Cost reduction and performance increase of PEM electrolysers
NOVEL: New materials & components
MEGASTACK: Manufacturing and upscale

Programme Review Days 2016
Brussels, 21-22 November

NOVEL
Novel materials and system designs for low cost, efficient and durable PEM electrolysers

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Programme Review Days 2016
Brussels, 21-22 November

PROJECT OVERVIEW

NOVEL

Project Information	
Call topic	SP1-JTI-FCH.2011.2.7 - Innovative Materials and Components for PEM electrolysers
Grant agreement number	303484
Application area (FP7) or Pillar (Horizon 2020)	Hydrogen production and distribution
Start date	01/09/2012
End date	30/11/2016
Total budget (€)	5 743 445
FCH JU contribution (€)	2 663 445
Other contribution	310 683 (Norwegian Research Council)
Stage of implementation	100% project months elapsed vs total project duration, at date of November 1, 2016
Partners	SINTEF, Fraunhofer ISE, CEA Liten, AREVA H2Gen, Johnson Matthey Fuel Cells, Teer Coatings, PSI

PROJECT SUMMARY - Objectives

NOVEL

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})

PROJECT SUMMARY - Partners

NOVEL

PAUL SCHERRER INSTITUT PSI

JM Johnson Matthey Fuel Cells *the power within*

Fraunhofer ISE

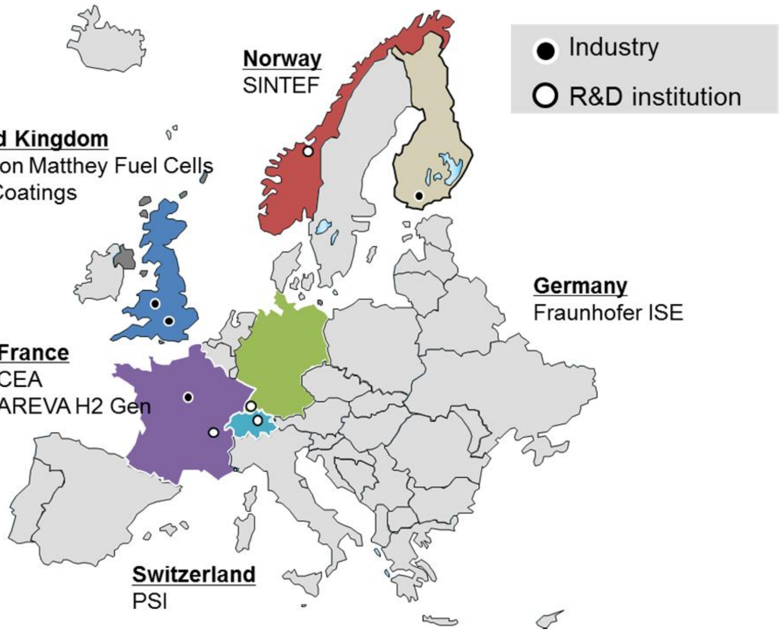
New Materials Development (Electrocatalysts & Membranes) → Component development and testing → Increased understanding of lifetime and degradation → Stack and system design

SINTEF

Innovation in Motion Miba (Teer Coatings Ltd)

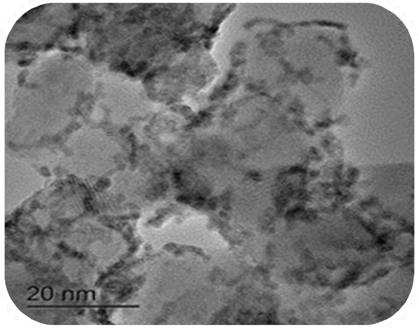
cea

AREVA H_2Gen

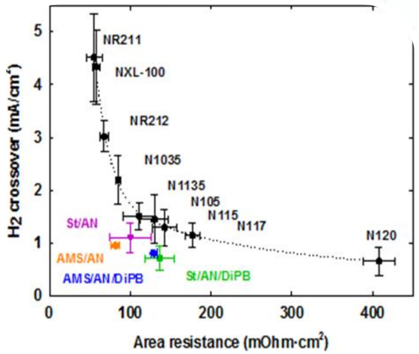


PROJECT SUMMARY – Main achievements

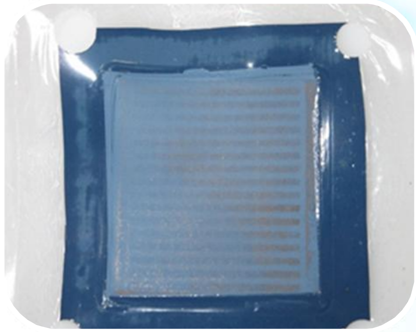
NOVEL



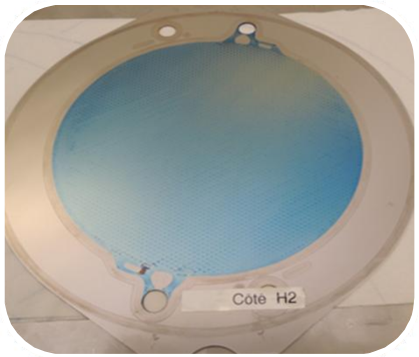
Highly active supported electrocatalysts



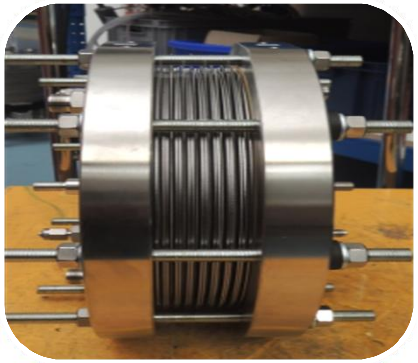
Membranes with lower cost and H_2 crossover



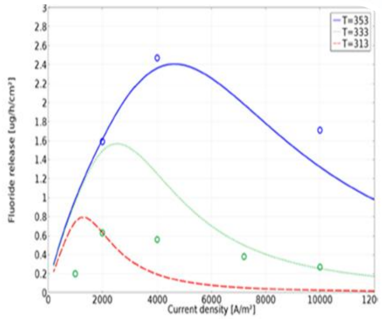
Advanced CCMs with higher performance



Non-noble metal coatings for bipolar plates



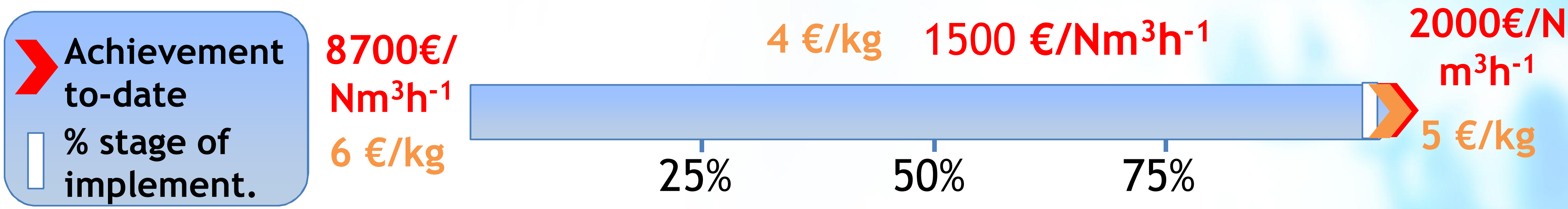
Low-cost stack design



Degradation mechanisms and AST protocols

PROJECT PROGRESS/ACTIONS - Cost

NOVEL



Aspect addressed	Parameter (KPI)	Unit	SoA 2016	FCH JU Targets		
				Call topic	2017	2020
Cost	CAPEX (stack only)	€/Nm^{3}h^{-1}	8700	2500	4000	2100
	H_2 Cost	€/kg	5-13	-	5-11	5-9

Future steps:

- *Further tests of stacks and novel materials to evaluate long term stability and causes for performance degradation.*
- *Improve manufacturability of new components*

PROJECT PROGRESS/ACTIONS - Cost

NOVEL

Achievement to-date

% stage of implement.

8700€/ Nm^3h^{-1}

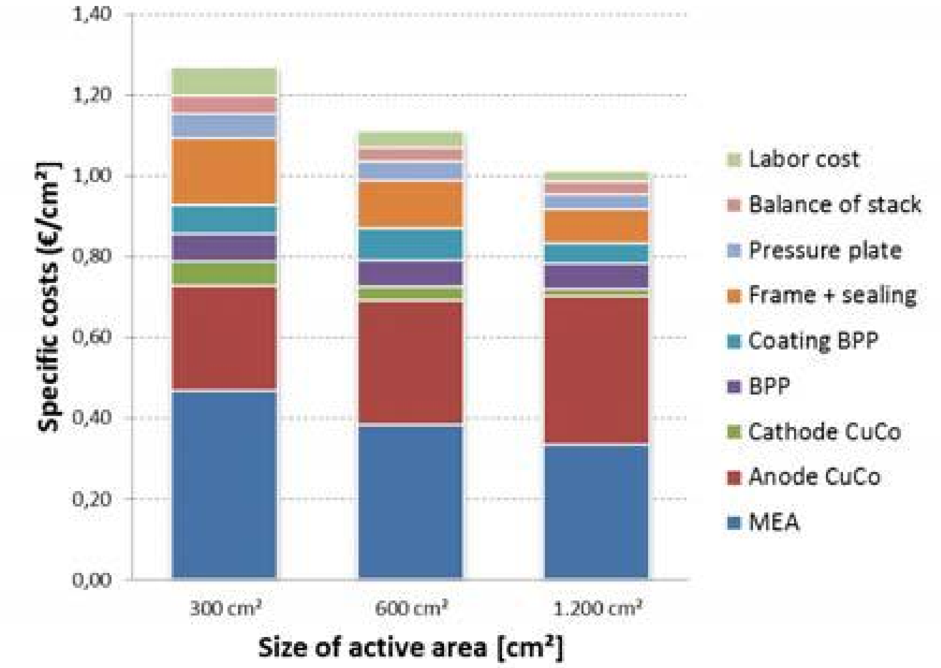
6 €/kg

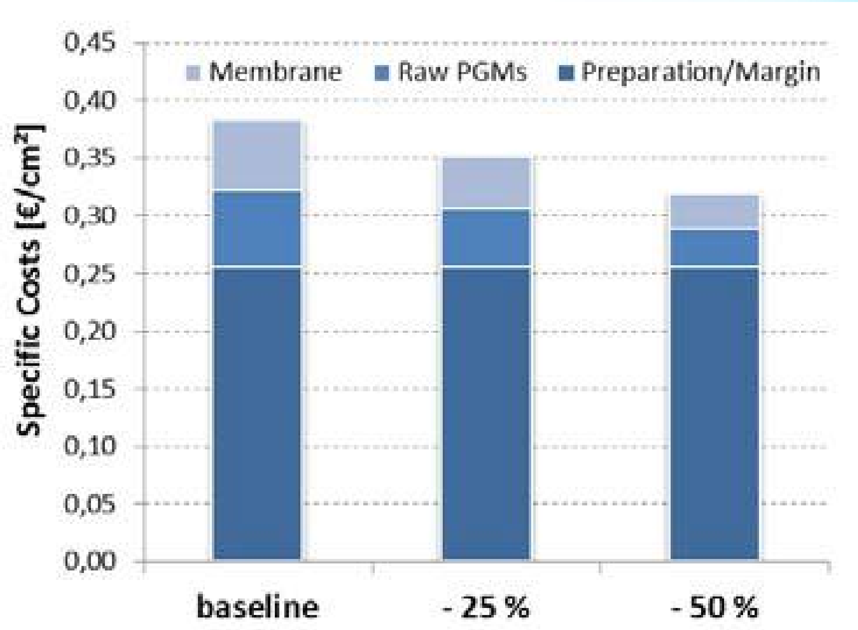
4 €/kg 1500 €/Nm^3h^{-1}

2000€/N m^3h^{-1}

5 €/kg

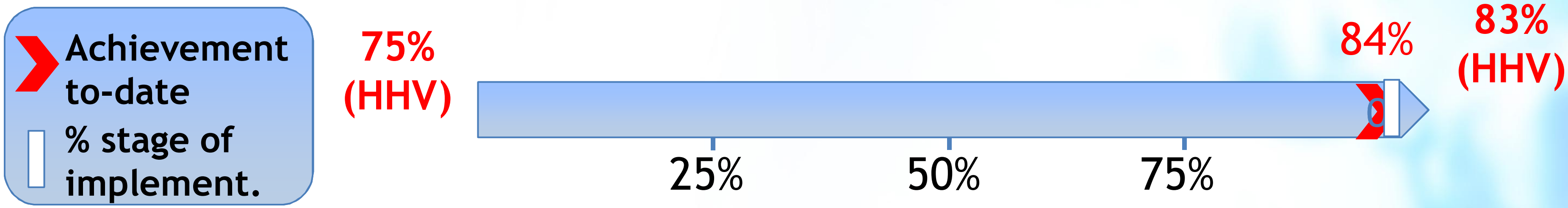
25% 50% 75%





PROJECT PROGRESS/ACTIONS - Efficiency

NOVEL



Aspect addressed	Parameter (KPI)	Unit	SoA 2016	FCH JU Targets		
				Call topic	2017	2020
Efficiency	Efficiency (HHV)	%	68	88	71	75
	Energy use	kWh/kg	57	44	55	52

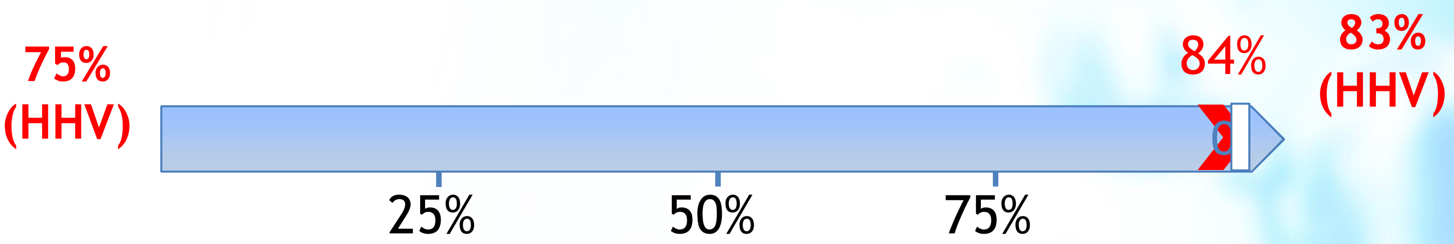
Future steps:

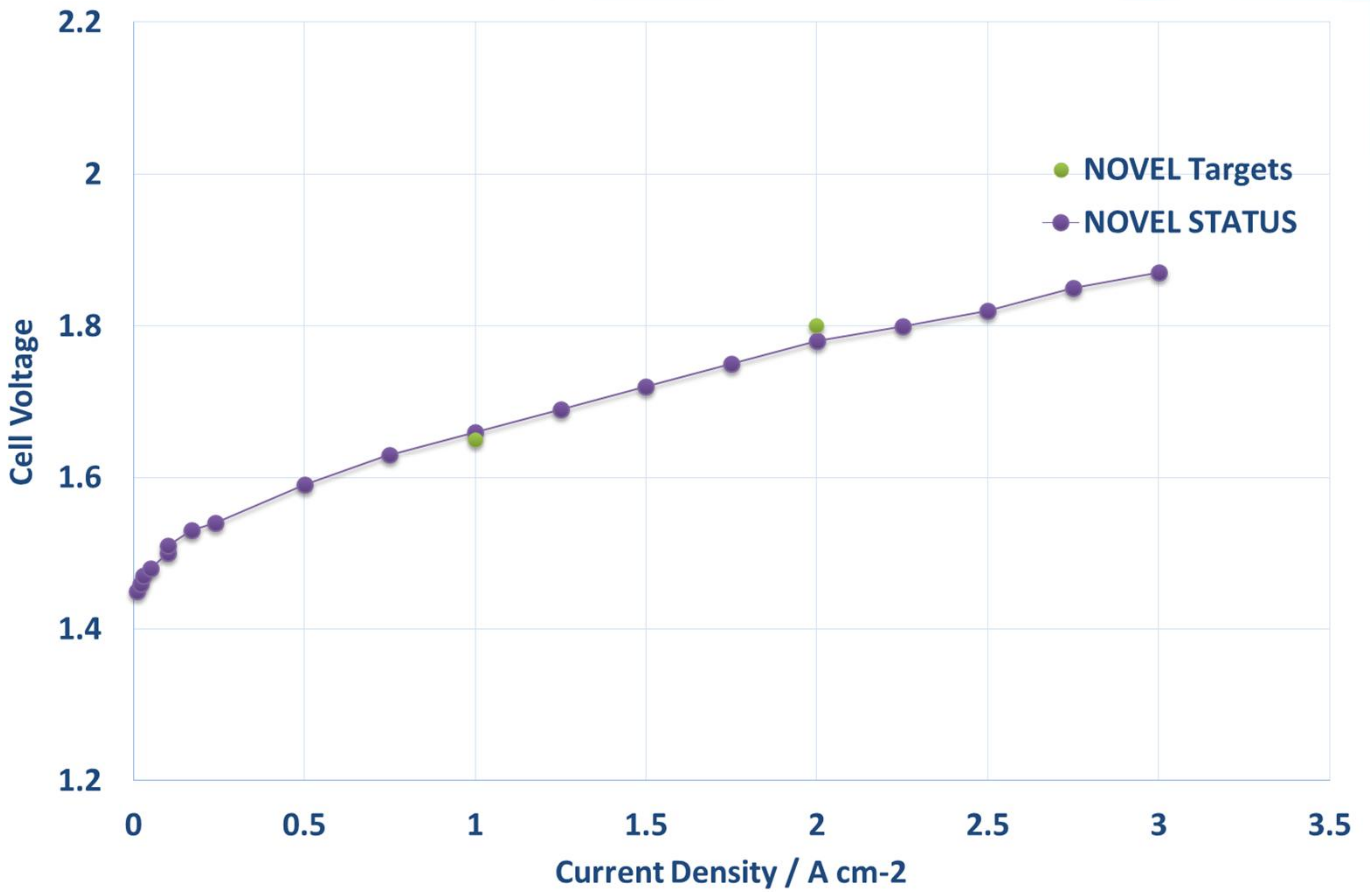
- *Further tests of stacks and novel materials to evaluate long term stability and causes for performance degradation.*
- *Improve manufacturability of new components*

PROJECT PROGRESS/ACTIONS - Efficiency

Achievement to-date

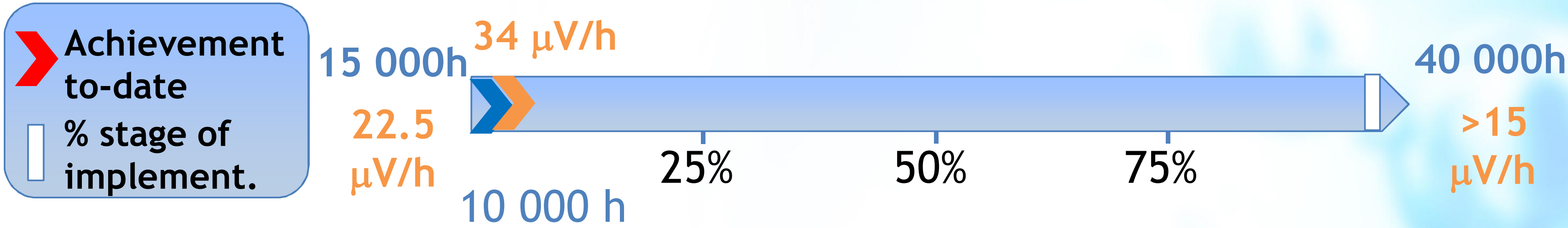
% stage of implement.





PROJECT PROGRESS/ACTIONS - Durability

NOVEL



Aspect addressed	Parameter (KPI)	Unit	SoA 2016	FCH JU Targets		
				Call topic	2017	2020
Durability	Lifetime	h		40000 h	-	-
	Degradation rate	µV/h		< 15	< 4	< 3

Future steps:

- *Further tests of stacks and novel materials to evaluate long term stability and causes for performance degradation.*
- *Improve manufacturability of new components*

SYNERGIES WITH OTHER PROJECTS AND PROGRAMMES

NOVEL

Interactions with projects funded under EU programmes	
NEXPEL	The NOVEL project is building upon the results generated in the FCH-JU NEXPEL project. Further development of the most promising technical solutions and introducing more novel materials and degradation mitigation strategies
SMARTCAT	Complementary activities on the fundamental understanding of electron mobility in oxides and methods for increasing the electronic conductivity of such materials
MEGASTACK	Collaboration on development of testing protocols for components and cells. AST development and dissemination events.
Interactions with national and international-level projects and initiatives	
Moxilayer	Development of oxide supported electrocatalysts for PEM electrolysers
IEA-ANNEX 30	Collaboration on development of standardized testing protocols for PEM electrolysers and cost reduction strategies.

DISSEMINATION ACTIVITIES

NOVEL

Public deliverables

- D6.2: condensed findings and conclusions from the organised international workshops on PEM electrolysis
- D6.3 Annual public progress reports

Conferences/Workshops

- 2 organised by the project
- >15 (with >20 presentations) in which the project has participated

Social media

Publications: 5

- M. Chandesris; *Membrane degradation in PEM water electrolyzer: numerical modeling and experimental evidence of the influence of temperature and current density*, Int.J. Hydrogen Energy, 1353-1366 (40) 2015
- A. Albert, A. Barnett, M.Thomassen, T. J. Schmidt, L. Gubler; *Radiation-Grafted Polymer Electrolyte Membranes for Water Electrolysis Cells: Evaluation of Key Membrane Properties. ACS Appl. Mater. Interfaces, 22203 (7) 2015*

Patents:

MEGASTACK
Stack design for a megawatt scale PEM electrolyser

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Programme Review Days 2016
Brussels, 21-22 November

PROJECT OVERVIEW

MEGASTACK

Project Information	
Call topic	SP1-JTI-FCH.2013.2.3 - Large capacity PEM electrolyser stack design
Grant agreement number	621233
Application area (FP7) or Pillar (Horizon 2020)	Hydrogen production and distribution
Start date	01/10/2014
End date	30/09/2017
Total budget (€)	3 451 654
FCH JU contribution (€)	2 168 543
Other contribution	363 375 (Norwegian Research Council)
Stage of implementation	70% project months elapsed vs total project duration, at date of November 1, 2016
Partners	SINTEF, Fraunhofer ISE, CEA Liten, ITM Power

PROJECT SUMMARY - Partners

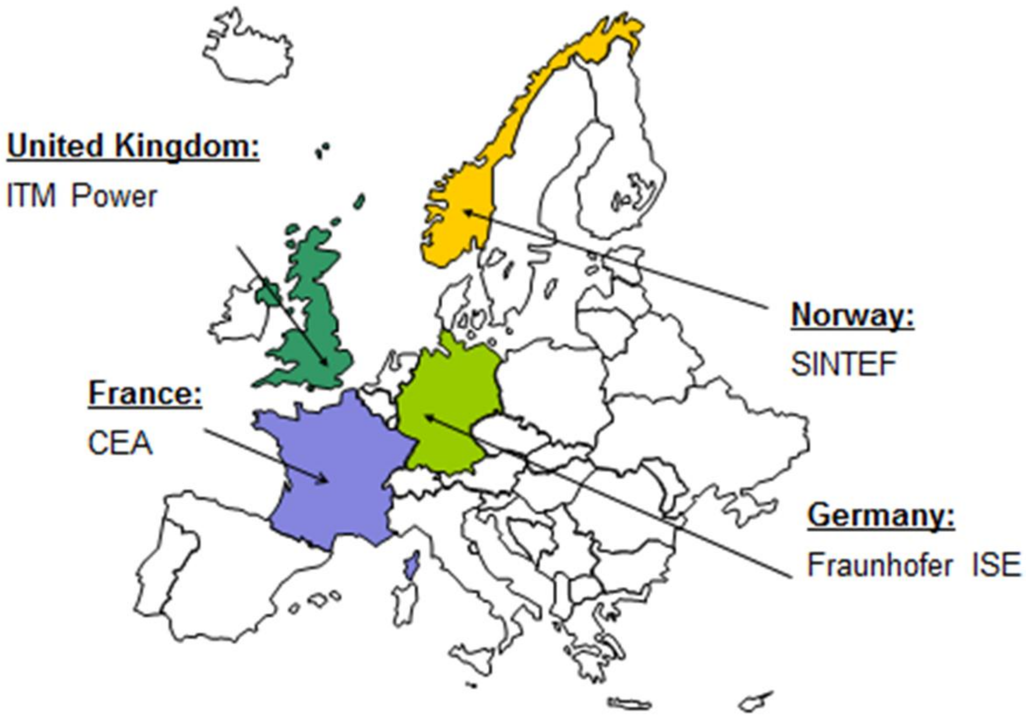
MEGASTACK

ITM POWER
Energy Storage | Clean Fuel

cea

SINTEF

Fraunhofer ISE



PROJECT SUMMARY - Objectives

MEGASTACK

Megastack main objectives:

Develop a cost efficient stack design for MW-sized PEM electrolysers.

Construct and demonstrate a prototype stack

75% Efficiency (LHV) @ 1.2 Acm^{-2} ;

stack cost < €2,500 / Nm^3h^{-1}

target lifetime of 40,000 h (< 15 μVh^{-1})

PROJECT SUMMARY - Approach

- Go large & smart
  - Increase active area and current density, reduce waste (square design)
  - Reduce part count and improve manufacturability/assembly
  - Develop new and more more cost efficient, large volume supply chains

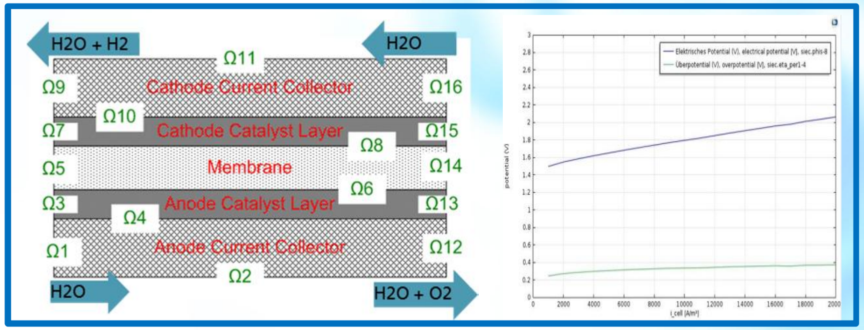
0.5MW

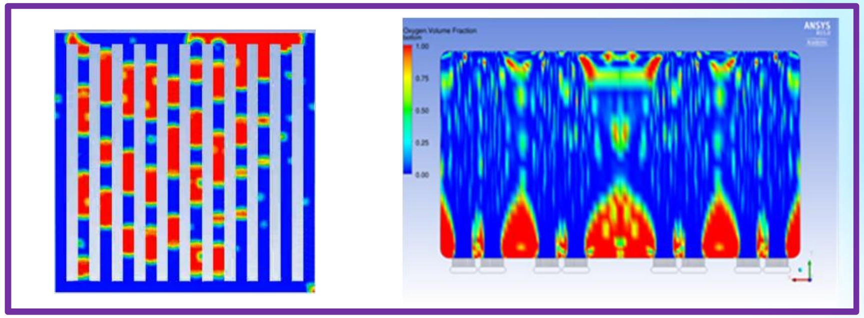
1MW

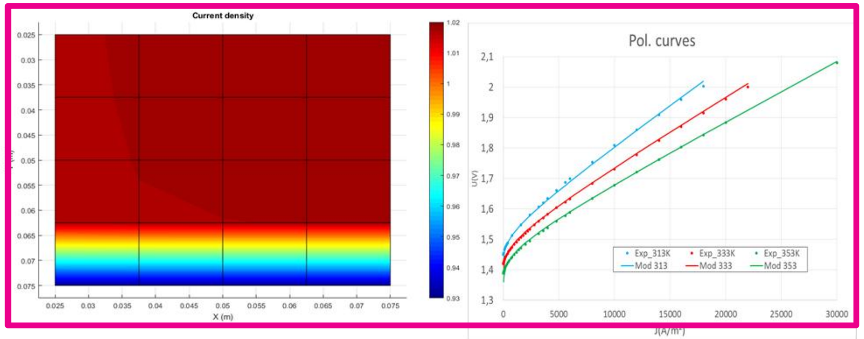
PROJECT SUMMARY - Approach

MEGASTACK

- Multiscale/multiphysics design tools
  - Improved understanding of fundamental transport processes in PEM electrolyser components
  - Two phase flow model for optimisation of cell designs
  - Multiphysics stack model for stack design and control







PROJECT PROGRESS/ACTIONS - Cost

MEGASTACK

Achievement to-date

% stage of implement.

8700€/ Nm^3h^{-1} 6 €/kg

~5 €/kg < 3000 €/ Nm^3h^{-1}

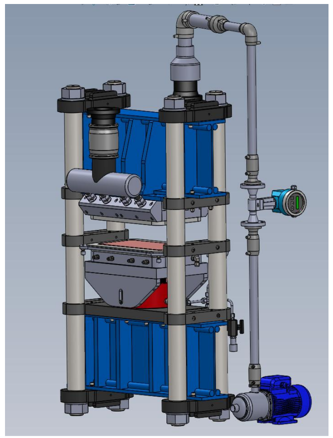
25% 50% 75%

2500€/ Nm^3h^{-1} 5 €/kg

Aspect addressed	Parameter (KPI)	Unit	SoA 2016	FCH JU Targets		
				Call topic	2017	2020
Cost	CAPEX	Nm^3h^{-1}	8700	2500	4000	2200
	H_2 Cost	€/kg	5-13	-	5-11	5-9

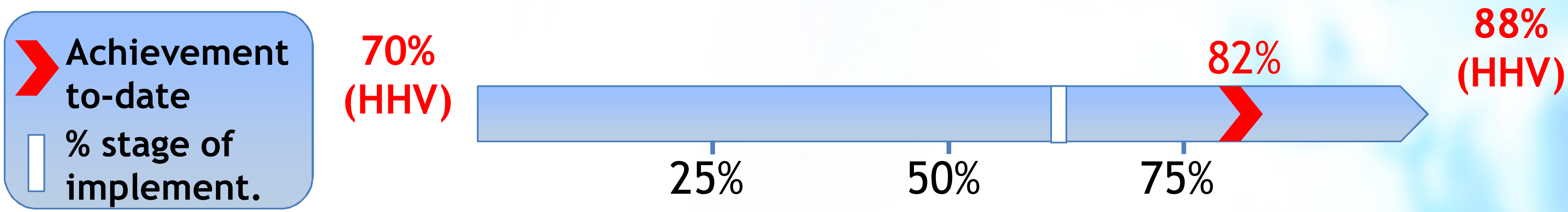
Future steps:

- *Construct "short stack" demonstration unit*
- *Perform HAZOP study, complete documentation and ensure safe reliable operation*
- *Demonstrate electrolyser capabilities*



PROJECT PROGRESS/ACTIONS - Efficiency

MEGASTACK

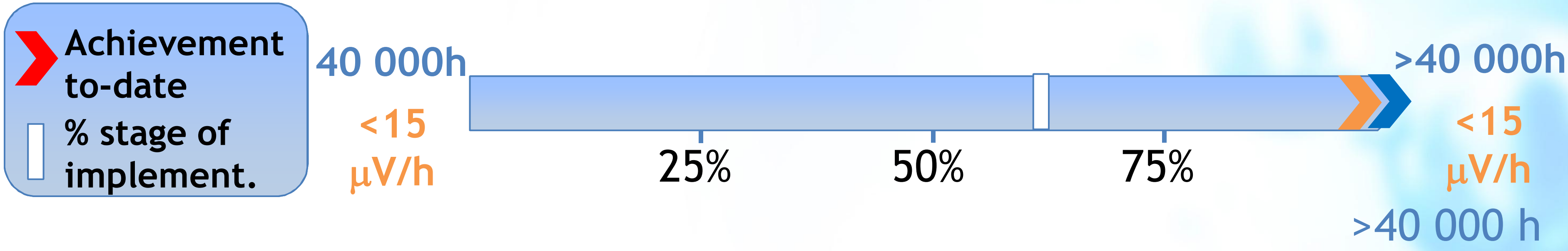


Aspect addressed	Parameter (KPI)	Unit	SoA 2016	FCH JU Targets		
				Call topic	2017	2020
Efficiency	Efficiency	%	68	88	71	75
	Energy use	kWh/kg	57	42	55	52

Future steps:

- *Further improvement of stack design by use of advanced modelling tools developed in the project*
- *Improved manufacturability, optimised components, higher current densities*

PROJECT PROGRESS/ACTIONS - Durability



Aspect addressed	Parameter (KPI)	Unit	SoA 2016	FCH JU Targets		
				Call topic	2017	2020
Durability	Lifetime	h		40000 h	N/A	N/A
	Degradation rate	µV/h		< 15	< 4	< 3

Future steps:

- *Evaluate long term durability of demonstrator stack*
- *Investigate possibility for increased current densities and alternative lower cost components without impact on durability*

SYNERGIES WITH OTHER PROJECTS AND PROGRAMMES

MEGASTACK

Interactions with projects funded under EU programmes	
NOVEL	Collaboration on development of testing protocols for components and cells. AST development and dissemination events.
PHAEDRUS	Megastack design based on elements from Phaedrus stack design
ELECTROHYPEM	Test protocols for evaluation of CCM durability
Interactions with national and international-level projects and initiatives	
IEA-ANNEX 30	Collaboration on development of standardized testing protocols for PEM electrolysers and cost reduction strategies.
JRC	Harmonisation of testing protocols and hardware for PEM electrolysers

DISSEMINATION ACTIVITIES

MEGASTACK

Public deliverables

- D1.1: Cost benefit analysis and cost and performance target for large scale PEM electrolyser stack
- D2.1: Cost benefit analysis and cost and performance target for large scale PEM electrolyser stack
- D3.2 Large scale MEA manufacture options and suppliers – testing of large scale MEAS

Conferences/Workshops

- 1 organised by the project
- 3 in which the project has participated

Social media

Publications: 0

- Publications on two phase flow modelling and transport processes in porous media in preparation

Patents: 0

-Megastack design based on existing ITM patents

Thank You!

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