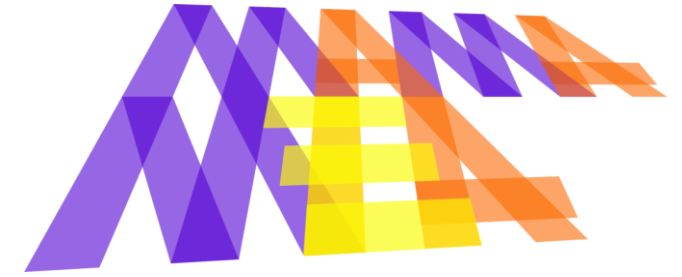
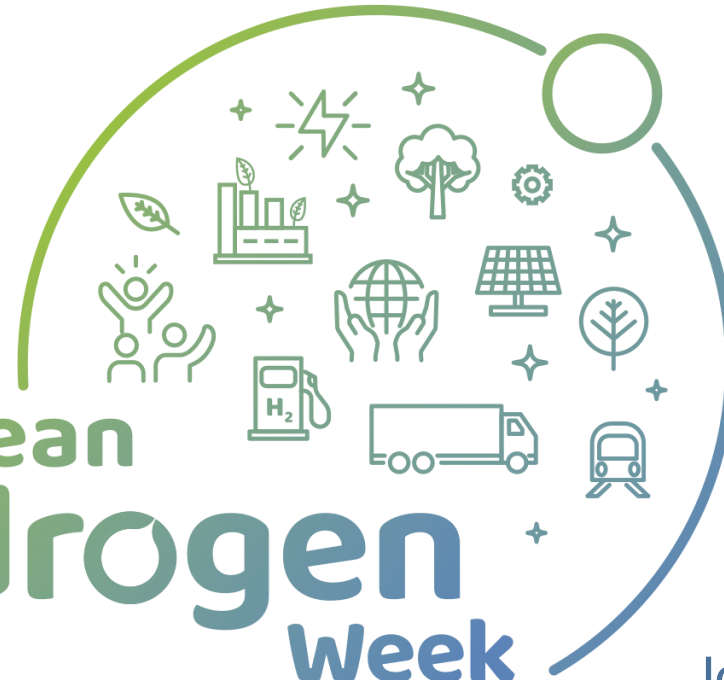


MAMA-MEA

Mass Manufacture of MEAs using high
speed deposition processes



European
Hydrogen
Week



Dr Silvain Buche
Johnson Matthey Fuel Cells



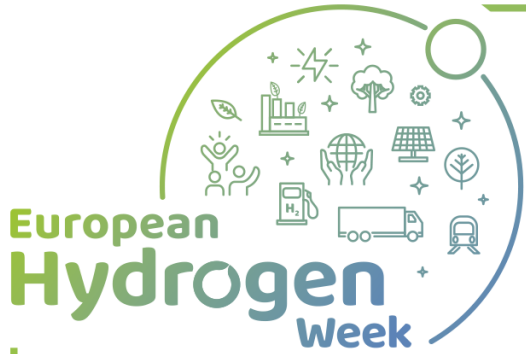
www.mama-mea.eu

Coordinator: Dr. Jiri Hrdlicka

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Project Overview

- Call year: 2017
- Call topic: FCH-02-8-2017: Step-change in Manufacturing of Fuel Cell Stack Components
- Project dates: 01.01.2018 - 30.06.2021
- % stage of implementation 01/11/2021: 100 %
- Total project budget: 3,189,816 €
- FCH JU max. contribution: 3,189,816 €
- Other financial contribution: 0 €
- Partners: Fraunhofer ENAS, INEA, JMFC, Nedstack, System Group, TU Chemnitz, UNIMORE



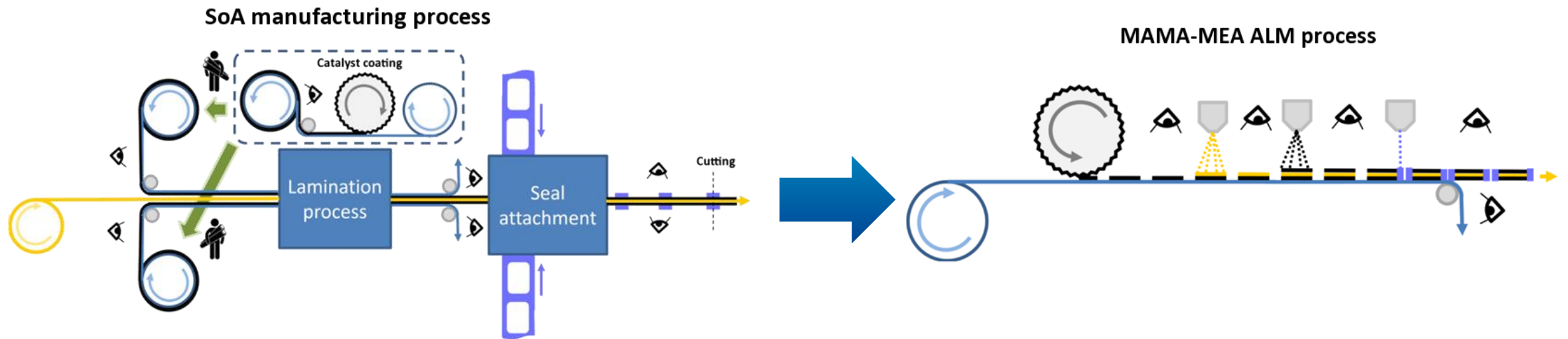
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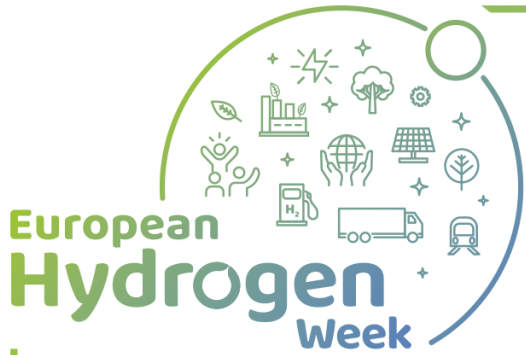


Project Summary

MAMA-MEA - Mass Manufacture of MEAs using high speed deposition processes

Main objective: Development and design of a high-volume additive manufacturing process for CCMs suitable for 10 GW/year production





Project Summary

MAMA-MEA KPIs

KPI	MAMA-MEA and FCH targets	Status in the project
Stack CAPEX	<350 €/kW	Assessment completed
Power density	>0.67 W/cm ²	Reached on short stacks
Degradation	<0.25 % / 1000 h	Validated
Lifetime expectation	20,000 h	Based on AST similar durability to baseline validated
Material utilisation	>95%	Assessment completed
Metal loading control	≤10 % at ≤0.1 mg _{Pt} /cm ²	Completed
Production web speed	~1 lm/s	Speed on the DCL for ALMCCMs 50 lm/min
Production capacity	Potential of reaching 10 GW/a	Assessment completed
Performance target	Within 10 % of benchmark CCM	Validated

Multi-Layer Deposition Processing

Demonstrate roll-to-roll Additive Layer Manufacture (ALM)



Achievement to-date

Small scale
concept



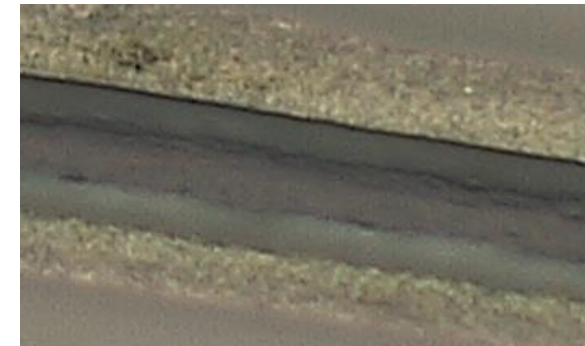
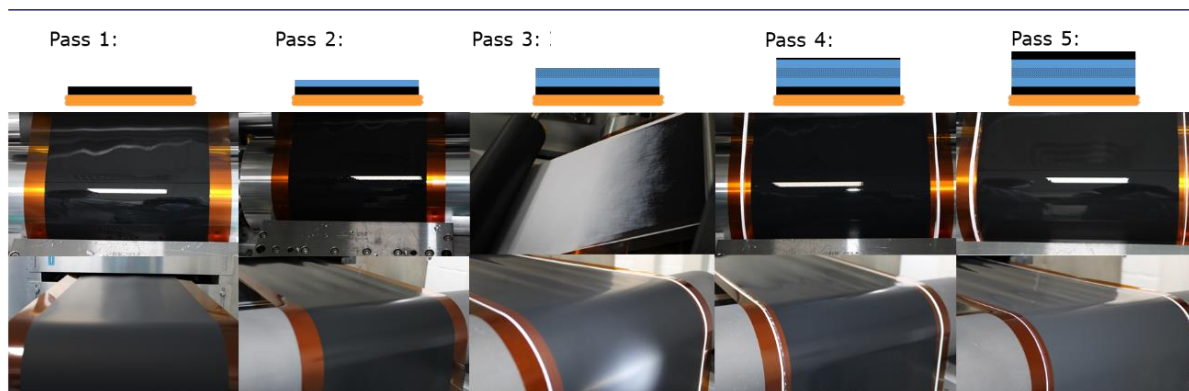
CCM roll
manufactured

25%

50%

75%

- Specification and technology assessment completed
- 14 trials carried out successfully on the roll-to-roll development coating line with various configurations and formulations. Layer quality on par with current high volume process line.



Edge Protection Seal Deposition

Demonstrate concept of process seal deposition integration



Achievement to-date

Not
demonstrated



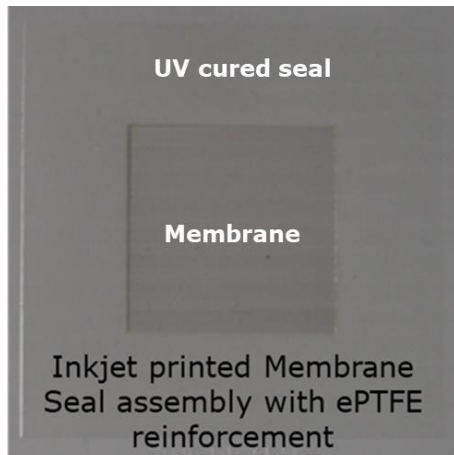
Process
Concept
Demonstrated

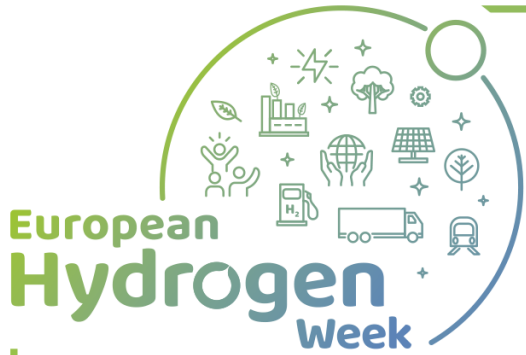
25%

50%

75%

- Inkjet seal printing concept fully demonstrated
- Roll-to-roll patch coating also demonstrated





Short Stack and Cell Testing

Fully printed CCM demonstrating equivalent performance and durability



Achievement to-date

Single cell



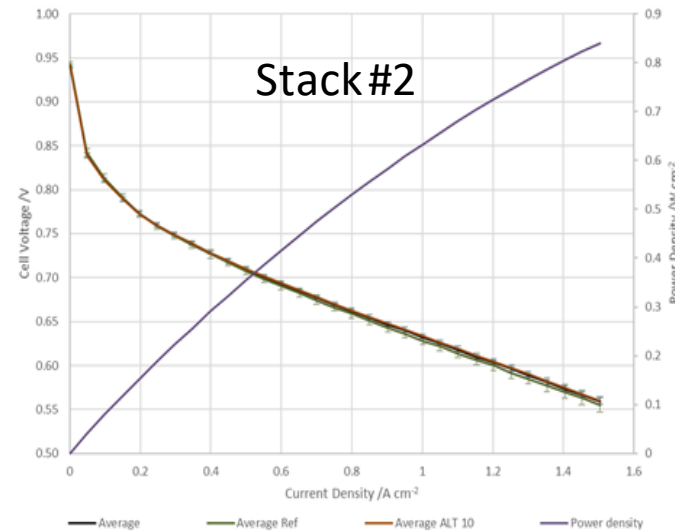
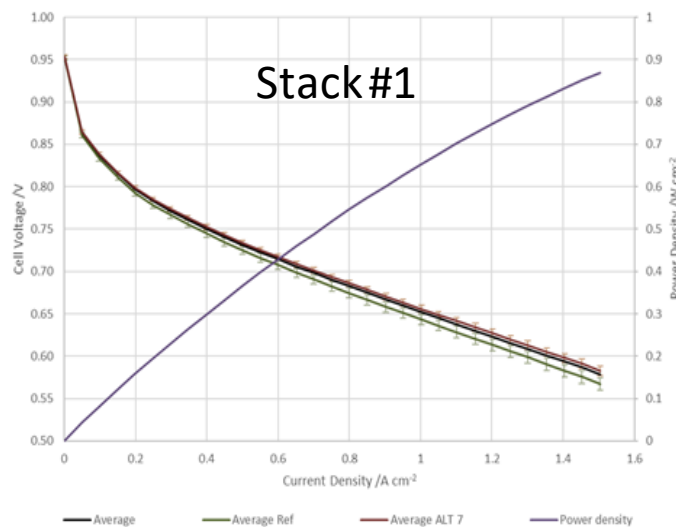
Short Stack Testing

25%

50%

75%

- Two short rainbow stacks (baseline + ALM MEAs) tested at Nedstack successfully, accelerated stress test equivalence confirmed



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Process Line Concept Development



Achievement to-date

Concept



Full process line
concept
developed

25%

50%

75%

- The MAMA-MEA project has developed and costed a fully printed CCM manufacturing process line. This includes mechanical design, sensors and actuators, control system design and SCADA system design
- Design is modular roll-to-roll manufacturing with a 120 m² footprint for a €15M cost for over 3GW/year production



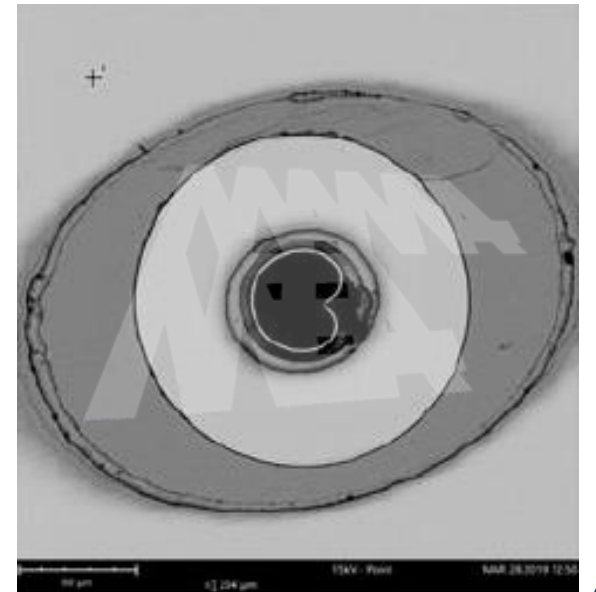
Risks, Challenges and Lessons Learned

Digital printing presents significant opportunities for the fuel cell industry. Inkjet in particular has a role to play but the technology, while it has demonstrated equivalent performance, is still not yet ready at high volume (assessed during MAMA-MEA project)

- Corrosion of industrial printheads by catalyst inks means lifetime is extremely limited
- Off-the-shelf inks are not readily printable and require significant modifications

MAMA-MEA has enabled the conversation to start with inkjet printhead manufacturers and System Group have gained valuable experience. Printhead development needs to continue.

- In-line quality control will be key for ALM, further work is needed



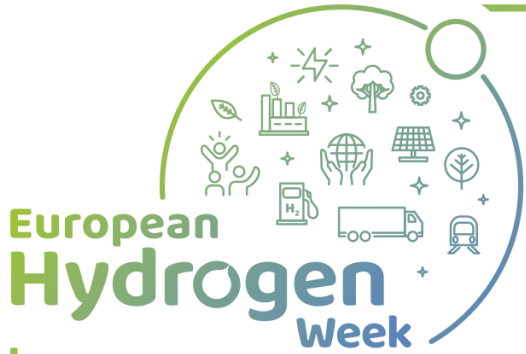
Exploitation Plan/Expected Impact

Exploitation

- Additive Layer Manufacturing is on **JMFC**'s technology roadmap
- **SG** is planning inkjet manufacturing machines for “CCM-like” products
- **INEA** is offering upgrades to existing manufacturing lines (e.g. new QC)
- **TUC**, **ENAS** and **UNIMORE** use the non-sensitive project outputs for academic and consultancy purposes

Impact

- **MAMA-MEA**'s high volume Additive Layer deposition manufacturing process addresses the growing demand for CCMs
- Higher utilisation of material - depositing only on the designated area -> cost/scrap reduction

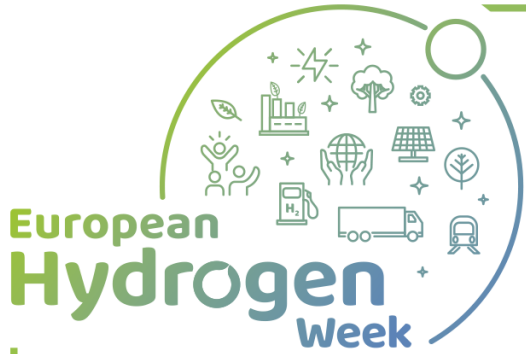


Synergies With Other Projects And Programmes

Interactions with projects funded under EU programmes

- **FIT-4-AMANDA:** Exchange of ideas, characterisation of FIT-4-AMANDA functional layers
- **INSPIRE & GAIA:** Exchange of materials
- **VOLUMETRIQ:** Exchange of R2R concepts and ideas
- **CAMELOT:** Digital printing concepts and experience shared





Dissemination Activities

Flyer

Facts and Figures

Full name: Mass Manufacture of MEAs Using High Speed Deposition Processes
Acronym: MAMA-MEA
Start date: 1 January 2018
Duration: 36 months
Total budget: 3.1 M€
EC funding: 3.1 M€

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Consortium

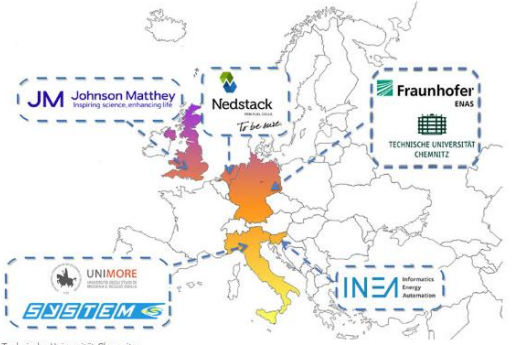


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MAMA-MEA brings together world-leading and highly experienced industrial, institutional and academic partners with expertise in coating technologies and process design, from both within and outside the fuel cell industry.



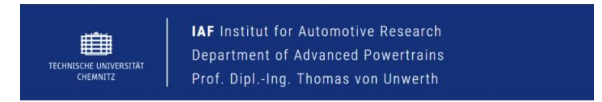
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This project has received funding from the FCH JU and European Union's Horizon2020 research and innovation programme under Grant Agreement no. 779591.

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Activities	#
Conferences	9
Workshops	6
Scientific publications	4
Communication with other projects	5
Education and training	3

Poster



H2020 RIA project

- Submitted within the call H2020-074-FCH 2017-1
- Duration: 36 months
- Start date: 1 January 2018
- EU Funding: 3.1 M€

Motivation

- Demand for PEM fuel cells will increase to 100,000 per annum from 2015
- For CO₂-free power generation, continuous manufacturing processes are currently being implemented to manufacture membrane
- Strong requirement for increased numbers of CO₂ membranes to manufacturing and change in terms of cost and quality
- Current CO₂ membranes and manufacturing costs will be reduced by up to 50% in the new CO₂ membranes

Objectives

- Development of an innovative additive layer deposition process that integrates all the main CO₂ components (membranes, catalyst layers, bipolar) in a single continuous roll-to-roll manufacturing process for the CO₂ fuel cell industry
- Enabling an increase in the volume manufacturing rate of up to 10 times compared to state-of-the-art processes
- Improving the material utilization and reducing material and manufacturing costs
- Improvement of additive layer deposition techniques from the coating and printing industry

Project partners

- Technische Universität Chemnitz (TUCh)
- Johnson Matthey Fuel Cells Ltd (JMFC)
- Fraunhofer ENAS
- System Group (SG)
- INEA
- Nedstack Fuel Cell Technology B.V. (NFC)

Project progress so far

Timeline from 1.1.2018 to 31.12.2022:

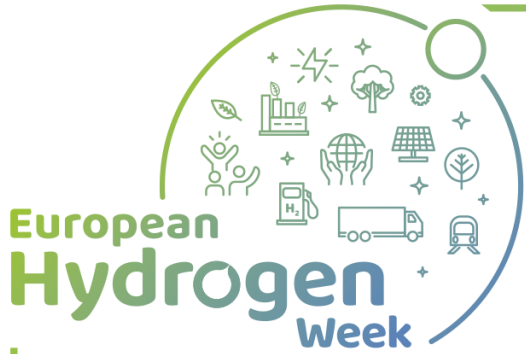
- 1.1.2018: Project start
- 3.1.2018: Kick-off meeting
- 6.1.2018: Deposition technologies selected for proof of concept
- 9.1.2018: Down selection of most promising technologies for additive layer
- 12.1.2018: Equipment address layer CO₂ performance and functionality achieved
- 15.1.2018: Produce and test the additive layer CO₂ stacks
- 18.1.2022: Project end

Consortium partners

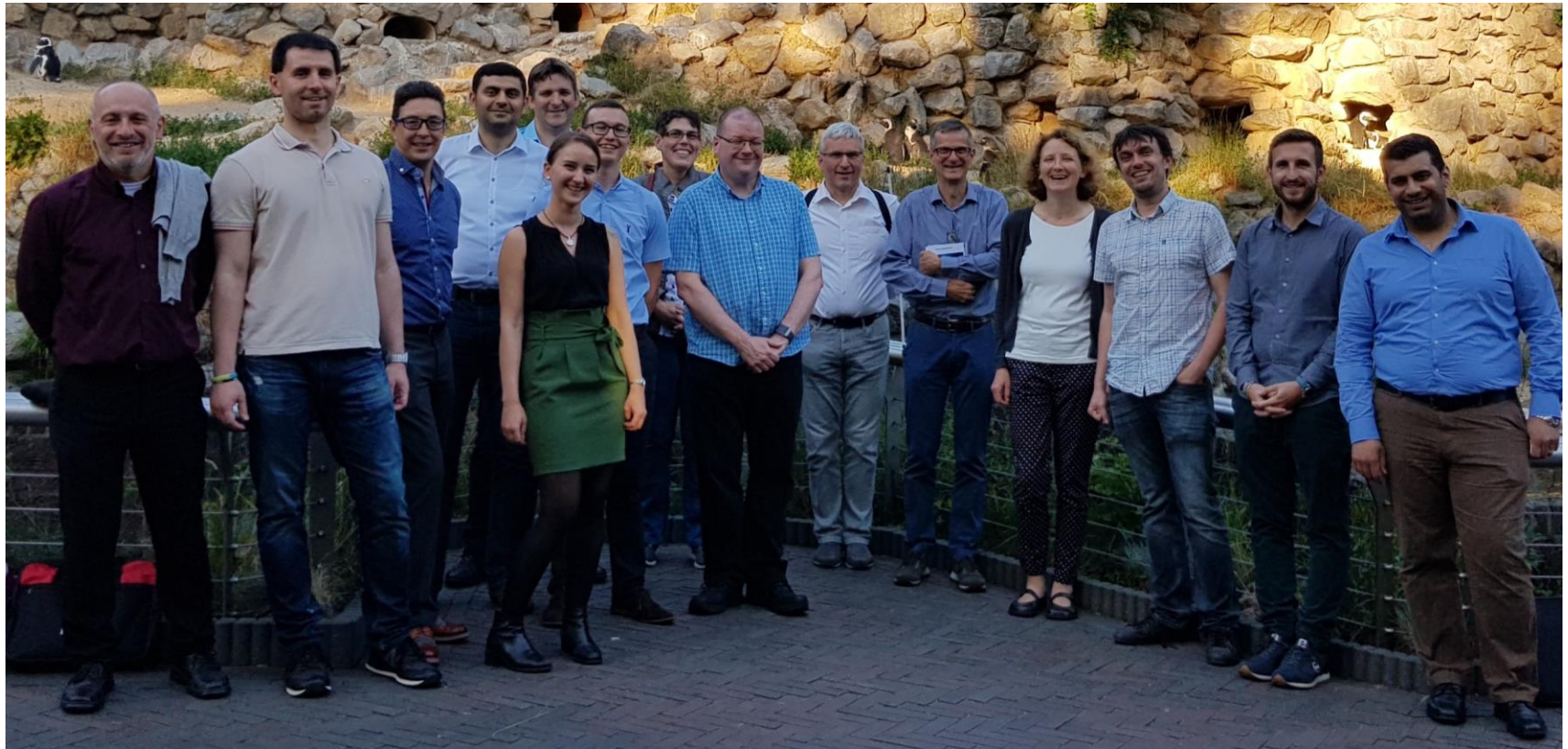
Consortium partners: TU Chemnitz, UNIMORE, Fraunhofer ENAS, INEA, JM Johnson Matthey, SYSTEM, Nedstack.

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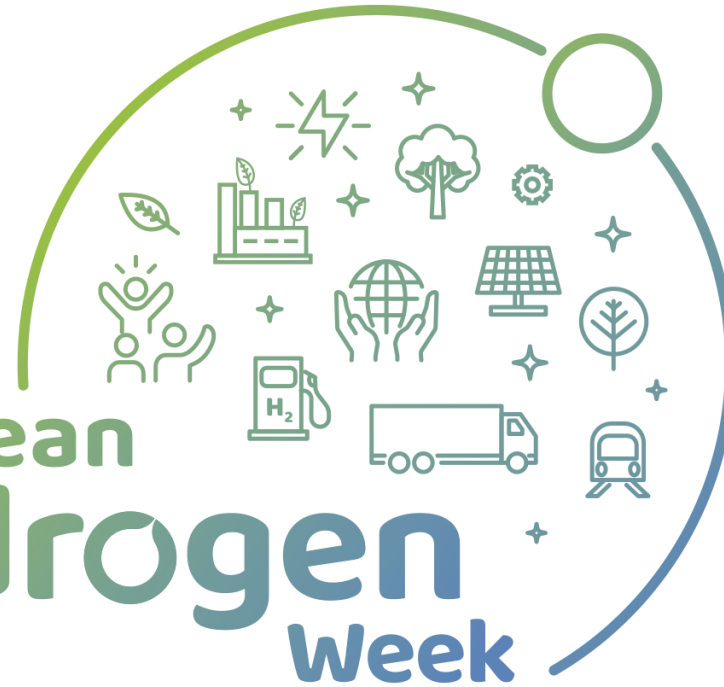




MAMA-MEA team thanks you for your attention



“This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under Grant Agreement No 779591. This Joint Undertaking receives support from the European Union’s Horizon 2020 Research and Innovation Programme, Hydrogen Europe and Hydrogen Europe Research”



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