European Commission

Harmonisation protocols, electrolyser durability and AST

Developing EU harmonised accelerated stress testing (AST) protocols for water electrolyser stacks

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Joint Research Centre

Acknowledgements

The current drafting of “EU harmonised AST protocols for low-temperature electrolyser - *A proposal for assessing performance degradation in stacks***” is possible - thanks to the support by partners of EU-funded projects from academia & industry as well as the financial support of the Clean Hydrogen Joint Undertaking (Clean H_2 JU).**

Clean Hydrogen Partnership

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Scope – Proposal of AST protocols for WE stacks

- Creating commonly accepted EU-wide AST protocols for assessing relevant performance degradation in **stacks** of low-temperature water electrolyser used in real-world applications particularly in hydrogen-to-industry (H2I) processes, power-to-hydrogen ($P2H_2$), and other energy storage (ES) applications (grid balancing services and off-grid) to generate green hydrogen from *renewable electricity*
- Not intended to replace existing testing practices available in various industries and research establishments but to allow for an **objective comparison** of test results emanating from different projects and research efforts obtained under defined (reference) conditions and representative *operation profiles*

Accelerated Lifetime Testing (ALT) versus Accelerated Stress Testing (AST)

ALT: destructive testing of a stack by subjecting it to aggravated conditions in excess of nominal conditions of real-life use, in an attempt to reveal faults and modes of failure in a short amount of time and to assess the stack's remaining useful life mainly for commercial purposes

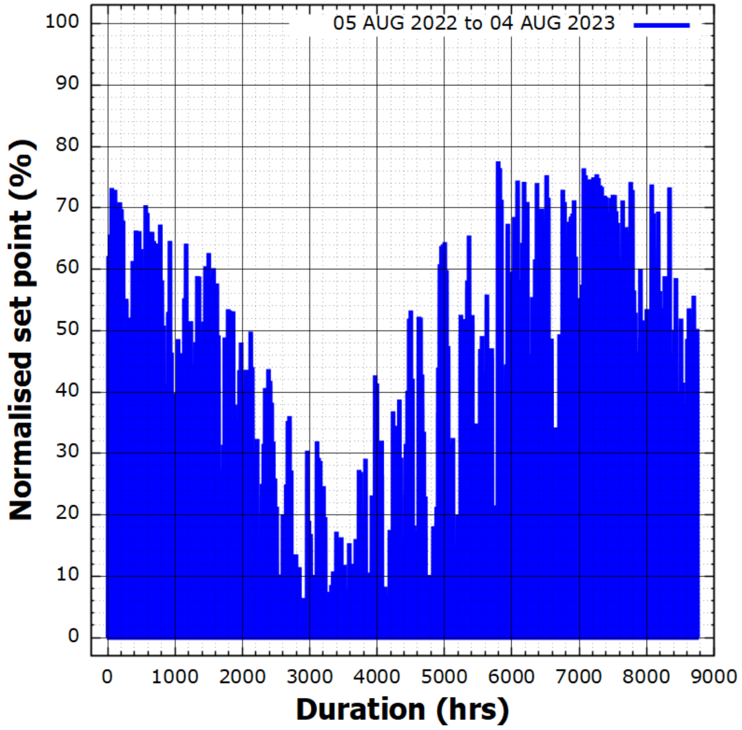
AST: intentionally non-destructive testing of a stack by applying high levels of stress when operated for a short time in an attempt triggering the same performance degradation mechanism(s) as presumably occur for a longer exposure of the stack when tested under normal conditions

AST protocols for AWE, AEMWE & PEMWE stacks

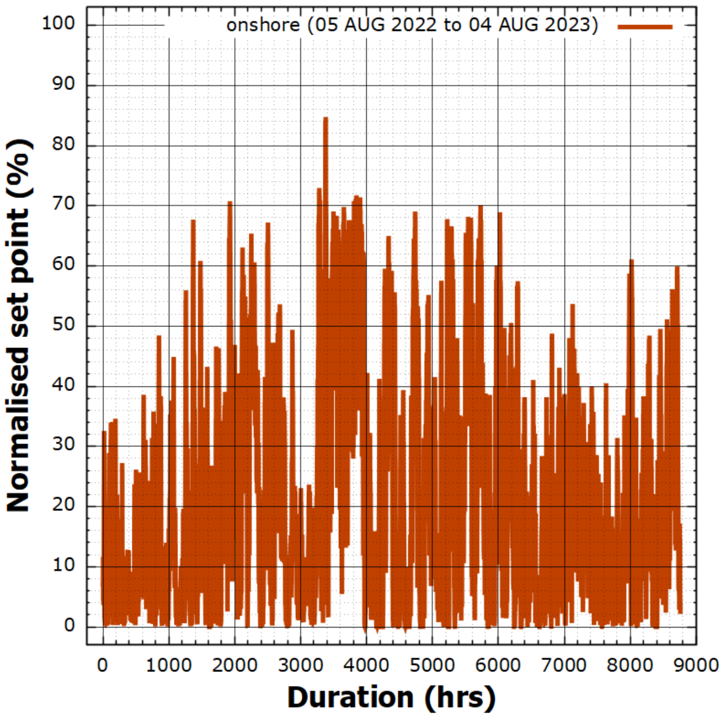
- Use of higher operating temperature, increased differential pressure operation, ionic water impurities and real-world renewable power profiles (PV & wind) with compressed duration inducing stress
- Public stakeholder consultation: December 2023

Sent on 8 Sep for expert feedback and comments by 13 Oct

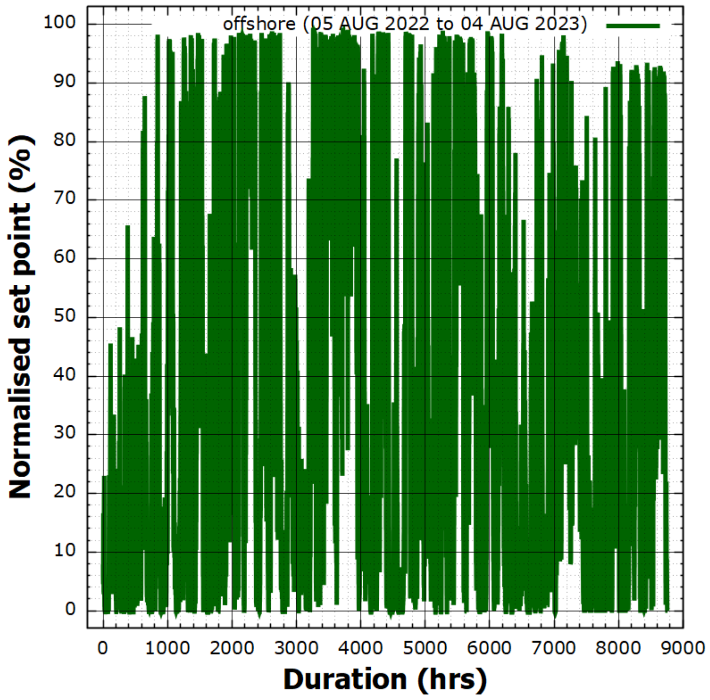
RES-derived operation profiles – PV & wind power



Photovoltaic (PV)



Onshore wind



Offshore wind

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KPI estimation

Evolution of stack performance degradation determined by polarisation curve and EIS measurements under reference operating conditions in periodic intervals k of fixed duration, t_k or fixed by specified number of operation profiles (simulated duty cycles) shortened in time by multiplication with compression factor, f_{compr} ($0< f_{compr} <1$):

- Total stack voltage deviations (absolute & relative) related to stack voltage at beginning of test (BoT), t_0, expressed in µV per hour, per m^3 and per kg of hydrogen generated and in %
- Total stack power deviations (absolute) related to stack power at t_0 expressed in mW per hour, per m^3 and per kg of hydrogen generated

KPI estimation

- Total deviations of ohmic and area-specific polarisation resistances (absolute & relative) related to their resistances at t_0 expressed in mW per hour and in %
- Total deviation in energy and electrical efficiencies (absolute & relative) for HHV and LHV of hydrogen related to the efficiencies at t_0 expressed in % per hour and in %

Questions

- Can the MEA test methodologies including AST protocols developed and applied in projects be readily transferred to water electrolyser (WE) stacks used in WE systems for real-world applications? If not, what has to change, why and how for a realistic and accurate assessment of stack performance/lifetime degradation?
- What are the stressors (individual and combined) likely to be relevant for WE stacks in a system context operated under real-world operating conditions (normal and abnormal) to affect the performance degradation of such stacks significantly while aiming at much shorter test durations in AST of stacks?

Questions

- What test methodologies need to be included (or excluded) in AST protocols for their potential use by academia & industry alike to allow as far as possible for a system-independent assessment of stack performance/lifetime degradation?
- Could todays challenges of electrolyser (non-CRM use, PGM reduction, iridium scarcity, PFAS) have an impact on assessing stack performance/lifetime degradation? If so, should test methodologies used in AST protocols (to remain relevant in the future) adequately account for these challenges?
- Are stack ALT necessary/useful/beneficial for complementing stack AST regarding the three LWTE technologies?

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Thank you

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