FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Electrolysis: Relevant RCS + Open Issues, Gaps, Needs for Guidance

Workshop on Safety of Electrolysis

Nick Hart, ITM Power

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Contents

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Regulations, Codes and Standards

- CE marking Directives (equivalent national Regulations) , for example:
  - The Pressure Equipment Directive, *European Directive 2014/68/EU (PED)*;
  - The Machinery Directive, *European Directive 2006/42/EC*;
  - The Low Voltage Directive, *European Directive 2014/35/EU*;
  - The Electromagnetic Compatibility Directive, *European Directive 2014/30/EU*.
  - Elements of the „ATEX Equipment Directive“, *European Directive 2014/34/EU*

- Others (national implementation of European Directives), for example:
  - Seveso (Directive 2012/18/EU on the control of major-accident hazards involving dangerous substances)
  - IED (Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control))
  - ATEX "Workplace" Directive (Directive 1999/92/EC on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres)

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Regulations, Codes and Standards

- National regulations (general) – examples:
  - Safety of pressure systems
  - Safety of machinery
  - Fire safety
  - Etc.

- Other specific requirements based on application
  - Refuelling station documents - typically national Regulations / Codes / Standards (or codes of practice)

- Standards:
  - ISO 22734 – Hydrogen generators using water electrolysis — Industrial, commercial, and residential applications
  - Quality standards (ISO 14687, ISO 19880-8, EN 17124)
  - Other (e.g. for grid injection)

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Background: Where are relevant standards (or codes) developed?

- Internationally, regionally, nationally – examples below:
  - Internationally, through involvement with ISO, IEC, or in Europe through involvement with CEN, CENELEC (via national standards organisation)
  - Through other international bodies: NFPA, EIGA?, EI?, etc.
  - Through national associations / organisations? E.g. BCGA..

- Co-ordination activities:
  - ISO committees, e.g. ISO TC 197 Strategic Planning Meetings (yearly)
  - Others (?): IAHySafe, Hydrogen Council, etc.
  - PNR funding and RCS activity through Hydrogen Europe & FCH JU e.g. RCS Strategy Coordination Group
  - CEN/CENELEC Sector Fora (e.g. SFEM WG H2, SFG-I, SFG-U)

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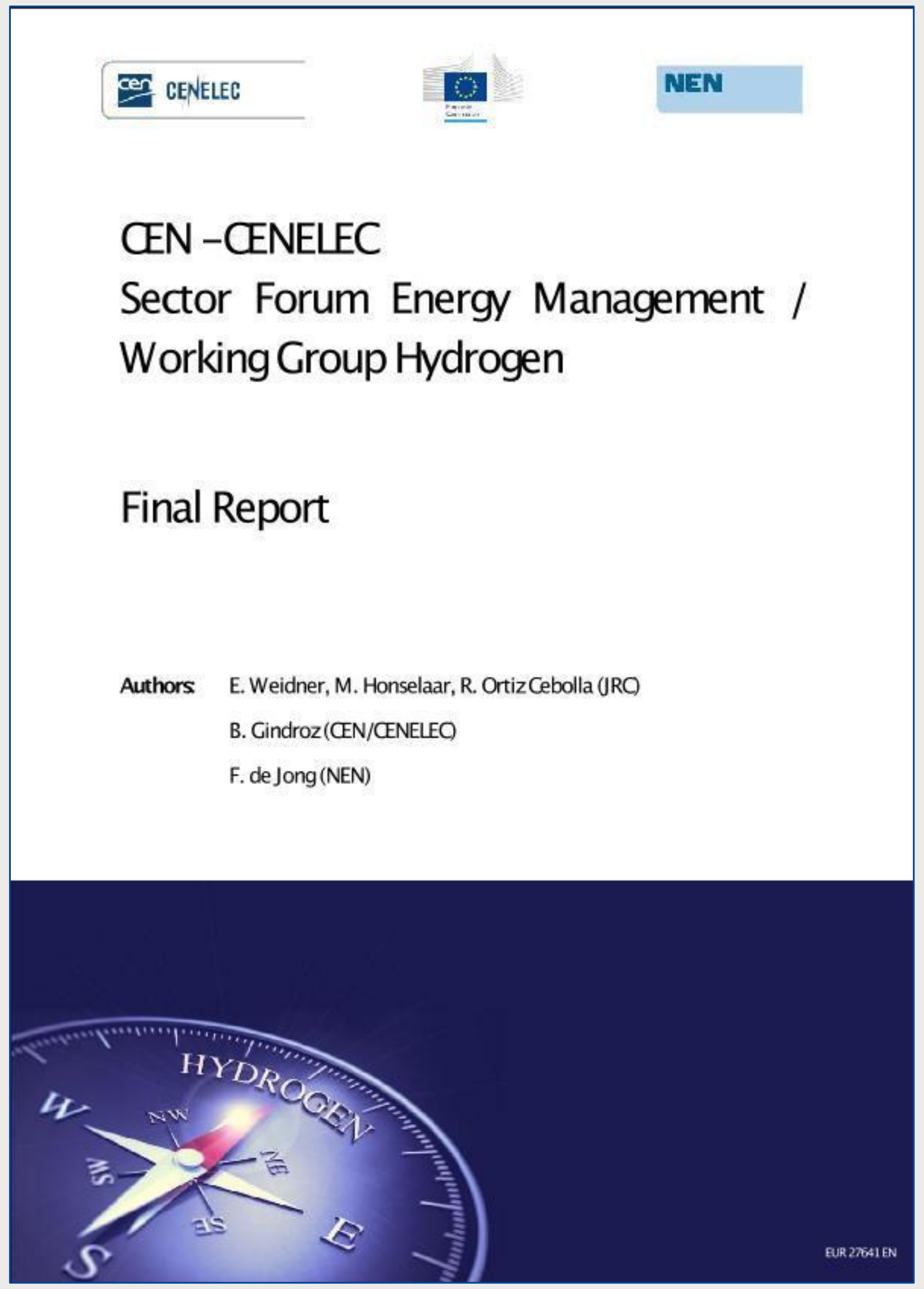
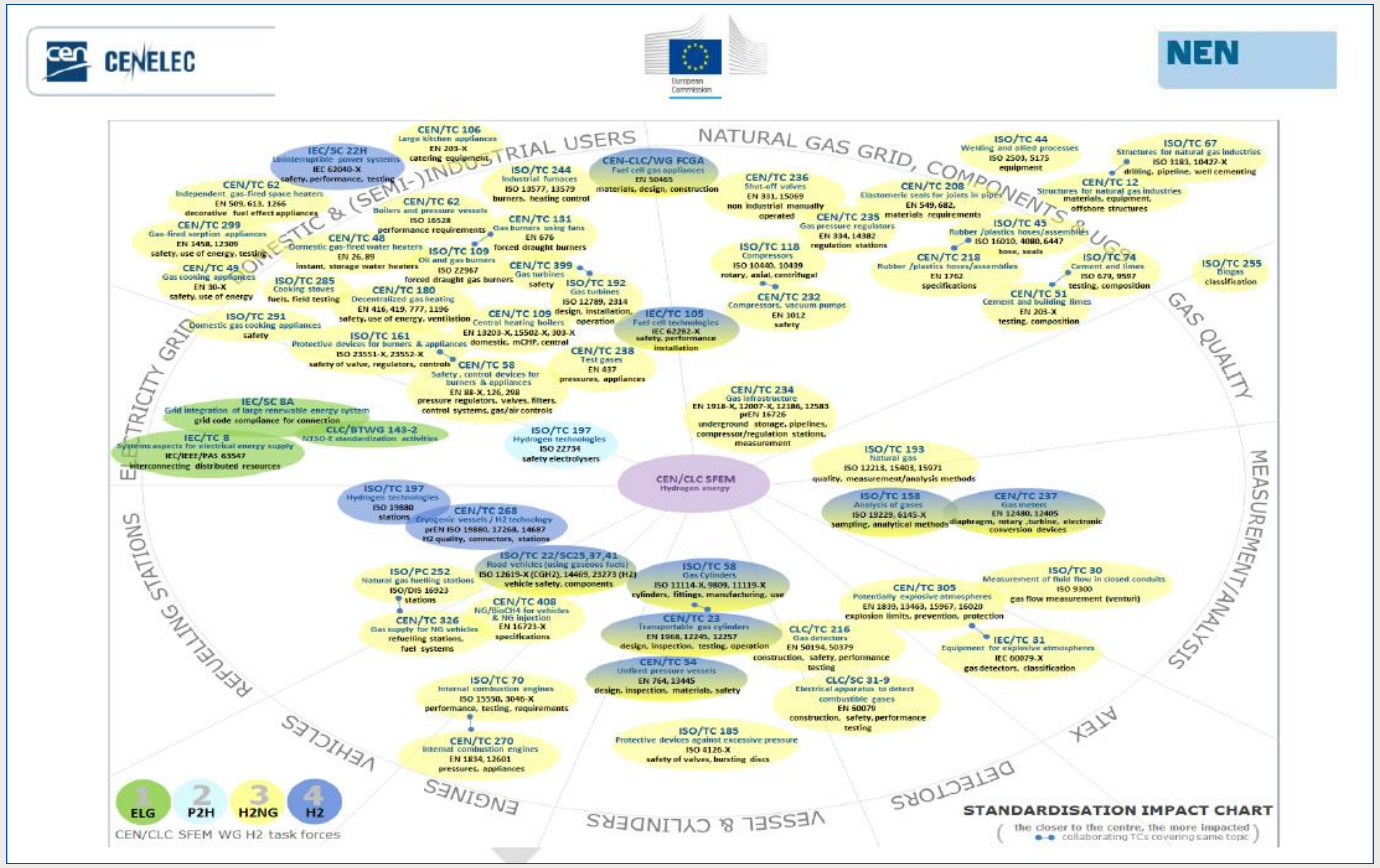
Status standards in 2016: CEN-CENELEC SFEM WG H2 report





See : https://ec.europa.eu/jrc/en/publication/cen-cenelec-sector-forum-energy-managementworking-group-hydrogen-final-report

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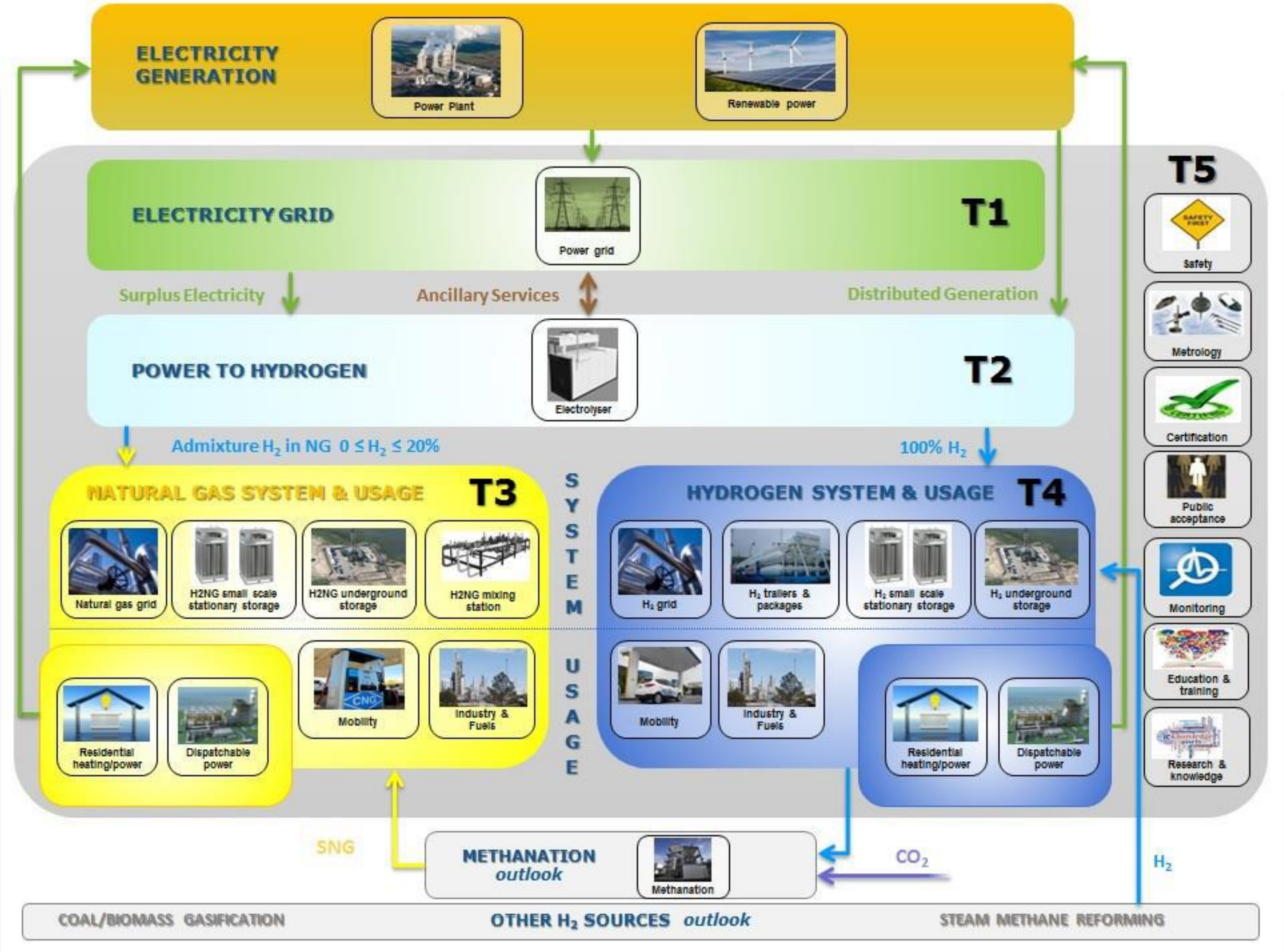

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Status standards in 2018: Updated CEN-CENELEC SFEM WG H2 report

CEN - CENELEC

Sector Forum Energy Management –
Working Group Hydrogen

2018 update report

2019

Status PNR	Ongoing PNR activities	Remaining PNR gaps/comments	Status RCS	Remaining RCS gap/comments	Timeline Roadmap identifiers		Actors involved
					Existing activities	Recommended additional activities	
* 2015 PNR action: New gas analysis devices for H_2>5% ⇒ 2018 status PNR action: No PNR performed (apart from sensors)	Current activities focussing on sensors, see below	State of the art analysis, research and development				*Impact: Low* *Urgency: Start immediately* *Time for finalisation: Less than 5 years* *Timing PNR: 2023* *Timing Standardisation: start the moment input from PNR is mature enough*	Manufacturers, research institutes and standardisation bodies
* 2015 PNR action: Gas analysis: sensors ⇒Topic relevance: >5 vol% H_2 ⇒ 2018 status PNR action: PNR performed as part of several ongoing projects. Detection of H_2 in buildings. Investigation existing sensors. Currently focussing on domestic applications.	Hydeploy project/GRHYD grid project. PNR work by BAM and JRC	Potential gaps regarding in line measurements. Follow up work is expected. Further work on suitability of combustible gas safety sensors for H2NG is needed. Work should focus on leak detection of H2/natural gas blend, through testing with different kinds of sensors, and development of new sensors for H2(blends).	Safety: EN 60079-10-1:2015, IEC 60079-10-1:2015 + COR1:2015 Published. Current stage 60.60 next stage 65.31 NWIP CEN/TC 237? / ISO TR 15916:2015 Current standard for hydrogen sensor is ISO 26142:2010. In addition, when deploying hydrogen sensors other standards should be followed, such as, for instance, the ones related to electric components	Definition of requirements. The text of document 31J/253/FDIS, future edition 2 of IEC 60079-10-1, prepared by SC 31J "Classification of hazardous areas and installation requirements", of IEC/TC 31 "Equipment for explosive atmospheres" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60079-10-1:2015. The following dates are fixed: • latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2016-07-13 • latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2018-10-13 This document supersedes EN 60079-10-1:2009.	PNR results expected in 2022. Standardisation assumed in the next revision cycle.	*Impact: High* *Urgency: Start immediately* *Time for finalisation: Less than 5 years* *Timing PNR: - 2022* *Timing Standardisation: 2021-2024*	TSO/DSO, sensor manufacturers, research institutes, certification and standardisation bodies
* 2015 PNR action: Pressure regulators and valves ⇒Topic relevance: >10 vol% H_2 ⇒ 2018 status PNR action: PNR performed as part of several ongoing projects. A pure H_2 grid will be constructed and natural gas pressure regulators will be used. Increased knowledge about suitability expected. H21: Testing of existing pressure reduction and valves for 100% H_2.	H2-Netz, H21, Hydeploy; H100 (SGN), The Green Village (Delft, NL)	Larger stations with preheating are not covered. Low number of stations covered in the projects.Material issues are not well covered. Blends are not well covered.	PN-EN 15848-1 / PN-EN 15848-2 / EN 334 / EN 14382 / EN 331 / EN 15069 Amendment 1 (ISO 15848-1:2015/Amd 1:2017) / EN ISO 15848-2:2015		PNR results expected in 2025. Standardisation assumed in the next revision cycle.	*Impact: Low* *Urgency: Start within 5 years* *Time for finalisation: Less than 5 years* *Timing PNR: 2025* *Timing Standardisation: 2022-2026*	Manufacturers, TSOs, DSOs, standardization bodies and testing laboratories.

See : https://ec.europa.eu/jrc/en/publication/cen-cenelec-sector-forum-energy-management-working-group-hydrogen-2018-update-report

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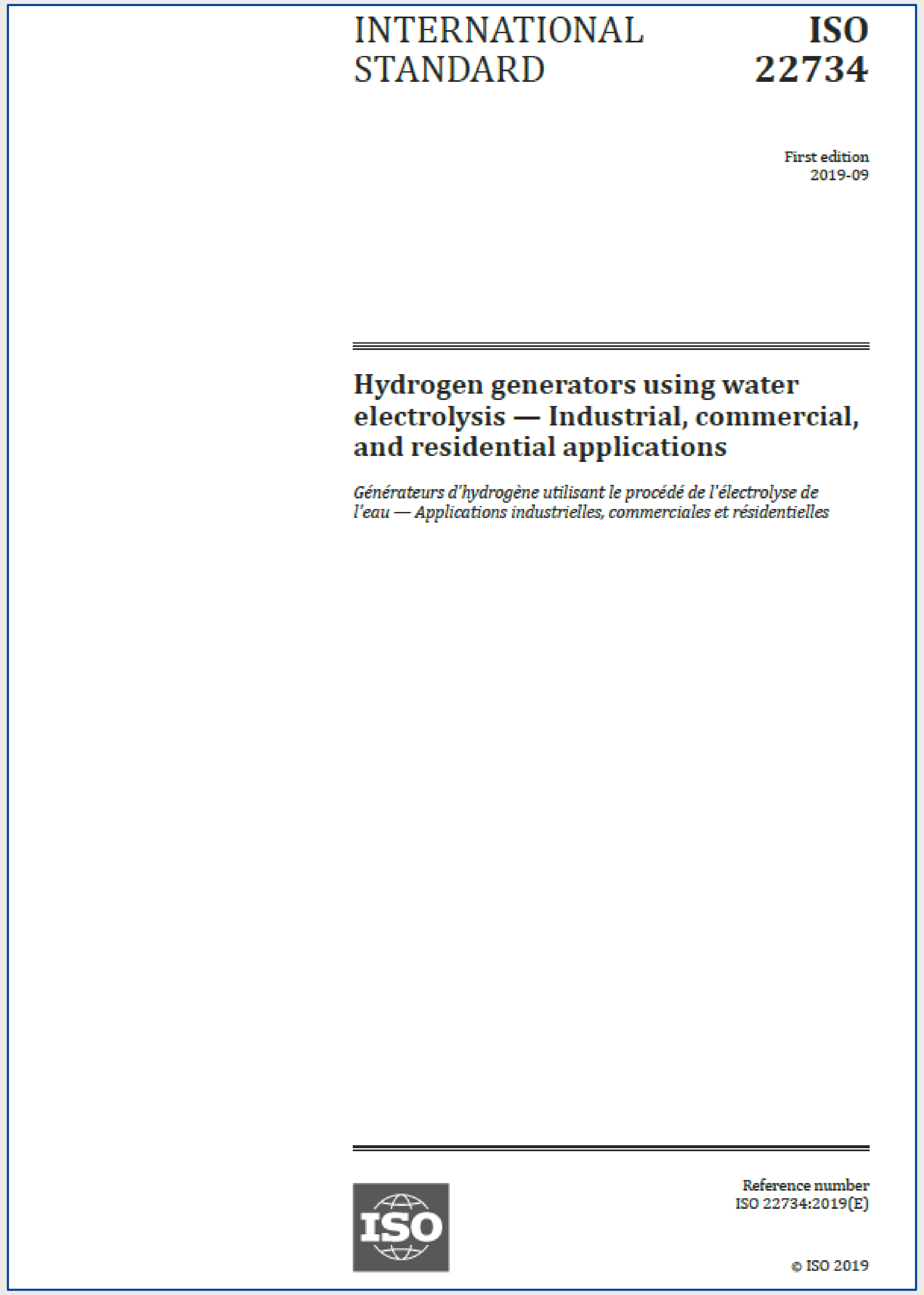
ISO 22734: 2019

Hydrogen generators using water electrolysis — Industrial, commercial, and residential applications

- Developed by ISO TC 197, originally as ISO 22734-1, for industrial and commercial applications, and ISO 22734-2, for residential applications
- Revision published in 2019, combining requirements from ISO 22734-1 and ISO 22734-2, for industrial and commercial applications, and residential applications (previously separated)
- Enabled consistency between documents
- Brought requirements up to date with learnings from manufacturer experience, and from other standards (e.g. ISO 19880-1)


INTERNATIONAL STANDARD

ISO 22734

First edition
2019-09

Hydrogen generators using water electrolysis — Industrial, commercial, and residential applications

Générateurs d'hydrogène utilisant le procédé de l'électrolyse de l'eau — Applications industrielles, commerciales et résidentielles

Reference number
ISO 22734:2019(E)

© ISO 2019

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ISO 22734: 2019 - contents

Requirements:

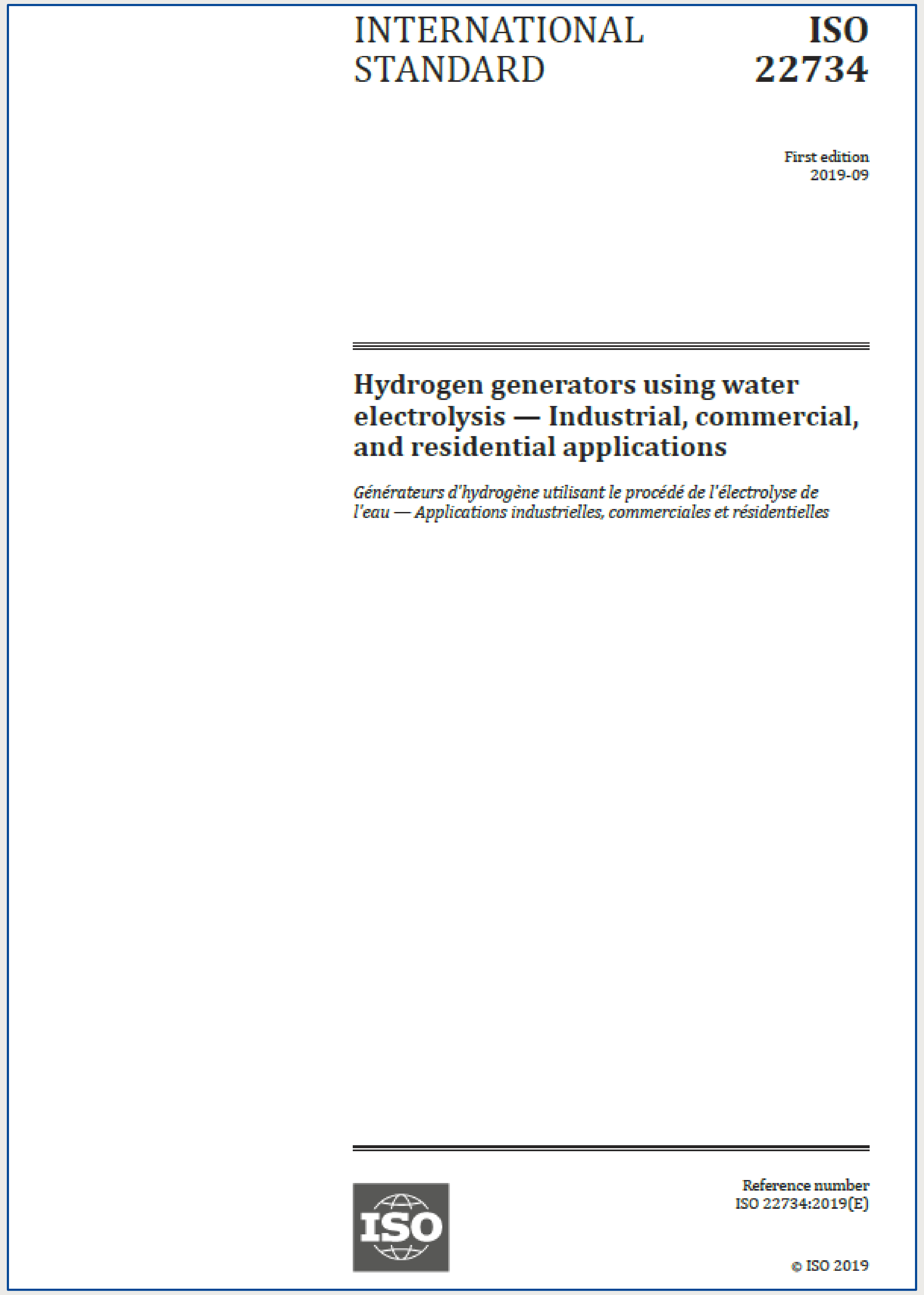
- Operating conditions: specifications, and gas quality
- Risk management
- Mechanical equipment (/components)
- Electrical equipment, including explosion protection
- Control system, including safety integrated functions (SIF)
- Electrolyte/membranes

Test methods:

- Type (qualification) tests
- Routine tests

Marking and labelling

Documentation



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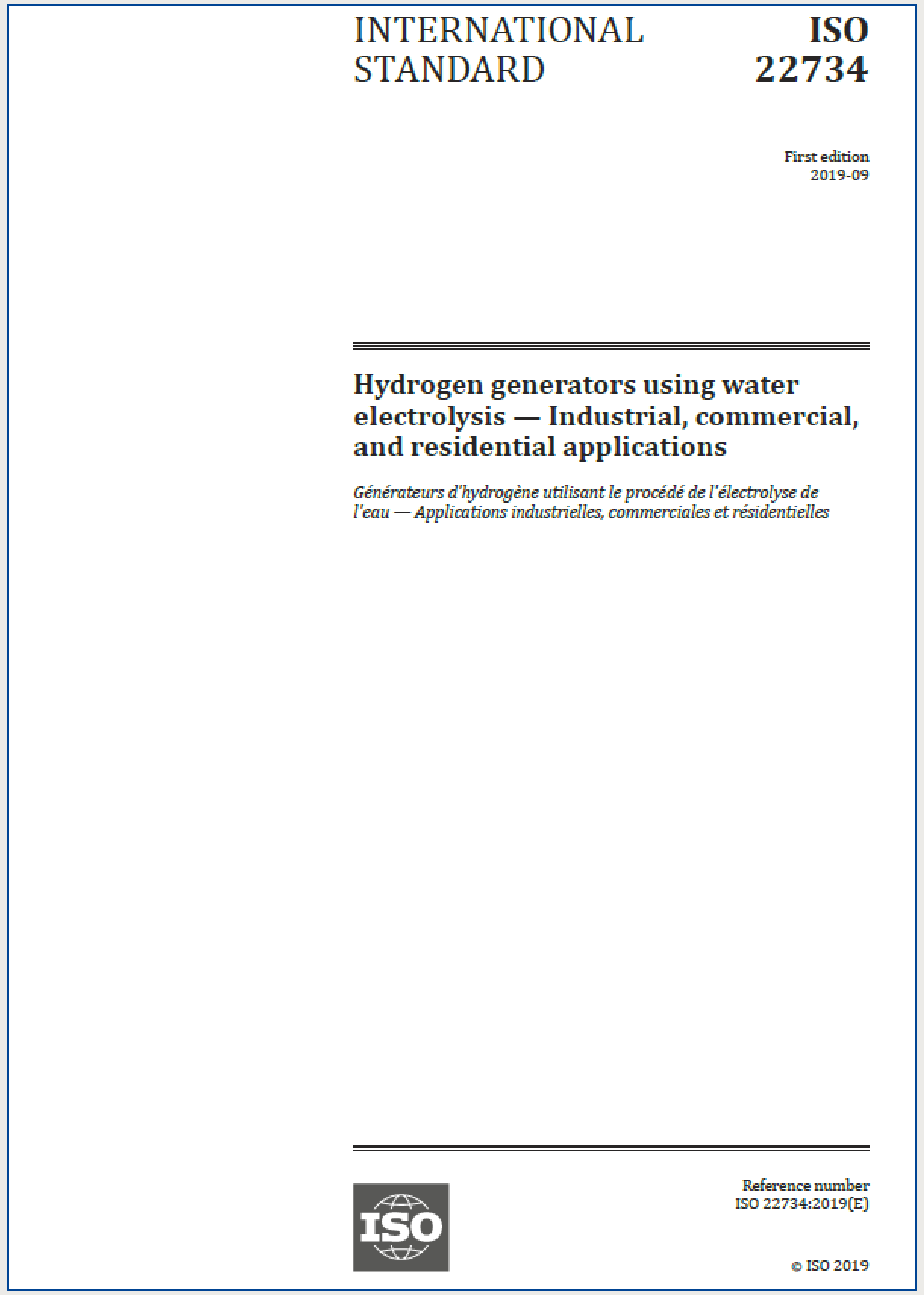
ISO 22734: 2019 – areas requested for potential further development

New requirements for dynamic operation:

- Safety requirements, including tests?
- Tests for performance when used for dynamic operation to be covered in new document ISO 22734-2 (note: no longer for residential applications)

Oxygen venting:

- Reasonable detail included for indoor venting
- Simple requirement “shall be vented in a way that will not create a hazardous condition”… can further requirements / guidance be developed / referenced?



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ISO 22734: 2019 – areas requested for potential further development

Requirements for scale up:

- Ensuring requirements appropriate to size of electrolyser
- Installation into buildings / parallels with other enclosed systems (e.g. HRS)
- Safety integrated systems become more important?
- (Oxygen venting, as above)
- Power electronics / connection to the grid (is this the right place or does this merit a separate document?)
- Separation distances?
- Others?

Need to gather experience, and bring to the revision process…

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					Existing activities	Recommended additional activities	
ELECTROLYSER R&D							
* 2018 PNR action: Upscaling system to MW (10-1000)-range	Ongoing projects: RefHyne, H2Future, HyBalance, Demo4Grid and others.	Manufacturing and safety aspects to be considered. The development of manufacturing techniques and production chains with increased automation needed and in-line quality control.	Covered by ISO 22734 – in process of revision	ISO 22734 may need to be updated to add more detail concerning larger scale electrolysers. To be established following publication of the revised ISO 22734, and the completion of any future projects.	PNR: current – 2022 (depending on project) Standardisation: N/A	*PNR:* *Impact: High* *Urgency: Start immediately* *Time for finalisation: Within 5 years* *Timing: current-2023* *Standardisation:* *Impact: Unknown* *Urgency: TBC on completion of existing projects* *Time for finalisation: TBC on completion of existing projects* *Timing: 2021+*	
* 2018 PNR action: High pressure electrolysis	Ongoing projects: FCH JU Project REFHYNE is developing a 10MW PEM electrolyser operating at 30bar. Projects NEPTUNE and PRETZEL are developing 100bar electrolysers are 10s of kW scale.	Understanding of limitations (if any) on electrolysis at sufficiently high pressures for injection directly into the transmission network, or to avoid/reduce the need for additional compression in other applications (e.g. HRS)	Covered by ISO 22734 – in process of revision	ISO 22734 may need to be updated to add more detail concerning higher pressure electrolysers. To be established following publication of the revised ISO 22734, and the completion of any future projects.	Nothing currently	*PNR:* *Impact: Medium* *Urgency: Start within 5 years* *Time for finalisation: Within 10 years* *Timing: 2020-2025* *Standardisation:* *TBC on completion of future projects*	Industrial and research organizations, Standardization bodies if necessary

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Closing remarks

- Need for identification of issues from practical experience:
  - Manufacturers
  - Operators
  - Additional stakeholders
  - Authorities
- Bring issues to appropriate co-ordination activity, for example:
  - ISO TC 197,
  - IAHySafe,
  - Hydrogen Council,
  - Hydrogen Europe,
  - FCHJU (or Clean Hydrogen for Europe, CHE) RCS Strategy Coordination Group,
  - SFEM WG H2, etc.
  - Others (?)

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Nick Hart
Compliance Officer
njh@itm-power.com

For further information
www.fch.europa.eu

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How best to move forward?

- Need for identification of issues from practical experience:
- How effective / beneficial is it for some of these areas to be looked at specifically for electrolysers?
  - Issues specific to electrolysers – yes
  - General issues relating to hydrogen – debatable
  - General issues relating to oxygen – doubtful
  - General issues relating to control – doubtful
  - General issues relating to power electronics – unclear if there are specific issues
  - Issues associated with operation (not really covered currently) – maybe, but again alignment with equipment like HRS is likely to be possible (and beneficial?)

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General areas for potential further development

Application of standards for hydrogen in enclosed spaces

- Hazardous areas
  - Suitability of IEC 60079-10-1? (specific risk assessment >10 bar, and specific detailed risk assessment >20 bar)
  - Are other options more appropriate for small enclosures? (particularly for Zone of negligible extent)
  - What happens to hazardous area once a minor leak is identified – how to know to shut down or change zone?
- Leak sizes
  - Appropriateness of Table B1 for typical hydrogen applications? (small bore tube, compression fittings, etc.)
  - What is necessary for zoning vs separation distances (probability?)
- Explosion relief (HySEA) -> CEN TC 305 document EN 14994
- Use of hydrogen sensors (location, set-points & responses, etc.)

……

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General areas for potential further development

Application of standards for hydrogen in enclosed spaces (continued):

- Can general guidance be prepared for various hydrogen systems (electrolysers, HRS, stationary fuel cell applications, hydrogen storage & use on boats, etc.:
  - CEN/CLC JTC6 activity, but wide ranging – not clear if it will fill the gap, also unclear how Ex rating etc. to be covered given range of applications – some where ignition protection is needed, others where it isn't even though leaks could be the same, or even more significant
  - Have output from projects such as HyIndoor etc. been fully utilized?

- Hydrogen venting:
  - Methods for defining hazardous areas when venting outdoors

Where would this sit at International level? ISO TC 197? CEN?

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Specific areas for potential further development

- Protection against ignition sources for stacks themselves:
  - Ventilation – energy penalty, noise issues, etc.
  - Inert atmosphere
  - Other methods?

Can further guidance be generated?

(Is this appropriate for a standard?)

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What other standards are needed to facilitate on-site supply to HRS?

- Currently ISO 19880-1 simply points to ISO 22734, and related quality standards
- CEN & CENELEC activity on multi-fuel stations, however not looking at electrolysers
- Upcoming FCH2JU project MultHyFuel
- Example: France – requirements on electrolyser come from overall HRS requirements in legislation
- Example: Issues associated with Industrial Emissions Directive (IED) make it unfavourable to utilise onsite generation as it pushes the HRS into a more onerous approval process by authorities
- Part of the plan for Nikola – are there any issues anticipated in the US, or are current codes and standards adequate?