

PRETZEL

Novel modular stack design for high

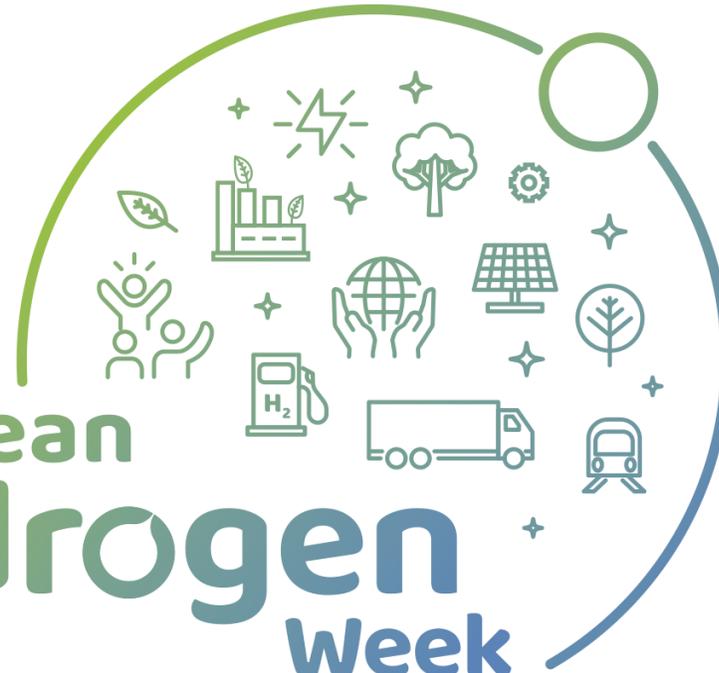
PREssure PEM water elec**TRO**ly**ZER**

t**E**chno**L**ogy with wide operation range and

reduced cost



European
Hydrogen
Week



Dr. Aldo Gago

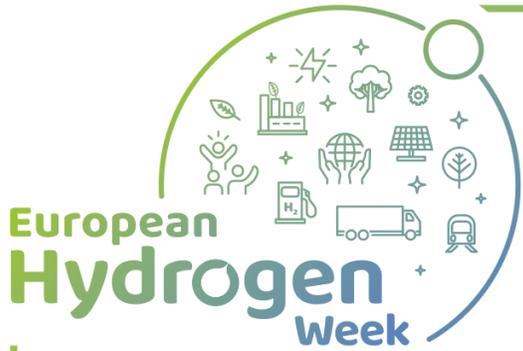
DLR

<http://pretzel-electrolyzer.eu/>

aldo.gago@dlr.de

#PRD2020
#CleanHydrogen





Project Overview

Call year:
2017

Call topic:
FCH-02-1-2017
Game changer
Water
Electrolysers

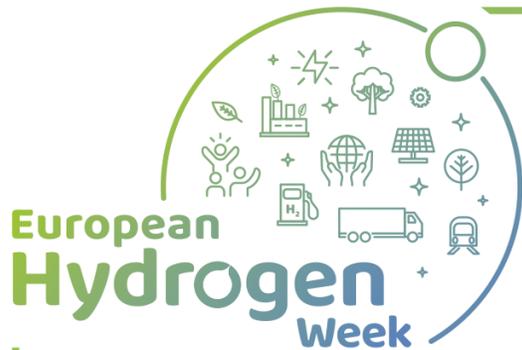
Project dates:
01/2018 - 06/2021

Total project budget:
1,999,088.75 €

PRETZEL

% stage of implementation
01/11/2019: 80 %

FCH JU max. contribution:
1,999,088.75 €
Other financial contribution: 0.00€



Partners

Westfälische Hochschule
Gelsenkirchen Bocholt Recklinghausen
University of Applied Sciences



Ibercat
SOLUCIONES CATALÍTICAS



DLR
Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

UP
Universitatea Politehnica Timișoara

CERTH
CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

ADAMANT
COMPOSITES

#PRD2020
#CleanHydrogen



PEMWE operation data (SoA)

PEM electrolyzer operation data of active players and State-of-Art (SoA) from MAWP:

- H₂ output pressure of ≤ 30 bar
- current density of up to 2.0 A cm^{-2}
- Cell potential of 2.0 - 2.2 V
- Water temperature of 60-70°C
- Capital cost 1,200.00 € kW⁻¹
- The porous transport layers (PTL) and bipolar plates (BPP) are the most expensive components (68-49%)

Example of commercial SoA stack

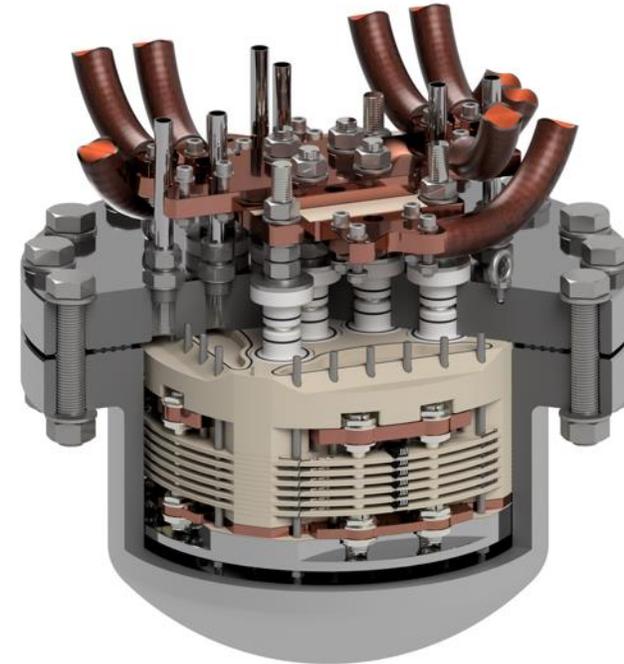


P. Lettenmeier, R. Wang, R. Abouataallah, F. Burggraf, A.S. Gago, K.A. Friedrich, Coated Stainless Steel Bipolar Plates for Proton Exchange Membrane Electrolyzers, J. Electrochem. Soc. 163 (2016) F3119–F3124. <https://doi.org/10.1149/2.0141611jes>.

Project Summary

500 cm² active area PRETZEL stack

- Objective: Develop and manufacture stack and system components for game changer PEMEL
- H₂ output pressure of 100 bar
- Rated current density of 4 A cm⁻² (ability for 1.5 times overload, 6 A cm⁻²)
- Water temperature of 90 °C
- System efficiency > 70%
- Durability > 2000 h
- System specific costs of below 750 € kW⁻¹



Progress/Actions - Current Density

Achievement to-date

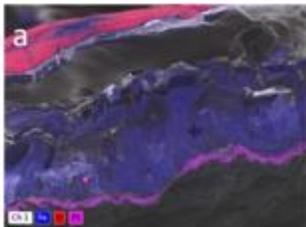
2 A cm⁻²



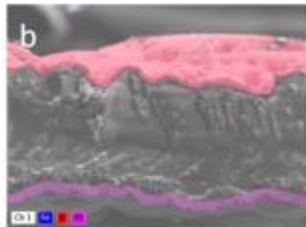
rated 4 A cm⁻²,
overload 6 A cm⁻²

- DLR developed coatings for stainless steel BPP and PTLs and were tested up to 6 A cm⁻² achieving an unprecedented cell efficiency of 77 %
- The coatings offer full protection against corrosion
- No contamination of the MEA was observed after AST

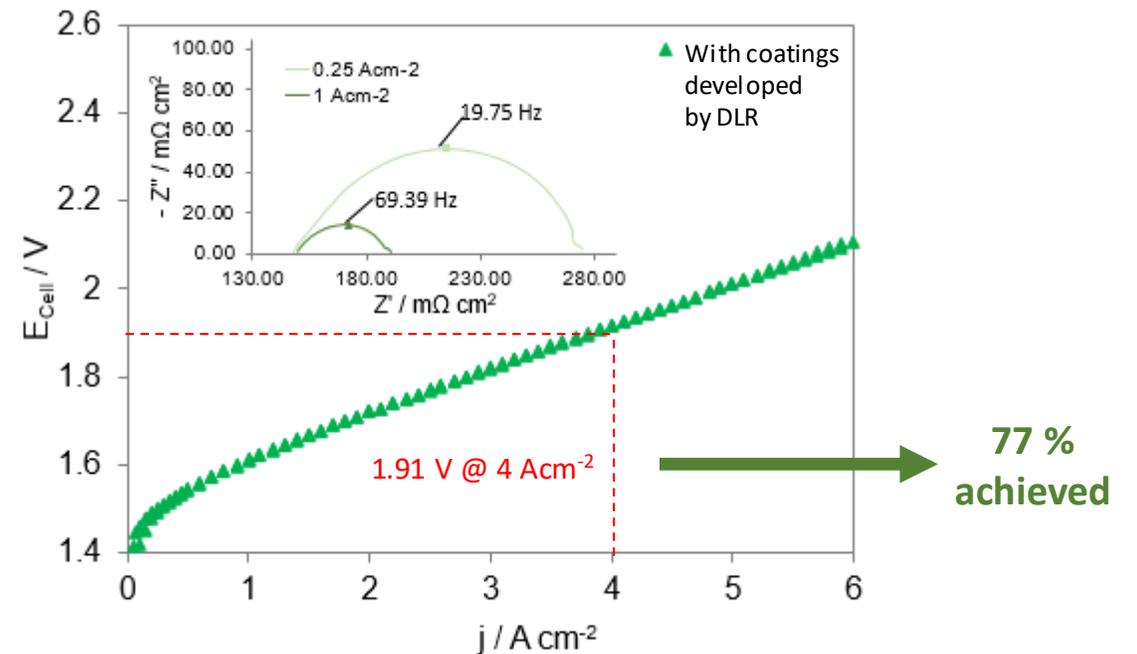
Without -



With - DLR coatings



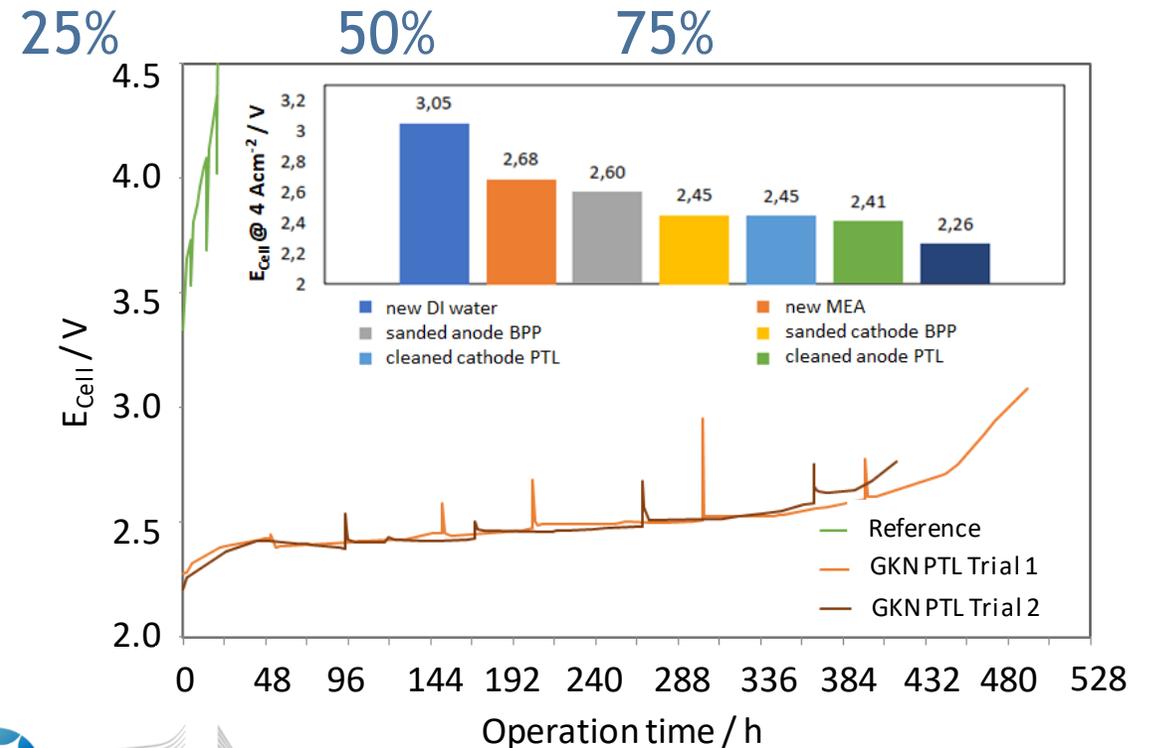
Fe contamination
(blue) of the MEA
after AST



Progress/Actions - Temperature



- GKN developed a Ti-based PTL that allows operation up to 6 A cm^{-2} at 90°C eliminating completely mass transport limitations
- PTLs from GKN has passed the durability AST at constant 4 A cm^{-2} and 90°C
- The degradation caused by the PTL was negligible
- UPT carried out corrosion tests at 90°C and demonstrated that a zero-tolerance material like Cu with DLR coatings can be used as an alternative to Ti for BPP



Progress/Actions - Pressure



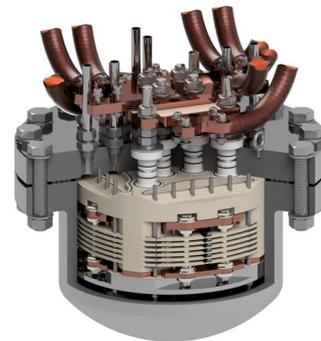
Achievement to-date

≤ 30 bar



100 bar

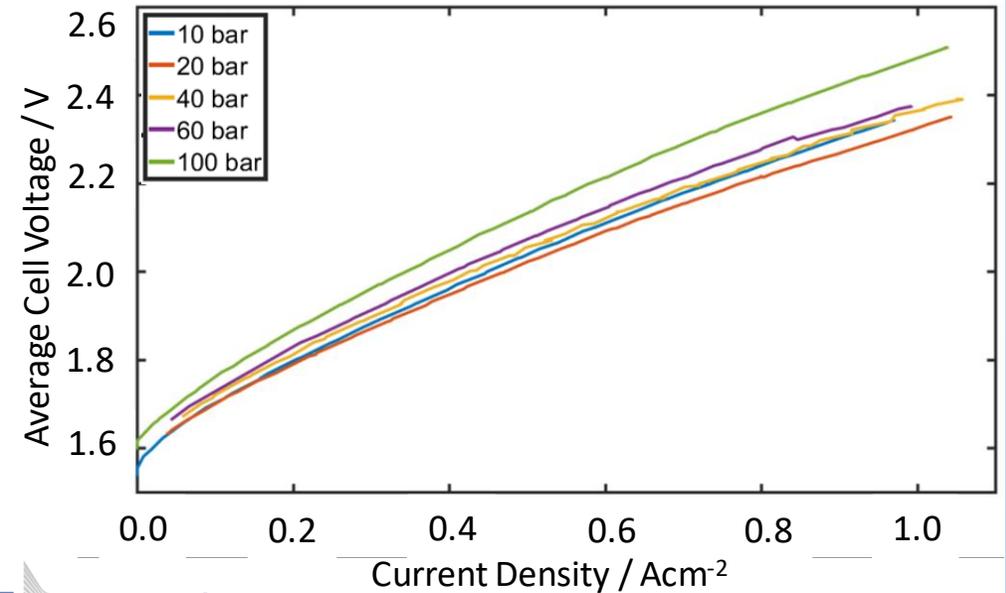
- First 100 bar H₂ pressure test in the 25 kW PEMWE from iGas energy was carried out successfully
- For this test an aged stack was used but it had the PTLs from GKN
- New 500 cm² active area stack from WHS is ready for assembly
- Due to the coronavirus situation, the project has been extended for six months.

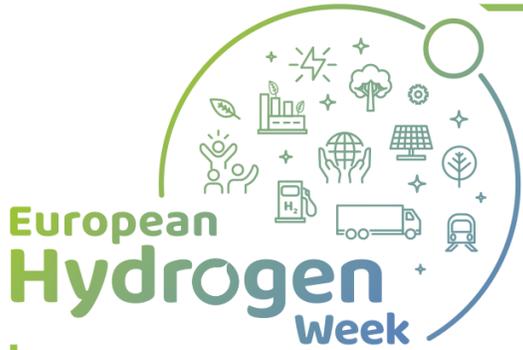


25%

50%

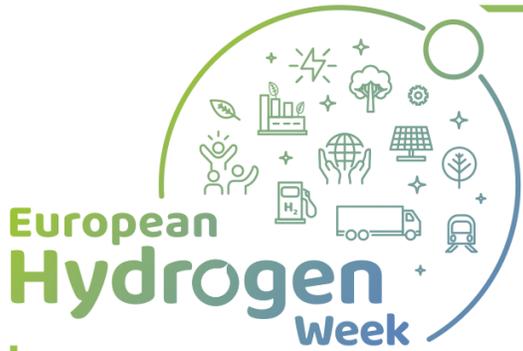
75%





Risks, Challenges and Lessons Learned

- **Risk:** ARMINES and IBERCAT will continue working on finding alternative supported catalysts in collaboration with CERTH and ADAMANT for the MEA development
- **Challenge:** Reducing PGM content in the electrodes using supported catalyst is a great challenge for a game changer PEMWE
- **Lesson learned:** If the PEMWEs are going to be scaled to GW in Europe, then much larger R&D efforts and more funding support are needed to reduce the use of PGMs.



Exploitation Plan/Expected Impact

Exploitation



Initial Exploitation plan will get updated with the support of Horizon Results Booster (HRB, partner ICON)



Consortium decided on latest exploitable results



Overall market situation and potential is under investigation for these exploitable results



Participation in a cluster of several EU funded projects with similar topic or interest

Impact



Efficiency increase of 24 % can be translated into savings of annual costs by €310 million (OPEX, 1GW plant)



Increased H₂ production rate due to operation at high current density



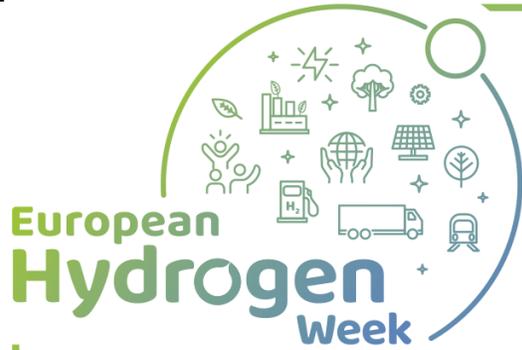
Reduced stack volume due to high specific production rates



Increased H₂ output pressure 100 bar augmented the overall efficiency of the system



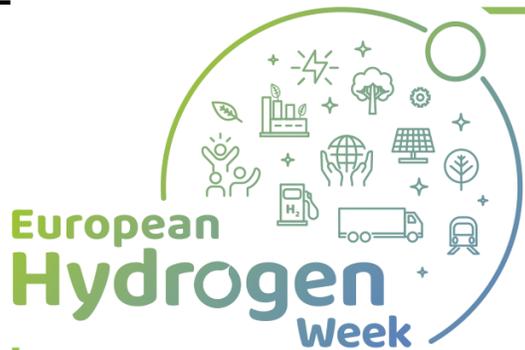
Green H₂ price of 3.5-5.0 €/kg achievable



Synergies With Other Projects And Programmes

Interactions with projects funded under EU programmes

- Project NEPTUNE: Internal Workshop was organized and performed, Joint Public Workshop planned for May 2021 appended to 5th International Workshop on Degradation Issues of Fuel Cells and Electrolysers



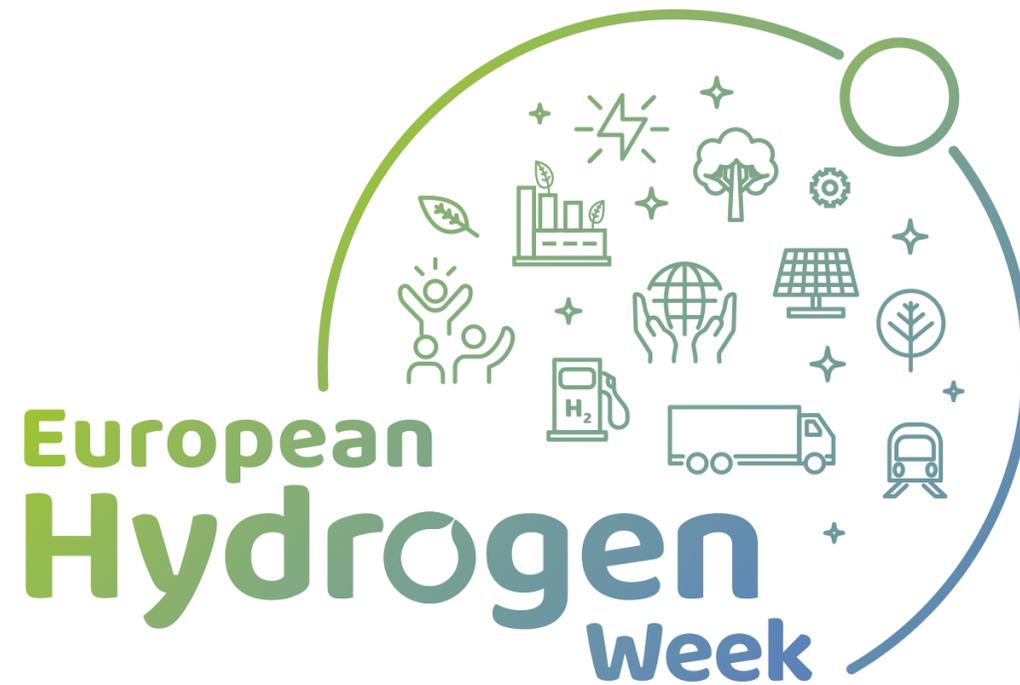
Dissemination Activities



<https://www.youtube.com/watch?v=dAuJU3wXuqk&feature=youtu.be>

#PRD2020
#CleanHydrogen





European
Hydrogen
Week

#PRD2020
#CleanHydrogen

