FUNDACIÓN PARA EL DESARROLLO DE LAS NUEVAS TECNOLOGÍAS DEL HIDRÓGENO EN ARAGÓN

SESSION 2: LOW TEMPERATURE ELECTROLYSER DEGRADATION PHENOMENA AND TEST METHODOLOGY

Alkaline electrolysis (Project HYPRAEL)

Laura Abadía

Fundación Hidrógeno Aragón (FHa)

Aragon Hydrogen Foundation

FUNDACIÓN PARA EL DESARROLLO DE LAS NUEVAS TECNOLOGÍAS DEL HIDRÓGENO EN ARAGÓN

- Research & Technological Development Center

Hydrogen as the energy vector in a global decarbonized energy system

- Private, non-profit entity: public-private collaborations & industrial development

- Suitable infrastructure to work with

large scale hydrogen equipment/systems

  - ✓ 8.5 meter in height
  - ✓ ATEX safety measures
  - ✓ gas detection equipment and ventilation

Founded in 23 December 2003

ADMINISTRACIONES PÚBLICAS / ADMINISTRATIONS

Ayuntamiento de Huesca · Ayuntamiento de Jaca · Ayuntamiento de Sabiñánigo · Gobierno de Aragón

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Jeremy Rifkin
Víctor Manuel Orera Clemente

R+D

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Our role:

Bring TRL3 to TRL6

Proof of concepts validation

Novel technologies validation

Testing under relevant envrionments

*HYPRAEL 2023-2026

Advanced stacks for H2 pressurized production at 80 bar

*HIGGS 2019-2023

Effect of blends H2/CH4 into the materials and components of transmission gas grids (80 bar)

MEFHYSTO 2020-2023

Advanced storage solutions

*BoSSTech 2021-2024

Robust Solid Oxide Fuel Cells

*4AirCRAFT 2021-2024

Production of jet fuels

Stack testing (AEL)

Hydrogen injection in the gas grid

Metrology of renewable gases

Use of H2

Production of alternative fuels

*Scientific Project coordinator

2 IN 1 WORKSHOP: Clean Hydrogen JU AEMEL Project Findings & JRC Testing Methodology on Electrolyser Degradation

HYPRAEL

Advanced alkaline electrolysis technology for pressurized H2 production with potential for near-zero energy loss

www.hyprael.eu

Laura Abadía – Project Coordinator
Aragon Hydrogen Foundation - FHa
Brussels, 29.09.2023

Clean Hydrogen Partnership

Co-funded by the European Union

The HYPRAEL project has received funding from the Clean Hydrogen Partnership under Grant Agreement No 101101452. This Partnership receives support from the European Union's Horizon Europe Research and Innovation program, Hydrogen Europe and Hydrogen Europe Research

OVERVIEW

- Starting date: 01/03/2023
- Duration: 36 months
- Funding: Clean Hydrogen Joint Undertaking
- Partners:

PROJECT ESSENTIALS

Development of advanced technologies for energy and cost-efficient compressed hydrogen production.

The main goal is to develop and validate the next generation of AEL for highly pressurised H2 production (at least 80bar and preferable 100bar)

To avoid cost intensive downstream mechanical compression processes though **key innovations** (advanced cell, stack and *Balance of Plan*).

Research on advanced and sustainable electrodes, separators, polymers and compositions; innovative architectures for advancing through upscaling and sustainable mass production

Key research activities

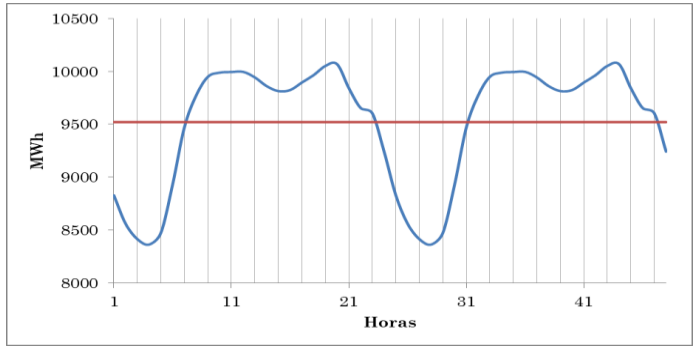
- Materials development and screening - Lab scale/single cell – *FhG*, *Agfa*,
  Electrodes and membranes: electrochemical tests, structural analysis, mechanical properties, chemical stability…
- Validation of upscaled components at pilot scale (60bar, 120ºC, 6-15 kW) – *FHa*
  Performance evaluation at stack level
- Demonstration at industrial scale (>80bar, >120ºC, >50kW cell stack) – *GHS*
  Conditions will be defined by
  1) Offshore wind turbine integrated with WE
  2) H2 for green methanol

Novelties validation at pilot scale

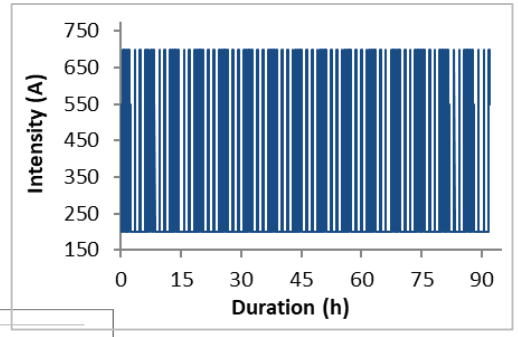
Validation of upscaled components at pilot scale (60bar, 120ºC,6-15 kW). August 2024. FHa

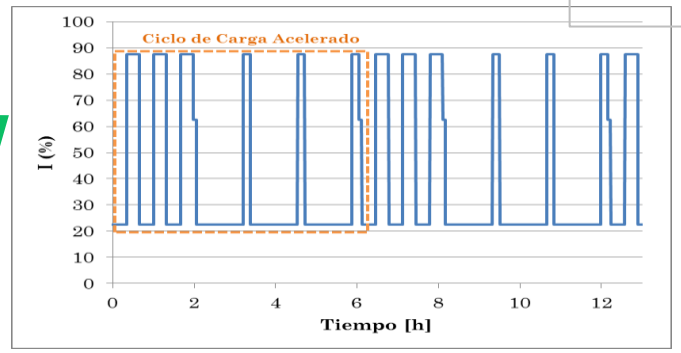
- Performance evaluation at stack level and high pressure (≤60 bar)
- The final stack developed in HYPRAEL will be tested inside a system which acts as a test station.
- Testing protocols will base on JRC protocols and previous EU projects
  - Investigate the effect of electrolyte concentration, temperature and pressure
  - 2 testing campaigns: 1st SoA stack (baseline), 2nd advanced stack
  - Stack performance under dynamic loads through definition of Accelerated Stress Tests (AST)

Testing activities. FHa's Background



Mapping Demand Response in Europe





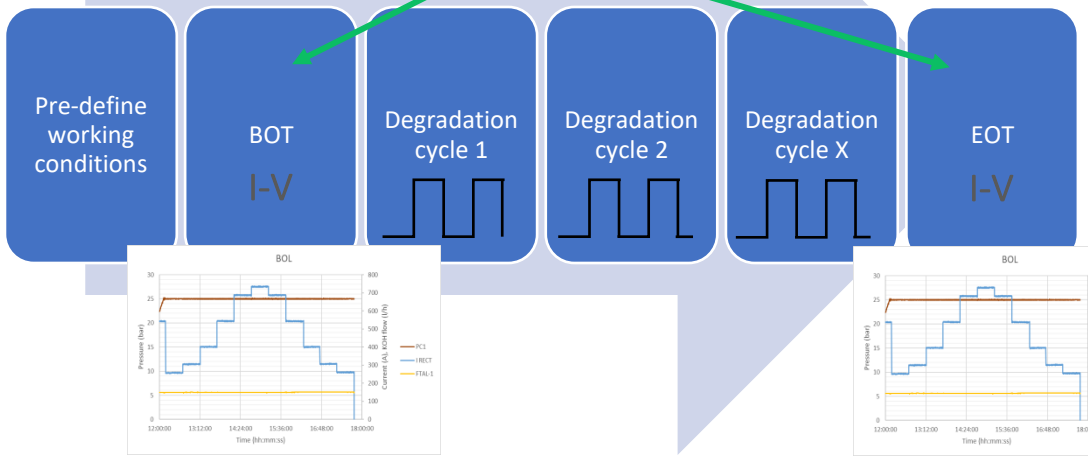
- ***Grid service constraints***
- ***System power (mim/max)***
- ***Operating conditions (T, P, KOH flow, ...)***

Design of AST protocols in **Elyntegration** project: Grid services

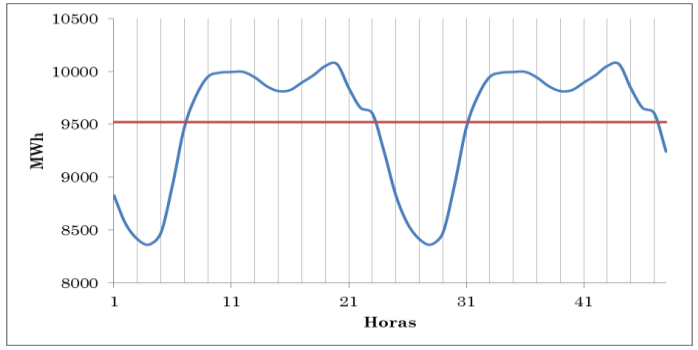
1st Characterization test with different KOH flow, T, P → cell voltage and gas purity → Operation window

2nd AST (load cycle at constant T and P)

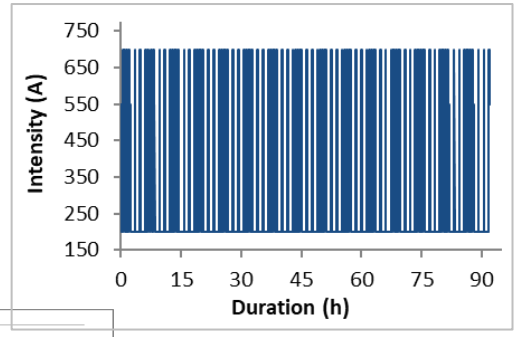
Polarization curves at the Beginning of test (BoT) and End of test (EoT)

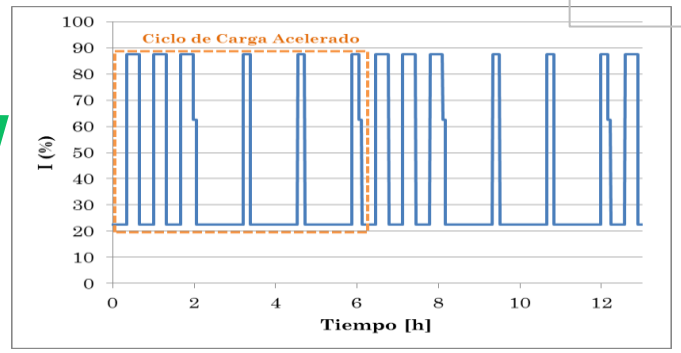


Testing activities. FHa's Background



Mapping Demand Response in Europe





- ***Grid service constraints***
- ***System power (min/max)***
- ***Operating conditions (T, P, KOH flow, ...)***

Design of AST protocols in **Elyntegration** project: Grid services

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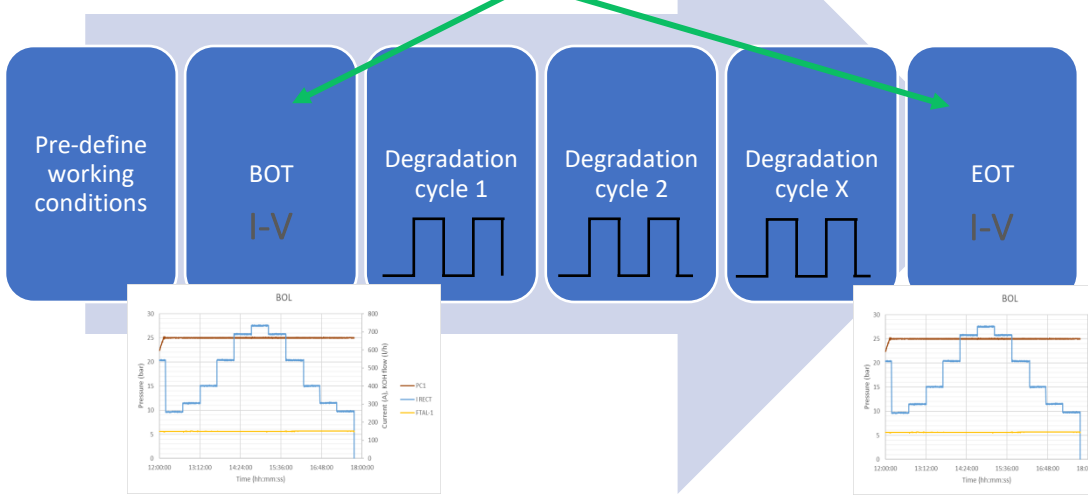
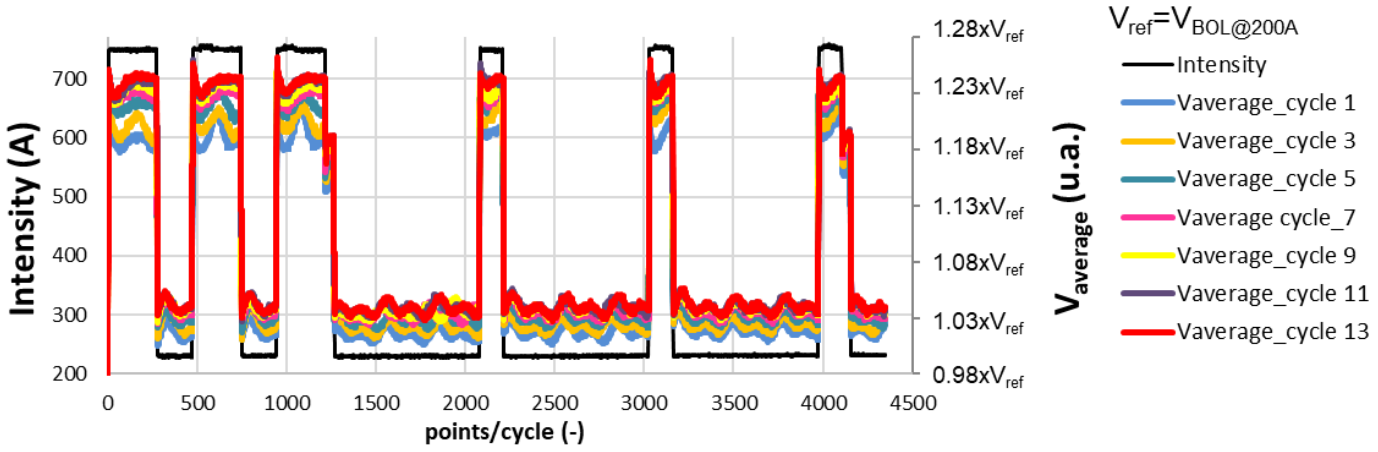
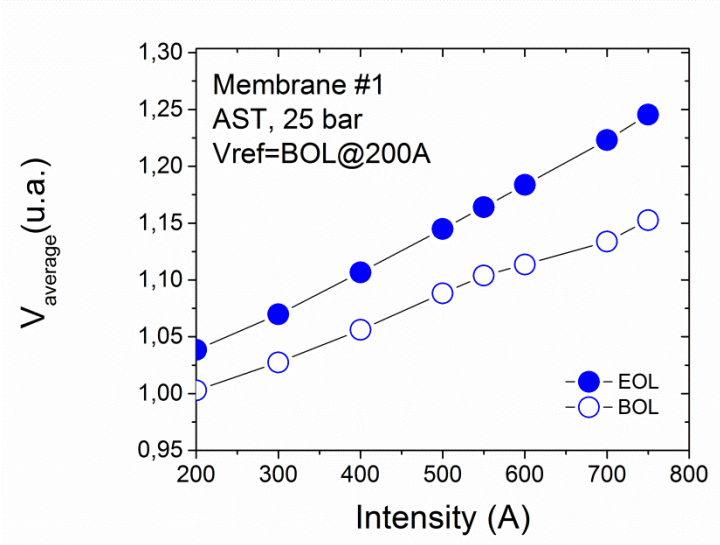


Testing activities. FHa's Background



Conclusions after 60 days of Dynamic operation:

- Some cells presented a sharp increase in the voltage degradation rate up to 12 % while in others degradation went down to 2-3%.
- Gas cross-over contamination was not affected by the dynamic conditions. Gas purities at high and low current densities at 25 bar were constant.



<u>Lessons learnt</u>: Thermal management at the stack is very challenging for high current density variations. **Thermal oscillations** repeat every cycle, **"hidden stressor"** → Advanced Control system. Less influential effect on equipment with high thermal inertia

HYPRAEL

Thank you for your attention

www.hyprael.com

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