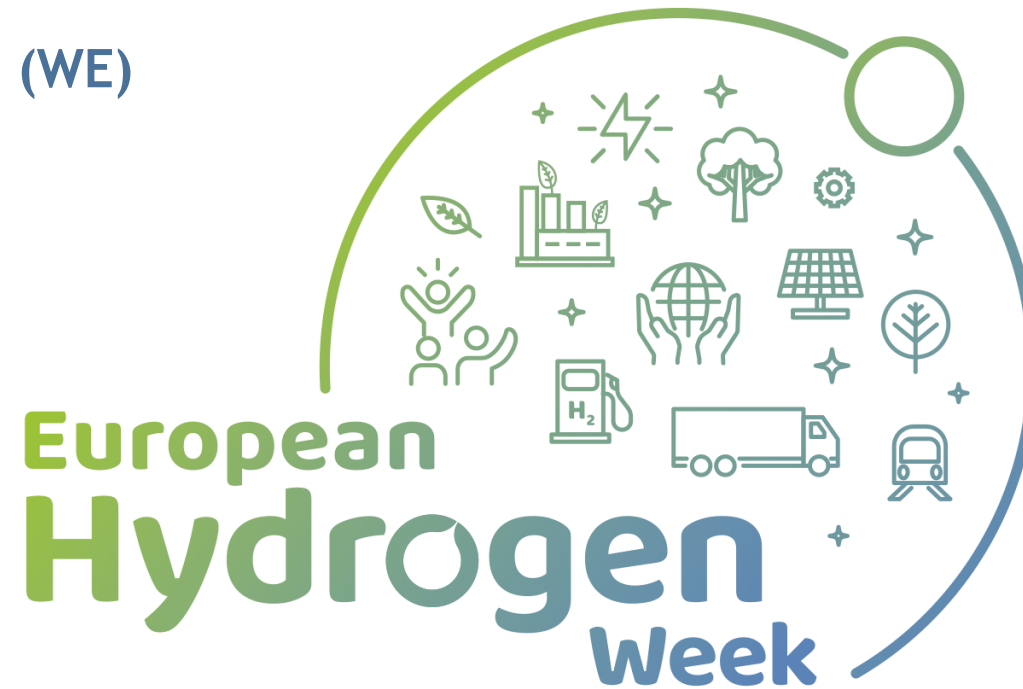


EU harmonisation activities
for water electrolyzers (WE)



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EU harmonisation activities for WE Objectives

- Creating a commonly accepted set of EU wide testing protocols and procedures (operating conditions & test methods) for assessing performance and durability of water electrolysis devices (low and high temperature) in energy storage applications.
- Not intended to replace existing testing practices available in various industries and academia but to allow for an objective comparison of results emanating from different research activities.
- The presented set of documents are proposed to be used in the electrolysis related FCH2JU funded projects.

EU harmonisation activities for WE Methodology

Identification of needs with experts panel in FCH2JU projects

- Terminology documents
- Low temperature WE testing procedures
- High temperature WE testing procedures



JRC to draft documents gathering info's from:

- FCH2JU projects results
- experts feedbacks
- Standard and metrology institutions

- Qualygrids, Anione, Channels, ElectroHyPem, Elygrid, Elyntegration, HPEM2gas, Neptune, Newly, Nexpel, Novel
- Approx 150 Experts consulted for LTWE and HTWE docs
- Terms newly defined or with ISO, IEC, ENTSO-E and BIPM/JCGM references.



Drafted documents submitted for FCH2JU public stakeholder consultation



Final version of documents released and published on EC, JRC and FCH2JU websites

<https://op.europa.eu/en/home>

<https://publications.jrc.ec.europa.eu/repository/>

<https://www.fch.europa.eu/page/fch-ju-jrc-deliverables>

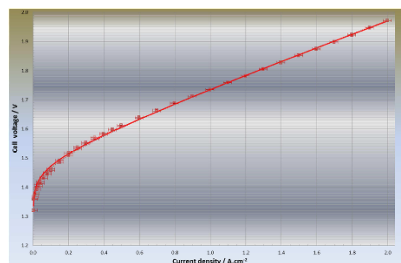
EU harmonisation activities for WE LTWE published documents (2018-2019)

JRC VALIDATED METHODS, REFERENCE
METHODS AND MEASUREMENTS REPORT

EU harmonised polarisation curve
test method for low-temperature
water electrolysis

Malkow T., Pilega A., Tsotridis G.,
De Marco G.

2018



EUR 29182 EN

JRC VALIDATED METHODS, REFERENCE
METHODS AND MEASUREMENTS REPORT

EU harmonised cyclic voltammetry
test method for low-temperature
water electrolysis single cells

Malkow, T., De Marco, G., Tsotridis, G.

2018

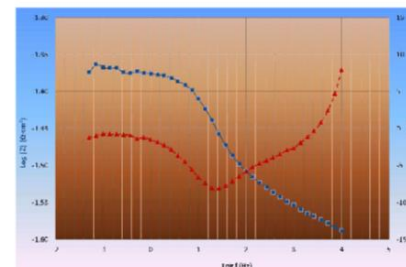
EUR 29285 EN

JRC VALIDATED METHODS, REFERENCE
METHODS AND MEASUREMENTS REPORT

**EU harmonised test procedure:
electrochemical impedance
spectroscopy for water
electrolysis cells**

Malkow, T., Pilega, A., Tsotridis, G.

2018



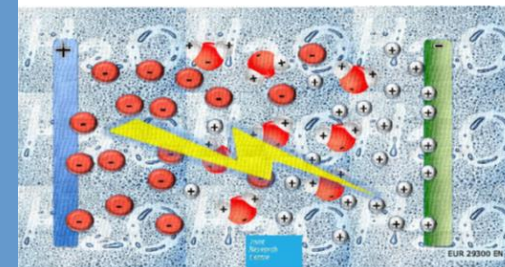
EUR 29267 EN

JRC TECHNICAL REPORTS

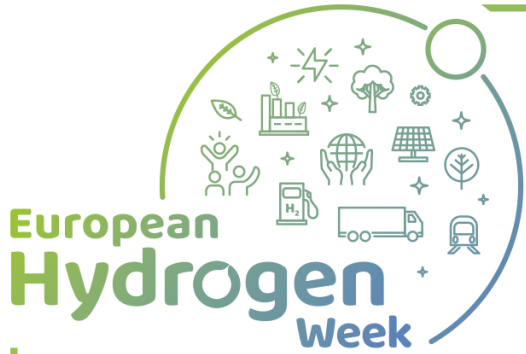
EU harmonised terminology for
low-temperature water
electrolysis for energy-storage
applications

Tsotridis G., Pilega A.

2018



EUR 29200 EN



LTWE harmonisation - Testing protocols for PEMWE, AWE & AEMWE technologies - Scope & needs

Define EU harmonised testing protocols for performance and degradation assessment of electrolysis technologies in energy storage applications (e.g. grid balancing) leading to contribution into ISO/AWI TR 22734/72

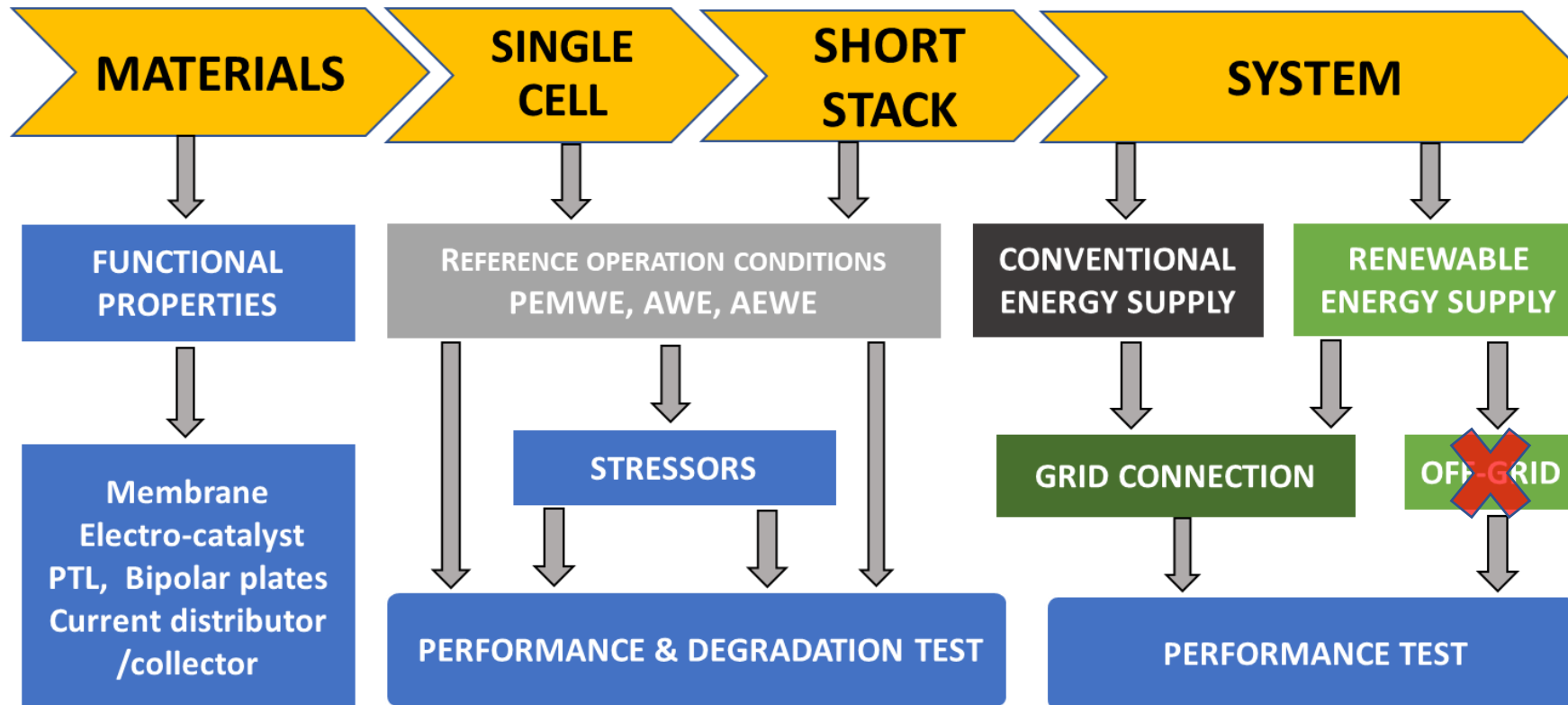
- Materials testing
- Single cells testing
- Stack testing
- System testing

Needs:

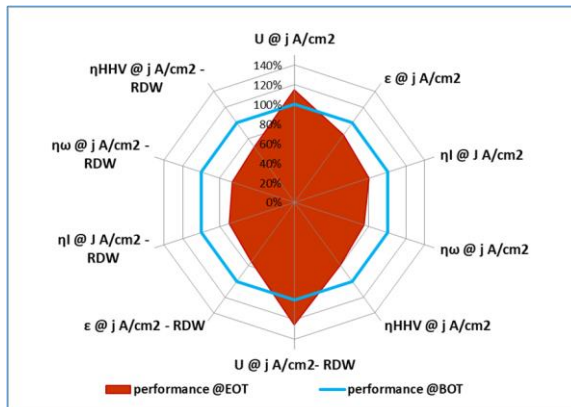
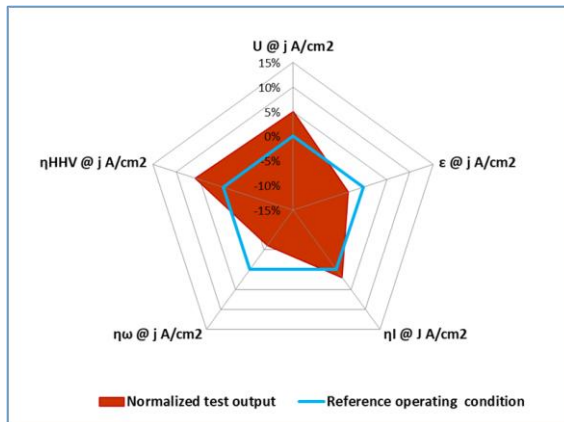
- objective assessment of the performance and durability of electrolyzers under real life conditions (top-bottom approach).
- Transient/dynamic loads using Real World Degradation profiles (based on testing protocols developed by QualyGridS).
- Critical issues on definition of accelerated stress test (AST) and off-grid load profiles.

Successful adoption of these tests requires that they are jointly developed and agreed by all stakeholders.

LTWE harmonisation - Content



LTWE harmonisation - indicators



PERFORMANCE Indicators	SYMBOL
Cell/short stack voltage U measured at current densities j	U
Energy efficiency at covered current densities j	ϵ
Current efficiency at covered current densities j	η_I
Total efficiency at current densities j	η_ω
Hydrogen production efficiency at covered current densities j	$\eta^{(HHV \text{ or } LHV)}$

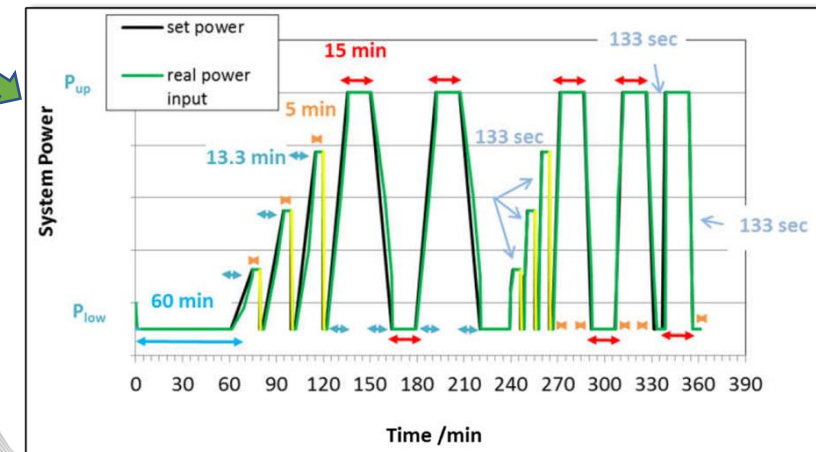
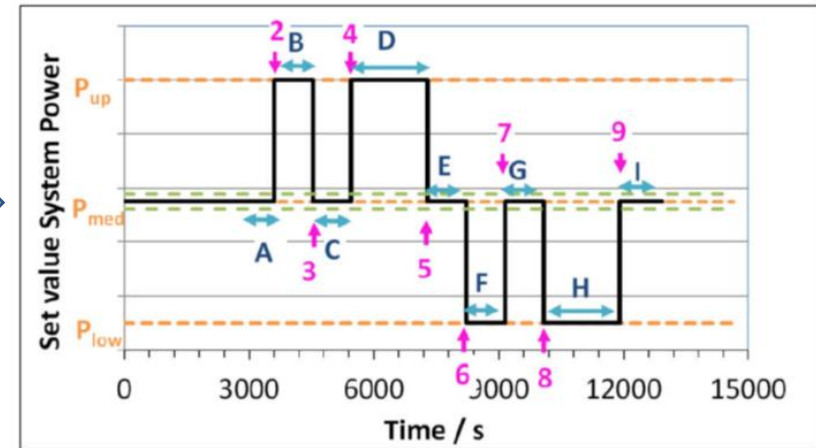
DEGRADATION indicators	SYMBOL
Total cell/stack voltage increase rate	\dot{U}
Reversible cell/stack voltage increase rate	\dot{U}_{rev}
Irreversible cell/stack voltage increase rate	\dot{U}_{irrev}
Stability factor	SF

LTWE harmonisation

-Real World degradation profiles examples

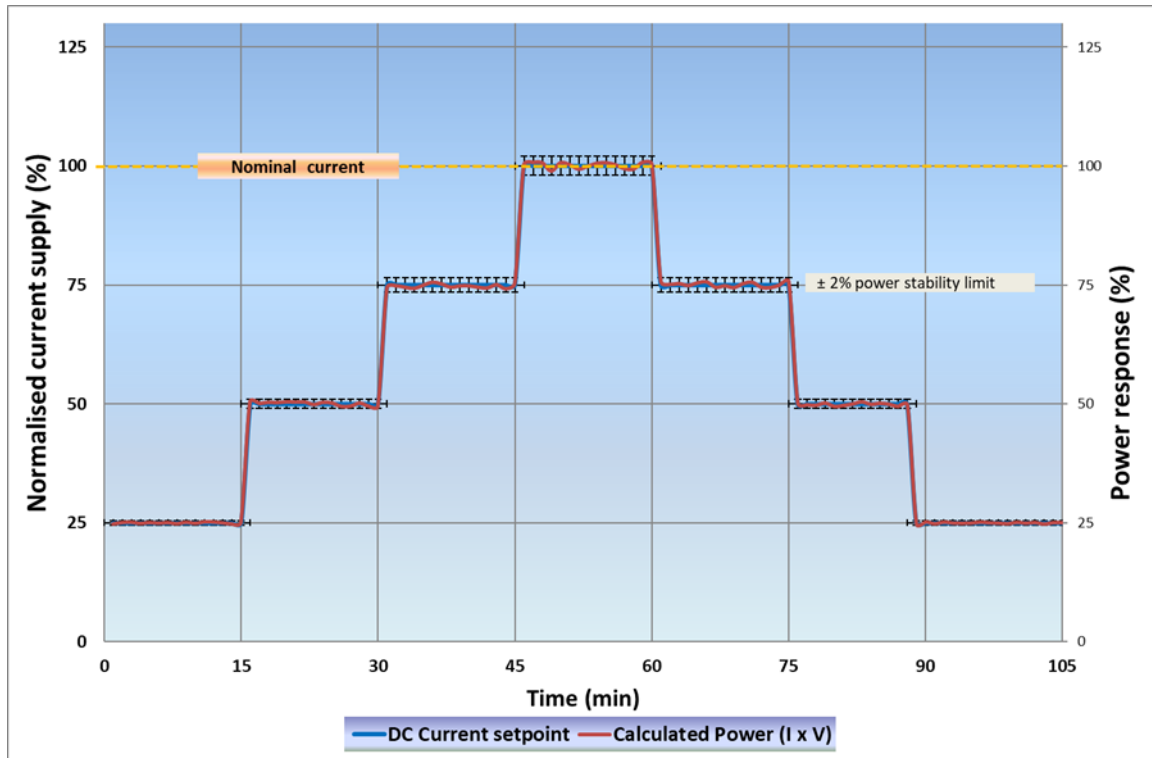
LOAD PROFILES FOR GRID BALANCING (FROM QUALYGRIDS PROJECT)

1	FREQUENCY CONTAINMENT RESERVE FCR
	AUTOMATED FREQUENCY RESTORATION RESERVE aFRR
2	➤ aFRR Negative Control Power
3	➤ aFRR Positive Control Power
	MANUAL FREQUENCY RESTORATION RESERVE mFRR
4	➤ mFRR Negative Control Power
5	➤ mFRR Positive Control Power
	REPLACEMENT RESERVES RR
6	➤ RR Negative (Upward) Control Power
7	➤ RR Positive (Downward) Control Power

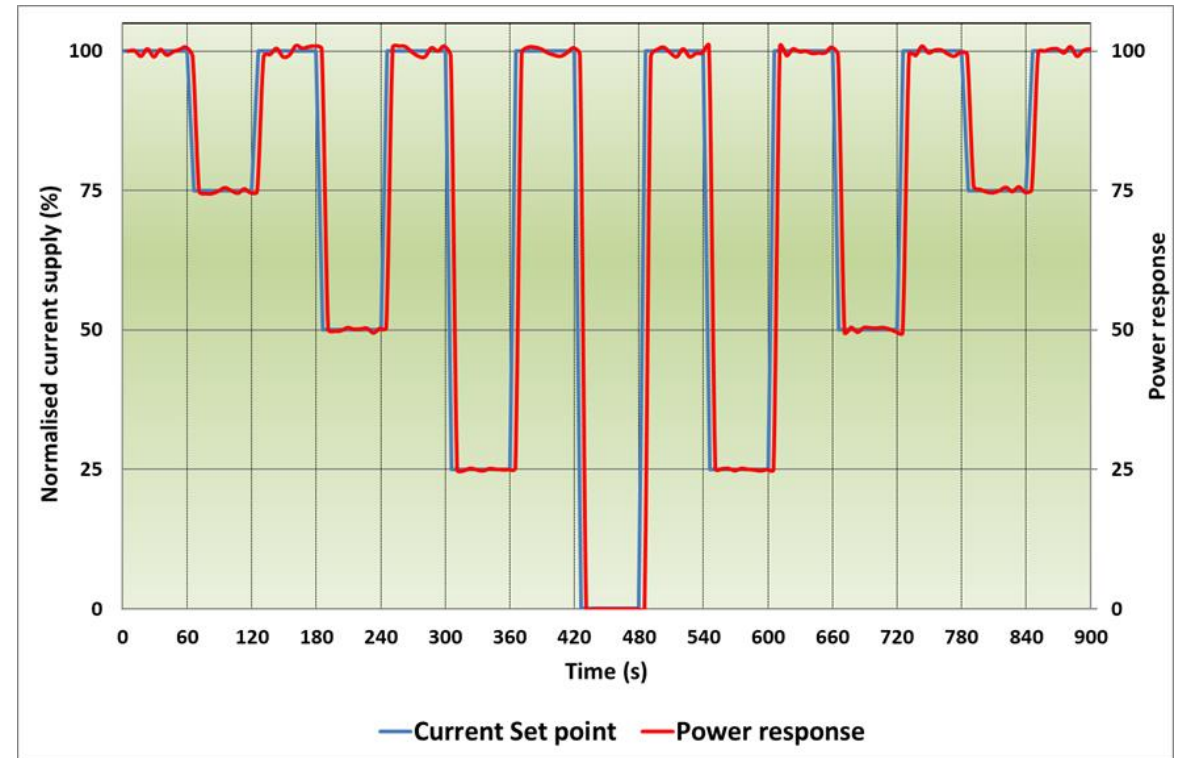


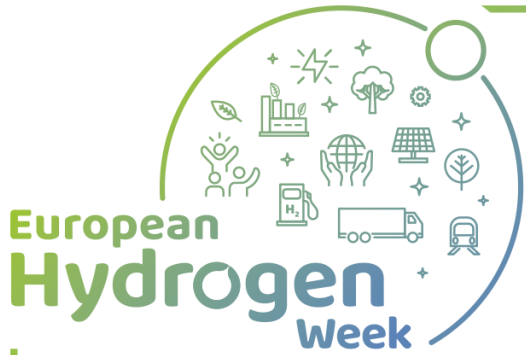
LTWE harmonisation -Accelerated stress test (AST) profiles

Flexibility test profile

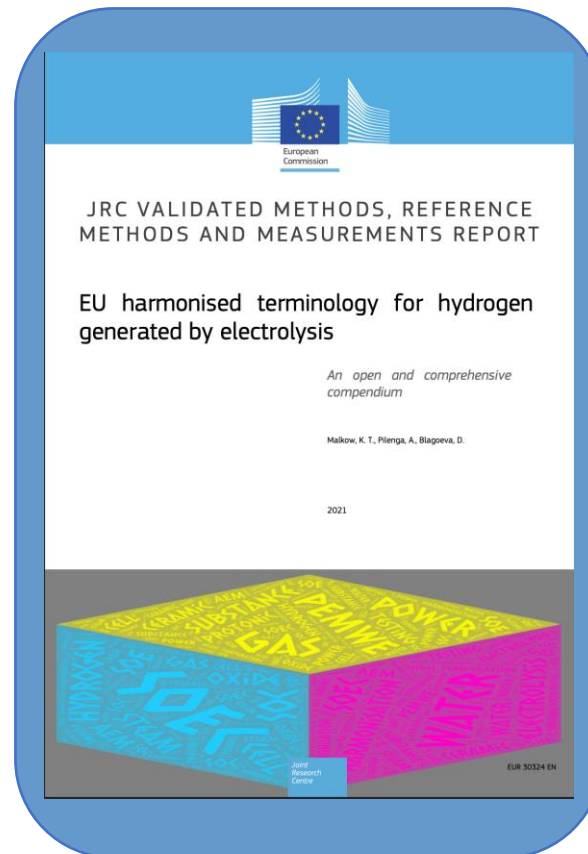
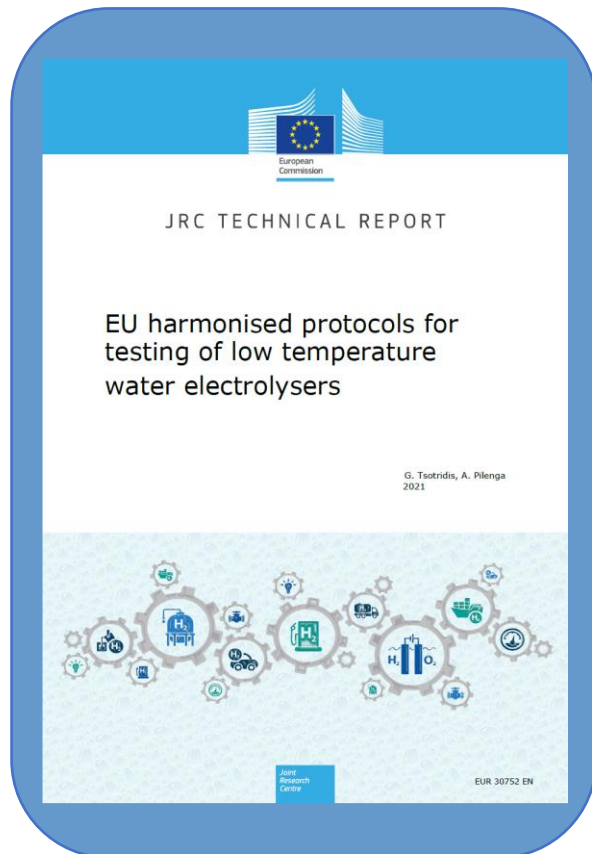


Reactivity test profile





EU harmonisation activities for WE HT & LT WE published documents -2021



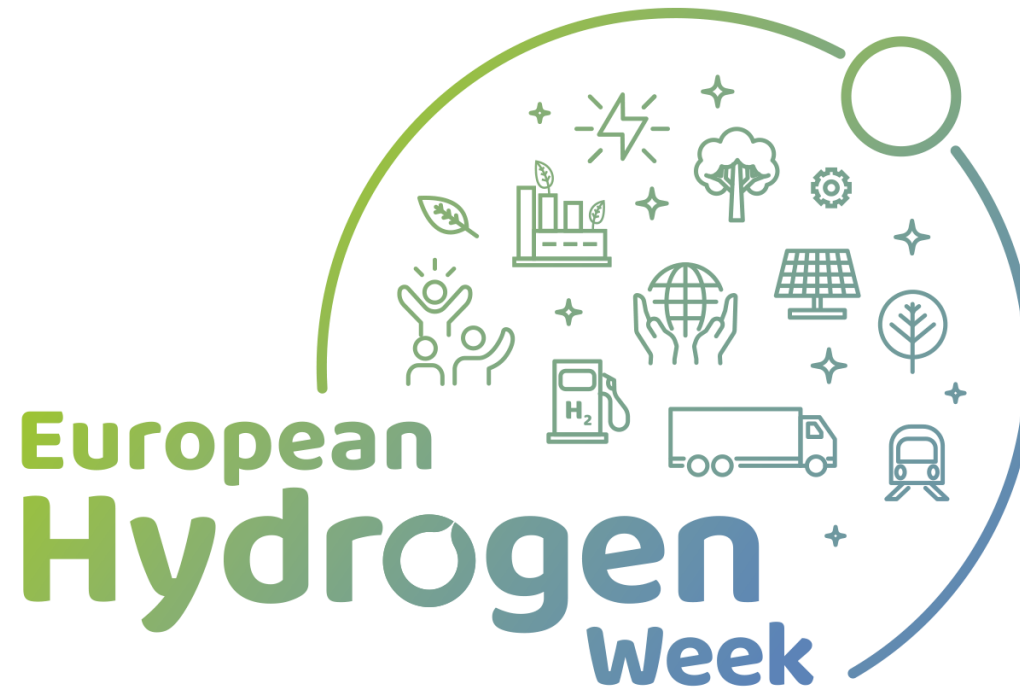
2022 activities follow up

Preparation of a document on high temperature water electrolyser testing protocol to be started with JRC drafted preliminary proposal of content to be discussed with panel of experts

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Looking forward for your feedback



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- G.Tsotridis, D. Blagoeva, G. De Marco, T. Malkow, M. Steen