation 01/11/2017: 100 %
- Total project budget: 9,144,435 €
- FCH JU max. contribution: 3,902,403 €
- Other financial contribution: 0 €
- Partners: DLR, CEA, JRC, CNR-ITAE, ITM, JMFC, ZSW, UAES, TUB, INPT, GIST, SLX

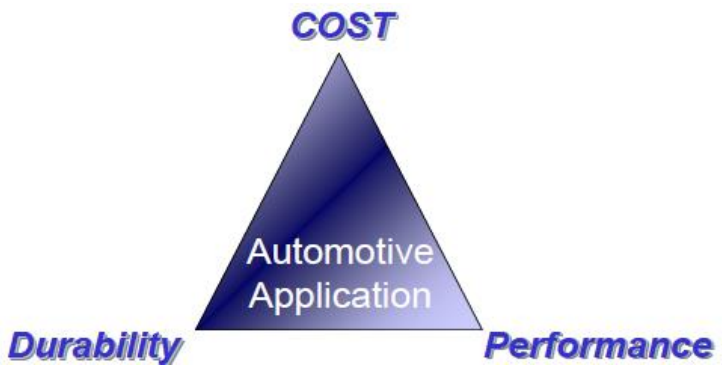
PROJECT SUMMARY

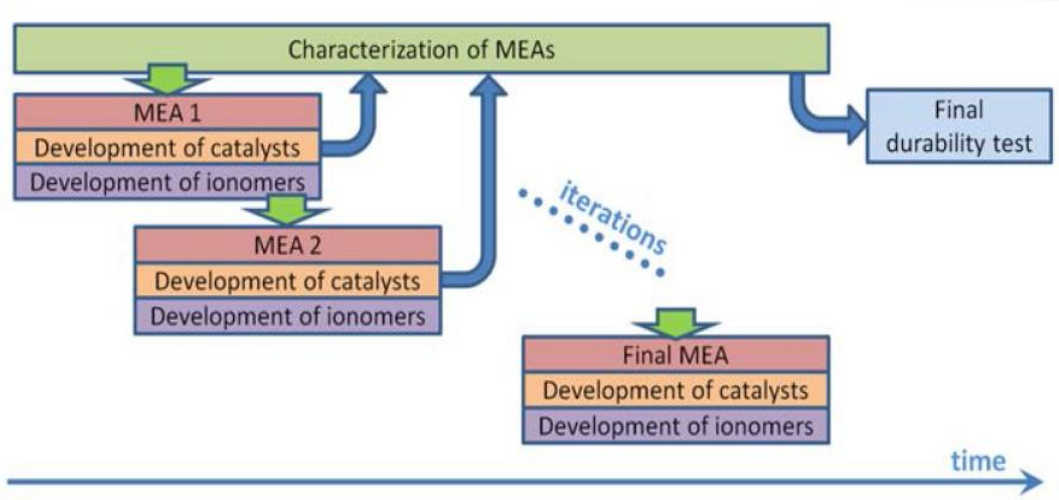


The objectives are to:

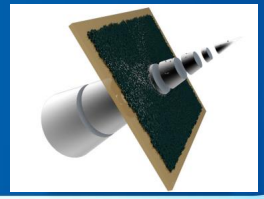
- increase life-time of low Pt-loaded MEAs (**0.2 mgcm^{-2}**) for automotive applications to 5,000 h in dynamic operation with degradation rates **<10 µVh^{-1}**
- to obtain a power density of 1 **Wcm^{-2}** (performance target achieved).

through identification of degradation mechanisms and subsequent material development to mitigate them.





PROJECT SUMMARY - Project MEAs

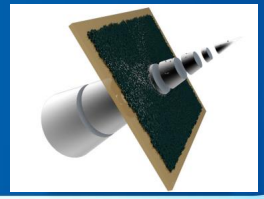


Work by all project partners feeds into low loaded MEAs for testing

Catalyst	Ionomer	Membrane	GDL
1. Improvement in Pt stability (JM)	1. Improved stability of ionomer (SLX)	1. Thinner membrane (SLX)	1. Modified GDL (CEA)
2. Identify stable carbon (JM)	2. Lower EW Ionomer (SLX) *(For Performance)*	2. ~~Hydrocarbon membrane~~ (ITM)	
3. Cell Reversal Stability (JM)	3. Move back to higher EW Ionomer (SLX) *(For Durability)*		
4. High Activity PtX Alloy (JM, CEA)			

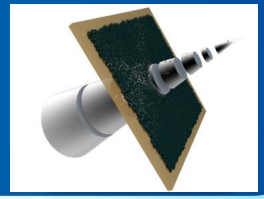
MEA Manufacture JM

PROJECT SUMMARY - Project MEAs



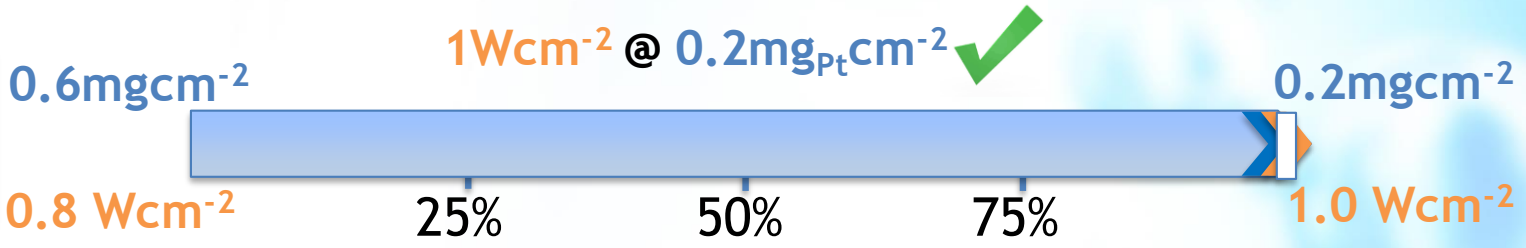
	Commercial Reference MEA	Project Reference MEA I	MEA II	MEA III	MEA IV	MEA IVb	MEA IVc	MEA V
Anode Catalyst	JM Catalyst	40% Pt/XC72R	HSA Pt/C	HSA Pt/C	HSA Pt/C	HSA Pt/C	HSA Pt/C	HSA Pt/C
Anode Loading, mg/cm^2_{Pt}	0.05	0.2	0.05	0.05	0.05	0.05	0.05	0.05
Cathode Catalyst	JM Catalyst	40% Pt/XC72R	HSA Pt/C	HSA Pt/C	Stable Pt/C	Stable Pt/C - Optimised	Stable Pt/C - Optimised	Stable Pt/C - Optimised
Cathode Loading, mg/cm^2_{Pt}	0.4	0.2	0.4	0.4	0.2	0.2	0.15	0.2
Ionomer	Non-Solvay	Solvay D79-20BS	Non-Solvay	Non-Solvay	Solvay D79-20BS	Solvay D79-20BS	Solvay D83-240BS	Solvay D83-240BS
Membrane	Non-Solvay	Solvay, 20 microns	Solvay, 20 microns	Solvay, 10 microns	Solvay, 10 microns	Solvay, 10 microns with stabilising agent	Solvay, 10 microns with stabilising agent	Solvay, 10 microns with stabilising agent
GDL	SGL 25BC Modified – provided by DLR	SGL 25BC Modified – provided by DLR	SGL 25BC Modified – provided by DLR	SGL 25BC Modified – provided by DLR	SGL 25BC Modified – provided by DLR	SGL 25BC Modified – provided by DLR	SGL 25BC Modified – provided by DLR	SGL 25BC Modified – provided by DLR

PROJECT PROGRESS/ACTIONS - Performance at reduced Pt-loading

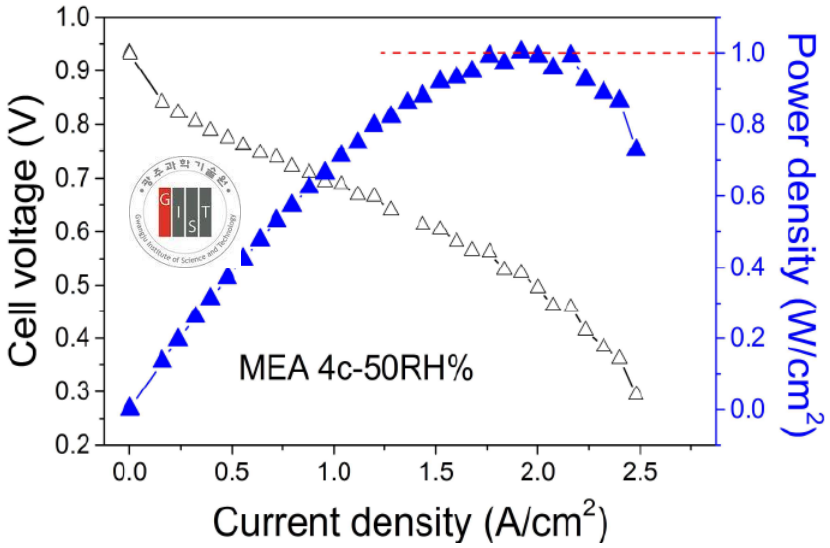


Achievement to-date

% stage of implement.



Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
Performance at reduced Pt-loading	Pt-loading	$mgcm^{-2}$	0.35*	0.2	0.2	<0.2
	Power density	Wcm^{-2}	1*	1	1	>1

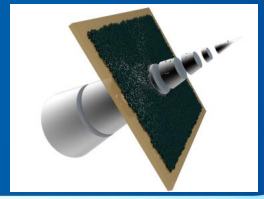


Conditions:

- 80° C cell temperature
- 50%RH
- 1.5 bar absolute pressure
- air stoich. 2.0

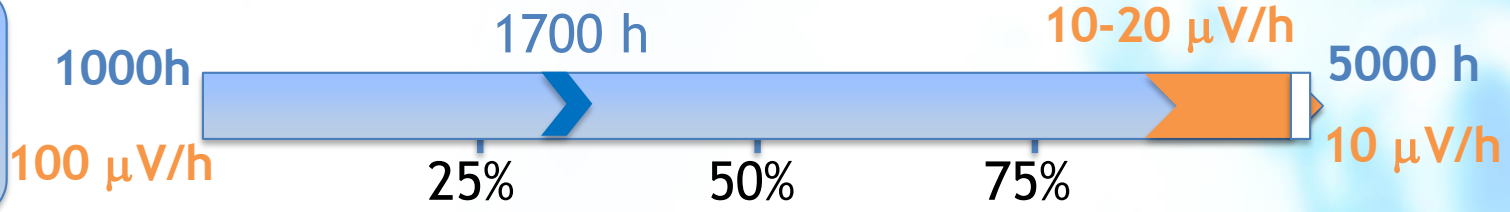
*Autostack-Core, Evo2 (2 bar pressure, 2.8 air stoich.)

PROJECT PROGRESS/ACTIONS - Durability at reduced Pt-loading



Achievement to-date

% stage of implement.

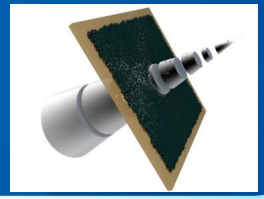


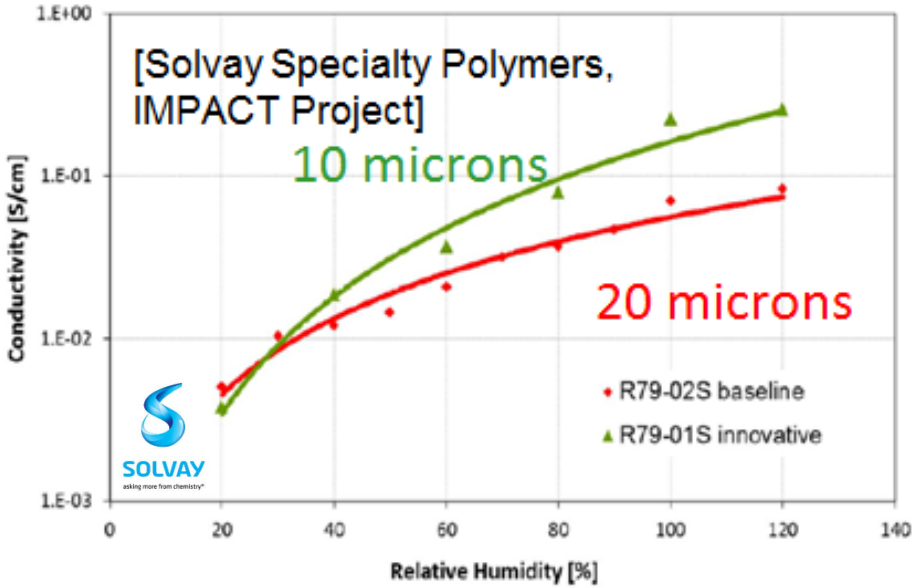
Aspect addressed	Parameter (KPI)	Unit	SoA 2017	FCH JU Targets		
				Call topic	2017	2020
Durability at **0.2 mg cm^{-2}** Pt-loading	Lifetime	h	<5000	5000	5000	6000
	Degradation rate	µV/h	<20*	10	10	<10

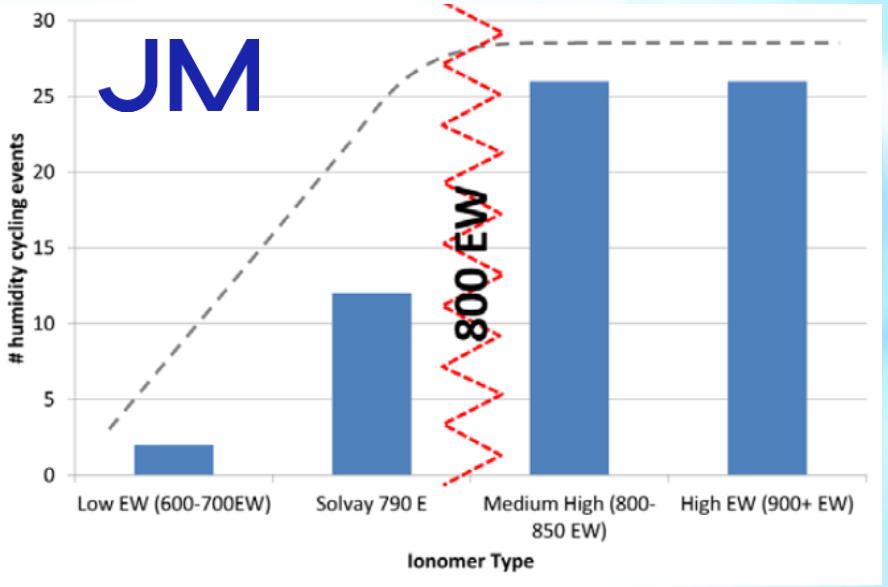
- 1700 h reached in stack durability test (instability/failure of individual cells)
- 10-20 µV/h achieved in 500 h single cell test

*Autostack-Core, Evo2

PROJECT PROGRESS/ACTIONS - Material Development







Development of highly conductive membranes with reduced H2 crossover

Optimizing ionomer in electrodes

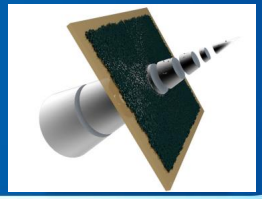
Consiglio Nazionale delle Ricerche CNR

ITAE

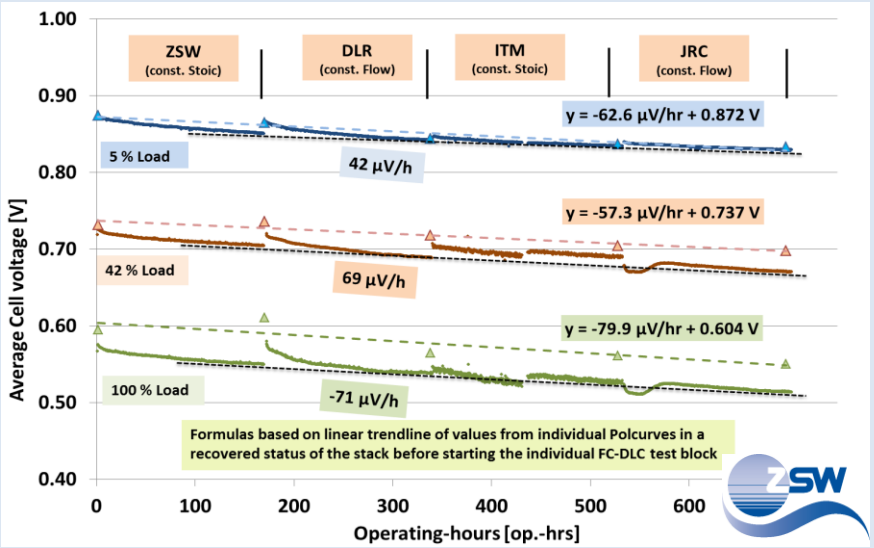
SAMPLE	Tafel Slope mV/dec	j_m@0.9V_{IRfree} mA/mg
40%Pt/C	**64**	**307**
PtCo8T/KB	72	457
Pt_1Ni_1/KB	69	357

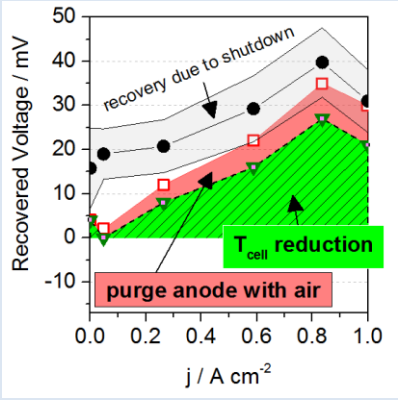
Development of PtCo/KB cats with superior mass activity

PROJECT PROGRESS/ACTIONS - Further Selected Achievements



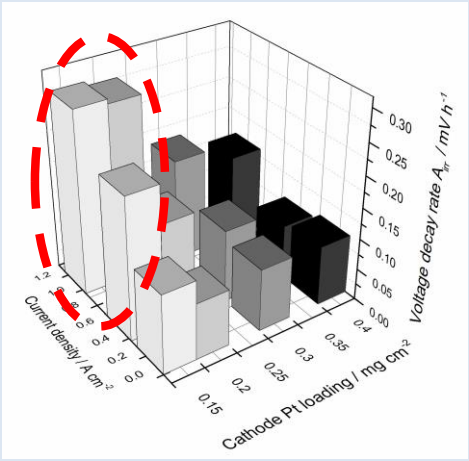
RR-Test

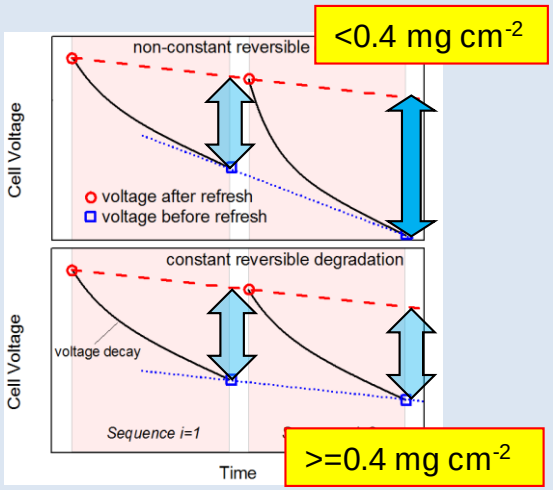




Investigation of recovery of reversible losses

Gazdzicki et al., J. Power Sources 327, 86 (2016)

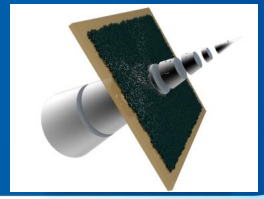


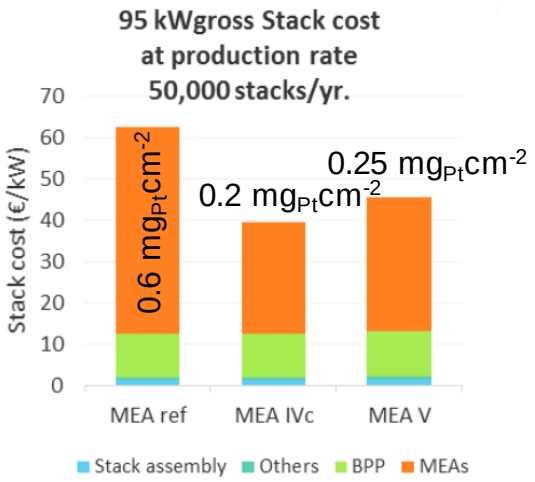


Understanding of impact of Pt-loading on reversible and irreversible degradation

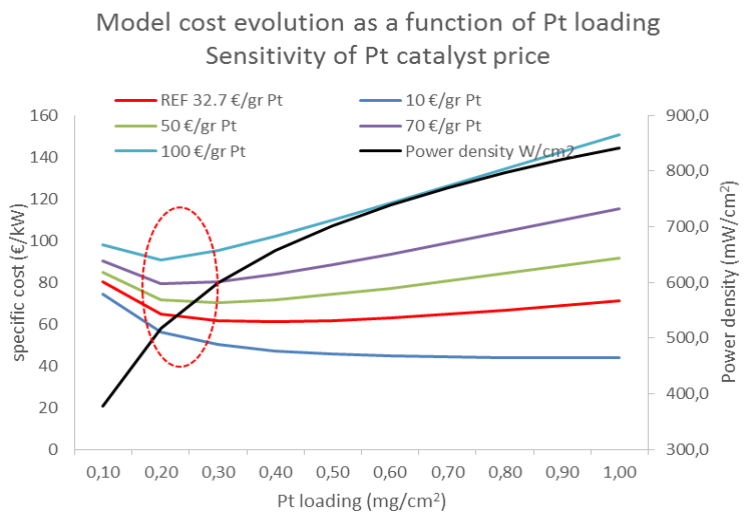
Gazdzicki et al., Fuel Cells (2017)

PROJECT PROGRESS/ACTIONS - Cost Model by CEA

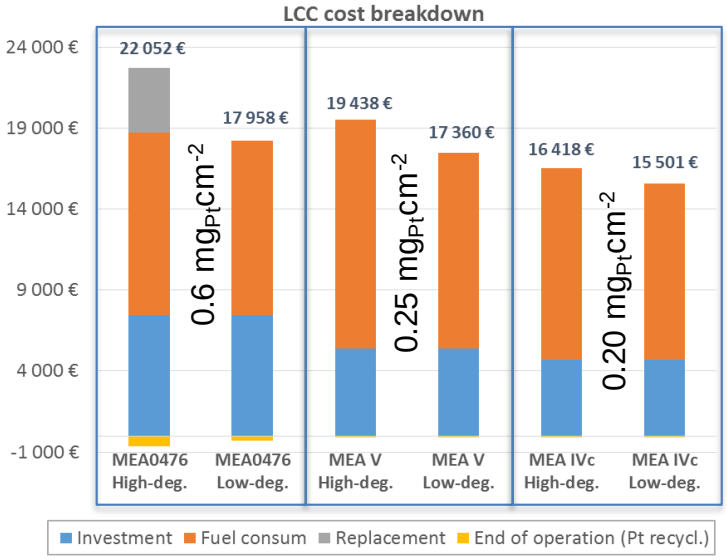




Stack cost breakdown

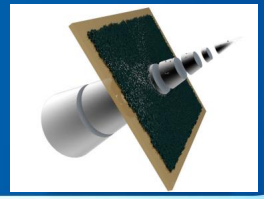


Sensitivity of cost on Pt price;
Power vs loading based on rainbow stack study



LCC for life cycle cost: combination of manufacturing cost and operating expenses including durability effects *(low and high degradation rates resulting from different test were used)*

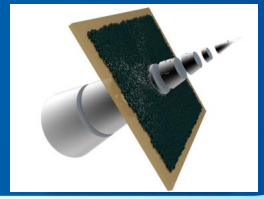
SYNERGIES WITH OTHER PROJECTS AND PROGRAMMES



Interactions with projects funded under EU programmes

- **IMPALA:** provides knowledge about improved GDLs, organization of common workshop
- **Stack-Test:** Test procedures (FC-DLC) developed in Stack-Test are used for the durability testing within IMPACT
- **DECODE:** provides knowledge about degradation processes and mechanisms. Moreover GDLs developed within DECODE are used as standard GDLs in IMPACT
- **Autostack-Core:** New insight on operating ultra-low Pt loading fuel cells under automotive conditions gained within IMPACT will be used

DISSEMINATION ACTIVITIES



Public deliverables

- D6.4 - Publication to the comparability of single cell and stack experiments for the investigation of degradation of PEFC
- D9.2 - Project fact sheet
- D9.4 & D9.6 - Summary reports of second public workshops

Conferences/Workshops

- 2 organised by the project + 1 summer school
- 33 in which the project has participated (but not organised)

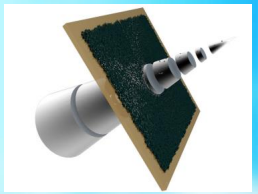
Social media

http://www.eu-project-impact.eu/

Publications: 15

- T. Morawietz et al., Quantitative in Situ Analysis of Ionomer Structure in Fuel Cell Catalytic Layers, *ACS Appl. Mater. Interfaces*, 2016, 8, 27044–27054
- R. Hiesgen et al., Insight into the Structure and Nanoscale Conductivity of Fluorinated Ionomer Membranes, *J. Electrochem. Soc. 2014, 161, F1214-F1223*

Patents: 0



Thank You!

Coordinator: andreas.friedrich@dlr.de