European Clean Hydrogen Alliance

ROADMAP ON HYDROGEN STANDARDISATION

March 2023

Contents

1. Executive Summary

The European Clean Hydrogen Alliance (ECH2A) brings together industry, public authorities, civil society and other stakeholders to support the large-scale deployment of clean hydrogen technologies by 2030. ECH2A identified, soon after its launch, the need for a robust and harmonised standardisation framework. That led to the creation of a dedicated Working Group (WG) on hydrogen standardisation in February 2022. This WG on Standardisation was tasked with the development of a standardisation roadmap and as a result it was able to:

- make a comprehensive analysis of ongoing hydrogen related standardisation activities;
- establish a comprehensive overview of standardisation gaps/priorities and needs along the whole value chain;
- increase information exchange about and improve the awareness of, future and ongoing standardisation activities;
- streamline standardisation ideas emanating from different initiatives;
- schedule topics in a timeline;

Common European and international hydrogen standards are key to the successful roll out of hydrogen technologies and applications. Considering the complexity of the technologies as well as the time needed to develop standards representing the 'State of the Art' (typically requiring a few years), a development plan with priorities for such standards should be established and be initiated as soon as possible.

It is essential that standards are developed in a timely fashion ensuring alignment with the legal/regulatory framework and development of technologies.

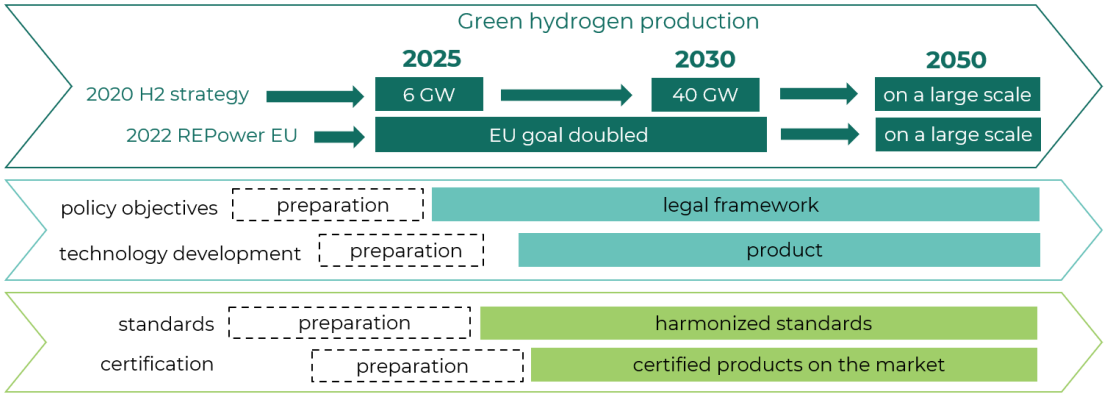

Figure 1: Policy framework in relation to development of hydrogen technologies

In the roadmap, more than 400 topics are listed and are "clustered" along the segments of the hydrogen value-chain.

A simple visualisation tool is proposed to quickly identify the state of play of standardisation activities. Some segments are already well addressed (mentioned as "under development") such as gas cylinders and building-residential applications meaning that most of these standards should be in place soon. Whereas a few other segments such as industry (commercial/industrial/process heat) and mobility (aviation, maritime and heavy-duty and road vehicles) will require the development of new standards.

Finally, the prioritisation work allowed to identify issues for which pre-normative research activities are needed; to name a few; safety aspects (e.g. material compatibility, leakage) or issues linked to different energy carriers.

Beyond the identification of individual standardisation topics, the WG on Standardisation identified in the roadmap a number of issues, namely complementary needs that are required to facilitate the implementation. The most important ones are the following:

a. A clear regulatory framework to give direction to the detailed standardisation work;
b. The publication of standardisation requests, which are mandates of the European Commission to prepare specific standards;
c. The engagement of industry in topics that "need to be developed" and/or topics for which no standardisation committees are exist or are yet active; furthermore, a good information exchange with associations such as Hydrogen Council, IPHE, IRENA, Hydrogen Europe and others is needed;
d. The need for an overall coordination of hydrogen standardisation activities focusing on the technical needs of industry; the alignment with European Commission policies and legislation and the implementation capacity of CEN-CENELEC;
e. Increased cooperation between European and international standardisation bodies based on the existing agreements (Vienna / Frankfurt agreement).

Finally, the WG on Standardisation issued a set of key actions which should pave the way for new hydrogen standards to accelerate the roll out of large-scale hydrogen solutions.

Key action 1: Integration of the identified standardisation topics list into the standard-setting process at EU level (CEN-CENELEC) and international level (ISO-IEC).

Key action 2: Prioritise, as a first step approach, topics that are not yet directly addressed in specific standardisation committees; topics that need further technical understanding to allow for identification of standardisation needs; topics that are horizontal and therefore relevant for different segments of the hydrogen value chain.

Key action 3: Get broader stakeholder engagement in the standardisation process by sending experts to the relevant standardisation committees.

Key action 4: Call on the European Commission to support the hydrogen standardisation process by issuing standardisation request(s).

Key action 5: Continuous support of the standardisation process by the WG on Standardisation.

Key action 6: Strengthen the coordination of the overall process, including with relevant Horizon Europe Partnerships.

Disclaimer

This roadmap reflects the work of the Working Group on Standardisation on Hydrogen set-up in the context of the European Clean Hydrogen Alliance. The list of standardisation issues and priorities identified do not necessarily represent the position of individual members of the Alliance.

2. Introduction

2.1 General

The European Clean Hydrogen Alliance (ECH2A) supports the large-scale deployment of clean hydrogen technologies by 2030 by bringing together renewable and low-carbon hydrogen production, transport, storage, demand in industry, mobility and other sectors. It aims to promote investments and stimulate the roll-out of clean hydrogen production and use.

Set up in July 2020, the European Clean Hydrogen Alliance is part of the EU's efforts to ensure industrial leadership and accelerate the decarbonization of industry in line with its climate change objectives. Its members come from industry, public authorities, civil society and other stakeholders.

The creation of the ECH2A is one of the measures foreseen by the European Industrial Strategy and the EU Hydrogen Strategy to support the emergence of a European hydrogen economy. The targets of the Hydrogen Strategy have been more recently strengthened by FitFor55[1] and REPowerEU[2], which, among several other measures, attribute to renewable hydrogen an important role in diversifying gas supplies and in reducing the dependence on fossil fuels, and the energy dependence from Russia. To achieve these goals, REPowerEU proposes a Hydrogen Accelerator to double the previous EU target to 20 million tons of hydrogen production and imports by 2030 and to enable the development of a hydrogen-compatible infrastructure.

This European policy framework for hydrogen aims at a massive deployment of hydrogen technologies and systems in the EU in the coming years spanning the required manufacturing capacities, supply chains and dedicated infrastructures. One of the enablers for this transformation of the industrial and energy system is the availability of a robust and harmonised standardisation framework. Technical work for this transformation has been ongoing for several years, producing European and international standards which have facilitated the development of research and innovation and demonstration and pilot projects. However, this standardisation process was not designed in view of the current projected acceleration to large-scale deployment. The production, transport, storage and use of hydrogen ten or hundred fold quantities greater than those available today calls for the adaptation and improvement of the existing standardisation framework notably for industrial productions and usage. Regarding specifically the safety dimension, it is also paramount to guarantee safe solutions to increase the market and users' confidence in the uptake of hydrogen technologies. Coherent and shared safety principles and approaches need to be informed by new pre-normative research, to guarantee an acceptable safety level in the presence of greater volumes of hydrogen being deployed across society at large, and therefore affecting more directly the population.

In line with the new European standardisation strategy, this new fit-for-purpose standardisation framework should be developed for and in Europe strengthening European leadership in the various international standardisation bodies where standards and technical regulations are developed for world-wide applications.

[1] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS: 'Fit for 55' - delivering the EU's 2030 climate target on the way to climate neutrality, Brussels 14.07.2021, COM/2021/550 final

[2] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS: REPowerEU Plan, Brussels, 18.05.2022, COM/2022/230 final

The wide breadth and complexity of the hydrogen value chain and rich diversity of hydrogen applications imply a multitude of diverse standardisation needs. Standardisation already has started for many segments. This needs to be brought into a comprehensive overview.

There is a clear need for better coordination and coherence of standardisation activities on hydrogen and a more strategic approach to this issue in order to achieve the EU policy objective to deploy hydrogen on a large scale in line with the Fitfor55, REPowerEU and industrial policy objectives.

The European Clean Hydrogen Alliance published a report[3] back in October 2021, identifying the lack of hydrogen standards as an important barrier to the roll out of hydrogen technologies and applications. Consequently, it established a dedicated Working Group on hydrogen standardisation.

Note:

When joining the European Clean Hydrogen Alliance, NGOs issued a declaration stating that they (i) agree to engage and contribute to the deployment of renewable hydrogen in terms of supply, demand and distribution as this promotes the rapid phase-out of the use and production of all fossil fuels in order to reach the objectives of the Paris Agreement.; (ii) thus do not consider fossil fuel based hydrogen as a short- or long-term solution; and (iii) contribute to targeting the use of renewable hydrogen specifically to those sectors and industrial processes which are hard to decarbonise (steel, cement and basic chemicals, aviation, shipping and heavy good vehicles).

2.2 ECH2A WG on Standardisation – Tasks and expectations

The main objective of the European Clean Hydrogen Alliance Working Group (WG) on Standardisation is to contribute to the better coordination, coherence and guidance of hydrogen standardisation activities and in line with the EU Strategy on Standardisation[4], to call for a more strategic approach to this issue in order to achieve the policy objective to deploy hydrogen on a large scale in line with our Fitfor55, RePowerEU and industrial policy.

The WG on Standardisation has been tasked to:

1. identify issues, gaps, challenges and priorities for the existing standardisation framework along the entire value chain,
2. develop a roadmap.

It is not the goal of the WG to design or develop standards. This is the mandate of the European standardisation bodies CEN, CENELEC, and/or of their international counterparts ISO or IEC.

The WG on Standardisation has been formed based via a call of expression of interest open to all members of the ECH2A. It is composed of 44 members, most of which are experts involved in standardisation committees at national, European and international levels who are very knowledgeable on standardisation processes and projects. The WG on Standardisation has been

[3] Report of the Alliance Roundtables on Barriers and Mitigation Measures, October 2021

[4] An EU Strategy on Standardisation Setting global standards in support of a resilient, green and digital EU single market, COM(2022) 31 final

complemented with representatives of CEN and CENELEC and representatives of National Standardisation Bodies. The list of experts and observers is provided in Annex I.

Thanks to the involvement of CEN and CENELEC representatives it has been possible to also take into account:

- ongoing work in the CEN and CENELEC Technical Committees;
- work from the CEN-CENELEC Sector Forum Energy Management and Transition / WG Hydrogen;
- the potential draft hydrogen standardisation request (initiated by DG ENER);
- the standardisation request on Alternative Fuels Infrastructure Directive (AFID), drafted by DG MOVE;
- ongoing international standardisation activities;
- sector specific activities for future standardisation, e.g. maritime.

Thus, the work of the WG on Standardisation also builds on the previous work done by CEN-CENELEC (see in particular cross-references in the standardisation list Annex II).

The WG on Standardisation organised itself in six subgroups, composed of 8-12 members, reflecting the structure of the Alliance and its roundtables. One additional subgroup was established to address cross-cutting issues.

The subgroups were tasked to:

- identify standardisation topics;
- describe standardisation gaps/needs;
- identify challenges along the entire value chain;
- specify the relevant segments' specific regulatory and standardisation framework.

The roadmap has been written via continuous exchanges between all the members of the WG on Standardisation. The ECH2A Roundtables provided additional input and commented on the draft list of identified standardisation topics to ensure that the entire hydrogen value-chain is covered.

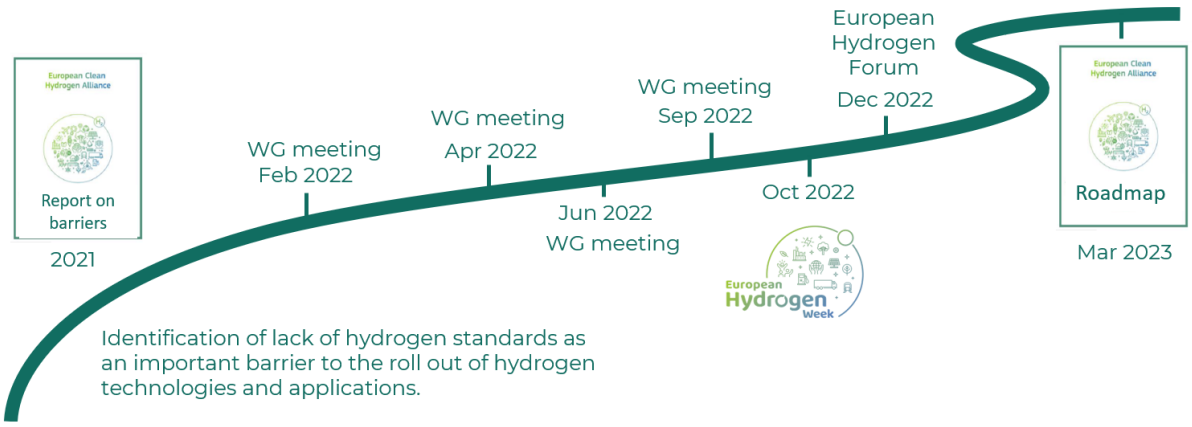

Figure 2 - Schematic representation of the process followed for the elaboration of the roadmap

3. Scope of the roadmap

This roadmap covers standardisation needs for the entire hydrogen value chain, from production, distribution, transport and storage to end-use applications (Figure 3). It considers hydrogen as an energy carrier available in the following forms:

- liquid hydrogen
- gaseous hydrogen
    - pure (100% H_2)
    - hydrogen-natural gas (H_2NG), H_2 blends
- others:
    - Liquid Organic Hydrogen Carrier (LOHC)
    - Liquid Inorganic Hydrogen Carrier (LIHC)
    - ammonia (NH_3)
    - methanol (CH_3OH)
    - OxyHydrogen (HHO)

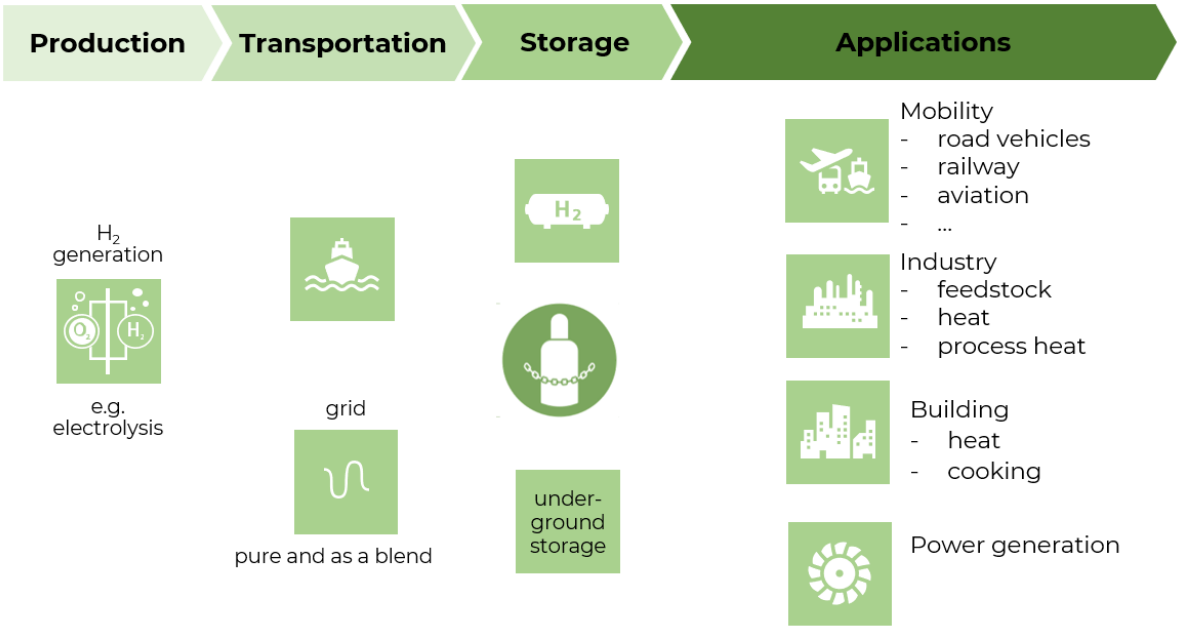

Figure 3: Schematic representation of the complex hydrogen value chain

It was agreed at the start of the process that the roadmap would not discriminate between different forms of hydrogen. Therefore, "clean hydrogen" means renewable and low-carbon hydrogen and is simply referred to as hydrogen in this document. It is also not the intention of the roadmap to discriminate between different hydrogen production pathways.

The roadmap represents the collective view of the members of the WG on Standardisation. It does not represent the views of the European Commission nor its services that facilitate the work of the European Clean Hydrogen Alliance.

4. Standardisation

4.1 Aim of Standards

A standard is a technical document designed to be used as a rule, guideline or definition. It is a consensus-built, repeatable way of doing something. Standards are created by bringing together all interested parties such as manufacturers, consumers and regulators of a particular material, product, process or service who agree on common specifications and/or procedures that respond to the needs of business, meet consumer expectations and guarantee acceptable levels of public safety. Standards are part of the knowledge economy that underpins European industry and society. They facilitate innovation and promote the adoption of new technologies. Standardisation bodies operate at national, regional or international level.

Figure 4 – Coherence of standardisation and innovation advantages

4.2 Explanation of the European standardisation process and timelines

European Standardisation is a key instrument for the consolidation of the Single Market and for strengthening the competitiveness of European companies, thereby creating the conditions for economic growth. European Standards are a valuable tool for facilitating cross-border trade – both within Europe's single market and also with the rest of the world. They reduce unnecessary costs for both suppliers and purchasers of products and services – in the public and private sectors. Standards ensure interoperability and safety, reduce costs and facilitate companies' integration in the value chain and trade. They complement European and national policies and make it easier for companies and other actors to respect relevant legislation.

The European Standardisation System is unique in the world and strictly respects the founding principles defined by the World Trade Organization (WTO) in the field of standardisation, namely coherence, transparency, openness, consensus, voluntary application, independence from special interests and efficiency.

Thanks to the work and involvement of an impressive number of experts nominated by CEN and CENELEC Members, as well as experts representing societal stakeholders (consumer organisations, environmental organisations, trade unions), SMEs and all relevant stakeholders (e.g. business and industry associations, public authorities, trade associations , etc.), European standardisation deliverables are market-driven and take into account the public interest as well as the concerns and priorities of society at large. An essential required characteristic of a European Standard is that it results from consensus of all parties participating in the drafting of standardisation deliverables.

Although technically anyone can propose work that will result in a European Standard, at CEN and CENELEC the work is usually channeled by their members (the CEN National Standardisation Bodies and the CENELEC National Committees). If enough CEN and/or CENELEC members are willing to be involved in the development process, the work is then assigned to a CEN and/or CENELEC Technical Committee (TC) in the field concerned. At the same time, 'standstill' is enforced on all national work surrounding the same topic. Once the Technical Committee is established, mirror committees of stakeholders at national level decide on the national contributions regarding the development of the standard. In addition to the CEN and/or CENELEC members, Technical Committees also include a number of observers, such as ISO/IEC members, the European Commission/EFTA, European partners including Annex I organisations, external European industry associations and other affiliate bodies. Indeed, only by including all relevant stakeholders can CEN and CENELEC deliver standards fit for purpose: not only reflecting 'State of the Art' technical requirements but also take into account digital, social/environmental/societal challenges.

Once the proposal for a standard has been evaluated and approved, the proposal goes on to the drafting stage which is based on consensus-building. When the draft standard is finalised, it goes up to public enquiry open to all interested parties. When the enquiry is over, the votes and comments on the standard are evaluated and depending on the result, the draft standard is either published or additionally worked upon and subsequently submitted to formal vote. This process lasts, on average for 2,5 - 3 years (see details on the dedicated CEN and CENELEC webpages).

Once published, European Standards shall be implemented by the CEN and CENELEC Members, with the obligation to withdraw any national standard that would conflict with the European Standard. Hence, one European Standard becomes the national standard in all 34 Member countries of CEN and CENELEC, ensuring a common level of quality, safety, security and sustainability. This guarantees that a manufacturer has easier access to the market of all the member countries when applying European Standards and this also applies whether the manufacturer is based in a member's territory or not.

4.3 Global standardisation activities

Most global standardisation activities are performed by ISO (the International Standardisation Organisation) and by IEC (the International Electrotechnical Commission).

Both organisations are working according to the same principles and similar procedures than CEN and CENELEC. Through their members from approximately 170 countries, they bring together experts to share knowledge and develop voluntary, consensus-based, market relevant International Standards that support innovation and provide solutions to global challenges.

Examples of hydrogen standardisation by ISO and IEC are provided in Annex VIII.

<u>European standardisation bodies in an international context</u>

The European standardisation bodies are part of a dynamic ecosystem, a global standardisation community that is constantly evolving in response to the ever-changing needs of our societies, a fast-moving global economy and the rapid rate of technological innovation. CEN and CENELEC have dedicated agreements with the International Organisation for Standardisation (ISO) and the International Electrotechnical Commission (IEC), promoting the benefits of European Standards to international trade and markets harmonisation. The high level of convergence between European and international standards is facilitated by the ongoing technical cooperation between CEN and ISO (Vienna Agreement) and between CENELEC and IEC (Frankfurt Agreement).

The main objectives of these agreements are to provide a:

- framework for the optimal use of resources and expertise available for standardisation work;
- mechanism for information exchange between international and European Standardisation Organisations (ESOs) to increase the transparency of ongoing work at international and European levels.

In the frame of their long-standing technical cooperation agreements with ISO (Vienna Agreement) and IEC (Frankfurt Agreement) CEN and CENELEC continuously encourage the alignment of European Standards to international ones. This agreement facilitates the development of ISO and IEC standards to support European legislative and policy needs and are valuable tools for the promotion, dissemination and implementation of ISO and IEC Standards in Europe. These agreements avoid the duplication of work and structures, thus allow expertise to be focused and used in an efficient way to the benefit of international standardisation.

CEN and CENELEC are fully engaged in joining forces with all willing actors to look for international solutions: CEN and CENELEC have a tradition of supporting the primacy of international standards by ISO and IEC thus ensuring a global level playing field.

Other global entities

For some sectors, specific global entities are setting requirements that need to be mentioned even if standards cannot refer to these due to their principally voluntary character. To name a few:

For Maritime IMO, the International Maritime Organisation, is the specialist United Nations agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. (see Annex V)

For Mobility, UNECE The United Nations Economic Commission for Europe plays a role. As a multilateral platform, UNECE facilitates greater economic integration and cooperation among its member countries and promotes sustainable development and economic prosperity. UNECE provides so called Global Technical Regulations to facilitate international cooperation within and outside the region. For example, GTR No 13 on Fuel Cell Electric Vehicles and GTR N 110 for CNG in vehicles.[5]

UNIDO, the United Nation Industrial Development Organization supports countries to industrialise in ways that foster digital and green transitions and accelerate progress with the Sustainable Development Goals. One of the main objectives is to support sustainable supply chains by setting global environmental and social standards, alongside knowledge and technology transfer to improve quality and add value.

4.4 Hydrogen standardisation landscape

Several European and international standardisation committees are responsible for hydrogen standardisation topics along the entire hydrogen value chain. Figure 5 shows a graphic summary of these Technical Committees at European and international level and their relationship. The figure represents currently known Technical Committees involved with hydrogen topics. Further Technical Committees are to be expected over time to tackle additional hydrogen standardisation aspects. The graph highlights the complexity and the large number of actors involved in the hydrogen standardisation process.

[5] Regulation No 110 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of I. specific components of motor vehicles using compressed natural gas (CNG) in their propulsion system; — II. vehicles with regard to the installation of specific components of an approved type for the use of compressed natural gas (CNG) in their propulsion system

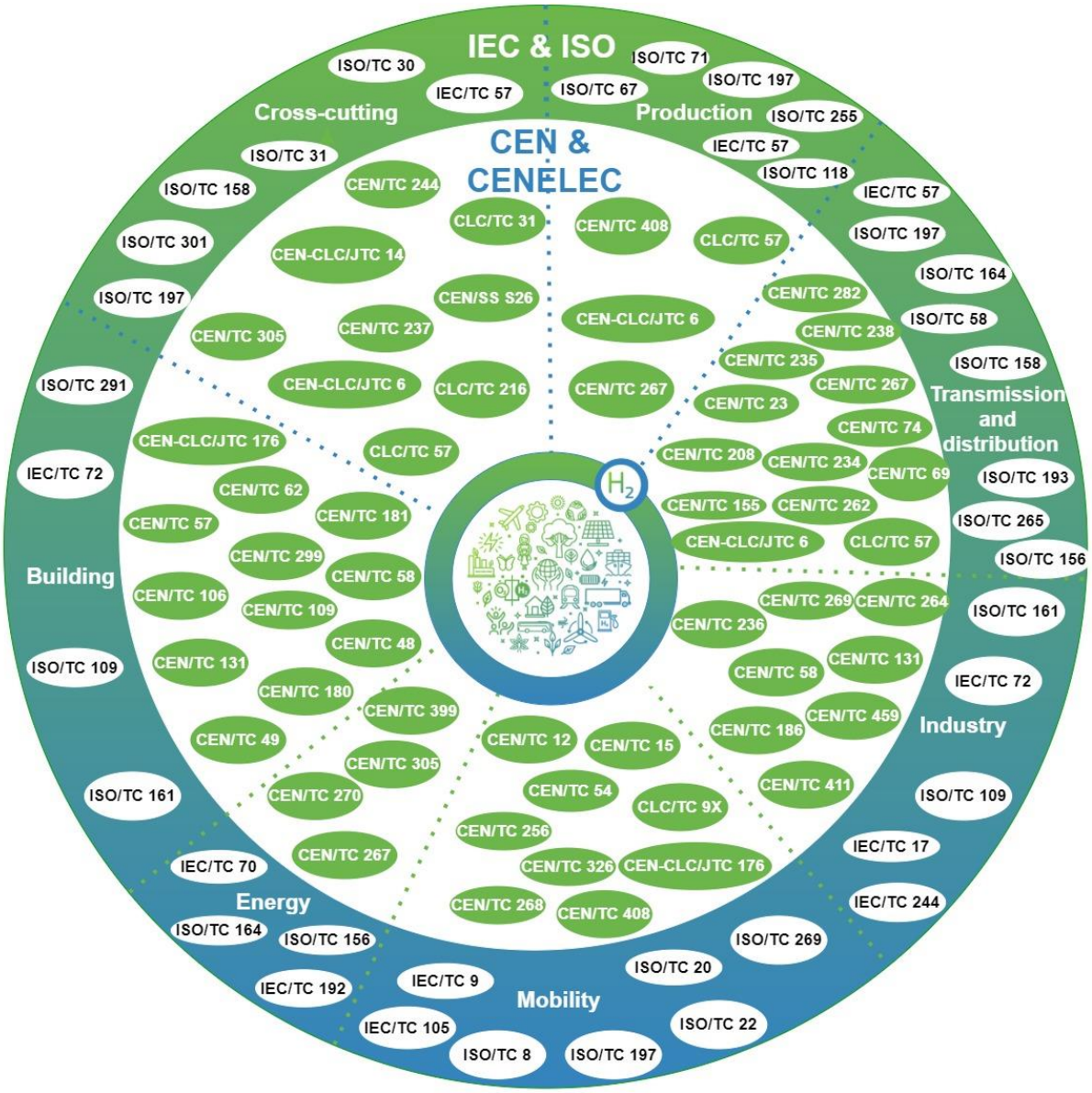

Figure 5 – European and international standardisation landscape for hydrogen topics

Note: The titles of the named standardisation committees in Figure 5 are provided in Annex III. Further details about certain international standardisation committees (e.g. ISO/TC 197 and IEC/TC 105) are given in Annex VIII.

4.5 Activities related to hydrogen standardisation in other organisations

Similar or related analysis and prioritisation work is being performed by industrial, governmental and international associations and bodies, such as the Hydrogen Council, the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA), the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE), the Clean Hydrogen Ministerial (HEM) and the United Nations Economic Commission for Europe (UNECE) and Industrial Development Organisation (UNIDO).

For example, since decades, the IEA dedicates specific attention to hydrogen and fuel cell topics in its two Technical Collaboration Programmes (TCP): Hydrogen and Advanced Fuel Cells which run various tasks dedicated to hydrogen safety and to other regulation, codes and standards (RCS) topics.

Annex IV provides information on the activities related to RCS (regulation, codes and standards) and information regarding other organisations.

Many standardisation issues require aligned approaches at global level such as trade aspects (definition of clean hydrogen and certification) and transport of hydrogen (maritime, etc.) that need international interoperability and consensus. For this, there is a need to strengthen the cooperation between inter-governmental bodies and standardisation bodies such as ISO and IEC, to identify early enough in the process issues that would preferably be addressed at international level. For example, hydrogen trade is a matter of governmental policies and international agreements and implies the adoption of a common certification system for low-GHG emissions hydrogen.

4.6 Pre-normative research

Pre-normative research (PNR) is an essential step for advancing regulations, codes, and standards. PNR activities aim at providing sound scientific and technological facts to either fill the existing gaps in RCS or progress beyond the knowledge available at that point in time, supporting the development of RCS.

Over the last years, several initiatives and instruments at the EU level have been focused on identifying the needs for PNR activities on fuel cells and hydrogen technologies and addressing the needs for R&I and coordination actions to support the development of RCS.

The following are the major European funding tools for PNR:

- the Clean Hydrogen Partnership (see Annex VI) and its precursor, the Fuel cells and Hydrogen Joint Undertaking have played and will continue to play a major role in setting a PNR strategy and funding PNR projects
- other European funding schemes of the Horizon Europe Framework Programme for research complement the contribution of the Clean Hydrogen Partnership
- the Metrology partnership (EURAMET, see Annex VII)
- the European Innovation Council and SMEs Executive Agency

CEN and CENELEC internal PNR initiatives (sector specific)

4.7 Regulatory and standardisation framework

A European hydrogen standardisation framework has obviously to align to the European policies enshrined by the general EU legislative framework related to climate law and the Green Deal, and further embedded in the more technical regulatory framework aiming to decarbonise specific sectors (industry, mobility and transport, etc.).

Regarding the overarching EU climate and energy policies, the following non-exhaustive pieces of legislation can be mentioned:

- European Climate Law[6]

[6] REGULATION (EU) 2021/1119 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law')
https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R1119&from=EN
https://ec.europa.eu/commission/presscorner/api/files/attachment/860462/Commission%20Communication%20on%20the%20European%20Green%20Deal%20Investment%20Plan_EN.pdf.pdf

- EU Hydrogen Strategy[7]
- FitFor55 package[8]
- Renewable Energy Directive[9]
- Hydrogen and Decarbonised Gas Market package [10]+[11]
- REPowerEU Plan and the Hydrogen Accelerator

Additional sector-specific pieces of legislation include:

- Directive for the Deployment of Alternative Fuels Infrastructure of 2014[12], and the follow-up Regulation proposal[13]
- Offshore Renewable Strategy[14]

Finally, the following are examples of more technical regulations making use of European harmonised standards for their implementation:

- ATEX - Equipment for potentially explosive atmospheres directive 2024/34/EU[15]
- PED - Pressure equipment Directive 2014/68/EU [16]
- GAR - Gas appliance regulation 2016/426/EU[17]

[7] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS: A hydrogen strategy for a climate-neutral Europe, COM(2020) 301 final, Brussels, 08.07.2020,

[8] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS: 'Fit for 55' - delivering the EU's 2030 climate target on the way to climate neutrality

[9] DIRECTIVE (EU) 2018/2001 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2018 on the promotion of the use of energy from renewable sources

[10] Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on common rules for the internal markets in renewable and natural gases and in hydrogen, COM(2021) 803 final, 2021/0425 (COD), Brussels, 15.12.2021

[11] Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the internal markets for renewable and natural gases and for hydrogen, COM(2021) 804 final, 2021/0424 (COD), Brussels, 15.12.2021

[12] DIRECTIVE 2014/94/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 October 2014 on the deployment of alternative fuels infrastructure

[13] Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU of the European Parliament and of the Council, COM(2021) 559 final, 2021/0223 (COD), Brussels, 14.07.2021

[14] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS An EU Strategy to harness the potential of offshore renewable energy for a climate neutral future , COM(2020) 741, Brussels, 19.11.2020 final

[15] DIRECTIVE 2014/34/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres

[16] DIRECTIVE 2014/68/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment

[17] REGULATION (EU) 2016/426 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 9 March 2016 on appliances burning gaseous fuels and repealing Directive 2009/142/EC

Each section in Chapter 6 is dedicated to a specific hydrogen end-use application or supply-chain element and provides a more complete list of the European Regulations to be considered for the specific standardisation needs.

Finally, the general objectives of the EU standardisation regulation 1025/2012 and the new (2022) European Standardisation strategy apply also to the hydrogen standardisation process.

Madrid Forum Conclusions (11th May 2022)

The Forum underlines the importance of defining quality standards for hydrogen and supports the Commission to mandate CEN and CENELEC to develop standards for the quality of hydrogen in the hydrogen network and at end-users with the involvement of all relevant market participants.

The Forum stresses the importance of enabling the cost-efficient integration of renewable and low carbon gases in the existing gas system. It is key to ensure that these gases have full access to wholesale and retail markets, infrastructure and cross-border trade.

5. Methodology at the basis of the roadmap

5.1 Identification of the standardisation topics

The basis of the roadmap are standardisation topics identified and collected by:

- the members of the WG on Standardisation subgroups
- CEN - CENELEC representatives
    - CEN-CENELEC list (incl. SFEM reports)
    - CEN-CENELEC SFEM WG H2 Workshops (background, approach + SFEM WG WS)

A list of approximately 400 standardisation topics were gathered. See Annex II.

The list includes a description of:

- the standardisation topics and gaps, identified by surveying the WG on Standardisation members and observers
- the relevance for 100% H_2 and / or H_2NG
- the status of the standardisation project:
    - in place: standard published; Hydrogen standardisation topic is already covered
    - under revision: an existing standard will be revised to address the hydrogen standardisation topic
    - in preparation: standardisation topic is addressed; preliminary project; new project
    - to be identified: no standardisation project nor committee is identified
- the responsible standardisation committee

In addition, a matching with the existing CEN-CENELEC draft work programme, elaborated in the context of the potential hydrogen standardisation request and further identified topics by CEN - CENELEC, was done in order to visualise which standardisation topic is already addressed by CEN-CENELEC and which are additionally identified by the WG on Standardisation. This gives a comprehensive picture of all topics and facilitates the overall implementation.

The number of mentioned topics reflects the wide scope and the diversity of standardisation topics. This list represents a snapshot of standardisation knowledge of the involved parties at the time of elaboration. Further topics will be identified over time.

The analysis of the identified topics has led to:

- a topic clustering and timelines based on the identified standardisation needs of the WG subgroups (6.2 to 6.8),
- a prioritisation (6.9),
- the identification of complementary needs (6.10).

5.2 State of development and timeline

This roadmap presumes that a coherent and appropriate set of standards is in place by 2030. A typical time frame for the development of a single standard is 2-3 years.

Based on the state of their standardisation the topics in the clusters were classified as (see 6.2 to 6.8.):

- under development: the main topic is already identified as a project or in a technical committee
- to be developed: for the main topic no project and/or technical committee was identified
- PNR: Pre-normative research topics
- in place: if the standards for the main topic are already published

Clear milestones have to be defined by CEN, CENELEC, ISO or IEC in line with the prioritisation.

6. Results of clustering, prioritisation and complementary needs

6.1 General

This chapter presents the results of the analysis described in the previous chapter.

The matter has been organised around hydrogen applications and/or supply chain segments, here called clusters:

- hydrogen production
- hydrogen infrastructure (transport, storage, delivery) - transmission and distribution (T&D)
- industrial applications
- mobility
- energy - sector integration including the power generation sector
- building - residential applications
- cross-cutting

In each of these clusters, the matter has been further grouped into ‘topics’. Each cluster section provides a short introduction on the technologies/sectors involved, the reference to the specific regulatory framework (RCS – regulations, codes and standards) and finally a list of technical needs and their timeline.

The prioritisation was carried out from an over-arching view to identify horizontal topics and related synergies and interdependencies for standardisation. Thus, it does not follow the cluster structure.

As standardisation is not a stand-alone action, complementary needs are identified that significantly support the standardisation action.

6.2 Cluster: Hydrogen production

6.2.1 RCS Framework

The hydrogen value chain begins with the first stage: production. Here different technologies, pathways' (water electrolysis, fossil or biological resources via SMR/ ATR, biomass, biomethane, and waste) and input resources (power, water, fuels, electricity, waste, biomass, biomethane, others) establish the energy vector hydrogen. Due to the anticipated international trade, hydrogen and its carriers – as a significant pillar for decarbonisation and as a substitute for more polluting energy sources – requires a global common standardisation system to avoid market fragmentation or barriers to cross-border trade.

The production stage includes the purification and compression and possibly storage at the production site. From the production stage other value chain steps are relevant and need to be considered as well, such as hydrogen transportation, distribution, storage, transformation or end-uses.

Legal and regulatory framework[18]

The basis for this transition will be developed mainly via the FitFor55 package and the Hydrogen and decarbonized gas market package but also with other regulations mentioned in section 4.7 above.

A series of legal, regulatory and standardised procedures and certifications are essential to enable production facilities and equipment along the process and to ensure that the hydrogen produced meets pre-established quality and emission requirements, including quantitative definitions of low-carbon and renewable hydrogen, a robust methodology for and accounting rules for the GHG-emission of the produced hydrogen (see cross-cutting aspects in section 6.8 below)

Standardisation framework

The European and international levels are the main sources of standardisation for hydrogen production. For the further development of European standards, it is important that the potential draft hydrogen standardisation request that has been in preparation between CEN and DG Energy is updated and that additional requests be published as needed.

6.2.2 Technical needs and timeline

The relevant technical committees are already in place and developing and updating the relevant standards for hydrogen production. Emphasis is on clean and alternative hydrogen production below defined emission thresholds.

Depending on the regulatory frame that still needs to be completed, besides electrolysis, other low-carbon production paths may exist, this might even include negative emission technologies.[19] Along with industry best practice, harmonised standards will be needed to ramp up production and ensure technology leadership of European engineering technologies.

Electricity grid connections, Power to X technologies, as well as gas quality aspects are crucial parts to standardise such as to facilitate hydrogen production. Taking into account material compatibility to ensure safety, will also be needed and shall be developed from PNR activities to feed international standards.

[18] An interesting overview is given on: EU Policies | FCHObservatory

[19] Pyrolysis - Potential and possible applications of a climate-friendly hydrogen production, DVGW energie/wasser-praxis kompakt, October 2022 (https://wvgw.de/dyn_pdf/ewp/2022/kompakt_Pyrolysis/)

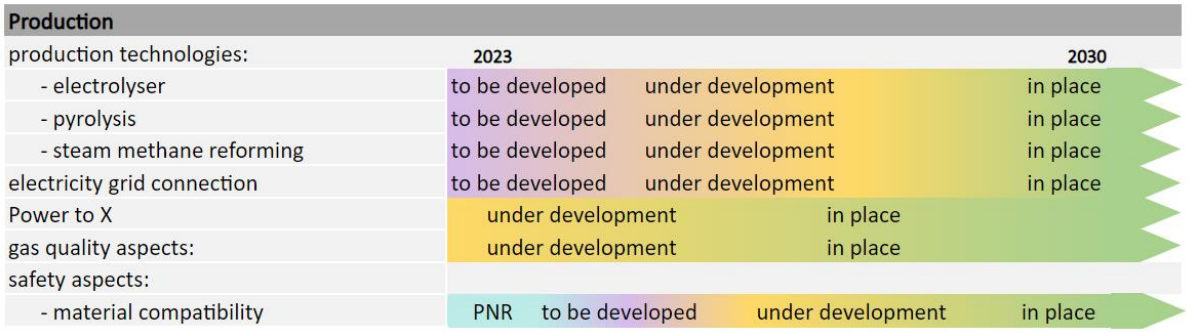

Figure 6: Cluster production – current status of standardization

6.3 Cluster: Infrastructure – Transmission and Distribution T&D

Infrastructure in the context of this study describes the grid from the injection facility up to the inlet connection of gas appliances. This includes injection, transmission, distribution, storage, compression, pressure regulation and measuring, installation, as well as related requirements on safety, gas quality, environment, emissions and management systems.

Gas infrastructure conveys gases (e.g. natural gas and biomethane) to residential, commercial and industrial end-users. It is technically possible to repurpose the existing natural gas infrastructure for the storage and conveyance of hydrogen and its blends from the production to the end-use with a limited extent of adaptations.

6.3.1 RCS Framework

Legal and regulatory framework

The existing infrastructure builds an essential and economic solution to convey hydrogen to the applications, such as industry, using hydrogen as combustion fuel and/or feedstock. It facilitates the transition from fossil natural gas to hydrogen and other low- and decarbonized gases and its blends. Thus, the repurposing and possibly extension of the infrastructure builds a basic element of the take-up of hydrogen market.

The repurposing of the infrastructure for hydrogen is a major contribution to the decarbonisation of the energy system.

For gas infrastructure and its repurposing the legislation in section 4.7 above applies. The following are of specific significance:

- Gas directive for the common European market
- Proposal for a Regulation on guidelines for trans-European energy infrastructure amending Regulations (EC) No 715/2009, (EU) 2019/942 and (EU) 2019/943 and Directives 2009/73/EC and (EU) 2019/944, and repealing Regulation (EU) No 347/2013
- The new Gas Directive proposal: Proposal for a Directive on common rules for the internal markets in renewable and natural gases and hydrogen (revision of Directive (EU) 2019/692 amending Directive 2009/73/EC concerning common rules for the internal market in natural gas), COM/2021/803 final, especially:
    - Article 19 (Cross-border coordination on gas quality)
    - Article 20 (Hydrogen blends at interconnection points between Union Member States in the natural gas system)

- A Gas Regulation proposal: Proposal for a Regulation of the European Parliament and of the Council on the internal markets for renewable and natural gases and for hydrogen (recast) COM/2021/804 final (revision of Regulation (EC) No 715/2009)
- Gas Network Codes for interoperability and data exchange (NC INT) – including gas quality aspects

Standardisation framework

The European standards for on-shore gas infrastructure are mainly elaborated at CEN level, whilst the standards for off-shore infrastructure are taken-over from international standards.

Standardisation of the gas infrastructure is composed by functional standardisation for design, construction, operation and maintenance and by standardisation of the necessary equipment (e.g. valves, meters, pressure regulators, safety devices, …).

For the repurposing and extension of the existing infrastructure, an update of these European and international standards is needed to include specific requirements on adaptation measures (choice of material, sealings, safety aspects) and also assessment criteria to make the infrastructure fit for purpose for hydrogen and to ensure its safety, operation and maintenance. This includes the provision of appropriate hydrogen quality standards to ensure the safe conveyance and use of hydrogen and its blends at end-use.

The revisions are well underway in the responsible CEN-CENELEC and ISO Technical Committees (e.g. CEN/TC 234, CEN/TC 69, CEN/TC 235, CEN/TC 236, CEN/TC 237, CEN-CLC/JTC 6; ISO/TC 67 SC 2, CEN/TC 12, ISO/TC 197) for 100% of hydrogen and blends. Examples are the CEN/TS 17977 for hydrogen used in repurposed natural gas systems and also the inclusion of hydrogen concentrations in the existing H-gas quality standard EN 16726.

The standardisation work is coordinated by bilateral liaisons and also by exchange in the CEN Sector Fora[20] on Gas infrastructure and Gas utilization.

The following standardisation requests are driving the present European standardisation of gas infrastructure and might need revision when the current draft legislation (see section 4.7 above) will be adopted:

- M/017 Standardisation mandate to CEN in the field of equipment and installation for the transmission and distribution of gas (Equ.& inst.-trans.& distr.-gas) EEC (PPD_93_38) Procurement procedures of entities operating in the water, energy, transport and telecommunications sectors
- M/71 Mandate to CEN for standardisation in the field of Pressure equipment (2014/68/EU (PED_2014) - Pressure equipment (in revision)
- M/400 Gas quality - further standardisation request on H_2 quality announced at Madrid Forum 05/2022
- M/475 Mandate to CEN for standards for biomethane for use in transport and injection in natural gas pipelines
- M/441 Measuring instruments for the development of an open architecture for utility meters involving communication protocols enabling interoperability

[20] A CEN or CEN-CENELEC Sector Forum builds an integral long-term interface amongst a number of Technical Committees of a sector and relevant CEN partners. It deals with common problems, the monitoring of progress of a work program and presenting CEN proposals for new fields of activities within the sector and across sectors, as well as taking initiatives to avoid duplication of work.

- M/533 for alternative fuels infrastructure in accordance with Regulation (EU) No 1025/2012 of the European Parliament and of the Council, to draft European standards

Further standardisation requests might be relevant for some specific aspects of infrastructure.

Furthermore, the coherence of the standards for infrastructure between the connection from production to application would be much supported by a dedicated EC standardisation request to CEN-CENELEC as it would give a comprehensive basis for coordination of all related standardisation activities.[21]

6.3.2 Technical needs and timeline

Based on the similarities and differences between methane (natural gas) and hydrogen, the impact of hydrogen on the gas infrastructure needs to be considered for adaptations of the infrastructure.

This should also be accounted for in the revision of the gas infrastructure standards needed to cover the repurposing of existing and the building of new gas grids to ensure suitability of the existing infrastructure or H2 and its blends with natural gas and biomethane.

Practically, new infrastructure for natural gas, currently in construction as a response to the energy crisis, is built to be operated also with hydrogen at a later stage. These infrastructures are so-called hydrogen-ready.

The extent and timeframe for revisions and new elaborations differ for each of the aspects and some aspects also rely on further research results.

As an example - from the technical perspective – about 80% of the requirements in existing functional system standards for the design, construction, operation and maintenance of gas infrastructure are also applicable for hydrogen, e.g. depending on the component (e.g. transmission pipelines > 16 bar; compressor stations). For other areas, research is on-going (see below).

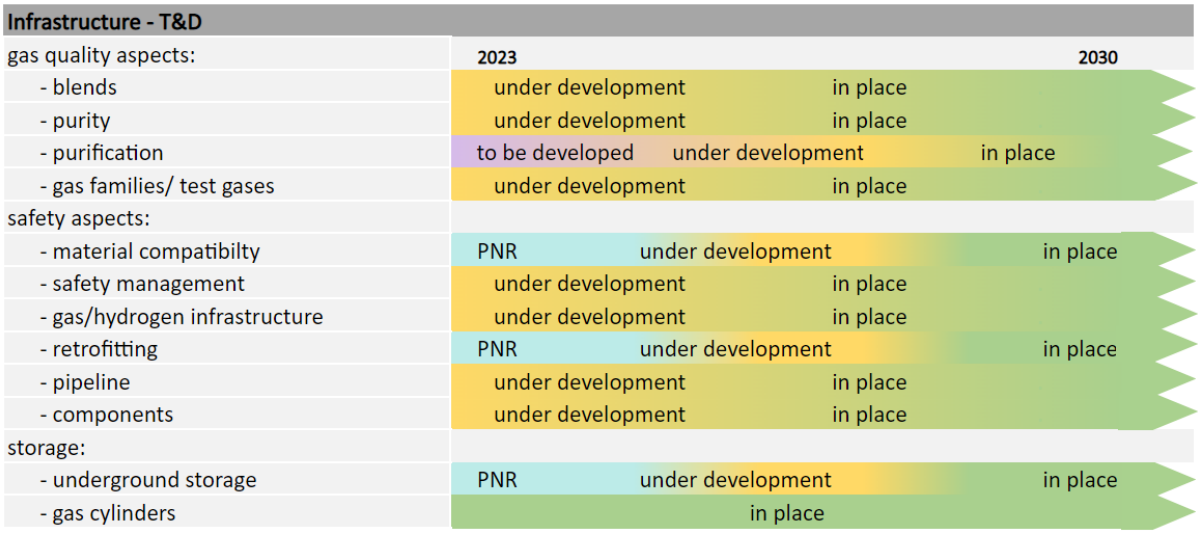

Figure 7: Cluster Infrastructure – current status of standardisation

[21] The process for a potential EC standardisation request to CEN-CENELEC started already in 2016. A draft document and possible first work programme is available. With the further development of the EC hydrogen strategy, the Fit for 55 and RepowerEU initiatives and finally also with the ECHA work on a standardisation roadmap, the process on the potential EC standardisation request has not been completed yet and will need a new set-up.

The following aspects need specific attention for 100% H_2 and blends:

- materials (steel, plastics, elastomers, sealings) and related effects (embrittlement, fracture mechanics, permeation, leakages etc.)
- safety aspects of hydrogen/ explosion prevention and protection (ATEX, detection, odorization etc.)
- interoperability within the technical system, including injection
- gas quality
  - hydrogen quality from repurposed grids
  - hydrogen quality from different production technologies
  - alignment of hydrogen quality standards between all stakeholders (all relevant CEN-CENELEC/ISO-IEC TCs involving producers, pipeline operators, end-users, technology providers such as LOHC.)
- volume in relation to energy content
- gas (underground) storage (CEN applied for an EISMEA project for PNR on the suitability of steel casings and tubings)
- definition of hydrogen terminals/hydrogen infrastructure
  - Standards needed for the handling of hydrogen and derivatives when using hydrogen terminals and injecting into the hydrogen grid to avoid issues at interconnection points.
  - The definition of hydrogen infrastructure in the "Hydrogen Package" and other regulations/directives should secure technological neutrality for all technologies. Thus, LOHC and other forms of carriers, to import hydrogen, should be able to access the hydrogen system.

In the revision and drafting process, existing (industry) documents (ASME, EIGA), national standards and/or codes of practice are used where technically appropriate (see repurposing above). Also this is valid for findings from European (technical) associations, such as Marcogaz[22] (infrastructure + gas quality aspects, EASEE-gas[23] (gas quality aspects), EU Prime Movers Group[24] and others.

6.4 Cluster: Industrial application

6.4.1 RCS Framework

The potential foreseen for hydrogen in the decarbonisation of industrial sectors relates to the different roles of the gas:

- hydrogen as a feedstock (i.e. a chemical, a raw material) for industrial processes
- hydrogen as a combustion fuel for industrial heating and process heat

Examples of the first role are the production of renewable ammonia by using renewable hydrogen, and the decarbonisation of the steel industry by using renewable or low-carbon hydrogen in alternative ore reduction processes, replacing natural gas.

For the second role, renewable or low-carbon hydrogen can replace the hydrocarbon fuels used traditionally in combustion aiming to produce heat or steam used in commercial and industrial processes, or used as process heat for the production of e.g. glass.

[22] MARCOGAZ – Hydrogen quality for blending with NG – Technical recommendations, published June 2022

[23] EASSE gas – Hydrogen Quality Specification, published February 2022

[24] Prime Movers Group (PMG) - Decarbonizing The Gas Value Chain, CHALLENGES, SOLUTIONS AND RECOMMENDATIONS, published January 2022

In this section the two roles are considered separately in order to address their specific standardisation needs.

Legal and standardisation framework - feedstock

The following high-level regulations and the cited in section 4.7 cover the valorisation of renewable hydrogen and are supporting the development and implementation of technical measures for the decarbonisation of industrial processes:

- European Emission Trade System 2018/410 (ETS)
- The 'Green Taxonomy' Regulation 2020/852
- Industrial Emission Directive 2010/75/EU (IED)
- Proposal for a Regulation establishing a carbon border adjustment mechanism COM(2021) 564 (CBAM)

These Commission legislative proposals are still under trilogue discussions. They also depend on the fixation of a methodology for the measure of the 'carbon level' of the hydrogen used (see section cross-cutting topics).

For chemical processes, analytical and control equipment and possibly separation equipment (e.g. membrane technology and/or pressure swing adsorption) will be required to keep the chemical processes under a stable operation and possibly to use the hydrogen. An additional burden in global competition is the cost of installing and operating this equipment. As separation processes always require energy, the installation of equipment to keep the chemical value chain running is a matter of debate in relation to other EU policies such as the EED and ETS, or financial aid.

Legal and standardisation framework - heating

The decarbonisation of the industrial heat sector is a challenge, due to the scarce availability of low-carbon alternatives and therefore of high priority. There is a wide range of applications from commercial heat applications through to industrial process heat applications which require high amounts of energy and where hydrogen is seen as the alternative, renewable fuel for this subsector.

The basis for this transition will be developed together with the following regulations and those mentioned in section 4.7. above:

- Gas Appliance Regulation 2016/426/EU (GAR);
- Medium Combustion Plant Directive EU 2015/2193 (MCPD)[25];
- Industrial Emission Directive 2010/75/EU (IED)[26];
- Machinery Directive 2006/42/EC[27]
- Pressure Equipment Directive 2014/68/EU
- Ecodesign Regulation EU/813 & 814/2013[28]

[25] DIRECTIVE (EU) 2015/2193 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants

[26] DIRECTIVE 2010/75/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

[27] DIRECTIVE 2006/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2006 on machinery, and amending Directive 95/16/EC

[28] COMMISSION REGULATION (EU) No 814/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for water heaters and hot water storage tanks

Standardisation in the industrial heat sector is focused on the European level (e.g. CEN/TC 131, CEN/TC 186, CEN/TC 58) with the aim of fulfilling the essential requirements of the named European regulations.

For the further development of the European standards, it is important that the current draft standardisation request on the Gas Appliances Regulation and the potential draft request on hydrogen will be published as soon as possible.

Standardisation on the international level is done independently but with the aim of transferring as many technical aspects as possible that are defined at European level to international standards.

According to industry, gas quality fluctuations caused by the use of hydrogen can be technically managed, but there is no "one-size-fits-all" solution and individual assessments will be required as applications and processes will be optimized for the typical (historical) natural gas quality at the exit. For sensitive equipment and raw material processes a CEN proposal foresees the Wobbe index variation limit of 3,7 MJ/m^3 (at reference condition of 15°C/15°C). Solution complexity depends on the specific application, installed equipment and expected hydrogen or by-product content. Installations and industrial processes switching from natural gas to hydrogen may involve very high CAPEX which need to be evaluated on a case-by-case basis.

6.4.2 Technical needs and timeline

Industrial applications			
commercial/ industrial/ process heat:	2023		2030
- combustion quality aspects	under development	in place	
- components	under development	in place	
- installation	under development	in place	
gas quality aspects:			
- blends	under development	in place	
- purity	under development	in place	
- variations	under development	in place	
- gas families/ test gases	under development	in place	
safety aspects:			
- leakage	under development	in place	
- material compatibility	under development	in place	
feedstock	to be developed	under development	in place

Figure 8: Cluster industry – current status of standardisation

It is of high priority to update existing standards for the design and test of the application for the use of H_2 blends[29] (e.g. materials, safety, performance, emissions, leakages, product testing, …) and 100% H_2 in the long-run. Therefore, it is important to define gas qualities in advance to adopt specific burner designs. The hydrogen gas quality / impurities have a huge impact on e.g. the Wobbe Index and therefore on the combustion process, efficiency and emissions. These potential influences need to be evaluated and tested in pre-normative studies/lab tests.

Note: A joint Task Force of the CEN-CENELEC Sector Fora for Gas infrastructure, Gas utilization and Energy management WG Hydrogen is investigating the hydrogen quality needs of industrial end-uses,

[29] Blends up to 20 % H2 are currently basis of the considerations in the CEN Technical Committees, whilst some stakeholder does not share the view on the use of hydrogen blends.

looking also into the impact of trace components and impurities and also into possible technical mitigation solutions.

Additional technical adaptations like specific sensors or material aspects have also to be considered. Specific field tests with various applications are needed in addition for the adopted burners.

In parallel it is important to update the existing European Standards for the use of 100% H_2 and H_2 blends to prepare the basis for certified burners. Therefore, harmonised test conditions need to be defined and validated under lab conditions.

For the feedstock subsector it was only possible to identify a few topics in the timeframe of preparing this roadmap. In order to develop a detailed work programme further work will be needed.

6.5 Cluster: Mobility

The mobility sector in this roadmap includes the following modalities:

- road vehicles
- heavy-duty on and off-road vehicles
- railways
- maritime vessels
- aviation

6.5.1 RCS Framework

6.5.1.1 Legal and regulatory framework

General Legal and regulatory framework - **mobility**

- Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure - Alternative Fuels Infrastructure Directive (AFID).
- Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU of the European Parliament and of the Council (AFIR).
- Sustainable and Smart Mobility Strategy

Legal and regulatory framework specific - **road vehicles**

- Regulations and standards are addressed by UNECE GTR (Global Technical Regulation). The scope of phase two of the GTR 13 (Global Technical Regulation concerning hydrogen and fuel cell vehicles) is dedicated to heavy duty vehicles (buses, long haul trucks).
- CO_2 emission performance standards for new heavy-duty vehicles
- CO_2 emission performance standards for passenger cars and light duty vehicles
- Public procurement for clean vehicles

Annex V contains a more detailed overview of all the legal and regulatory framework of heavy-duty vehicle related topics.

Legal and regulatory framework specific - **maritime vessels**

- Proposal for EU regulation of the European Parliament and the Council on the use of renewable and low-carbon fuels in maritime transport and amending Directive 2009/16/EC (FuelEU Maritime initiative)

- European Directive (EU) 2016/1629 laying down technical requirements for inland waterway vessels
- Rhine Vessel Inspection Regulations on the Rhine and on the other waterways of the Union

Annex V contains a more detailed overview of all the legal and regulatory framework for maritime related topics.

Legal and regulatory framework specific - **railways**

The general European regulatory framework for the authorization of rolling stock is based on the Directive on the Interoperability of the Rail System within the EU 2016/797 and the Directive on Railway Safety 2016/798. The use of hydrogen propulsion systems in the railway domain is managed through:

- The Rolling Stock - Locomotive and Passenger Technical Specification for Interoperability, established in accordance with Chapter 2 of the Interoperability Directive and specifically its Article 10 on innovative solutions,
- The Common Safety Methods, established in accordance with Article 6 of the Railway Safety Directive.

Legal and regulatory framework specific - **aviation**

- Proposal for a regulation of the European Parliament and of the Council on ensuring a level playing field for sustainable air transport (ReFuelEU Aviation proposal)

6.5.1.2 Standardisation framework

This section describes the standardisation framework. For railways, maritime vessels and aviation specific additional aspects are referred to separately.

Existing general standardisation requests for **mobility** are:

- M/533 - Standardisation request addressed to CEN, CENELEC and ETSI in support of the implementation of the Directive 2014/94/EU on the deployment of alternative fuels infrastructure
- M/581 - Standardisation request to the European standardisation organisations as regards communication exchange, electricity and hydrogen supply for road, maritime transport and inland navigation in support of Directive 2014/94/EU and its planned revision under the 'FitFor55 package.

Standardisation framework specific - **railways**

European actors are leading international standardisation activities at CEN, CENELEC, ISO and IEC in the relevant railway committees (CEN/TC 256, CLC/TC 9X, ISO/TC 269 and IEC/TC 9), with the aim to provide a mature and proven in use input for future EU regulation. Regarding the on-board hydrogen propulsion subsystem, work is proceeding at the ISO and IEC level through the IEC 63341 series:

- Part 1 for fuel cells,
- Part 2 for compressed hydrogen storage systems,
- Part 3 for fuel cell testing.

All these documents are developed in active liaison/ cooperation between IEC/TC 9, IEC/TC 105 and ISO/TC 197 and benefit from the strong involvement of European experts through CLC/TC 9X as this project is a parallel development under Frankfurt Agreement.

Regarding the infrastructure subsystem, work is taking place within ISO/TC 269.

Standardisation framework specific - **maritime and inland shipping**

For the maritime sector, vessels are regulated by IMO – The International Maritime Organisation. Further information on the contents and relations are given in Annex V.

For inland shipping the relevant standardisation body is not IMO but the European Committee for the Development of Standards in the Field of Inland Navigation (CESNI). It was created in June 2015 by the CCNR at the request of the European Commission. It brings together all the Member States of the European Union as well as Switzerland, to draw up unified standards applicable both on the Rhine and on the other waterways of the Union, in the field of technical prescriptions, professional qualifications and information technology. Also, there is CEN/TC 15 in charge of inland navigation vessels.

In the framework of M/580, CEN/TC 268 is in charge of developing two standards for inland vessels:

- A European standard containing technical specifications with a unified solution for compressed (gaseous) hydrogen refuelling points and bunkering for maritime and inland waterway hydrogen-fuelled vessels
- A European standard containing technical specifications with a unified solution for liquefied hydrogen refuelling points and bunkering for maritime and inland waterway hydrogen-fuelled vessels

Standardisation framework specific - **aviation**

The standardisation work on this specific sector is just starting. Hydrogen for aviation decarbonisation has recently been brought to the attention of International Civil Aviation Organisation ICAO and one of the challenges identified is to develop dedicated standards regarding hydrogen for aviation in particular issues related to the safety framework (leakage, firefighting, safe handling of cryogenic H2, …). Initial initiatives have been launched (see Annex V).

6.5.2 Technical needs and timeline

General technical need and timeline - **mobility**

The following Figure 9 shows the main topics to be considered in the standardisation process on mobility. Due to the complexity of the mobility segment the given topics are generic and further details are given in the standardisation list (Annex II) and in the paragraphs below.

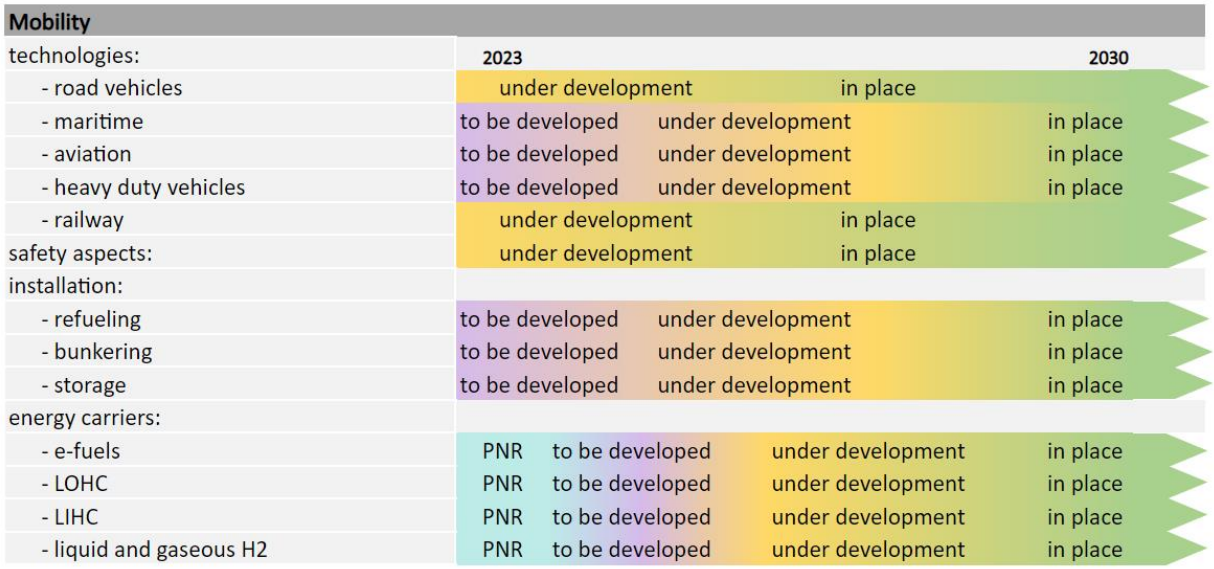

Figure 9: Cluster mobility – current status of standardisation

Technical need and timeline - r**oad and rail transport**

In the framework of M/533, CEN/TC 268 developed three standards for road vehicles:

- EN 17127:2020 'Outdoor hydrogen refueling points dispensing gaseous hydrogen and incorporating filling protocols'
- EN ISO 17268:2020 'Gaseous hydrogen land vehicle refueling connection devices (ISO 17268:2020)
- EN 17124:2022 'Hydrogen fuel - Product specification and quality assurance - Proton exchange membrane (PEM) fuel cell applications for road vehicles'

Also, in the framework of the standardisation request M/581, CEN/TC 268 is entrusted with developing two standards for heavy duty vehicles:

- A European standard containing technical specifications with a unified solution for hydrogen refueling points dispensing compressed (gaseous) hydrogen for heavy duty vehicles
- A European standard containing technical specifications with a unified solution for hydrogen refueling points dispensing liquefied hydrogen for heavy duty vehicles

The development of (international) standards for vehicle on-board hydrogen storage (350 bar, 500 bar, 700 bar, liquid, LOHC) and the safe integration of on-board H2 storage and hydrogen propulsion systems and refueling infrastructure & processes will be necessary in road and rail transport to provide the necessary framework. In the railway domain, the main challenge is to adapt the regulatory framework for the authorization of rolling stock to trains with a hydrogen propulsion subsystem. However, this requires a complete, mature and proven in use normative referential, which is now being drafted (see above) and the adaptation of other relevant norms that did not consider this type of propulsion technology (e.g Fire & Smoke).

It is only once this normative framework is fully available, that the sector will be able to propose the relevant modification of the European regulatory framework for train authorization. It is expected that a first set of complete norms should be available by 2025 and updated on the basis of project return of experience by 2028. Prescriptive Regulatory changes before the availability of such a mature

normative framework would be counterproductive. Progress on the standardisation of hydrogen refueling infrastructure for all mobility applications is also important to de-risk investments and reduce costs. Standardisation of hydrogen refueling systems' design and interface and of the building norms for certifying HRS should be envisaged for a European widespread network to develop.

Technical need and timeline - **maritime**

A comprehensive standardisation approach for different propulsion systems in shipping is crucial to meet decarbonisation targets. This includes providing norms for the deployment of all promising technologies. Vessels with propulsion systems using LOHC as a H2 fuel carrier will be rolled out for use in the second half of the 2020s, as such the requisite standardised framework is a high priority.

A secure regulatory underpinning for liquid carriers such as LOHC will also be vital to provide certainty for hydrogen imports.

In the framework of the standardisation request M/580, CEN/TC 268 is entrusted with the development of two standards for maritime (and inland) vessels:

- A European standard containing technical specifications with a unified solution for compressed (gaseous) hydrogen refueling points and bunkering for maritime and inland waterway hydrogen-fueled vessels
- A European standard containing technical specifications with a unified solution for liquefied hydrogen refueling points and bunkering for maritime and inland waterway hydrogen-fueled vessels

The following aspects need specific attention to enable a fast realisation of LOHC/fuel cell powertrains:

- Development of (international) standards for vessel on-board hydrogen storage (350 bar, 500 bar, 700 bar, liquid e.g. LOHC)
    - Standards for new ship fuel types that will be required to achieve Fit for 55 goals are needed. It is essential to start work on regulating for future zero-emission ships to encourage first movers. The first on-ship fuel cell powertrains with an on-board liquid organic hydrogen carrier release units are in development.
- Safe integration of on-board H2 storage and hydrogen propulsion systems
    - Standards will be needed to provide a framework for the safe integration of on-board H2 storage and propulsion systems where hydrogen or its derivatives (e.g. LOHC) are used including on board hydrogen generation from hydrogen derivatives (e.g. dehydrogenation of liquids such as LOHC).
- Integration of high-temperature applications in vessels
    - Provide a framework for the integration of high-temperature applications (e.g. dehydrogenation, high-temperature fuel cells and on-board fuel cell waste heat usage) in inland and maritime vessels
- Refueling points and bunkering
    - LOHC / liquid hydrogen derivative refueling points and bunkering for maritime and inland waterway vessels – ISO 8217 "Petroleum Products – Fuel (class F)" applies to LOHC
- LOHC as an alternative fuel/fuel carrier
    - The maritime on-board usage of LOHC as a hydrogen fuel carrier
- Safety issues for maritime transport, storage and use

    - Guidelines for the use of hydrogen in its gaseous and liquid forms as well as its storage in either of these or other forms (hydrides). LOHC needs to be added to ISO/TR 15916:2015 “Basic considerations for the safety of hydrogen systems)
- Transport and storage:
    - Lack of standards for marine bulk **storage** of hydrogen carriers (e.g. LOHC) covering both existing and new terminals. This includes conversion services (liquefaction, (de)hydrogenation, purification, etc.). Such standards will become increasingly important to handle the envisaged future H_2 imports.
    - Standards are needed for the **transport** of renewable hydrogen via hydrogen carriers (e.g. LOHC) for different transport pathways offshore, onshore and for inland hubs (road, rail, shipping).
    - Multi-modal transport will be needed to ensure optimal geographical coverage of hydrogen supply.

Technical need and timeline - a**viation**

Standardisation mapping will need to be further refined, as stakeholders from this segment did not come forward to participate in the WG on Standardisation. From a legislative perspective it is recommended, in conjunction with the standardisation mapping, to look into an AFI for aviation, notably in the context of the future EU Regulation on Clean Aviation.

6.6 Cluster: Energy – Sector integration including power generation sector

The energy system integration sector includes activities to facilitate

- the take-up and use of hydrogen in power and combined heat (CHP) and power generation and
- flexibility of the grid.

It also addresses hydrogen storage and distribution of hydrogen networks as well as local grid and heat distribution networks that reach out to local off-takers allowing for generating units to maximize their efficiency and load factors.

Regarding power generation, existing turbines must be assessed on an individual basis as they have been constructed to specific requirements agreed between operators and technology suppliers. For the majority of engine power plants, only minor modifications will be necessary to allow for the use of up to 25% by volume of H_2 - depending on the base gas. In many cases it will be possible to upgrade the plant for use with 100% by volume H_2. Today's newly constructed power stations are usually operated with natural gas but can be designed and built to be H_2 ready. A paper providing a definition for H2-ready engines was published by EUGINE in September 2021[30]. Depending on the percentage of hydrogen that the engine can handle three different "H_2-Ready categories" are listed

- H_2-Readiness Level A: 100% vol. hydrogen
- H_2-Readiness Level B: up to 25% vol. hydrogen blended into natural gas
- H_2-Readiness Level C: up to 10% vol. hydrogen blended into natural gas

Note: This cluster ‘sector integration’ is named ‘energy’ in the list with identified topics in Annex II.

[30] Prime Movers Group (PMG) - Decarbonizing The Gas Value Chain, CHALLENGES, SOLUTIONS AND RECOMMENDATIONS, published January 2022

6.6.1 RCS Framework

Legal and regulatory framework

Hydrogen brings many opportunities for the decarbonization of the energy sector as highlighted in the Communication "P*owering a climate-neutral economy: An EU Strategy for Energy System Integration*"[31]. This issue was brought forward in the FitFor55 package and the Hydrogen and decarbonised gas market package.

The integration of the variable electricity generation sources expected in the short-medium term will also require deployment of resources providing flexibility to the energy system. Together with energy storage solutions, gas turbines (power generation) are also key assets for balancing the electricity system.

There is a policy need to better assess how (both as a fuel and a produced output) clean hydrogen shall be introduced over time in power plants and CHP systems of differing forms based, for example on a methodology in delivering the required decarbonised residual load.

Standardisation framework

The process of developing standards in this field is only starting. It requires much more research and innovation activities.

Most standards still need to be developed and a lot of attention will have to be paid to safety aspects.

Together with the specific topics related to the energy conversion system, the overall concept of energy infrastructure must also be considered.

6.6.2 Technical needs and timeline

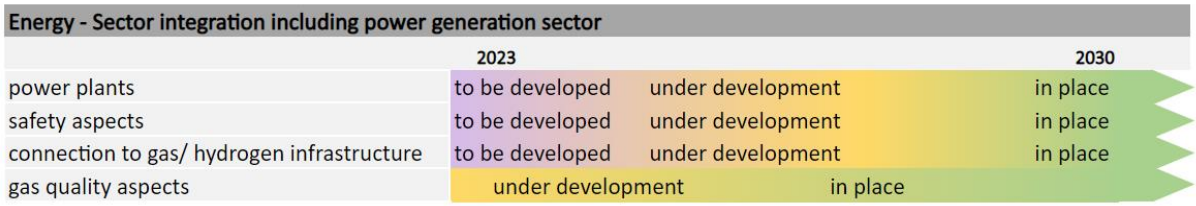

Figure 10: Cluster sector integration – current status of standardisation

For the sector integration, it was only possible to identify a few topics in the timeframe of preparing this roadmap. In order to develop a detailed work programme further work will be needed.

6.7 Cluster: Building – Residential application

Gas heating appliances (i.e. condensing boilers, micro-CHP including fuel cells, gas and hybrid heat pumps) will need to continue to play an important role, complementing the electrification of heating. In order to fully decarbonise the gas-based heating sector, a significant increase in the use of green gases, whether biomethane or hydrogen, in both pure and blended form, is needed.

6.7.1 RCS Framework

Legal and regulatory framework

Buildings account for 40% of the energy consumed and 36% of energy-related direct and indirect greenhouse gas emissions in Europe. Most of the emissions are from the existing building stock, which

[31] Powering a climate-neutral economy: An EU Strategy for Energy System Integration, COM(2020) 299 final.

would require deep renovation to reduce CO_2 emissions. It is of high priority to increase the renovation rate (EU renovation wave) of the building stock but also to replace fossil fuels by renewable gases such as hydrogen in addition to electrification.

The basis for this transition will be developed from the RSC defined in the FitFor55 package and the Hydrogen and decarbonized gas market package. The following regulatory texts are of specific importance:

- Energy Performance of Buildings Directive[32]
- Gas appliance regulation 2016/426/EU
- Regulation on Ecodesign (EU) 813 & 814/2013[33] and Energy labelling (EU) 811 & 812/2013[34], where the current preliminary study for regulation update suggests the introduction of H2 ready devices working with 20% H2 blends and 100% hydrogen.

There is an urgent need to develop and certify appliances (boilers, hybrids, thermally-driven heat pumps, micro-CHP, etc.) which are able to run with alternative renewable gases such as hydrogen.

Standardisation framework

Standardisation in the residential heating sector is mainly carried out at the European level. Most standards are harmonized with the Gas Appliances Directive.

It is important to ensure that European standards continue to develop and that:

- the draft standardisation request for Gas Appliance Regulation is finalised and published
- the potential standardisation request for hydrogen will be finalised and published.[35]

The process of updating the standards to make all heating appliances "100% vol. H_2 ready", enabling them to cope with the various fluctuations in the methane/hydrogen mix, is well underway and is expected to be fully completed by the end of this decade. In this area, several technical committees are currently working on the necessary standardisation requirements for hydrogen. Meanwhile, currently installed appliances cannot be re-certified or re-classified in general for hydrogen use due to certification rules. As a result, a country-by-country / case-by-case approach is being applied, to ensure that installed appliances are compatible when hydrogen blending is introduced into networks.

[32] DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 May 2010 on the energy performance of buildings

[33] COMMISSION REGULATION (EU) No 813/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters

[34] COMMISSION DELEGATED REGULATION (EU) No 812/2013 of 18 February 2013 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to the energy labelling of water heaters, hot water storage tanks and packages of water heater and solar device

[35] The process for a potential EC standardisation request to CEN-CENELEC started already in 2016. A draft document and possible first work programme is available. With the further development of the EC hydrogen strategy, the Fit for 55 and RepowerEU initiatives and finally also with the ECHA work on a standardisation roadmap, the process on the potential EC standardisation request has not been completed yet and will need a new set-up.

6.7.2 Technical needs and timeline

The relevant CEN Technical Committees are already elaborating and updating the relevant standards for hydrogen use in buildings. The focus is on pure hydrogen and for a transition period for blending with natural gas respectively biomethane.

Building - residential application			
	2023		2030
combustion quality aspects	under development	in place	
components	under development	in place	
installation	under development	in place	
gas quality aspects:			
- blends	under development	in place	
- purity	under development	in place	
- variations	under development	in place	
- gas families/ test gases	under development	in place	
safety aspects:			
- leakage	under development	in place	
- material compatibility	under development	in place	
efficiency	under development	in place	

Figure 11: Cluster building – current status of standardisation

It is of high priority to update existing standards for the design and testing of applications using 100% hydrogen and H_2 blends regarding e.g. materials, safety, performance, emissions, leakage, product testing, etc.. Therefore, common test conditions have to be aligned with the relevant European regulations. Additional experts have to be involved in the process and lab testing for the validation of the standardised test conditions are needed especially for 100% H_2.

Furthermore, it is important that all relevant technical standardisation committees dealing with products and appliances used in buildings are involved to speed up this standardisation process.

As a basis for design developments, it is important to define and guarantee properly the gas quality distributed in the pipelines locally/regionally and the related gas quality information communicated to end-users (e.g. Wobbe Index). [36]

6.8 Cluster: Cross-cutting

Within the scope of this cross-cutting section are topics that apply to a wider range of aspects of the value chain. These range from energy carriers, sustainability criteria and guarantees of origin of hydrogen, metrology and analysis, as well as general safety aspects.

Cross-cutting includes the topics that are relevant for different parts of the hydrogen value chain, including global trade as a commodity. For the development of hydrogen trading in particular, certification is an essential element of any transaction. Certification of hydrogen and its derivatives would include information on compliance with standards and regulatory requirements and would be verifiable against data on sustainability criteria such as environmental footprint and renewable energy usage data. This would enable hydrogen and derivatives to be differentiated from other, more polluting fuels and gases.

The cross-cutting issues for standardisation are:

[36] Prime Movers Group (PMG) - Decarbonizing The Gas Value Chain, CHALLENGES, SOLUTIONS AND RECOMMENDATIONS, published January 2022

- energy/hydrogen carriers
- sustainability and origin of hydrogen, including Live-cycle-analysis (LCA) and Performance Energy Factors (PEF)
- (voluntary) carbon credits
- approaches to guarantee public safety for new hydrogen applications and systems (safety aspects)
- metrology (see Annex VII)
- chains of custody: guarantees of origin, mass balance systems, book and claim systems
- training of personnel/education

6.8.1 RCS Framework

Sustainability aspects and hydrogen valorisation

In May 2022, the European Commission consulted on two proposed delegated acts clarifying EU rules applicable to renewable hydrogen under the 2018 Renewable Energy Directive. The first proposal covers renewable fuels of non-biological origin (RFNBO) and sets the criteria for products that fall under the 'renewable hydrogen' category.

The second proposal puts forward a detailed scheme to calculate the life-cycle emissions of renewable hydrogen and recycled carbon fuels to meet the greenhouse gas emission reduction threshold set in the Renewable Energy Directive. Both are still under trialogue discussions.

In addition to these two delegated acts, the Gas Directive – currently in revision – aims at defining low-carbon hydrogen, gases and fuels based on life-cycle climate impacts. A delegated act will clarify EU rules applicable to these energy carriers.

The 2018 Renewable Energy Directive called to expand the system of Guarantees of Origin to other energy carriers, including hydrogen, while the proposal for revised Gas Directive refers to mass balance systems as chain of custody systems for low-carbon hydrogen, gases and fuels.

Public safety

While industrial safety has been optimised along more than a century of hydrogen uses in chemical and petrochemical processes, the development of a global hydrogen economy requires deployment of hydrogen systems in areas of society where they have never been till now. This will probably imply the movement of hydrogen quantity at many orders of magnitude higher than the level currently transported.

The European regulatory framework already in place is able to cover, for example with the ATEX and the PED directives and the related set of harmonised standards, the present needs. The work ongoing at the international standardisation bodies ISO and IEC is also translating the general safety principles and rules into hydrogen-specific requirements. However, the framework already in place must be broadened and adapted to the new hydrogen applications. This effort must occur in parallel with the improvements of general approaches and methodologies, in particular in the areas of risk assessment, and mitigation, and risk-informed design.

6.8.2 Technical needs and timeline

Figure 12: Cluster cross-cutting – current status of standardisation

Both, the domestic production and the import of hydrogen will be based on multiple modes and technologies.

The import of (renewable) hydrogen will play a role in the future. Hydrogen can be liquified or bound to molecules that are easier to transport in liquid form (e.g. LOHC, HydroSil, KBH_4, and others). To enable the realisation of these options, it is important to establish standards for all viable modes of transport. Furthermore, because of the need for a diversified hydrogen infrastructure, standards should ensure coverage of all technologies.

Technical standards related to the quality, storage and handling of hydrogen carriers (e.g. LOHC, HydroSil, KBH_4, and others) will be needed to ensure reliable operation of plants and certainty along the entire value chain.

It is crucial that sensing technologies provide reliable and comparable results when use to measure and meter chemical and physical properties of hydrogen (such as quality and quantity, temperature and pressure, etc.). To achieve this important need these technologies and systems have to be calibrated with metrological references to ensure traceability and proper validation in documentary standards.

Measurement solutions for quality assurance and assessment, leak detection, energy content, storage or flow metering of hydrogen in gaseous or liquified form and in hydrogen carriers (e.g. LOHC), are not metrologically validated and standardised yet and therefore cannot be widely adopted in the hydrogen value chain.

Moreover, a new, standardised and harmonised methodology is needed to calculate the GHG footprint of hydrogen systems along their entire value chain. In combination with a set of robust and hydrogen-specific sustainability criteria, this methodology will allow for the assessment of the sustainability of the hydrogen produced domestically or imported.

Credible systems to determine and certify the sustainability criteria of the produced and imported hydrogen and derivates are paramount. In the supply chains, hydrogen and derivates from different sources and technologies might be mixed. Yet, consumers willing to pay a premium for renewable hydrogen must be given reliable information about the actual nature of the hydrogen or derivative delivered, which requires the development of credible chain of custody systems, such as mass balance systems or guarantees of origin.

Similarly, to PNR activities, there will be a need to ensure a communication channel between the work of the WG on Standardisation, CEN-CENELEC and the Metrology Partnership

6.9 Prioritisation

To enable a functioning hydrogen market requires in the end that all systems, processes, equipment and applications are ready to be operated with hydrogen. Prioritisation here means giving a specific focus on aspects that need more intensive attention and action to facilitate either the initiation of standardisation processes or to develop requested contents, without neglecting standardisation that is already on a good track.

Furthermore, it is important to acknowledge that – due to the manifold parallel working technical standardisation committees - several standardisation topics can be treated in parallel by the experts.

The list of identified standardisation topics (see Annex II) shows that in some parts of the value chain topics are already well addressed and are advanced in the standardisation process; their publication could be expected within the next two - three years. For other parts there are standardisation topics that have been identified but not yet in process or that have not been allocated to CEN-CENELEC/ ISO-IEC Technical Committees or for which information in the WG on Standardisation is not yet mature.

The analysis of the standardisation list showed that it is important to introduce a prioritisation of standardisation activities in order to better coordinate/ streamline the standardisation activities. Under this context the following three aspects should be treated under high priority:

1. Horizontal aspects: topics on which other topics depend
2. Topics to be developed: topics where no project and/or relevant Technical Committee were identified
3. Pre-normative research topics: topics that need more knowledge prior to standardisation

<u>Horizontal aspects:</u>

Some topics are indicated by several WG subgroups (see Annex II). This emphasises their horizontal relevance for different sectors.

Their processing should be given a higher priority due to the fact that other standardisation projects depend on their finalisation. The following Table 1 summarizes these horizontal aspects and their details. It is not considered exhaustive.

Table 1 – Horizontal aspects with further details

Horizontal aspects	**details**
terminology / definitions	collection of relevant topics
sustainability and origin	guarantee of origin (chain of custody)
	emissions / GHG
gas quality aspects	purity
	gas families / test gases
	quality measurement
safety aspects	material compatibility
	potential explosive atmosphere
	leakage
	odorisation
components / equipment	valves

Horizontal aspects	details
	pipes
	seals
installation	bunkering
	refueling
	storage
energy / hydrogen carrier	liquid hydrogen
	gaseous hydrogen
	other carriers
	LOHC
	LIHC - Liquid Inorganic Hydrogen Carrier & HydroSil
	KBH_4 and other solid H_2 carriers
	metal hydride (e.g. iron pellets)
	ammonia
	methanol
	HHO
metrology	measurement (e.g. quality and volume)
	efficiency
	certification

Topic to be developed

Identified standardisation topics which were not able to be assigned to an existing project or standardisation committee are highlighted in the standardisation list in Annex II and should also be dealt with as a priority. Additional efforts are needed to get e.g. all the stakeholders involved and find consensus on how the standardisation of these topics could commence as soon as possible.

Examples are standards for different hydrogen carriers such as Liquid Organic Hydrogen Carriers (LOHC) or refueling stations. Here additional efforts are needed to identify and/or establish the relevant standardisation committees, get experts involved within them and start the work on standardisation as soon as possible.

Pre-normative research topics

Pre-normative research efforts were also highlighted in the standardisation list set out in Annex II as needing to be given enhanced priority, since they build an important bridge between innovations and early standardisation needs.

An example would be material compatibility studies to assess the impact of hydrogen on components or piping.

Fortunately, in many areas these studies are already ongoing as set out in the roadmap's summary of ongoing pre-normative research projects.

For examples on pre-normative research partnerships, reference is made to Annexes VI and VII.

6.10 Complementary needs

The individual standardisation topics would require complementary actions to facilitate their implementation. The most important ones are the following:

a) A clear regulatory framework to give direction to the detailed standardisation work:

The boundaries for the production and use of hydrogen need to be legally stipulated to enable the standardisation community to define the proper aspects in their standards (e.g., gas quality issue - in which modes of blending will be allowed – what will appliances need to be manufactured for)

b) The publication of standardisation requests, which are mandates of the European Commission (EC) to prepare specific standards:

   The cooperation between EC and CEN-CENELEC needs to be further streamlined and speeded-up to achieve a coherent set of standardisation requests for all parts of the hydrogen chain, including the review of existing draft standardisation requests and the establishment of additional requests.

c) The engagement of industry especially in those topics that "need to be developed":

   Especially for the topics for which no standardisation committees exist or are active, stakeholders (e.g. ECH2A members, European associations, consumer organisations) need to pro-actively involve themselves in the standardisation bodies or CEN standardisation liaisons or partners.

   For some topics the standardisation committees are already active, nevertheless additional expertise should support the efficiency of the standards' drafting process.

   The limited level of technical detail in this document shows that further input of stakeholder, including members of the European Clean HYdrogen Alliance, is needed to come to the full picture.

   Furthermore, enhanced information exchange with associations such as the Hydrogen Council, Hydrogen Europe and other organisations is needed.

d) The need for an overall coordination of H_2 standardisation activities focusing on the technical needs of industry, coordination on pre-normative research (PNR) with Horizon Europe Partnerships and the alignment with EC policies and legislation and the implementation capacity of CEN-CENELEC:

   With a view to the actual transition and technical dimension it is crucial to bring the needs, knowledge and policies of all parties together to come efficiently to a coherent set of standards at reasonable terms.

e) Increased cooperation between European and international standardisation bodies based on the existing agreements (Vienna / Frankfurt agreement):

   Aligned standards at global scale are supporting the global and economic ramp-up of hydrogen technologies. From the European perspective, active involvement by European parties including leadership in the European and international standardisation processes are crucial to satisfy the EC policies and European industries' expectations.

7. Implementation

For the ramp-up of the European hydrogen economy it is essential that standards are available for the European stakeholders in time and that these standards are in line with the targets set by the European decarbonisation agenda.

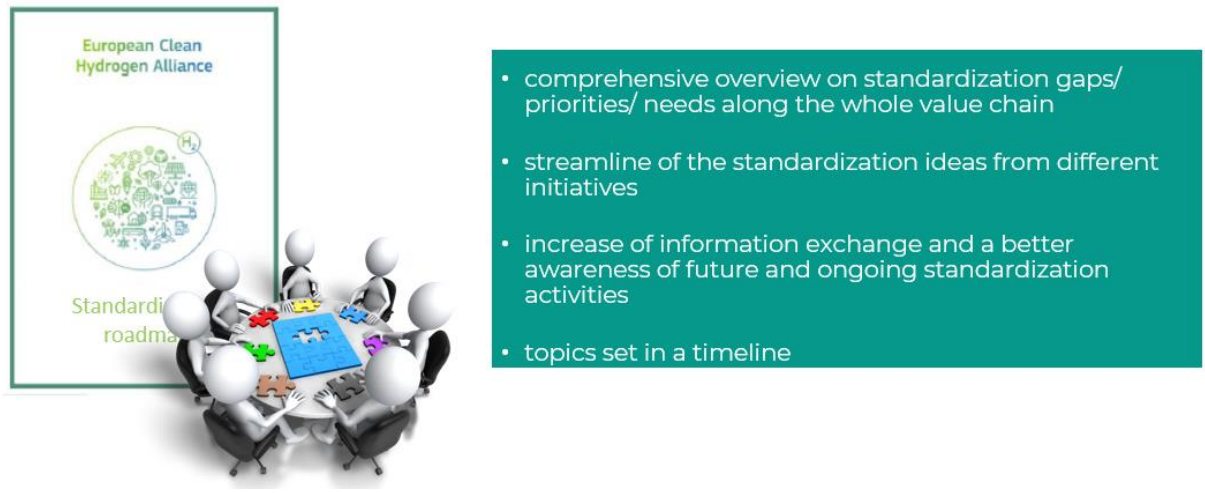

Figure 13 – Achievements of the WG on Standardisation

This roadmap gives a comprehensive overview on ongoing and missing standardisation topics along the whole hydrogen value chain, sets priorities, puts the topics in a timeline and clusters the main aspects of the specific hydrogen segments.

The list of collected standardisation topics (see Annex II) is not exhaustive. The topics mentioned represent a snapshot of standardisation knowledge of the WG on Standardisation members and CEN-CENELEC standardisation representatives at the time of elaboration; further topics will certainly be identified over time.

Next to the standardisation topics additional complementary needs are highlighted in this roadmap, which are essential for streamlining the standardisation process. An effective and time optimized implementation of hydrogen standards is essential and can only be achieved:

- through appropriate resources
- through good coordination
- and through the involvement of the relevant stakeholders.

As consequence of the investigations, the WG on Standardisation comes to the following key actions:

Key action 1: Integration of the standardisation topics list into the standard-setting process at EU level (CEN-CENELEC) and international level (ISO-IEC)

The ECH2A roadmap should be integrated into the work programme of the relevant standardisation bodies at CEN-CENELEC.

At CEN-CENELEC in co-operation with the national standardisation bodies, further analysis, prioritisation and resource allocation to the corresponding existing or new standardisation committees should be carried out. The overall process should be efficiently coordinated at CEN -CENELEC level, in co-operation with ISO and IEC (under respectively the Vienna and Frankfurt Agreements), to achieve a coherent set of standards and to avoid duplicative or contradictory work.

Whilst acknowledging the status of the national standardisation bodies (being members with voting rights) and CEN and CENELEC (cooperation partners) towards ISO and IEC, an efficient communication and information sharing procedure also needs to be established to enhance overall cooperation.

Key action 2: Prioritisation

To enable the hydrogen take-up, finally standards are necessary for the entire value chain. Prioritisation, in a first step, needs to ensure that all topics are actively dealt with in standardisation. Therefore, prioritisation here is targeted to streamline the standardisation activities.

Specific focus should be put on areas where:

- topics are not yet directly addressed in specific Technical committees
- topics need further technical understanding and identification of standardisation needs
- topics are horizontal and therefore relevant for different segments of the hydrogen value chain
- topics need additional pre-normative research activities

The final schedule of implementation should be determined by CEN-CENELEC based on the upcoming EC legislation and with help of the specific expertise in the dedicated technical committees depending on the

- availabilities of technical knowledge
- availabilities of technical committees

It is acknowledged that many topics could be standardised in parallel due to committee structure in CEN-CENELEC.

Key action 3: Stakeholder engagement in the standardisation process

A broader stakeholder engagement is essential for the development of standards. Therefore, the WG on Standardisation requests the European Clean Hydrogen Alliance members and further stakeholders to better commit and verify/ensure their representation and input of expertise into the standardisation process. For SMEs and start-ups this task can be done via industrial associations.

Similarly, it is key that the European Commission, the European Standardisation Organisations and their national members, the National Standardisation Bodies, effectively facilitate participation of societal stakeholders (environmental, consumer and employee organisations) and SMEs in the drafting of the relevant standardisation deliverables as indicated in the Standardisation Regulation 1025/2012 and EU Strategy on Standardisation.

This Roadmap can be used to inform stakeholders about the ongoing standardisation projects and facilitate their exchange with the National Standardisation Bodies for involvement.

Key action 4: Call on the European Commission to support the hydrogen standardisation process

The WG on Standardisation calls on the European Commission to support the standardisation process by:

- reflecting these needs in the EC Annual Union Work Programme for European standardisation (AUWP);
- issuing one or more standardisation requests covering the whole supply and value chain;
- providing funding for standardisation, its coordination and especially pre-normative research in the segments of the value chain that are at the beginning of the process but also in those sectors for which standardisation is already ongoing;
- providing clarification together with CEN-CENELEC on harmonised terminologies in legal and normative documents (e.g. low carbon hydrogen).

The European Commission should make best efforts to ensure that the necessary policy framework and legal requirements are put in place for the standardisation deliverables to underpin their implementation.

Key action 5: Continuous support of the standardisation process

The WG on Standardisation should continuously monitor and support the ongoing standardisation process in order to:

- create awareness and transparency of the ongoing standardisation in the ECH2A Forum;
- identify further needs of pre-normative research and standardisation topics and communicating to the standardisation bodies;
- motivate ECH2A members to actively participate (encouraging nominations via National Standardisation Bodies) in technical standardisation committees;
- inform ECH2A members about the progress of standardisation;
- update the Standardisation Roadmap on a regular basis.

Key action 6: Strengthen the coordination of the overall process, including relevant Horizon Europe Partnerships

The WG on Standardisation considers Partnerships as the most efficient way to realize pre-normative research at European level. It strongly recommends to continue and possibly extend the cooperation between the Partnerships, the European Commission and the standardisation bodies:

- to use synergies to streamline the PNR activities and
- make the research results available to the standardisation community.

Annex I – ECH2A WG on Standardisation Members and Observers

List of Clean Hydrogen Alliance Working Group Members

BAUER Stephan	RAG Austria	Austria
BERG Joachim	Wasagroup	Finland
BONAVITA Nunzio	ABB	Italy
BOZHILOV Angel	Hydrogenica Corporation	Bulgaria
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DE DOMINGO Lucas	Pucelab	Spain
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DEGROOTE Quentin	Fluxys	Belgium
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GISSIBL Gerhard	BMW	Germany
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JEGOUX Mathilde	ENGIE	France
JORDAN Jon	North Sea H2 Ports and Maritime Community	United Kingdom
LEGRAND Stéphanie	GRTgas	France
LOVAS László	Hungarian Gas Storage	Hungary
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RAVINEL Baptiste	Cellcentric	Germany
ROSSI Ettore	Sit SPA	Italy
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STEDE Eva	EWE Gasspeicher	Germany
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STORMS Ward	Toyota Motor Europe	Belgium
TARELHO Luis	University Aveiro	Portugal
Ten HAVE Daan	KIWA Nederland	Netherland
VAN ALMSICK Tobias	Open Grid Europe GmbH	Germany
WAGNER Jochen	IFIEC - BASF	Germany
WEZEL Ralf	EUTurbines	Belgium
WOLF Hergen Thore	Sunfire	Germany
ZALEWSKI Lukasz	PKN Orlen	Poland

List of Observers

GINDROZ Bernard	CEN-CENELEC JTC6	Belgium
VAN DEN BRINK Françoise	CEN-CLC SFEM/WG on Hydrogen - NEN	Netherland
VOGT Lydia	DIN	Germany
ADAM Philipp	DIN	Germany
SCHÜLKEN Hiltrud	DIN	Germany
VELK Per	Danish Standards	Denmark
CARREIRA da CRUZ Marc -Antoine	CEN and CENELEC	Belgium
VIGNERON Catherine	CEN and CENELEC	Belgium
LINKE Wilfried	BDH-Koeln	Germany
KUHN Maximilian	Hydrogen Europe	Belgium
ASKAR Enis	BAM	Germany

Annex II – Identified standardisation topics from the ECH2A WG on Standardisation

A list of approximately 400 standardisation topics were gathered by the members of the WG on Standardisation.

The list includes:

- a description of the standardisation topic/ issue
- a detailed description of the standardisation gaps
- the relationship of the standardisation topic to 100% H_2 and / or H_2NG (blends of hydrogen to natural gas)
- the status of the standardisation topic:
    - in place: standard published; standardisation topic is already covered
    - under revision: an existing standard will be revised to address the H_2 standardisation topic
    - in preparation: standardisation topic is addressed; preliminary project; new project
    - to be identified: no standardisation project nor technical committee is identified
- the responsible Technical Committee (TC)
- information regarding pre-normative research (PNR) needs - highlighted in blue
- topics to be developed – highlighted in green
- further identified topics by CEN-CENELEC (CEN-CENELEC SFEM WG H2 Workshops)
- a matching with the existing draft hydrogen standardisation request list in order to visualize which standardisation topic was already identified by CEN-CENELEC (Y) and which are additional (N)

The number of mentioned topics reflects the wide scope and the diversity of standardisation topics. This list represents a snapshot of standardisation knowledge of the involved parties at the time of elaboration. Further topics will be identified over time.

Note: The subgroup RT5 Energy is named ‘sector integration’ in 6.6.

Table A2.1 – Standardisation topics identified by the WG on Standardisation and CEN-CENELEC

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT4 Mobility ECH2A	aviation	safety standards at airports and aircraft handling architecture.	x		to be identified	to be identified	to be identified	N
RT4 Mobility	aviation - installation - refueling	hydrogen refueling infrastructure	x		to be identified	to be identified	to be identified	N
RT3 Industry heating	combustion quality aspects	gas quality impact: rate of change of Hydrogen content on application side	x	x	EN 676 Forced draught burners for gaseous fuels ISO 13577-2 Industrial furnaces and associated processing equipment - Safety - Part 2: Combustion and fuel handling systems	in preparation	CEN/TC 131, ISO/TC 244/WG 2, CEN/TC 186, CEN/TC 57, CEN/TC 269	Y
RT3 Industry heating	combustion quality aspects	air excess value is one of the main items and influence the flame properties	x		EN 676 Forced draught burners for gaseous fuels ISO 13577-2 Industrial furnaces and associated processing equipment - Safety - Part 2: Combustion and fuel handling systems	in preparation	CEN/TC 131, ISO/TC 109, ISO/TC 244/WG 2	Y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT3 Industry heating	combustion quality aspects	flame temperatures	x		EN 676 Forced draught burners for gaseous fuels ISO 13577-2 Industrial furnaces and associated processing equipment - Safety - Part 2: Combustion and fuel handling systems	in preparation	CEN/TC 131, ISO/TC 244/WG 2	Y
RT3 Industry heating	combustion quality aspects	flame radiation	x		EN 676 Forced draught burners for gaseous fuels ISO 13577-2 Industrial furnaces and associated processing equipment - Safety - Part 2: Combustion and fuel handling systems	in preparation	CEN/TC 131, ISO/TC 109, ISO/TC 244/WG 2	Y
RT3 Industry heating	combustion quality aspects	measurement devices for the H2 content of the exhaust gas of 1,000 ppm, 2,000 ppm and 10,000 ppm	x		EN 676 Forced draught burners for gaseous fuels ISO 13577-2 Industrial furnaces and associated processing equipment - Safety - Part 2: Combustion and fuel handling systems	in preparation	CEN/TC 131, ISO/TC 109, ISO/TC 244/WG 2	Y
RT3 Industry heating	combustion quality aspects	flame sensing in 100% H2 burners	x		EN 298 Automatic burner control systems for burners and appliances burning gaseous or liquid fuels	in preparation	CEN/TC 58/WG 12, IEC/TC 72	Y
RT3 Industry heating	combustion quality aspects	oxygen level in gas	x		EN 676 Forced draught burners for gaseous fuels ISO 13577-2 Industrial furnaces and associated processing equipment - Safety - Part 2: Combustion and fuel handling systems	in preparation	CEN/TC 131, ISO/TC 109, ISO/TC 244/WG 2	Y
RT3 Industry heating	combustion quality aspects	flash back	x		EN 676 Forced draught burners for gaseous fuels ISO 13577-2 Industrial furnaces and associated processing equipment - Safety - Part 2: Combustion and fuel handling systems	in preparation	CEN/TC 131, ISO/TC 109, ISO/TC 244/WG 2	Y
RT3 Industry heating	combustion quality aspects	commissioning without adjustment of the appliances without knowing the real-time	x	x	EN 676 Forced draught burners for gaseous fuels	in preparation	CEN/TC 131, ISO/TC 109,	Y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
		gas quality distributed in blends with hydrogen			ISO 13577-2 Industrial furnaces and associated processing equipment - Safety - Part 2: Combustion and fuel handling systems		ISO/TC 244/WG 2	
RT3 Industry heating	combustion quality aspects	adaptive combustion controls	x	x	EN 12067-2 Gas/air ratio controls for gas burners and gas burning appliances - Part 2: Electronic types EN 676 Forced draught burners for gaseous fuels ISO 13577-2 Industrial furnaces and associated processing equipment - Safety - Part 2: Combustion and fuel handling systems	in preparation	CEN/TC 131, ISO/TC 109, ISO/TC 244/WG 2	Y
RT3 Industry heating	combustion quality aspects	adaptive combustion controls	x	x	CEN/TR 17924 Safety and control devices for burners and appliances burning gaseous and/or liquid fuels - Guidance on hydrogen specific aspects EN 12067-2 Safety and control devices for burners and appliances burning gaseous or liquid fuels - Control functions in electronic systems - Part 2: Fuel/air ratio control / supervision of the electronic type	in preparation	CEN/TC 58/WG 15	Y
RT3 Industry heating	combustion quality aspects	sensor technology for flame detection	x		EN 298 Automatic burner control systems for burners and appliances burning gaseous or liquid fuels EN 676 Forced draught burners for gaseous fuels ISO 13577-2 Industrial furnaces and associated processing equipment - Safety - Part 2: Combustion and fuel handling systems	in preparation	CEN/TC 131, ISO/TC 244/WG 2, CEN/TC 58	Y
RT3 Industry heating	combustion quality aspects	flue gas sensors	x		EN 16340 Safety and control devices for burners and appliances burning gaseous or liquid fuels - Combustion product	in preparation	CEN/TC 131, ISO/TC	Y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
					sensing devices EN 676 Forced draught burners for gaseous fuels ISO 13577-2 Industrial furnaces and associated processing equipment - Safety - Part 2: Combustion and fuel handling systems		244/WG 2, CEN/TC 58	
RT3 Industry heating	combustion quality aspects	dependency of burner performance from H2 quality	x	x	EN 676 Forced draught burners for gaseous fuels	in preparation	CEN/TC 131	Y
RT3 Industry heating	combustion quality aspects	fulfillment of the given regulatory requirements MCPD ((EU) 2015/2193 1- 50 MW), IED (2010/75/EU) and ErP ((EU) 813/2013)	x		EN 676, EN 303-3 and EN 15502-2-7, EN 203 series, EN 14394, EN 17082, EN 416 and EN 419, EN 12309 series	to be identified	CEN/TC 106, CEN/TC 109/WG 3, CEN/TC 131, CEN/TC 57, CEN/TC 180, CEN/TC 299	Partly
RT3 Industry heating	combustion quality aspects	hydrogen blends for industrial heat - hydrogen oxy combustion solution		x	to be identified	to be identified	to be identified	N
RT3 Industry heating CEN-CENELEC	combustion quality aspects	impact of H2 addition on the critical parameters: flash-back (safety), process efficiency, emissions (i.e. NOx)	x	x	to be identified	to be identified	CEN/TC 264, ISO/TC 193, CEN/TC 238, additional TCs to be identified	Y
RT6 Building	combustion quality aspects	premix fans in 100% H2 applications	x	x	CEN/TR 17924 Safety and control devices for burners and appliances burning gaseous and/or liquid fuels - Guidance on hydrogen specific aspects EN 13611 Safety and control devices for burners and appliances burning gaseous or liquid fuels"	in preparation	CEN/TC 109/WG 1, CEN/TC 58	Y
RT6 Building	combustion quality aspects	flame sensing in 100% H2 burners	x		EN 298 Automatic burner control systems for burners and appliances burning gaseous or liquid fuels	in preparation	CEN/TC 58/WG 12	Y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT6 Building	combustion quality aspects	oxygen level in gas	x		CEN/TS 15502-3-3 and EN 16726	in preparation	CEN/TC 109/WG 1, CEN/TC 234/WG 11	partly
RT6 Building	combustion quality aspects	flash back	x		CEN/TS 15502-3-3 and EN 437	in preparation	CEN/TC 109/WG 1, CEN/TC 238/WG 1	Y
RT6 Building	combustion quality aspects	commissioning without adjustment of the appliances without knowing the real-time gas quality distributed in blends with hydrogen		x	CEN/TS 15502-3-1 Gas-fired central heating boilers — Part 3-1 — H2NG and ACCF	in preparation	CEN/TC 109/WG 1	Y
RT6 Building	combustion quality aspects	adaptive combustion controls		x	CEN/TS 15502-3-1	in preparation	CEN/TC 109/WG 1	Y
RT6 Building	combustion quality aspects	adaptive combustion controls	x	x	CEN/TR 17924 Safety and control devices for burners and appliances burning gaseous and/or liquid fuels - Guidance on hydrogen specific aspects EN 12067-2 Safety and control devices for burners and appliances burning gaseous or liquid fuels - Control functions in electronic systems - Part 2: Fuel/air ratio control / supervision of the electronic type	in preparation	CEN/TC 58/WG 15	Y
RT2 T&D	components/ equipment	pressure regulators for the use with hydrogen and its blends with natural gas/biomethane	x	x	EN 334 Gas pressure regulators for inlet pressure up to 10 MPa (100 bar)	to be identified	CEN/TC 235	Y
RT3 Industry heating	components/ equipment	installation of e.g. valves, pressure regulators, pipeline in the buildings	x	x	e.g. EN 331, EN 334, EN 13480 series, EN 15001	to be identified	CEN/TC 236, CEN/TC 235, CEN/TC 234	Y
RT5 Energy	components/ equipment	combustion units	x	x	to be identified	to be identified	to be identified	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT2 T&D CEN-CENELEC	components/ equipment	compressors	x	x	to be identified	to be identified	to be identified	Y
RT2 T&D	components/ equipment - gas measurement	measuring systems (functional requirements)	x	x	EN 1776 Gas infrastructure - Gas measuring systems - Functional requirements	in preparation	CEN/TC 234	Y
RT2 T&D CEN-CENELEC	components/ equipment - pipes	steel pipe for pipeline transportation systems	x	x	ISO 3183 Petroleum and natural gas industries — Steel pipe for pipeline transportation systems - Annex M	to be identified	CEN/TC 12	Y
RT2 T&D CEN-CENELEC	components/ equipment - pipes	pipes/material - plastic pipes	x	x	EN 1555 series (polyethylene pipes, fittings and other assemblies)	to be identified	CEN/TC 155	Y
RT1 Production	components/ equipment - purity	systems for hydrogen drying, separation, compression and purification; product and functional standards for the components and operation of these systems	x		several standards: Air compressors and compressed air systems	in place	ISO/TC 118/SC 6	N
RT2 T&D	components/ equipment - safety aspects	safety shut-off devices	x	x	EN 14382 Gas safety shut-off devices for inlet pressure up to 10 MPa (100 bar)	to be identified	CEN/TC 235, CEN/TC 69	Y
RT5 Energy	components/ equipment - safety aspects	operation safety of compressors	x	x	EN 1012-3 Compressors and vacuum pumps - Safety requirements	to be identified	CEN/TC 232	N
RT2 T&D	components /equipment - valves	performance requirements and tests for valves for hydrogen/gas transportation in pipelines	x	x	EN 14141 Valves for natural gas transportation in pipelines - Performance requirements and tests	to be identified	CEN/TC 69	Y
RT5 Energy	components/ equipment - valves	valves - power and heat generation	x	x	EN 334 Gas pressure regulators for inlet pressures up to 10 MPa (100 bar)	to be identified	CEN/TC 235	Y
RT5 Energy	components/ equipment - valves	valves - power and heat generation	x	x	EN 12266-1 Industrial valves — Testing of valves — Part 1: Pressure tests, test procedures and acceptance criteria - Mandatory requirements	to be identified	CEN/TC 69	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT2 T&D CEN-CENELEC	components/ equipment - valves	equipment and devices installed in the gas chain - pipeline valves	x	x	EN 13942 Petroleum and natural gas industries - Pipeline transportation systems - Pipeline valves (ISO 14313:2007 modified)	to be identified	CEN/TC 12	Y
RT2 T&D CEN-CENELEC	components/ equipment - valves	equipment and devices installed in the gas chain - valves for MOP up to and including 16 bar	x	x	EN 13774 Valves for gas distribution systems with maximum operating pressure less than or equal to 16 bar - Performance requirements -	to be identified	CEN/TC 69	Y
RT5 Energy	components/ equipment - seals	sealing	x	x	to be identified	to be identified	to be identified	N
RT7 Cross-cutting	digitalisation	sensor networks digital certificates machine readable certificates			to be identified	to be identified	to be identified	N
RT1 Production	electrolysers	electricity grid connection for ancillary services by electrolysers and regarding power quality requirements - standardisation (other than regulation on system operation at national level) of procedures for testing, inspection and certification of facilities and performance; Measurement and assessment of power quality characteristics of grid connected electrolysers; EU harmonised protocols for testing of low temperature water electrolysers, JRC 2021	x		to be identified	to be identified	CEN/CLC JTC 6	Y
RT1 Production CEN-CENELEC	electrolysers	control strategies for integrating electrolysers with intermittent renewable energies (mapping operational boundaries)	x		to be identified	to be identified	CEN-CLC/JTC 6	Y
RT1 Production CEN-CENELEC	electrolysers	electrolyser - development of measurement methods and test procedures for electrolyser performance dedicated to the needs of ancillary service requirements	x		to be identified	to be identified	CEN-CLC/JTC 6	Y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT1 Production CEN-CENELEC	electrolysers	electrolyser - frequency, voltage control and other grid service requirements of grid operators – technical oriented	x		to be identified	to be identified	CEN-CLC/JTC 6	Y
RT1 Production CEN-CENELEC	electrolysers	electrolyser - key performance indicators	x		to be identified	to be identified	CEN-CLC/JTC 6	Y
RT1 Production CEN-CENELEC	electrolysers	electrolyser - harmonisation of requirements	x		to be identified	to be identified	CEN-CLC/JTC 6	Y
RT1 Production CEN-CENELEC	electrolysers - metrology	electrolyser - development of measurement methods and test procedures for electrolyser performance – single cells, stacks and systems testing protocols	x		to be identified	to be identified	CEN-CLC/JTC 6	Y
RT1 Production CEN-CENELEC	electrolysers - quality aspects	electrolyser - oxygen quality	x		to be identified	to be identified	CEN-CLC/JTC 6	Y
RT3 Industry feedstock	energy / hydrogen carrier	Labelling of renewable/low-carbon ammonia	x		to be identified	to be identified	to be identified	N
RT4 Mobility	energy / hydrogen carrier	hydrogen for e-fuels At the moment there is no standardisation for those application, there is a need to add those requirements.		x	to be identified	to be identified	to be identified	N
RT4 Mobility ECH2A	energy / hydrogen carrier	Methanol and ammonia norms for utilization as transport fuel.	x		to be identified	to be identified	to be identified	N
RT7 Cross-cutting ECH2A Industry	energy / hydrogen carrier	Definition and standards for certifying low carbon and green hydrogen as well as liquid hydrogen - either as an end product or for logistics reasons	x		to be identified	to be identified	to be identified	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT7 Cross-cutting	energy / hydrogen carrier	quality of LOHCs reliable operation of the plants - purity of LOHC			to be identified	to be identified	to be identified	N
RT7 Cross-cutting	energy / hydrogen carrier	Standards for all possible modes of hydrogen transport/storage (carrier) to ensure clarity in this part of the value chain. - LOHC, LIHC - LH2 - gaseous hydrogen - others	x		to be identified	to be identified	to be identified	N
RT2 T&D	energy / hydrogen carrier	HHO as alternative to 100% or H2NG in several sectors (e.g. when used as a fuel product specific standards need to be addressed)			to be identified	to be identified	to be identified	N
RT2 T&D CEN-CENELEC	energy / hydrogen carrier	Liquid hydrogen - transport, storage and use - Adaptation of standards on LNG transport to liquefied hydrogen			to be identified	to be identified	CEN/TC 268, CEN/TC 282, (ISO/TC 220, ISO/TC 67/SC9)	Y
RT1 Production CEN-CENELEC	energy / hydrogen carrier	Methanation	x		ISO AWI 23898 Gasification systems for bio-syngas and biomethane production	in preparation	CEN/TC 408, ISO/TC 255	Y
RT1 Production CEN-CENELEC	energy / hydrogen carrier	LH2 - safety topics - mitigation strategies and risk assessment	x		to be identified	to be identified	to be identified	Y
RT4 mobility ECH2A Industry	energy / hydrogen carrier - maritime -	standards for using ammonia (or other hydrogen carriers such as methanol) as fuels for shipping, heavy road transport or aviation are missing.	x		to be identified	to be identified	to be identified	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
	heavy duty - aviation -							
RT2 T&D	fuel cell aspects - energy / hydrogen carrier	fuel cell	x		to be identified	to be identified	IEC/TC 105	N
RT4 Mobility	gas engines	combustion engines	x		to be identified	to be identified	to be identified	N
RT5 Energy CEN-CENELEC	gas engines	gas engines including variable H2 concentrations	x	x	EN 1834 series Reciprocating internal combustion engines - Safety requirements for design and construction of engines for use in potentially explosive atmospheres ISO 15550 Internal combustion engines — Determination and method for the measurement of engine power — General requirements ISO 3046 Reciprocating internal combustion engines — Performance	to be identified	CEN/TC 270, ISO/TC 70	Y
RT2 T&D	gas quality aspects	H2 as blend with natural gas/biomethane (esp. Wobbe Index, Oxygen and total sulfur content, Hydrogen and relative density)		x	EN 16726 Gas infrastructure - Quality of gas - Group H (EN 16723-1 Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network - Part 1: Specifications for biomethane for injection in the natural gas network)	under revision	CEN/TC 234	Y
RT3 Industry heating	gas quality aspects	max. hydrogen content allowed /guaranteed for end-use		x	EN 16726 Gas infrastructure - Quality of gas - Group H	under revision	CEN/TC 234/WG 11	Y
RT3 Industry heating	gas quality aspects	Wobbe index, oxygen		x	EN 16726 Gas infrastructure - Quality of gas - Group H	under revision	CEN/TC 234/WG 11	Y
RT6 Building	gas quality aspects	Wobbe index	x	x	EN 16726 Gas infrastructure - Quality of gas - Group H	under revision	CEN/TC 234/WG 11	Y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT6 Building	gas quality aspects	max. Hydrogen content allowed /guaranteed for end-use		x	EN 16726 Gas infrastructure - Quality of gas - Group H	under revision	CEN/TC 234/WG 11	Y
RT6 Building	gas quality aspects	rate of change of hydrogen content		x	CEN/TS 15502-3-1 Gas-fired central heating boilers ...	in preparation	CEN/TC 109/WG 1	N
RT2 T&D CEN-CENELEC	gas quality aspects	adaptation of gas analysis methods - purity analysis and treatment of purity data	x	x	ISO 19229 Gas analysis — Purity analysis and the treatment of purity data	in preparation	ISO/TC 158	Y
RT2 T&D CEN-CENELEC	gas quality aspects	sensors for concentration monitoring H2 and H2NG	x	x	to be identified	to be identified	CLC/SC 31-9	Y
RT7 Cross-cutting CEN-CENELEC	gas quality aspects	determination of gas quality parameters - Determination of hydrogen, inert gases and hydrocarbons up to C8	x	x	EN ISO 6974 (series) Natural gas - Determination of hydrogen, inert gases and hydrocarbons up to C8 - Gas chromatographic	to be identified	CEN/TC 238	Y
RT2 T&D	gas quality aspects - gas families / test gases	Gas families and test gases for H2 • Gas/hydrogen analysis methods • Gas/hydrogen quality monitoring	x	x	EN 437 Test gases - Test pressures - Appliance categories	under revision	CEN/TC 238	Y
RT3 Industry heating	gas quality aspects - gas families / test gases	appliance testing - missing test gases	x	x	EN 437 Test gases - Test pressures - Appliance categories;	in preparation	CEN/TC 238	Y
RT6 Building	gas quality aspects - gas families / test gases	missing test gases for appliance testing	x	x	EN 437 Test gases - Test pressures - Appliance categories CEN/TS 15502-3-1 Gas-fired heating boilers ... CEN/TS 15502-3-3 Gas-fired heating boilers ...	in preparation	CEN/TC 238, CEN/TC 109/ WG 1	Y
RT3 Industry heating	gas quality aspects - metrology - measurement	gas quality measurement devices	x	x	to be identified	to be identified	to be identified	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT1 Production	gas quality aspects - purity	hydrogen and gas quality quality control and measurement methodologies purity of hydrogen Impurities like inert gases Wobbe index from repurposed infrastructure	x		ISO 14687 Hydrogen fuel quality — Product specification (harmonized with CEN 17214)	under revision	ISO/TC 197	Y
RT2 T&D	gas quality aspects - purity	H2 quality in industry	x	x	several standards	to be identified	CEN/CLC JTC 6, ISO/TC 197, CEN/TC 234	partly
RT2 T&D	gas quality aspects - purity	hydrogen quality in pipelines	x		CEN/TS XXX (WI 00234096) EN 17124 Hydrogen Fuel - Product Specification And Quality Assurance - Proton Exchange Membrane (PEM) Fuel Cell Applications for Road Vehicles ISO 14687 Hydrogen fuel quality — Product specification	(1) in preparation (2) under revison	CEN/TC 234, CEN/CLC JTC 6, ISO/TC 197	Y
RT2 T&D	gas quality aspects - purity	purification of hydrogen fuel gases divers aspects e.g. pressure swing absorption	x		to be identified	to be identified	to be identified	Y
RT2 T&D ECH2A Industry	gas quality aspects - purity	standards for hydrogen purity and gas quality handling, including blending	x		CEN/TS XXX (WI 00234096) Gas infrastructure — Quality of gas — Hydrogen used in converted/rededicated gas systems ISO 14687 Hydrogen fuel quality — Product specification	in preparation	CEN/TC 234, CEN/CLC JTC 6, ISO/TC 197	Y
RT3 Industry heating	gas quality aspects - purity	purity of hydrogen/ impurities like inert gases/Wobbe index from repurposed infrastructure	x		CEN/TS XXX (WI 00234096) Gas infrastructure — Quality of gas — Hydrogen used in converted/rededicated gas systems	in preparation	CEN/TC 234/WG 11	Y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT3 Industry heating	gas quality aspects - purity	purity of hydrogen/ impurities like inert gases/Wobbe index as fuel	x		ISO 14687:2019 Hydrogen fuel quality — Product specification	under revision	ISO/TC 197	Y
RT3 Industry heating	gas quality aspects - purity	purity of volatile blends max 30 %		x	EN 16726 Gas infrastructure - Quality of gas - Group H	under revision	CEN/TC 234	Y
RT5 Energy	gas quality aspects - purity	purity of hydrogen/ impurities like inert gases/Wobbe index from repurposed infrastructure	x		CEN/TS XXX (WI 00234096) Gas infrastructure — Quality of gas — Hydrogen used in converted/rededicated gas systems	in preparation	CEN/TC 234	Y
RT5 Energy	gas quality aspects - purity	purity of hydrogen/ impurities like inert gases/Wobbe index as fuel	x		ISO 14687 Hydrogen fuel quality — Product specification	under revision	ISO/TC 197	Y
RT5 Energy	gas quality aspects - purity	purity of volatile blends		x	EN 16726 Gas infrastructure - Quality of gas - Group H CEN/TS XXX (WI 00234096) Gas infrastructure — Quality of gas — Hydrogen used in converted/rededicated gas systems ISO 14687 Hydrogen fuel quality — Product specification	(1) in preparation (2) under revision	CEN/TC 234, CEN/CLC JTC 6, ISO/TC 197	N
RT5 Energy	gas quality aspects - purity	max. hydrogen content allowed /guaranteed for end-use		x	CEN/TS XXX (WI 00234096) Gas infrastructure — Quality of gas — Hydrogen used in converted/rededicated gas systems ISO 14687 Hydrogen fuel quality — Product specification	(1) in preparation (2) under revision	CEN/TC 234, CEN/CLC JTC 6, ISO/TC 197	Y
RT6 Building	gas quality aspects - purity	purity	x		CEN/TS XXX (WI 00234096) Gas infrastructure — Quality of gas — Hydrogen used in converted/rededicated gas systems	in preparation	CEN/TC 234	Y
RT2 T&D	gas quality aspects -	Methodologies for analysis and measurement of impurities in Hydrogen, norms for quality of hydrogen to all	x		EN 17124 Hydrogen Fuel - Product Specification And Quality Assurance - Proton Exchange Membrane (PEM) Fuel	(1) in preparation	CEN/TC 268, ISO/TC 197	Y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
	quality measurement	utilizations way (including directing hydrogen to NG pipelines)			Cell Applications for Road Vehicles ISO 14687 Hydrogen fuel quality — Product specification	(2) under revison		
RT2 T&D CEN-CENELEC	gas quality aspects - metrology	adaptation of gas analysis methods - calibration of gas mixtures (H2NG)	x	x	EN ISO 6145 Gas analysis - Preparation of calibration gas mixtures using dynamic volumetric methods	to be identified	CEN/TC 238, ISO/TC 193	Y
RT2 T&D CEN-CENELEC	gas quality aspects - metrology	adaptation of gas analysis methods - sampling guidelines	x	x	EN ISO 10715, Natural gas — Sampling guideline	to be identified	CEN/TC 238, ISO/TC 193	Y
RT5 Energy CEN-CENELEC	gas turbines	Gas turbines including variable H2 concentrations	x	x	EN ISO 21789 Gas turbine – Safety; as this standard details the minimum fuel system requirements, which would need to change. ISO 3977-4 Gas turbines — Procurement — Part 4: Fuels and environment ISO 3977 Gas turbines – Procurement (all parts); need to address reliability and maintenance concerns ISO 11042 (all parts) Exhaust gas emissions. ISO 11086 Vocabulary ISO 19859 Power generation applications ISO 2314 Acceptance testing ISO 19372 Microturbines ISO 19860 Trend monitoring and data storage ISO 18888 Acceptance tests – combined cycle plant	to be identified	ISO/TC 192	Y
RT1 Production	gas/hydrogen infrastructure	material testing standards	x	x	EN 1594 Gas infrastructure - Pipelines for maximum operating pressure over 16 bar - Functional requirements	under revision	CEN/TC 234	Y
RT2 T&D	gas/hydrogen infrastructure	pipelines for distribution of hydrogen and its blends with natural gas/biomethane	x	x	EN 12007-1 Gas infrastructure - Pipelines for maximum operating pressure up to and including 16 bar -	in preparation	CEN/TC 234	Y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
					Part 1: General functional requirements Part 2: Specific functional requirements for polyethylene (MOP up to and including 10 bar) Part 3: Specific functional requirements for steel Part 4: Specific functional requirements for renovation Part 5: Service lines - Specific functional requirements Part 6: (CEN TS)			
RT2 T&D	gas/hydrogen infrastructure	pressure regulation stations (Functional requirements)	x	x	EN 12186 Gas infrastructure - Gas pressure regulating stations for transmission and distribution - Functional requirements	in preparation	CEN/TC 235	Y
RT2 T&D	gas/hydrogen infrastructure	pressure regulation installations on service lines (functional requirements)	x	x	EN 12279 Gas supply systems - Gas pressure regulating installations on service lines - Functional requirements	in preparation	CEN/TC 234	Y
RT2 T&D	gas/hydrogen infrastructure	pressure testing, commissioning ad decommissioning of hydrogen/gas network	x	x	EN 12327 Gas infrastructure - Pressure testing, commissioning and decommissioning procedures - Functional requirements	in preparation	CEN/TC 234	Y
RT2 T&D	gas/hydrogen infrastructure	compressor stations (design, construction, operation of new stations)	x	x	EN 12583 Gas supply systems - Compressor stations - Functional requirements	in place	CEN/TC 234	Y
RT2 T&D	gas/hydrogen infrastructure	Safety Management System (SMS) and Pipeline Integrity Management System (PIMS) for hydrogen/gas infrastructure	x	x	EN 17649:2022 Gas infrastructure - Safety Management System (SMS) and Pipeline Integrity Management System (PIMS) - Functional requirements (Merger of EN 15399 (DSO) + EN 16348 (TSO))	in place	CEN/TC 234	Y
RT2 T&D	gas/hydrogen infrastructure	pipework for buildings - maximum operating pressure less than or equal to 5 bar (functional recommendations)	x	x	EN 1775 Gas supply - Gas pipework for buildings - Maximum operating pressure less than or equal to 5 bar - Functional recommendations	in preparation	CEN/TC 234	Y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT2 T&D	gas/hydrogen infrastructure	transmission pipelines for maximum operating pressure over 16 bar including non-metallic pipelines and including or complemented by the method of conformity assessment for Hydrogen service	x	x	EN 1594 Gas infrastructure - Pipelines for maximum operating pressure over 16 bar - Functional requirements	under revision	CEN/TC 234	Y
RT2 T&D	gas/hydrogen infrastructure	welding of steel pipework used for hydrogen and its blends with natural gas	x	x	EN 12732 Gas infrastructure - Welding steel pipework - Functional requirements	in place	CEN/TC 234	Y
RT2 T&D	gas/hydrogen infrastructure	hydrogen injection facilities	x	x	EN 17928-1 Gas infrastructure - Injection stations - Part 1 General requirements EN 17928-3 Gas infrastructure - Injection stations -Part 3: Specific requirements regarding the injection of hydrogen fuel gas	in preparation	CEN/TC 234	Y
RT2 T&D	gas/hydrogen infrastructure	installation pipework with an operating pressure greater than 0,5 bar for industrial installations and greater than 5 bar for industrial and non-industrial installations	x	x	EN 15001-1/-2 Gas Infrastructure - Gas installation pipework with an operating pressure greater than 0,5 bar for industrial installations and greater than 5 bar for industrial and non-industrial installations - Part 1: Detailed functional requirements for design, materials, construction, inspection and testing Part 2: Detailed functional requirements for commissioning, operation and maintenance	in preparation	CEN/TC 234	Y
RT2 T&D ECH2A Industry	gas/hydrogen infrastructure	standards and technical rules linked to retrofitting/blending and repurposing of new pipelines, underground gas storages and LNG terminals	x	x	several standards	in preparation	CEN/TC 234	Y
RT2 T&D ECH2A Industry	gas/hydrogen infrastructure	technical standards for infrastructure planning, infrastructure operation and infrastructure maintenance	x		several standards	in preparation	CEN/TC 234	Y
RT5 Energy	gas/hydrogen infrastructure	design and stress calculation of the line pipe containing pure Hydrogen or H2NG blend	x	x	EN 1594 Gas infrastructure - Pipelines for maximum operating pressure over 16 bar - Functional requirements	under revision	CEN/TC 234	y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT5 Energy	gas/hydrogen infrastructure	industrial piping - pipes and sealing for gas fuel system at the power plant	x	x	EN 15001-1 Gas infrastructure - Gas installation pipework with an operating pressure greater than 0,5 bar for industrial installations and greater than 5 bar for industrial and non -industrial installations - Part 1: Detailed functional requirements for design, materials, construction, inspection and testing	to be identified	CEN/TC 234	Y
RT5 Energy	gas/hydrogen infrastructure	pipes - material aspects - power and heat generation	x	x	EN 12007-3 Gas supply systems — Pipelines for maximum operating pressure up to and including 16 bar – Part 3: Specific functional recommendations for steel	in preparation	CEN/TC 234	Y
RT6 Building	gas/hydrogen infrastructure	installation of e.g. valves, pressure regulators, pipeline in the building	x	x	to be identified	under revision	CEN/TC 234	Y
RT2 T&D ECH2A Industry	gas/hydrogen infrastructure - hydrogen storage	missing construction/building norms for H2 storage in gaseous and liquid form	x		to be identified	to be identified	CEN/TC 234	partly
RT2 T&D	gas/hydrogen infrastructure - hydrogen terminal - injection in grid	standards needed for the handling of hydrogen and derivatives when using hydrogen terminals and injecting into the hydrogen grid to avoid issues at interconnection points. here: hydrogen terminal for the transformation of liquid hydrogen or liquid ammonia or LOHC into gaseous hydrogen . Here to add also LIHC and solid state forms	x		to be identified	to be identified	to be identified	N
RT2 T&D	gas/hydrogen infrastructure - material compatibility	Materials for metallic industrial piping used for hydrogen and its blends with natural gas, particulary the related requirements of prevention of brittle fracture at low temperatures and including the evaluation of compliance for hydrogen service of the existing or new pressure equipment and	x	x	EN 13480-2 Metallic industrial piping - Part 2: Materials	to be identified	CEN/TC 267	N

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		links for the selection of proper material testing standards for hydrogen service. This standard should be updated to include non-metallic pipes.						
RT2 T&D CEN-CENELEC	gas/hydrogen infrastructure - hydrogen terminal - energy / hydrogen carrier	LH2 - safety topics - harmonized safety distances on liquification plants	x	x	to be identified	to be identified	to be identified	Y
RT2 T&D	gas/hydrogen infrastructure - storage	storage in aquifers including methodology for analyzing the interactions between H2 and the reservoir rock, the cap rock, microbiological effects underlying and the leaks.	x	x	EN 1918-1 Gas infrastructure - Underground gas storage - Part 1: Functional recommendations for storage in aquifers	in preparation	CEN/TC 234	Y
RT2 T&D	gas/hydrogen infrastructure - storage	storage in oil and gas fields including methodology for analyzing the interactions between H2 and the reservoir rock, the cap rock, microbiological effects underlying and the leaks	x	x	EN 1918-2 Gas infrastructure - Underground gas storage - Part 2: Functional recommendations for storage in oil and gas fields	in preparation	CEN/TC 234	Y
RT2 T&D	gas/hydrogen infrastructure - storage	storage in solution-mined salt cavities including methodology for analyzing the interactions between H2 and the salt cavern, the effects of the pressure variations and leak	x	x	EN 1918-3 Gas infrastructure - Underground gas storage - Part 3: Functional recommendations for storage in solution-mined salt cavities	in preparation	CEN/TC 234	Y
RT2 T&D	gas/hydrogen infrastructure - storage	storage in rock caverns methodology for analyzing the interactions between H2 and the rock cavern, the effect of the pressure variations and leak	x	x	EN 1918-4 Gas infrastructure - Underground gas storage - Part 4: Functional recommendations for storage in rock caverns	in preparation	CEN/TC 234	Y
RT2 T&D	gas/hydrogen infrastructure - storage	underground storage surface facilities including requirements for each type of components: piping, valves, burners, compressors, treatment technology	x	x	EN 1918-5 Gas infrastructure - Underground gas storage - Part 5: Functional recommendations for surface facilities	in preparation	CEN/TC 234	Y

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RT3 Industry heating	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard preparation and product approval (certification process)	x	x	EN 303-3 Heating boilers - Part 3: Gas-fired central heating boilers - Assembly comprising a boiler body and a forced draught burner EN 15502-2-7 Heating boilers - Part 2-7: Specific standard for gas-fired central heating units	to be identified	CEN/TC 109/WG 3	Y
RT3 Industry heating	harmonized standards	missing standardisation request on GAR and H2 which is the basis for product approval (certification process)	x	x	EN 203 Gas heated catering equipment - series	in preparation	CEN/TC 106	Y
RT3 Industry heating	harmonized standards	missing standardisation request on GAR and H2 which is the basis for product approval (certification process)	x	x	EN 676 Forced draught burners for gaseous fuels	in preparation	CEN/TC 131	Y
RT3 Industry heating	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard preparation and product approval (certification process)	x	x	EN 14394 Heating boilers - Heating boilers with forced draught burners - Nominal heat output not exceeding 10 MW and maximum operating temperature of 110 °C	to be identified	CEN/TC 57	N
RT3 Industry heating	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard preparation and product approval (certification process)	x	x	EN 12953 series Shell boilers, EN 12952 series Water-tube boilers and auxiliary installations	to be identified	CEN/TC 269	N
RT3 Industry heating	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard preparation and product approval (certification process)	x	x	EN 17082 Domestic and non-domestic gas-fired forced convection air heaters for space heating not exceeding a net heat input of 300 kW, EN 416 Gas-fired overhead radiant tube heaters and radiant tube heater systems for non-domestic use - Safety and energy efficiency EN 419 Gas-fired overhead luminous radiant heaters for non-domestic use - Safety and energy efficiency	to be identified	CEN/TC 180	N

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RT3 Industry heating	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard preparation and product approval (certification process)	x	x	EN 12309 Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - series	to be identified	CEN/TC 299	N
RT3 Industry heating	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard preparation and product approval (certification process)	x	x	EN 1829-1 High-pressure water jet machines - Safety requirements - Part 1: Machines	to be identified	CEN/TC 197	N
RT3 Industry heating	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard preparation and product approval (certification process)	x	x	EN 50465 Gas appliances - Combined heat and power appliance of nominal heat input inferior or equal to 70 kW	to be identified	CEN/CLC JTC 17	N
RT6 Building	harmonized standards	missing references to EN (gas safety -) standards that are (to be-) harmonised under GAR (eg EN 437 including reference to test methods from eg EN 15502 series)	x	x	EN 62282-3-100 Fuel cell technologies - Part 3-100: Stationary fuel cell power systems - Safety (and possibly other (and possibly other EN 62282 standards as well)	to be identified	CEN/CLC JTC 17	N
RT6 Building	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard preparation and product approval (certification process)	x	x	EN 13611 Safety and control devices for burners and appliances burning gaseous and/or liquid fuels - General requirements all Part 2 standards: EN 88-1, EN 88-2, EN 88-3, EN 161, EN 298, EN 12067-2, EN 126, ...	in preparation	CEN/TC 58, ISO/TC 161	Y
RT6 Building	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard preparation and product approval (certification process)	x	x	EN 15502 series Gas-fired heating boilers	in preparation	CEN/TC 109/WG 1	N
RT6 Building	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard preparation and product approval (certification process)	x	x	EN 303-3 Heating boilers - Part 3: Gas-fired central heating boilers - Assembly comprising a boiler body and a forced draught burner EN 15502-2-7 Heating boilers - Part 2-7: Specific standard for gas-fired central heating units	to be identified	CEN/TC 109/WG 3	Y

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RT6 Building	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard preparation and product approval (certification process)	x	x	EN 26 Gas-fired instantaneous water heaters for the production of domestic hot water EN 89 Gas-fired storage water heaters for the production of domestic hot water	in preparation	CEN/TC 48	Y
RT6 Building	harmonized standards	missing standardisation request on GAR and H2 which is the basis for product approval (certification process)	x	x	EN 30 series Domestic cooking appliances burning gas	in preparation	CEN/TC 49	Y
RT6 Building	harmonized standards	missing standardisation request on GAR and H2 which is the basis for product approval (certification process)	x	x	EN 203 series Gas heated catering equipment	in preparation	CEN/TC 106	Y
RT6 Building	harmonized standards	missing standardisation request on GAR and H2 which is the basis for product approval (certification process)	x	x	EN 676 Forced draught burners for gaseous fuels	in preparation	CEN/TC 131	Y
RT6 Building	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard preparation and product approval (certification process)	x	x	EN 17082 Domestic and non-domestic gas-fired forced convection air heaters for space heating not exceeding a net heat input of 300 kW EN 416 Gas-fired overhead radiant tube heaters and radiant tube heater systems for non-domestic use - Safety and energy efficiency EN 419 Gas-fired overhead luminous radiant heaters for non-domestic use - Safety and energy efficiency	to be identified	CEN/TC 180	N
RT6 Building	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard preparation and product approval (certification process)	x	x	EN 613 Independent closed-fronted gas-fired type B11, type C11, type C31 and type C91 heaters EN 509 Decorative fuel-effect gas appliances EN 14829 Independent gas-fired flueless space heaters for nominal heat input not exceeding 6 kW	to be identified	CEN/TC 62	N
RT6 Building	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard	x	x	EN 12309 series Gas-fired sorption appliances for heating and/or cooling	to be identified	CEN/TC 299	N

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		preparation and product approval (certification process)			with a net heat input not exceeding 70 kW			
RT6 Building	harmonized standards	missing standardisation request on GAR and H2 which is the basis for standard preparation and product approval (certification process)	x	x	EN 50465 Gas appliances - Combined heat and power appliance of nominal heat input inferior or equal to 70 kW	to be identified	CEN/CLC JTC 17	N
RT4 Mobility ECH2A	heavy duty / road vehicles	standardisation of fuel cell modules for heavy duty applications e.g. “StasHH mission” project.	x		to be identified	to be identified	to be identified	N
RT4 mobility ECH2A Industry	heavy duty / road vehicles	accelerate the transition of tube trailers standard pressure to higher standard (500 bars) (Inland distribution archetype)	x		to be identified	to be identified	to be identified	N
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles	refueling points - Fuel cells	x		EN 17124:2022 Hydrogen fuel - Product specification and quality assurance for hydrogen refuelling points dispensing gaseous hydrogen - Proton exchange membrane (PEM) fuel cell applications for vehicles	to be identified	CEN/TC 268	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles	refueling points - Outdoor points	x		EN 17127 ‘Outdoor hydrogen refuelling points dispensing gaseous hydrogen and incorporating filling protocols’	in preparation	CEN/TC 268	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles	refueling system interface	x		ISO 13984:1999 ‘Liquid hydrogen — Land vehicle fuelling system interface’	to be identified	ISO/TC 197	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles	Liquid hydrogen as fuel	x		to be identified	to be identified	CEN/TC 268, CEN/TC 326	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles	liquid H2 transfer process & equipment - cheaper testing materials	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles	liquid H2 transfer process & equipment - hoses	x		to be identified	to be identified	to be identified	Y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles	liquid H2 transfer process & equipment - testing harmonized	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles	LH2 refuelling connection devices - Land vehicle - liquid H2 transfer process and and equipment (hoses)	x		EN ISO 17268 'Gaseous hydrogen land vehicle refuelling connection devices' (M/533)	to be identified	CEN/TC 268	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - combustion	CH2NG vehicles and engines - combustion system - Effect of hydrogen on the combustion on different engine types		x	EN 16723-2 Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network - Part 2: Automotive fuels specification	in preparation	CEN/TC 408	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - combustion	CH2NG vehicles - Refueling station (Effect on components as compressor and storages)	x	x	EN ISO 16923 Natural gas fuelling stations - CNG stations for fuelling vehicles	under revision	CEN/TC 326	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - components	refueling connection devices	x		EN ISO 17268 'Gaseous hydrogen land vehicle refuelling connection devices'	in preparation	CEN/TC 268, ISO/TC 197	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - installation	CH2NG filling stations - related to billing		x	to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - installation	CH2NG vehicles - Qualification methods for steel tanks for H2NG with hydrogen concentrations above 2 vol%	x	x	ISO 13985 Liquid hydrogen — Land vehicle fuel tanks ISO/TS 15869 Gaseous hydrogen and hydrogen blends — Land vehicle fuel tanks	to be identified	ISO/TC 22, CEN/TC 408, ISO/TC 197, ISO/TC 58	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - installation - bunkering	bunkering safety risk - Harmonizing of scenarios and data structures	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - installation - safety	sensors for leak detection of H2 and H2NG	x	x	ISO 26142:2010 Hydrogen detection apparatus — Stationary applications and possible additional standards	in place	ISO/TC 197, CLC/TC 31/SC31-9, JTC 6	Y

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RT4 Mobility	heavy duty / road vehicles - installation - refueling	hydrogen refueling points dispensing compressed (gaseous) hydrogen for heavy duty vehicles	x		to be identified	in preparation	CEN/TC 268	y
RT4 Mobility	heavy duty / road vehicles - installation - refueling	hydrogen refueling points dispensing liquefied hydrogen for heavy duty vehicles	x		to be identified	in preparation	CEN/TC 268	y
RT4 Mobility	heavy duty / road vehicles - installation - refueling	hydrogen connectors on hydrogen refueling solutions (HRS); it is necessary to create a one standard for hydrogen pistol on HRS corresponding with one standard of connector on the all hydrogen vehicles	x		to be identified	to be identified	to be identified	Y
RT4 Mobility ECH2A	heavy duty / road vehicles - installation - refueling	standard for certifying hydrogen refueling systems (to avoid certification by each hydrogen car manufacturer or by member state), especially valid for heavy duty vehicles and buses.	x		to be identified	to be identified	to be identified	N
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - metering	metering - CH2NG filling stations (related to billing)	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - storage	Fuel cell systems for propulsion - Hydrogen storage - remote monitoring and emptying tank towing/intervention	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - storage	fuel cell systems for propulsion - Hydrogen storage - location of fuel cells in heavy duty applications	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	transfer safety risk - Use of risk assessments	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	transfer safety risk - validated models for assessing consequence	x		to be identified	to be identified	to be identified	Y

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RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	crashing safety risk - first aid response guidelines	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	crashing safety risk - flare off the hydrogen (compressed or liquefied) fuel tank on a crashed or burnt out vehicle / empty storage tanks after an incident or because of different situations	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	crashing safety risk - flaring of H2	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	crashing safety risk - master switch to disconnect H2 system	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	crashing safety risk - performance based standards	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	crashing safety risk - reporting formats	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	safety risk - fueling protocols for heavy duty (Gaseous H2)	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	safety risk - fueling protocols for heavy duty (Gaseous H2) - communication system on the transfer of H2; distribution trailer, station and vehicle - Communications	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	safety risk - fueling protocols for heavy duty (Gaseous H2) - communication system on the transfer of H2; distribution trailer, station and vehicle - communications	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	safety risk - fueling protocols for heavy duty (Gaseous H2) - communication system on	x		to be identified	to be identified	to be identified	Y

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		the transfer of H2; distribution trailer, station and vehicle - Interlocks						
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	safety risk - Fueling protocols for heavy duty (Gaseous H2) - communication system on the transfer of H2; distribution trailer, station and vehicle - protocols	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	safety risk - fueling protocols for heavy duty (Gaseous H2) - communication system on the transfer of H2; distribution trailer, station and vehicle - Trailer operating rules	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	safety risk - Liquid H2 transfer	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects	safety risk - transportation of dangerous goods	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects - energy / hydrogen carrier	safety topics for the use of alternative hydrogen carriers e.g LOHC or metalhybride	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects - leakage	Leakage related safety risks (safety, leakage related hydrogen characteristics) - SoA of tank technologies	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	heavy duty / road vehicles - safety aspects - leakage	leakage related safety risks (safety, leakage related hydrogen characteristics) - ventilation	x		to be identified	to be identified	to be identified	Y
RT1 Production	hydrogen production	all possible hydrogen production facilities including their components, devices, connections, single cells, stacks, generators, etc. such as: - catalytic/electrolyers - thermal/pyrolysis, water shift reactor - steam methane reforming with CCS	x		to be identified	to be identified	to be identified	N

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		- gasification of organic fractions from multiple solid waste (MSW)						
RT7 Cross-cutting	hydrogen production - safety aspects	requirements for design modular hydrogen systems 1. Reliable interface functions between the modules, safety-related functions 2. Tightness of the interfaces 3. Decoupling concepts (see also Protective systems) 4. Concepts and requirements for exceeding critical thresholds (5 t or 50 t according to RL 2018/12/EU)	x		to be identified	to be identified	to be identified	N
RT7 Cross-cutting	hydrogen production - safety aspects	requirements for design and functioning of cyber security for hydrogen plants	x		to be identified	to be identified	CEN/CLC JTC 6	N
RT7 Cross-cutting	hydrogen production - safety aspects	requirements for dynamic operating regimes of electrolysis plants (Dynamic Mode Operation, DMO)	x		to be identified	to be identified	CEN/CLC JTC 6	N
RT4 mobility ECH2A	installation - refueling	standardisation on hydrogen refueling infrastructure for all mobility application (design, interface with building norms)	x		to be identified	to be identified	CEN/TC 268 and others to be identified	Partly
RT4 Mobility ECH2A	maritime	defining technical requirements towards zero-carbon shipping with the International Maritime Organisation (IMO).	x		to be identified	to be identified	to be identified	N
RT4 Mobility CEN-CENELEC	maritime	liquid hydrogen - transport, storage and use (e.g. maritime is looking into liquid hydrogen for transport and use)	x		ISO 24132 Ships and marine technology — Design and testing of marine transfer arms for liquefied hydrogen	in preparation	ISO/TC 8	Y
RT4 Mobility CEN-CENELEC	maritime	transfer process & equipment - testing	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime	transfer process & equipment - hoses	x		to be identified	to be identified	to be identified	Y

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RT4 Mobility CEN-CENELEC	maritime	fuel cell power systems - modelling tools/ energy management prediction	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime	inland waterways -H2 powered boats	x		to be identified	to be identified	CESNI	Y
RT4 Mobility CEN-CENELEC	maritime	integration of high-temperature applications in inland vessels	x		to be identified	to be identified	to be identified	Y
RT4 Mobility	maritime - energy / hydrogen carrier	maritime on-board usage of LIHC as a H2 fuel carrier	x		to be identified	to be identified	to be identified	N
RT4 Mobility	maritime - energy / hydrogen carrier	maritime on-board usage of LOHC or KBH4 as a H2 fuel carrier	x		to be identified	to be identified	to be identified	N
RT4 Mobility	maritime - energy / hydrogen carrier	safety of LIHC in maritime transport, storage and use	x		ISO/TR 15916 Basic considerations for the safety of hydrogen systems	under revision	ISO/TC 197, CEN/CLC/JTC 6	Y
RT4 Mobility	maritime - energy / hydrogen carrier	Safety of LOHC in maritime transport, storage and use	x		ISO/TR 15916 Basic considerations for the safety of hydrogen systems	under revision	ISO/TC 197, CEN/CLC/JTC 6	Y
RT4 Mobility ECH2A	maritime - energy / hydrogen carrier - safety aspects	safety standards and classification for hydrogen, ammonia, and methanol powered ships.	x		to be identified	to be identified	to be identified	N
RT4 mobility ECH2A Industry	maritime - energy / hydrogen carrier - storage	technical standards related to the storage and handling of hydrogen carriers (LIHC)	x		to be identified	to be identified	to be identified	N
RT4 mobility ECH2A Industry	maritime - energy / hydrogen carrier - storage	technical standards related to the storage and handling of hydrogen carriers (LOHC)	x		to be identified	to be identified	to be identified	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT4 Mobility ECH2A Industry	maritime - installation - bunkering	Standard for bunkering of compressed hydrogen for maritime application missing as well as qualification of pressure tanks with compressed H2 gas for maritime use – suggested mitigation measure is to extend non-maritime standards applications to maritime use.	x		to be identified	in preparation	CEN/TC 268 and others to be identified	Y
RT4 Mobility	maritime - installation - bunkering - refueling	gaseous compressed hydrogen refueling points and bunkering for maritime and inland waterway hydrogen-fueled vessels	x		to be identified	in preparation	CEN/TC 268	y
RT4 Mobility	maritime - installation - bunkering - refueling	liquefied hydrogen refueling points and bunkering for maritime and inland waterway hydrogen-fueled vessels	x		to be identified	in preparation	CEN/TC 268	y
RT4 Mobility	maritime - installation - bunkering - refueling	LOHC/liquid hydrogen derivative refueling points and bunkering for maritime and inland waterway vessels	x		to be identified	to be identified	to be identified	N
RT4 Mobility CEN-CENELEC	maritime - installation - bunkering - safety aspects	bunkering safety risk - validated models for assessing consequence	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - installation - bunkering - safety aspects	bunkering safety risk - harmonizing of scenarios and data structures	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - installation - bunkering - safety aspects	bunkering safety risk - use of risk assessments	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - metrology	effective billing system	x		to be identified	to be identified	to be identified	Y

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RT4 Mobility CEN-CENELEC	maritime - qualification and training	training about the safety aspects of hydrogen/H2NG	x	x	to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - qualification and training	training about the safety aspects of hydrogen/H2NG - Standards of Training, Certification, and Watchkeeping (STCW)	x		to be identified	to be identified	CEN-CLC/JTC 6	Y
RT4 Mobility CEN-CENELEC	maritime - safety aspects	safety for combining energy sources - hybrid systems, e.g battery pack and hydrogen	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - safety aspects	safety topics - possible new failure scenarios	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - safety aspects	safety topics - risk assessments for ship environment and system	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - safety aspects	safety topics - rupture / failure frequencies	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - safety aspects	safety topics for the use of alternative hydrogen carriers e.g LOHC or metalhybride	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - safety aspects	safety topics -guideline for certification of systems	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - safety aspects	inland waterways - safety standard for the use of alternative hydrogen carriers e.g LOHC or metalhybride	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - safety aspects	crashing safety risk - performance based standards	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - safety aspects - explosive atmospheres	safety topics - methodology for the exclusion/setback/hazardous areas	x		to be identified	to be identified	to be identified	Y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT4 Mobility ECH2A	maritime - storage	Development of (international) standards for vehicle on-board hydrogen storage (350bar, 500 bar, 700bar, liquid).	x		ISO 19886 series Gaseous hydrogen — Fuelling stations	to be identified	to be identified	N
RT4 Mobility CEN-CENELEC	maritime - storage	fuel cell systems for propulsion - hydrogen storage - location of fuel cells in maritime applications (on board / below deck)	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - storage	fuel cell systems for propulsion - hydrogen storage - Onboard storage Technical report based on cooperation between standardisation and regulatory work (ESTRIN)	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - storage	fuel cell systems for propulsion - hydrogen storage - swapping & fixed storage	x		to be identified	to be identified	to be identified	Y
RT4 Mobility CEN-CENELEC	maritime - storage	inland waterways -storage of hydrogen (liquified and gaseous),	x		to be identified	to be identified	CESNI	Y
RT4 Mobility	maritime - storage	Integration of hightemperature applications (e.g. dehydrogenation, high temperature fuel cells and on-board fuel cell waste heat usage) in inland and maritime vessels.	x		to be identified	to be identified	to be identified	N
RT4 Mobility	maritime - storage	marine bulk storage of hydrogen carriers (e.g. LOHC) covering both existing and new terminals. This includes conversion services (liquefaction, (de)hydrogenation, purification, etc.).	x		to be identified	to be identified	to be identified	N
RT4 Mobility	maritime - storage	Onshore and inland hubs (storage with multi-modal access) standards	x		to be identified	to be identified	to be identified	N
RT4 Mobility	maritime - storage	On-board storage of hydrogen carriers (e.g. LOHC) on ships (maritime)	x		to be identified	to be identified	to be identified	N
RT4 Mobility	maritime - storage	On-board storage of hydrogen carriers and direct usage on ships (maritime)	x		to be identified	to be identified	to be identified	N

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RT4 Mobility	maritime - storage	vessel on-board hydrogen storage (350bar, 500 bar, 700bar, liquid e.g. LOHC, LIHC), including for new ship fuel types	x		ISO 19886 (IGF Code (MSC.1/Circ 1455, 2013)	to be identified	to be identified	N
RT4 Mobility	maritime - storage	safe integration of onboard H2 storage and hydrogen propulsion systems where hydrogen or its derivatives (e.g. LOHC) are used on-board, including the H2 generation from hydrogen derivatives (e.g. dehydrogenation of liquids such as LOHC) .	x		EN IEC 60079 series Explosive atmospheres	to be identified	CLC/TC 31	N
RT7 Cross-cutting CEN-CENELEC	metrology	adaptation of gas analysis methods - reference conditions	x	x	EN ISO 13443, Natural gas — Standard reference conditions	to be identified	CEN/TC 238, ISO/TC 193	Y
RT7 Cross-cutting	metrology - certification	certification procedures			to be identified	to be identified	to be identified	N
RT7 Cross-cutting	metrology - energy carrier	energy content and metering of hydrogen in LOHC	x		to be identified	to be identified	to be identified	N
RT7 Cross-cutting CEN-CENELEC	metrology - gas analysis	gas analysis instruments - Definition and harmonisation of key performance requirements	x		to be identified	to be identified	to be identified	Y
RT3 Industry heating	metrology - measurement	gas metering devices	x	x	EN 12261, EN 1359, EN 14236, EN 12480, EN 17526, EN 12405-1, ISO 17089	in preparation	CEN/TC 237, ISO/TC 30	Y
RT5 Energy	metrology - measurement	gas metering devices gas fuel system at the power plant	x	x	EN 12261, EN 1359, EN 14236, EN 12480, EN 17526, EN 12405-1, ISO 17089	in preparation	CEN/TC 237, ISO/TC 30	Y
RT6 Building	metrology - measurement	gas metering devices	x	x	EN 12261, EN 1359, EN 14236, EN 12480, EN 17526, EN 12405-1, ISO 17089	in preparation	CEN/TC 237, ISO/TC 30	Y
RT7 Cross-cutting	metrology - measurement	quality and quantity metering of variable H2/natural gas mixtures in European pipeline networks			to be identified	to be identified	to be identified	N
RT7 Cross-cutting CEN-CENELEC	metrology - measurement	determination of gas quality parameters - calculation of compression factor	x	x	EN ISO 12213 series Natural gas - Calculation of compression factor	in preparation	CEN/TC 238	Y

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RT7 Cross-cutting CEN-CENELEC	metrology - measurement	gas detection systems; development and harmonisation of standards related to gas detection	x	x	EN 50194 Electrical apparatus for the detection of combustible gases in domestic premises (to revise for H2)	under revision	CLC/TC 216	Y
RT7 Cross-cutting CEN-CENELEC	metrology - measurement	measurement of fluid flow	x	x	ISO 5168 Measurement of fluid flow — Procedures for the evaluation of uncertainties	to be identified	CEN/TC 237, ISO/TC 30	y
RT7 Cross-cutting CEN-CENELEC	metrology - measurement	flow measurement for distribution			ISO 10790 Measurement of fluid flow in closed conduits — Guidance to the selection, installation and use of Coriolis flowmeters (mass flow, density and volume flow measurements)	to be identified	CEN/TC 237, ISO/TC 31	Y
RT1 Production	metrology - efficiency	power performance measurements of hydrogen generator systems (all technologies); method to assess and evaluate a system's efficiency	x		(1) EU harmonised protocols for testing of low temperature water electrolysers, JRC 2021, (2) VDI 4634 Power-to-X; Hydrogen Production	(1) in place, (2) in preparation	VDI	N
RT7 Cross-cutting	metrology - efficiency	method for determining and specifying the system efficiency of hydrogen technology systems (efficiency factor)			to be identified	to be identified	to be identified	N
RT7 Cross-cutting	metrology - efficiency	method for determining and specifying the system efficiency of hydrogen technology systems (efficiency factor)			to be identified	to be identified	to be identified	N
RT5 Energy	power plants - components	valves and sealing for gas fuel system at the power plant	x	x	to be identified	to be identified	to be identified	N
RT5 Energy	power plants - safety aspects	fire protection for plant	x	x	EN ISO 16852 Flame arresters - Performance requirements, test methods and limits for use	to be identified	CEN/TC 305	N
RT5 Energy	power plants - safety aspects	plant safety concept	x	x	to be identified	to be identified	to be identified	N
RT5 Energy	power plants - safety aspects	plant ventilation concept	x	x	to be identified	to be identified	to be identified	N

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RT5 Energy	power plants - safety aspects	gas and H2 detectors	x	x	to be identified	to be identified	to be identified	N
RT5 Energy	power plants - safety aspects	purging concept	x	x	to be identified	to be identified	to be identified	N
RT5 Energy	power plants - safety aspects	exhaust system and related equipment design for safe operation	x	x	to be identified	to be identified	to be identified	N
RT5 Energy	power plants - safety aspects	machine room access control	x	x	to be identified	to be identified	to be identified	N
RT5 Energy	power plants - safety aspects	O&M guidelines	x	x	to be identified	to be identified	to be identified	N
RT5 Energy	power plants - safety aspects		x	x	IEC 61010-1 Safety requirements for electrical equipment for measurement, control, and laborytory use - Part 1: General Requirements	to be identified	to be identified	N
RT5 Energy	power plants - storage	H2 storage			to be identified	to be identified	to be identified	N
RT5 Energy	power plants - certification	plant certification	x	x	to be identified	to be identified	to be identified	N
RT5 Energy	power plants - combustion quality aspects	combustion aspects oxygen			to be identified	to be identified	to be identified	N
RT1 Production	Power to X	Power to X performance and durability requirements; definitions of efficiencies and specifications of KPI are required. Degradation rate.	x		EN work item in consultation	in preparation	CEN/CLC JTC 6	N
RT7 Cross-cutting	qualification and training	specific training and qualification for operation and maintenance of hydrogen related equipment			to be identified	to be identified	CEN/CLC JTC 6	N
RT7 Cross-cutting CEN-CENELEC	qualification and training	training about the safety aspects of hydrogen/H2NG	x	x	ISO/TR 15916 Basic considerations for the safety of hydrogen systems	under revision	CEN/CLC JTC 6	Y
RT7 Cross-cutting	qualification and training	competency management system (CMS) based on EN ISO 9000	x	x	to be identified	to be identified	CEN/CLC JTC 6	Y

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CEN-CENELEC								
RT4 Mobility	railways	railway applications - rolling stock - fuel cell systems for propulsion - performance requirements and test methods	x		EN IEC 63341-3 Railway applications - Rolling stock - Part 3: Fuel cell systems for propulsion - Performance requirements and test methods	in preparation	IEC/TC 9, IEC/TC 105	y
RT4 Mobility	railways - fuel cells	fuel cell systems for propulsion	x		EN IEC 63341-1 Railway applications – Rolling stock – Fuel cell systems for propulsion - Part 1: Fuel Cell System	in preparation	IEC/TC 9	y
RT4 Mobility	railways - refueling	rail vehicle hydrogen refueling equipment	x		to be identified	in preparation	ISO/TC 269/AHG 2	y
RT4 Mobility ECH2A Industry	railways - refueling	safe integration of on-board H2 storage and hydrogen propulsion systems and refueling infrastructure & process in road and rail transport	x		EN IEC 63341 series Railway applications – Rolling stock – Fuel cell systems for propulsion	in preparation	IEC/TC 9	N
RT4 Mobility	railways - storage	fuel cell systems for propulsion - hydrogen storage system	x		EN IEC 63341-2 Railway applications - Rolling stock - Fuel cell systems for propulsion - Part 2: Hydrogen storage system	in preparation	IEC/TC 9	y
RT3 Industry feedstock	refiners	hydrogen for refiners		x	to be identified	to be identified	to be identified	N
RT4 Mobility	road vehicles	hydrogen fuel - product specification and quality assurance - proton exchange membrane (PEM) fuel cell applications for road vehicles	x		EN 17124 Hydrogen fuel - Product specification and quality assurance - Proton exchange membrane (PEM) fuel cell applications for road vehicles	in place	CEN/TC 268	y
RT4 Mobility	road vehicles	hydrogen retrofit – internal combustion engine retrofit	x		to be identified	to be identified	CEN/TC 268	N
RT4 Mobility	road vehicles	slow fuelling stations – need fueling protocol and requirements.	x		EN 17127 Outdoor hydrogen refuelling points dispensing gaseous hydrogen and incorporating filling protocols	to be identified	CEN/TC 268	Y
RT4 Mobility CEN-CENELEC	road vehicles - gas quality aspects	CH2NG vehicles+ determination of gas quality parameters in relation with H2NG and H2/biomethane (incl. variations)		x	EN 16723-2 Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network - Part 2: Automotive fuels specification	under revision	CEN/TC 408	Y

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RT4 Mobility	road vehicles - installation - refueling	gaseous hydrogen land vehicle refueling connection devices	x		EN ISO 17268 Gaseous hydrogen land vehicle refuelling connection devices	in place	CEN/TC 268	y
RT4 Mobility	road vehicles - installation - refueling	outdoor hydrogen refueling points dispensing gaseous hydrogen and incorporating filling protocols	x		EN 17127 Outdoor hydrogen refuelling points dispensing gaseous hydrogen and incorporating filling protocols	in place	CEN/TC 268	y
RT4 Mobility	road vehicles - installation - refueling	hydrogen refueling system testing and verification methodology	x		to be identified	to be identified	CEN/TC 268	partly
RT4 Mobility	road vehicles - installation - refueling	minimum State of Charge (SoC) requirement for hydrogen refueling systems	x		EN 17127 Outdoor hydrogen refuelling points dispensing gaseous hydrogen and incorporating filling protocols	to be identified	CEN/TC 268	Y
RT4 Mobility	road vehicles - installation - refueling	Factory Acceptance Testing (FAT) or Site Acceptance Testing (SAT) requirements of hydrogen refueling system (HRS) are not known	x		EN 17127 Outdoor hydrogen refuelling points dispensing gaseous hydrogen and incorporating filling protocols	to be identified	CEN/TC 268	Y
RT4 Mobility ECH2A Industry	road vehicles - installation - refueling	standard for certifying hydrogen refueling systems (to avoid certification by each H2 car manufacturer)	x		to be identified	to be identified	to be identified	N
RT1 Production	safety aspects	gas grid connection devices & assemblies, materials, measurement equipment, operational issues, etc. Compatibility of materials in devices and operational matters in both production and transmission systems (and also in the mixing station) must be considered, for hydrogen and natural gas requirements.	x	x	EN 17928 Gas infrastructure - Injection stations - Part 1 General requirements Part 3: Specific requirements regarding the injection of hydrogen fuel gas	in preparation	CEN/TC 234	Y
RT4 mobility ECH2A Industry	safety aspects	missing standards on safety/pressure limits in H2 transportation.	x		to be identified	to be identified	to be identified	N
RT6 Building	safety aspects	cooking appliances and space heaters - (indoor) air quality (e.g. polluting, poisoning) due to combustion of H2 (cooking appliances)	x	x	EN 30 series	to be identified	CEN/TC 62, CEN/TC 49	Y

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RT7 Cross-cutting	safety aspects	create public acceptance			to be identified	to be identified	to be identified	N
RT7 Cross-cutting	safety aspects	Requirements for design and functioning of protective systems for prevention of flame transmission and explosion propagation for hydrogen applications			to be identified	to be identified	to be identified	N
RT7 Cross-cutting	safety aspects	Basic safety levels and measures appropriate graded for users (risk assessment and safety requirements) for: 1.Process industry (large plants, specially trained personnel including hydrogen safety) 2.Commercial use (small plants, trained personnel without special knowledge of hydrogen) 3.Installations and facilities for public use (user without training and knowledge, children)			to be identified	to be identified	to be identified	N
RT7 Cross-cutting CEN-CENELEC	safety aspects	Loses due to permeation (complete chain) - permeation rates	x	x	to be identified	to be identified	to be identified	Y
RT7 Cross-cutting CEN-CENELEC	safety aspects	Safety risks on properties in the building environment	x	x	Technical Report (WI JT006002) Safe use of hydrogen in built constructions	in preparation	CEN/CLC JTC 6	Y
RT2 T&D CEN-CENELEC	safety aspects	Grid corrosion	x	x	to be identified	to be identified	CEN/TC 262, CEN/TC 459, (CEN/TC 234)	Y
RT2 T&D CEN-CENELEC	safety aspects	Equipment and devices installed in the gas chain - Safety devices for protection against excessive pressure	x	x	EN ISO 4126 Safety devices for protection against excessive pressure	in place	CEN/TC 69	Y
RT3 Industry heating CEN-CENELEC	safety aspects	current industrial gas processes (process equilibrium, process control, for the industry sectors identified as sensitive gas customers:	x	x	to be identified	to be identified	to be identified	Y

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		like glass industry, metal and steel industry, etc.)						
RT3 Industry feedstock CEN-CENELEC	safety aspects	current industrial gas processes (process equilibrium, process control, for the industry sectors identified as sensitive gas customers: metal and steel industry, etc.)	x	x	to be identified	to be identified	to be identified	Y
RT5 Energy	safety aspects	Pressure in the gas burning equipment	x		ISO 14687 Hydrogen fuel quality — Product specification	under revision	ISO/TC 197	Y
RT5 Energy	safety aspects	General Hydrogen properties, material aspects,...	x		ISO/TR 15916 Basic considerations for the safety of hydrogen systems	under revision	ISO/TC 197	Y
RT3 Industry heating	safety aspects - leakage	admissible leakage rate (up to 5 bar)	x	x	CEN/TR 17924 Safety and control devices for burners and appliances burning gaseous and/or liquid fuels - Guidance on hydrogen specific aspects EN 13611 Safety and control devices for burners and appliances burning gaseous or liquid fuels	in preparation	CEN/TC 58/WG 15	Y
RT3 Industry heating	safety aspects - leakage	admissible leakage rate (> 5 bar) - High pressure range	x	x	to be identified	to be identified	CEN/TC 235	Y
RT6 Building	safety aspects - leakage	Leakage (up to 5 bar)	x	x	CEN/TR 17924 Safety and control devices for burners and appliances burning gaseous and/or liquid fuels - Guidance on hydrogen specific aspects EN 13611 Safety and control devices for burners and appliances burning gaseous or liquid fuels"	in preparation	CEN/TC 58/WG 15	Y
RT6 Building	safety aspects - leakage	Leakage (> 5 bar) - High pressure range	x	x	to be identified	to be identified	CEN/TC 235	Y
RT7 Cross-cutting CEN-CENELEC	safety aspects - leakage	leakage related safety risks (safety, leakage related hydrogen characteristics) - large H2 releases	x	x	to be identified	to be identified	to be identified	Y

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RT7 Cross-cutting CEN-CENELEC	safety aspects - leakage	leakage related safety risks (safety, leakage related hydrogen characteristics) - validation models	x	x	to be identified	to be identified	to be identified	Y
RT2 T&D	safety aspects - material compatibility - gas/hydrogen infrastructure	determination of testing method for the hydrogen tolerance of metallic and non-metallic materials in specific environment including consideration of the contact of the test piece with the test environment	x	x	EN ISO 6892-1:2020 Metallic materials - Tensile testing - Part 1: Method of test at room temperature EN ISO 6892-2:2018 Metallic materials - Tensile testing. Part 2: Method of test at elevated temperature EN ISO 6892-3:2015 Metallic materials - Tensile testing - Part 3: Method of test at low temperature	to be identified	CEN/TC 459/SC 1, ISO/TC 164	N
RT2 T&D	safety aspects - material compatibility - gas/hydrogen infrastructure	corrosion of metals and alloys	x	x	EN ISO 7539-11 Corrosion of metals and alloys. Stress corrosion cracking. Part 11: Guidelines for testing the resistance of metals and alloys to hydrogen embrittlement and hydrogen-assisted cracking	to be identified	CEN/TC 262, ISO/TC 156	N
RT5 Energy	safety aspects - potential explosive atmosphere	Gas detection and explosion risk assessment	x	x	EN ISO/IEC 80079-20-1 Explosive atmospheres - Part 20-1: Material characteristics for gas and vapour classification - Test methods and data	to be identified	CEN/TC 305	N
RT5 Energy	safety aspects - potential explosive atmosphere	Explosion protection - power and heat generation	x	x	ISO 80079-36 & 37 for non-electrical equipment and IEC/TS 60079-46 for equipment assemblies	to be identified	CEN/TC 305	N
RT7 Cross-cutting	safety aspects - potential	harmonised/compatible standards to facilitate import/export of equipment with explosive requirements			to be identified	to be identified	CEN/TC 305 maybe in combination	N

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	explosive atmosphere	(e.g. for non-atmospheric conditions and protective systems (PNR)					with other TC's	
RT7 Cross-cutting	safety aspects - potential explosive atmosphere	Non atmospheric conditions - 1.Standards for methods of determining safety-related parameters in non-atmospheric conditions (pressures, temperatures, oxygen contents deviating from atmospheric conditions and for mixtures of hydrogen with other gases) are required. 2.Requirements for safe handling of pure oxygen, specifically in electrolysis systems and plants 3. Requirements for high pressure applications 4.Requirements for low temperature applications 5.Requirements for applications with mixtures of hydrogen with other gases Standards for methods of determining safety-related parameters in non-atmospheric conditions (pressures, temperatures, oxygen contents deviating from atmospheric conditions and for mixtures of hydrogen with other gases) are required.			IEC/TS 60079-46 Explosive atmospheres - Part 46: Equipment assemblies IEC 80079-36 Explosive atmospheres - Part 36: Non-electrical equipment for explosive atmospheres - Basic method and requirements	to be identified	CEN/TC 305, IEC/TC 31, IEC/TC 31/SC 31M [Non-electrical equipment and protective systems for explosive atmospheres]	N
RT7 Cross-cutting CEN-CENELEC	safety aspects - potential explosive atmosphere	Leakage related safety risks (safety, leakage related hydrogen characteristics)	x	x	CEN/TR Deliverable for relevant TCs to serve as guidance for adaptation of their standards and further revision (EN 1839, EN 15967, EN ISO 15848, ISO/TR 15916)	in preparation	CEN-CLC/JTC 6, CEN/TC 305	Y
RT7 Cross-cutting	safety aspects - potential	Leakage related safety risks (safety, leakage related hydrogen characteristics)	x	x	EN 1839 Determination of the explosion limits and the limiting oxygen	in preparation	CEN/TC 305	Y

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CEN-CENELEC	explosive atmosphere				concentration (LOC) for flammable gases and vapours			
RT7 Cross-cutting CEN-CENELEC	safety aspects - potential explosive atmosphere	Leakage related safety risks (safety, leakage related hydrogen characteristics)	x	x	EN 15967 Determination of maximum explosion pressure and the maximum rate of pressure rise of gases and vapours	in preparation	CEN/TC 305	Y
RT7 Cross-cutting CEN-CENELEC	safety aspects - potential explosive atmosphere	Leakage related safety risks (safety, leakage related hydrogen characteristics)	x	x	EN ISO 15848 Industrial valves - Measurement, test and qualification procedures for fugitive emissions	in preparation	CEN/TC 69	Y
RT7 Cross-cutting CEN-CENELEC	safety aspects - leakage	leakage related safety risks (safety, leakage related hydrogen characteristics) - confined spaces	x	x	to be identified	to be identified	to be identified	Y
RT1 Production	safety aspects - material compatibility	plastic materials (such as low-density polyethylene LLDPE for low pressure hydrogen pipe and fittings)	x	x	to be identified	to be identified	to be identified	N
RT2 T&D	safety aspects - material compatibility	grid corrosion	x	x	EN ISO 7539-11 Corrosion of metals and alloys. Stress corrosion cracking. Part 11: Guidelines for testing the resistance of metals and alloys to hydrogen embrittlement and hydrogen-assisted cracking	to be identified	CEN/TC 262, ISO/TC 156	N
RT2 T&D	safety aspects - material compatibility	sealings and connections in piping systems	x	x	EN 549 Rubber materials for seals and diaphragms for gas appliances and gas equipment	to be identified	CEN/TC 208	Y
RT2 T&D	safety aspects - material compatibility	suitability assessment of the existing gas infrastructure for hydrogen	x		CEN/TS (002340xx)	in preparation	CEN/TC 234	partly
RT2 T&D	safety aspects - material compatibility	material/material compatibility for unfired pressure vessels for hydrogen, including the specific criteria for selection of material to avoid hydrogen related adverse effects (e.g. hydrogen embrittlement)	x		EN 13445-2 Unfired pressure vessels. Part 2: Materials.	to be identified	CEN/TC 54	N

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RT3 Industry heating	safety aspects - material compatibility	hydrogen material compatibility for combustion technologies	x	x	EN 676 Forced draught burners for gaseous fuels ISO 13577-2 Industrial furnaces and associated processing equipment - Safety - Part 2: Combustion and fuel handling systems	in preparation	CEN/TC 131, ISO/TC 244/WG 2	Y
RT3 Industry heating	safety aspects - material compatibility	elastomers	x	x	EN 549 Rubber materials for seals and diaphragms for gas appliances and gas equipment	to be identified	CEN/TC 208	Y
RT5 Energy	safety aspects - material compatibility	material compatibility (metal, hydrogen embrittlement)	x	x	EN ISO 6892-1 Metallic materials. Tensile testing. Part 1: Method of test at room temperature • EN ISO 6892-2 Metallic materials. Tensile testing. Part 2: Method of test at elevated temperature • EN ISO 6892-3 Metallic materials. Tensile testing. Part 3: Method of test at low temperature	to be identified	CEN/TC 459, ISO/TC 164	N
RT5 Energy	safety aspects - material compatibility	material compatibility (metal, hydrogen embrittlement, corrosion)	x	x	EN ISO 7539-11 Corrosion of metals and alloys. Stress corrosion cracking. Part 11: Guidelines for testing the resistance of metals and alloys to hydrogen embrittlement and hydrogen-assisted cracking	to be identified	CEN/TC 262, ISO/TC 156	N
RT6 Building	safety aspects - material compatibility	hydrogen material compatibility for combustion technologies	x	x	CEN/TR 17924 Safety and control devices for burners and appliances burning gaseous and/or liquid fuels - Guidance on hydrogen specific aspects EN 13611 Safety and control devices for burners and appliances burning gaseous or liquid fuels"	in preparation	CEN/TC 58/WG 15	Y

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RT6 Building	safety aspects - material compatibility	material compatibility: lubricants, rubber, elastomers, sealing materials	x	x	EN 377 Lubricants for applications in appliances and associated controls using combustible gases except those designed for use in industrial processes EN 549 Rubber materials for seals and diaphragms for gas appliances and gas equipment EN 682 Elastomeric seals - Material requirements for seals used in pipes and fittings carrying gas and hydrocarbon fluids EN 751 (part 1 to 3) Sealing materials for metallic threaded joints in contact with 1st, 2nd and 3rd family gases and hot water ...	in preparation	CEN/TC 208	Y
RT2 T&D CEN-CENELEC	safety aspects - material compatibility	sealings and connections	x	x	EN 13090:2001 Means for resealing threaded joints of gas pipework in buildings	to be identified	CEN/TC 108	Y
RT2 T&D CEN-CENELEC	safety aspects - material compatibility	sealings and connections	x	x	EN 682:2002/A1:2005 Elastomeric seals - Materials requirements for seals used in pipes and fittings carrying gas and hydrocarbon fluids	to be identified	CEN/TC 208	Y
RT2 T&D CEN-CENELEC	safety aspects - material compatibility	sealings and connections	x	x	EN 377:1993+A1:1996 Lubricants for applications in appliances and associated controls using combustible gases except those designed for use in industrial processes	to be identified	CEN/TC 108	Y
RT2 T&D CEN-CENELEC	safety aspects - material compatibility	sealings and connections	x	x	EN 751 series Sealing materials for metallic threaded joints in contact with 1st, 2nd and 3rd family gases and hot water Part 1: Anaerobic jointing compounds Part 2: Non-hardening jointing compounds Part 3: Unsintered PTFE tapes	under revision	CEN/TC 208	Y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT1 Production	safety aspects - odorisation	odorisation of hydrogen and its blends with natural gas - choice of odorants		x	ISO/TR 16922 Natural gas - Guidelines for odorizing gases	in preparation	ISO/TC 193	Y
RT3 Industry heating	safety aspects - odorisation	hydrogen odorisation	x		ISO/TR 16922:2022 Natural gas - Odorization (future Technical Specification - TS)	in preparation	ISO/TC 193, CEN/TC 234	Y
RT6 Building	safety aspects - odorisation	odorisation	x		ISO/TR 16922 Natural gas - Guidelines for odorizing gases	in preparation	ISO/TC 193, CEN/TC 234	Y
RT5 Energy	safety aspects - potential explosive atmosphere	Explosion protection for plant	x	x	EN ISO/IEC 80079-0 Explosive atmospheres – Part 0: Equipment – General requirements EN ISO/IEC 60079-1 Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures "d" IEC 60079-20-1 Explosive atmospheres – Part 20-1: Material characteristics for gas and vapour classification – Test methods and data EN ISO/IEC 60079-29-1 Explosive atmospheres - Part 29-1: Gas detectors - Performance requirements of detectors for flammable gases EN ISO/IEC 60079-14 Explosive atmospheres – Part 14: Electrical installations design, selection and erection EN ISO/IEC 60079-10-1 Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres	to be identified	CEN/TC 305	N
RT7 Cross-cutting	safety aspects - potential explosive atmosphere	a special risk assessment procedure for assemblies like compressors intended for use in hydrogen applications			EN 15198 Methodology for the risk assessment of non-electrical equipment and components for intended use in potentially explosive atmospheres IEC/TS 60079-46 Explosive atmospheres - Part 46: Equipment assemblies IEC 80079-36 Explosive atmospheres -	under revision	CEN/TC 305, IEC/TC 31, IEC/TC 31/SC 31M [Non-electrical equipment and	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CE NELEC identifiy cation
					Part 36: Non-electrical equipment for explosive atmospheres - Basic method and requirements		protective systems for explosive atmospheres]	
RT1 Production	storage - gas cylinders	material testing standards	x		EN ISO 11114-4 Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 4: Test methods for selecting steels resistant to hydrogen embrittlement.	to be identified	CEN/TC 23	Y
RT2 T&D	storage - gas cylinders	compatibility of cylinder and valve materials with gas contents - metallic materials	x		EN ISO 11114-1 Gas cylinders - Compatibility of cylinder and valve materials with gas contents - Part 1: Metallic materials	in place	ISO/TC 58, CEN/TC 23	Y
RT2 T&D	storage - gas cylinders	compatibility of cylinder and valve materials with gas contents - non-metallic materials	x		EN ISO 11114-2 Gas cylinders - Compatibility of cylinder and valve materials with gas contents - Part 2: Non-metallic materials	in place	ISO/TC 58, CEN/TC 23	Y
RT2 T&D	storage - gas cylinders	compatibility of cylinder and valve materials with gas contents - test methods for selecting steels resistant to hydrogen embrittlement	x		EN ISO 11114-4 Transportable gas cylinders - Compatibility of cylinder and valve materials with gas contents - Part 4: Test methods for selecting steels resistant to hydrogen embrittlement	in place	ISO/TC 58, CEN/TC 23	Y
RT2 T&D	storage - gas cylinders	compatibility of cylinder and valve materials with gas contents - test methods for evaluating plastic liners	x		EN ISO 11114-5 Gas cylinders - Compatibility of cylinder and valve materials with gas contents - Part 5: Test methods for evaluating plastic liners	in place	ISO/TC 58, CEN/TC 23	Y
RT2 T&D	storage - gas cylinders	fully wrapped carbon composite cylinders and tubes for hydrogen	X		EN 17339 Transportable gas cylinders – Fully wrapped carbon composite cylinders and tubes for hydrogen	under revision	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	cylinders and tubes for stationary storage of gaseous hydrogen	X		EN 17533 Gaseous hydrogen - Cylinders and tubes for stationary storage	under revision	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	gully wrapped composite cylinders	x		EN 12245 Transportable gas cylinders - Fully wrapped composite cylinders	in place	CEN/TC 23	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT2 T&D	storage - gas cylinders	hoop wrapped composite gas cylinders	x		EN 12257 Transportable gas cylinders - Seamless, hoop-wrapped composite cylinders	in place	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	non-refillable, small transportable, steel cylinders of capacities up to and including 120 ml containing compressed or liquefied gases (compact cylinders) - design, construction, filling and testing	x		EN 16509 Transportable gas cylinders. Non-refillable, small transportable, steel cylinders of capacities up to and including 120 ml containing compressed or liquefied gases (compact cylinders). Design, construction, filling and testing	in place	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	specification for the design and construction of refillable transportable seamless normalized carbon manganese steel gas cylinders of water capacity up to 0,5 litre for compressed, liquefied and dissolved gases and up to 1 litre for carbon dioxide	x		EN 13293 Transportable gas cylinders - Specification for the design and construction of refillable transportable seamless normalised carbon manganese steel gas cylinders of water capacity up to 0,5 litre for compressed, liquefied and dissolved gases and up to 1 litre for carbon dioxide	in place	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	specification for the design and construction of refillable transportable seamless steel gas cylinders of water capacities from 0,5 litre up to and including 150 litres - Part 3: Cylinders made of seamless stainless steel with an Rm value of less than 1100 MPa	x		EN 1964-3 Transportable gas cylinders - Specification for the design and construction of refillable transportable seamless steel gas cylinders of water capacities from 0,5 litre up to and including 150 litres - Cylinders made of seamless stainless steel with an Rm value of less than 1 100 MPa	in place	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	battery vehicles and multiple-element gas containers (MEGCs) - design, manufacture, identification and testing	x		EN 13807 Transportable gas cylinders - Battery vehicles and multiple-element gas containers (MEGCs) - Design, manufacture, identification and testing	in place	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	specification for the design and construction of refillable transportable welded aluminium alloy gas cylinders	x		EN 12862 Transportable gas cylinders - Specification for the design and construction of refillable transportable welded aluminium alloy gas cylinders	in place	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	refillable welded steel gas cylinders - Design and construction - carbon steel	x		EN 13322-1:2003/A1 Transportable gas cylinders - Refillable welded steel gas	in place	CEN/TC 23	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
					cylinders - Design and construction - Part 1: Carbon steel			
RT2 T&D	storage - gas cylinders	refillable welded steel gas cylinders - Design and construction - stainless steel	x		EN 13322-2:2003/A1 Transportable gas cylinders - Refillable welded steel gas cylinders - Design and construction - Part 2: Stainless steel	in place	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	refillable welded receptacles of a capacity not exceeding 150 litres - welded austenitic stainless steel cylinders made to a design justified by experimental methods	x		EN 14638-3:2010/AC Transportable gas cylinders - Refillable welded receptacles of a capacity not exceeding 150 litres - Part 3: Welded carbon steel cylinders made to a design justified by experimental methods	in place	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	specification for welded pressure drums up to 1000 litre capacity for the transport of gases - Design and construction	x		EN 14208 Transportable gas cylinders - Specification for welded pressure drums up to 1000 litre capacity for the transport of gases - Design and construction	in place	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	gases and gas mixtures - properties of pure gases	x		EN 720-1 Transportable gas cylinders - Gases and gas mixtures - Part 1: Properties of pure gases	in place	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	gas cylinder identification - colour coding	x		EN 1089-3 Transportable gas cylinders - Gas cylinder identification (excluding LPG) - Part 3: Colour coding	in place	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	pressure relief device bursting disc pressure relief devices (excluding acetylene gas cylinders)	x		EN 14513 Transportable gas cylinders - Bursting disc pressure relief devices (excluding acetylene gas cylinders)	in place	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	cylinder bundles for permanent and liquefied gases (excluding acetylene) - Inspection at time of filling	x		EN 13365:2002/A1:2005 Transportable gas cylinders - Cylinder bundles for permanent and liquefied gases (excluding acetylene) - Inspection at time of filling	in place	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	battery vehicles for permanent and liquefied gases (excluding acetylene) - inspection at time of filling	x		EN 13385 Transportable gas cylinders - Battery vehicles for permanent and liquefied gases (excluding acetylene) - Inspection at the time of filling	in place	CEN/TC 23	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT2 T&D	storage - gas cylinders	periodic inspection and testing, in situ (without dismantling) of refillable seamless steel tubes of water capacity between 150 l and 3 000 l, used for compressed gases	x		EN 16753 Gas cylinders - Periodic inspection and testing, in situ (without dismantling) of refillable seamless steel tubes of water capacity between 150 l and 3 000 l, used for compressed gases	in place	CEN/TC 23	N
RT2 T&D	storage - gas cylinders	refillable seamless aluminium alloy gas cylinders - design, construction and testing	x		EN ISO 7866:2012/A1:2020 Gas cylinders - Refillable seamless aluminium alloy gas cylinders - Design, construction and testing	in place	ISO/TC 58, CEN/TC 23	N
RT2 T&D	storage - gas cylinders	quenched and tempered steel cylinders and tubes with tensile strength less than 1 100 MPa	x		EN ISO 9809-1 Design, construction and testing of refillable seamless steel gas cylinders and tubes - Part 1: Quenched and tempered steel cylinders and tubes with tensile strength less than 1 100 MPa	in place	ISO/TC 58, CEN/TC 23	N
RT2 T&D	storage - gas cylinders	quenched and tempered steel cylinders and tubes with tensile strength greater than or equal to 1 100 MPa	x		EN ISO 9809-2 Design, construction and testing of refillable seamless steel gas cylinders and tubes - Part 2: Quenched and tempered steel cylinders and tubes with tensile strength greater than or equal to 1 100 MPa	in place	ISO/TC 58, CEN/TC 23	N
RT2 T&D	storage - gas cylinders	normalized steel cylinders and tubes	x		EN ISO 9809-3 Design, construction and testing of refillable seamless steel gas cylinders and tubes - Part 3: Normalized steel cylinders and tubes	in place	ISO/TC 58, CEN/TC 23	N
RT2 T&D	storage - gas cylinders	stainless steel cylinders with an Rm value of less than 1 100 Mpa	x		EN ISO 9809-4 Design, construction and testing of refillable seamless steel gas cylinders and tubes - Part 4: Stainless steel cylinders with an Rm value of less than 1 100 Mpa	in place	ISO/TC 58, CEN/TC 23	N
RT2 T&D	storage - gas cylinders	refillable seamless steel tubes of water capacity between 150 l and 3000 l - Design, construction and testing	x		EN ISO 11120 Gas cylinders. Refillable seamless steel tubes of water capacity between 150 l and 3000 l. Design, construction and testing	in place	ISO/TC 58, CEN/TC 23	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT2 T&D	storage - gas cylinders	construction of composite cylinders standards that are applicable for use with hydrogen on European level	x		e.g.: ISO 11119-1, -2, -4 and -4; ISO 11515 etc Gas cylinders - Design, construction and testing of refillable composite gas cylinders and tubes	to be identified	ISO/TC 58	N
RT2 T&D	storage - gas cylinders	gas cylinders -inspection at time of filling and for the periodic inspection and testing	x		e.g.: EN ISO 18119 Gas cylinders - Seamless steel and seamless aluminium-alloy gas cylinders and tubes - Periodic inspection and testing; EN ISO 11623 Gas cylinders - Composite construction - Periodic inspection and testing	to be identified	ISO/TC 58, CEN/TC 23	N
RT2 T&D	storage - gas cylinders	closures and accessories	x		e.g.:EN ISO 10297:2014/Amd 1:2017 Gas cylinders — Cylinder valves — Specification and type testing — Amendment 1: Pressure drums and tubes; EN ISO 11117 Gas cylinders — Valve protection caps and guards — Design, construction and tests; EN ISO 15996 Gas cylinders — Residual pressure valves — Specification and type testing of cylinder valves incorporating residual pressure devices; EN ISO 23826 Gas cylinders — Ball valves — Specification and testing etc...	to be identified	ISO/TC 58, CEN/TC 23	N
RT5 Energy	storage - gas cylinders	material selection and testing	x		EN ISO 11114-4 Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 4: Test methods for selecting steels resistant to hydrogen embrittlement	in place	CEN/TC 23, ISO/TC 58	Y
RT2 T&D	storage - gas cylinders - material compatibility gas/hydrogen infrastructure	selection of metallic and non-metallic materials for pipelines and pressure equipment and their testing	x		EN ISO 11114-4 Transportable gas cylinders — Compatibility of cylinder and valve materials with gas contents — Part 4: Test methods for selecting steels resistant to hydrogen embrittlement	to be identified	CEN/TC 23	Y

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT1 Production	storage - pressure vessels	design and stress calculation of pressure vessels containing pure hydrogen or natural gas blend	x	x	EN 13445-1 Unfired pressure vessels - Part 1: General	to be identified	CEN/TC 54	N
RT1 Production	storage - pressure vessels	design and stress calculation of pressure vessels containing pure hydrogen or natural gas blend.	x	x	EN 13480-2 Metallic industrial piping - Part 2: Materials	to be identified	CEN/TC 267	N
RT4 mobility ECH2A Industry	storage - pressure vessels	technical standard for vessel tank pressure, for tank typology or tank volume – establish standards in terms of type of tanks to be filled in and pressure so that the filling protocol of the station is adapted to the majority of river vessels.	x		to be identified	to be identified	CEN/TC 268, CEN/TC 54	N
RT5 Energy	storage - pressure vessels - components	pipes and sealing for gas fuel system at the power plant	x	x	EN 13480-2 Metallic Industrial Piping - Part 2: Materials	to be identified	CEN/TC 267	N
RT5 Energy	storage - pressure vessels - safety aspects	design, stress calculation, material selection of pressure vessels and material testing of station piping system (underground storage)	x	x	EN 13480-2 Metallic industrial piping. Part 2: Materials	to be identified	CEN/TC 267	N
RT5 Energy	storage - pressure vessels - safety aspects	design and stress calculation of pressure vessels containing pure hydrogen or H2NG blend	x	x	EN 13445-1 Unfired pressure vessels - Part 1: General	to be identified	CEN/TC 54	N
RT5 Energy	storage - pressure vessels - safety aspects - material compatibility	material compatibility material selection of pressure vessels containing pure hydrogen or H2NG blend	x	x	EN 13445-2 Unfired pressure vessels - Part 2: Materials	to be identified	CEN/TC 54	N
RT1 Production	sustainability and origin	environmental management for concrete and concrete structure; definition for calculation of efficiency, key performance indicators (KPI), GHG emissions, certification of origin	x	x	ISO 13315-2 Environmental management for concrete and concrete structures — Part 2: System boundary and inventory data	under revision	ISO/TC 71	partly
RT3 Industry feedstock	sustainability and origin	fertilizer production - labelling of renewable/low-carbon H2/NH3	x		to be identified	to be identified	to be identified	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT7 Cross-cutting	sustainability and origin - emissions / GHG - energy/hydrogen carriers	definitions for carbon footprint of LIHC based hydrogen need to be added to EN 16325	x		EN 16325 Guarantees of Origin for electricity, gaseous hydrocarbons, and hydrogen,and heating & cooling.	under revision	CEN/CLC JTC 6, CEN/CLC JTC 14	Y
RT7 Cross-cutting	sustainability and origin - emissions / GHG - energy/hydrogen carriers	definitions for carbon footprint of LOHC based hydrogen need to be added to EN 16325	x		EN 16325 Guarantees of Origin for electricity, gaseous hydrocarbons, and hydrogen,and heating & cooling	under revision	CEN/CLC JTC 6, CEN/CLC JTC 14	Y
RT7 Cross-cutting	sustainability and origin - guarantee of origin - efficiency aspects	definition of production system boundaries, including electrolysers and other technologies of production of hydrogen and other equipment (BOP) as basis for efficiency calculation and key performance indicators (KPI) and also all emissions (scope 1-4) and impact categories attributable to upstream, for the purposes of certification of origin	x		EN 16325 Guarantees of Origin for electricity, gaseous hydrocarbons, and hydrogen,and heating & cooling	under revision	CEN/CLC JTC 6, CEN/CLC JTC 14	Y
RT3 Industry feedstock	sustainability and origin - emissions / GHG	ammonia production metrology for determining GHG emissions	x		to be identified	to be identified	to be identified	N
RT3 Industry feedstock	sustainability and origin - emissions / GHG	fertilizer produced from renewable/low-carbon H2/NH3 metrology for determining GHG emissions	x		to be identified	to be identified	to be identified	N
RT3 Industry feedstock	sustainability and origin - emissions / GHG	mass balance method chain of custody	x		to be identified	to be identified	to be identified	N
RT4 Mobility ECH2A Industry	sustainability and origin - emissions / GHG	missing Well-to-Wheel standard for GHG emissions measurement	x		ISO TS 19870 Methodology for Determining the Greenhouse Gas Emissions Associated with the Production, Conditioning and Transport of Hydrogen to Consumption Gate	in preparation	ISO/TC 197	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT7 Cross-cutting	sustainability and origin - emissions / GHG	calculation of the carbon footprint of hydrogen carbon capture and utilization / storage (CCU, CCS) including solid carbon - boundaries, flows, benchmark			EN ISO 14040 Environmental management — Life cycle assessment — Principles and framework EN ISO 14044 Environmental management — Life cycle assessment — Requirements and guidelines EN ISO 14067 Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification	to be identified	CEN/SS S26, ISO/TC 207	N
RT7 Cross-cutting ECH2A Production	sustainability and origin - emissions / GHG	emission factors for carbon footprint calculation and GHG emission savings.			to be identified	to be identified	to be identified	N
RT7 Cross-cutting ECH2A Production	sustainability and origin - emissions / GHG	carbon footprint benchmarks Technologies for production of low-carbon hydrogen production and co-production: fossil with CCS, waste to hydrogen, a.o.	x		to be identified	to be identified	to be identified	N
RT7 Cross-cutting	sustainability and origin - emissions / GHG	emission factors for carbon footprint calculation / GHG emission savings increasing transparency and comparability for hydrogen production technologies	x	x	to be identified	to be identified	to be identified	N
RT7 Cross-cutting	sustainability and origin - emissions / GHG	benchmark system for different types of low carbon H2 production based on emissions		x	to be identified	to be identified	to be identified	N
RT7 Cross-cutting	sustainability and origin - emissions / GHG	live cycle analysis for CCU - criteria for granting a carbon credit from co-produced substances to the produced hydrogen lower carbon footprint - mass balance in order to certify only a fraction of the hydrogen as being “Green”	x		EN ISO 14040+A1 Environmental management - Life cycle assessment - Principles and framework 14044:2006+A1:2018+A2 Environmental management - Life cycle assessment - Requirements and guidelines EN ISO 14067 Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification	to be identified	to be identified	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
RT7 Cross-cutting	sustainability and origin - emissions / GHG	certification of carbon removals - exension from partial carbon footprint or carbon footprint to quantifying the environmental footprint related to the production of the amount of energy for which the GO is issued	x		to be identified	to be identified	to be identified	N
RT3 Industry heating	sustainability and origin - guarantee of origin	guarantee of origin of delivered gas required	x	x	EN 16325 Guarantees of Origin related to energy - Guarantees of Origin for Electricity, gaseous hydrocarbons, Hydrogen, and heating & cooling	in preparation	CEN/CLC JTC 6, CEN/CLC JTC 14	Y
RT6 Building	sustainability and origin - guarantee of origin	guarantee of origin of delivered gas required	x	x	EN 16325 Guarantees of Origin for electricity, gaseous hydrocarbons, and hydrogen, and heating & cooling	in preparation	CEN/CLC JTC 6, CEN/CLC JTC 14	Y
RT7 Cross-cutting ECH2A Industry	sustainability and origin - guarantee of origin	standards for guarantees of origin and Certificates	x		EN 16325 Guarantees of Origin for electricity, gaseous hydrocarbons, and hydrogen, and heating & cooling.	to be identified	CEN/CLC JTC 6, CEN/CLC JTC 14	Y
RT7 Cross-cutting	sustainability and origin - guarantee of origin	guarantee of origin of hydrogen and it blends with natural gas or biomethane	x	x	EN 16325 Standard on Guarantees of Origin related to energy	under revision	CEN/CLC JTC 6, CEN/CLC JTC 14	Y
RT7 Cross-cutting ECH2A Industry	taxonomy	taxonomy/ sustainable finance standards			to be identified	to be identified	CEN Sector Forum Energy Managment	N
RT1 Production	terminology / definitions	There is no consistency in hydrogen classification based on its production method. Required to provide certainty by clarifying the emissions threshold associated with different hydrogen production technologies. low carbon hydrogen should be defined.	x		to be identified	to be identified	to be identified	N

contribution by	issue / topic horizontal aspects	standardisation gap details / description	100% H2	H2NG	standards	status of standardi-sation	relevant TC	CEN/CENELEC identifiy cation
		A clear definition of hydrogen produced via methane pyrolysis using biogas is needed						
RT2 T&D	terminology / definitions	Gas cylinders – Vocabulary	x		EN ISO 10286 Gas cylinders - Vocabulary	under revision	ISO/TC 58, CEN/TC 23	N
RT3 Industry heating	terminology / definitions	missing basic hydrogen terminology	x	x	EN ISO 24078 Hydrogen in energy systems - vocabulary	in preparation	CEN/CLC JTC 6	Y
RT6 Building	terminology / definitions	missing basic Hydrogen terminology	x	x	EN ISO 24078	in preparation	CEN/CLC JTC 6	Y
RT7 Cross-cutting ECH2A Industry	terminology / definitions	definitions of renewable and low-carbon hydrogen (to classify the different types of technologies to transport hydrogen)	x		to be identified	to be identified	CEN/CLC JTC 6	N
RT7 Cross-cutting	terminology / definitions	definition the term and use of LIHC	x		to be identified	to be identified	to be identified	N
RT7 Cross-cutting	terminology / definitions	definition the term and use of LOHC	x		to be identified	to be identified	to be identified	N
RT7 Cross-cutting	terminology / definitions	technology-open definition of renewable and low-carbon hydrogen based on emissions	x	x	to be identified	to be identified	to be identified	N
RT5 Energy		fuel mixing	x	x	to be identified	to be identified	to be identified	N
RT5 Energy		fuel dosing	x	x	to be identified	to be identified	to be identified	N
RT5 Energy		ignition system	x	x	to be identified	to be identified	to be identified	N
RT5 Energy		venting	x	x	to be identified	to be identified	to be identified	N

Annex III – CEN-CENELEC, ISO-IEC Technical Committees

Technical committee	Title
CEN/TC 12	materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries
CEN/TC 15	inland navigation vessels
CEN/TC 23	transportable gas cylinders
CEN/TC 48	domestic gas-fired water heaters
CEN/TC 49	gas cooking appliances
CEN/TC 54	unfired pressure vessels
CEN/TC 57	central heating boilers
CEN/TC 58	safety and control devices for burners and appliances burning gaseous or liquid fuels
CEN/TC 62	independent gas-fired space heaters
CEN/TC 69	industrial valves
CEN/TC 74	flanges and joints
CEN/TC 106	large kitchen appliances using gaseous fuels
CEN/TC 109	central heating boilers using gaseous fuels
CEN/TC 131	gas burners using fans
CEN/TC 155	plastics piping systems and ducting systems
CEN/TC 180	decentralized gas heating
CEN/TC 181	dedicated liquified petroleum gas appliances
CEN/TC 186	industrial thermoprocessing - safety
CEN/TC 208	elastomeric seals for joints in pipework and pipelines
CEN/TC 234	gas infrastructure
CEN/TC 235	gas pressure regulators and associated safety devices for use in gas transmission and distribution
CEN/TC 236	non industrial manually operated shut-off valves for gas and particular combinations valves-other products
CEN/TC 237	gas meters
CEN/TC 238	test gases, test pressures, appliance categories and gas appliance types
CEN/TC 244	measurement of fluid flow in closed conduits - dormant
CEN/TC 256	railway applications
CEN/TC 262	metallic and other inorganic coatings, including for corrosion protection and corrosion testing of metals and alloys
CEN/TC 264	air quality
CEN/TC 267	industrial piping and pipelines
CEN/TC 268	cryogenic vessels and specific hydrogen technologies applications
CEN/TC 269	shell and water tube boilers
CEN/TC 270	internal combustion engines
CEN/TC 282	installation and equipment for LNG
CEN/TC 299	gas-fired sorption appliances, indirect fired sorption appliances, gas-fired endothermic engine heat pumps and domestic gas-fired washing and drying appliances
CEN/TC 305	potentially explosive atmospheres - Explosion prevention and protection

CEN/TC 326	natural gas vehicles - Fuelling and operation
CEN/TC 399	gas turbines applications - safety
CEN/TC 408	natural gas and biomethane for use in transport and biomethane for injection in the natural gas grid
CEN/TC 411	bio-based products
CEN/TC 459	ECISS - European Committee for Iron and Steel Standardization
CEN/SS S26	environmental management
CEN-CLC/JTC 14	energy management and energy efficiency in the framework of energy transition
CEN-CLC/JTC 6	hydrogen in energy systems
CEN-CLC/JTC 17	fuel cell gas appliances
CLC/TC 9X	electrical and electronic applications for railways
CLC/TC 31	electrical apparatus for potentially explosive atmospheres
CLC/TC 57	power systems management and associated information exchange
CLC/TC 216	gas detectors
IEC/TC 9	electrical equipment and systems for railways
IEC/TC 31	equipment for explosive atmospheres
IEC/TC 57	power systems management and associated information exchange
IEC/TC 72	automatic electrical control
IEC/TC 105	fuel cell technologies
ISO/TC 8	ships and marine technology
ISO/TC 17	steel
ISO/TC 20	aircraft and space vehicles
ISO/TC 22	road vehicles
ISO/TC 30	measurement of fluid flow in closed conduits
ISO/TC 58	gas cylinders
ISO/TC 67	oil and gas industries including lower carbon energy
ISO/TC 70	internal combustion engines
ISO/TC 71	concrete, reinforced concrete and pre-stressed concrete
ISO/TC 109	oil and gas burners
ISO/TC 118	Compressors and pneumatic tools, machines and equipment
ISO/TC 156	corrosion of metals and alloys
ISO/TC 158	analysis of gases
ISO/TC 161	Controls and protective devices for gas and/or oil
ISO/TC 164	mechanical testing of metals
ISO/TC 192	gas turbines
ISO/TC 193	natural gas
ISO/TC 197	hydrogen technologies
ISO/TC 244	industrial furnaces and associated processing equipment
ISO/TC 255	biogas
ISO/TC 265	carbon dioxide capture, transportation, and geological storage
ISO/TC 269	railway applications
ISO/TC 291	domestic gas cooking appliances
ISO/TC 301	energy management and energy savings

Annex IV – Activities related to hydrogen standardisation in other organizations

Hydrogen Council

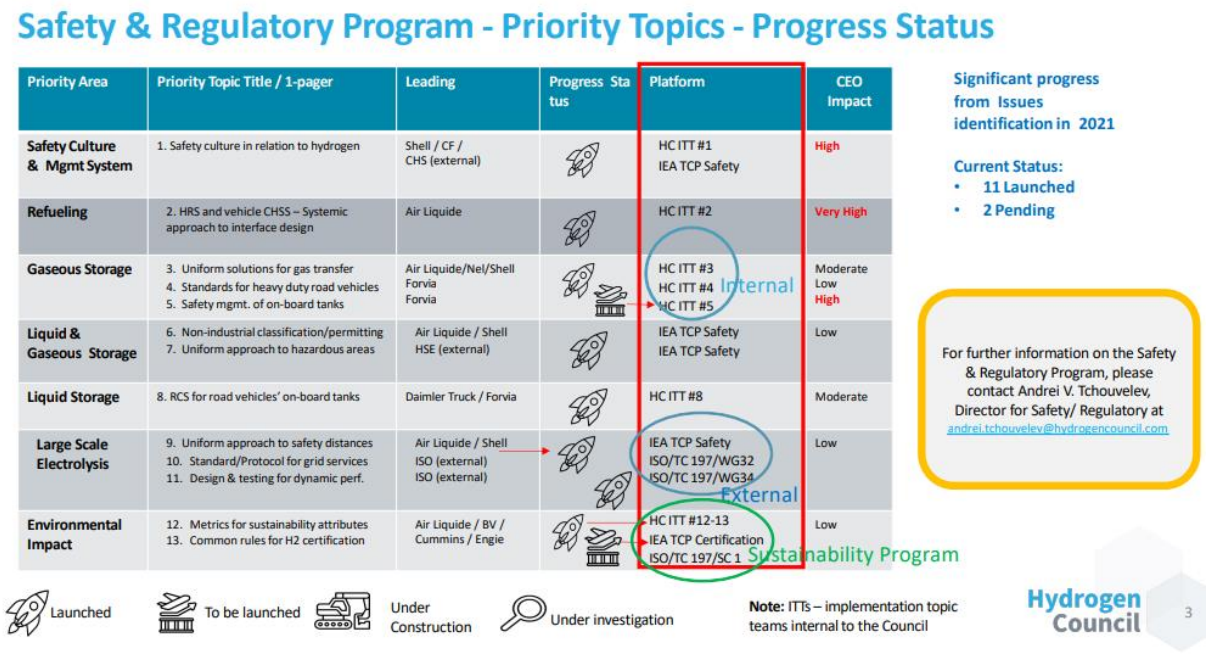
The Hydrogen Council, a global CEO-led initiative to advance the role for hydrogen in the energy transition globally, was launched at the World Economic Forum in Davos in January 2017. It Comprises close to 145 multinational companies representing the entire hydrogen value chain. Using its global reach to promote collaboration between governments, industry and investors, the Council provides guidance on accelerating the deployment of hydrogen solutions around the world.

The Hydrogen Council also serves as a resource for safety standards and an interlocutor for the investment community, while identifying opportunities for regulatory advocacy in key geographies.

It recently performed a gap analysis and identified over 400 RCS gaps through desktop review, interviews and expert review. These gaps list was then refined within its members and led to 13 key gaps across 7 segments reported hereafter:

Safety culture	#1	Safety culture in relation to hydrogen
Refueling	#2	Hydrogen refueling station and vehicle CHSS – Systemic approach to interface design
Gaseous storage	#3	Uniform solutions for connections and transfer between distribution infrastructure and HRS
	#4	Standards for heavy-duty road vehicles
	#5	Safety management for CHSS in road transport vehicles
Liquid & gaseous storage	#6	Non-industrial classification and implications for permitting and regulatory issues
	#7	Uniform approach to determine hazardous areas for CHSS and liquid hydrogen
Liquid storage	#8	Standards and regulation for onboard storage in road transport vehicles
Large-scale electrolyzers	#9	Harmonized methodologies to define safety distances for large-scale electrolyzer operations
	#10	Standards and test protocols for electrolyzers providing electricity grid services
	#11	Standardized design and test requirements for electrolyzers operating under dynamic conditions
Environmental impact measurement	#12	Metrics and methodologies for measuring sustainability attributes of hydrogen
	#13	Common rules and standards to underpin hydrogen certification systems

The RCS gaps covered mainly fall into safety performance and costs categories and apply to the production of hydrogen and its use for mobility. Worth to mention is that all gaps have been rated as highly critical and should be addressed within 2 to 3 years. Important to mention also is that these gaps have been mapped versus activities at ISO, IEC and other standardisation bodies. The progress status of the different RCS gaps is summarized on the figure below.

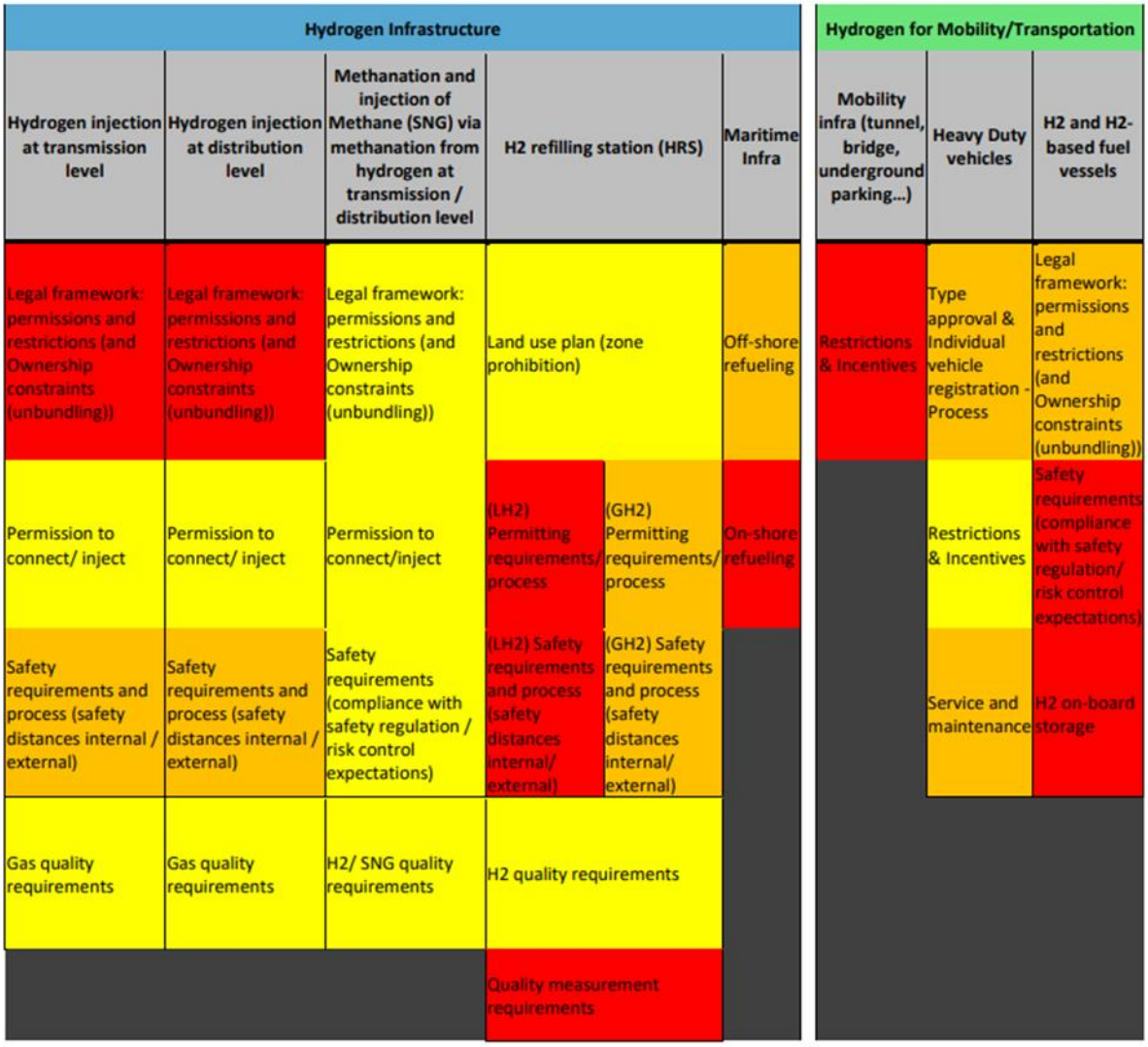


The progress status of the different RCS gaps is summarized on the figure above.

IPHE – International partnership for hydrogen and fuel cells in the economy

The IPHE is an international inter-governmental partnership. Its objective is to facilitate and accelerate the transition to clean and efficient energy and mobility systems using hydrogen and fuel cell technologies across applications and sectors. This partnership provides a forum for sharing information on initiatives, policies and technology status to accelerate the cost-effective transition to the use of hydrogen and fuel cells in the economy. IPHE Working Group on regulations, codes, standards and safety issued in 2021 a high-level gap analysis of regulatory areas for actions. This work aimed in first instance to inform governmental administration of the overarching challenges and priorities therefore it did not enter in the technical details provided by the work of the Hydrogen Council.

A heat map of the critical areas identified by the IPHE is given in the picture below (red is considered most critical, orange is moderately critical, and yellow is less critical). Each of the main topics in grey in the table have been further handled in more details in other tables[1].



The results indicate that there are broad regulatory gaps for deployment of hydrogen technologies, particularly as the industry scales up and expands beyond road transportation. Critical areas of focus for regulatory improvements include the regulatory framework for inclusion of hydrogen in the natural gas system, both at the point of distribution and at the point of transmission. For hydrogen refuelling infrastructure, gaps exist primarily around scale-up and the use of liquid hydrogen, though these gaps lean primarily toward R&D needs. The most critical gaps for hydrogen mobility/transportation appear to be around acceptance of non-road transportation modes (rail, marine, aviation); feedback here and through the 2020 Research Priorities Workshop indicates a need for international collaboration, particularly where the IMO is concerned. More broadly, results of the survey determined that safety, including maintenance requirements, approvals, and inspections, is a priority and safety improvements should be incorporated into efforts to address the other gaps identified.

[1] IPHE working paper, Compendium of Regulatory Areas for Action in Hydrogen Infrastructure and Mobility/Transportation Technologies, (2021) available at http://1fa05528-d4e5-4e84-97c1-ab5587d4aabf.usrfiles.com/ugd/45185a_f6e26899e84e4881b712f953e15e6a21.pdf

IRENA - International Renewable Energy Agency

The International Renewable Energy Agency (IRENA) is a lead global intergovernmental agency for energy transformation that serves as the principal platform for international cooperation, supports

countries in their energy transitions, and provides state of the art data and analyses on technology, innovation, policy, finance and investment. IRENA drives the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy in the pursuit of sustainable development, energy access, and energy security, for economic and social resilience and prosperity and a climate-proof future.

IRENA's membership comprises 167 countries and the EU. Together, they decide on the Agency's strategic direction and programmatic activities, in line with the global energy discourse and priorities to accelerate the deployment of renewables-based energy transitions worldwide.

IRENA is implementing a project entitled "Quality Infrastructure (QI) for Green Hydrogen: technical standards and quality control for the production and trade of renewable hydrogen"[1] . The objective of the project is to develop a comprehensive roadmap for the development and implementation of the Quality Infrastructure services -standards, testing, certification, metrology- needed to scale-up a global green hydrogen production and trade. The project team for the past 4 months has been undertaking desk research on the existing quality infrastructure tools that are available for green hydrogen production and trade. The findings from this desk research will greatly inform the development a roadmap on the development of the quality infrastructure to overcome existing quality, sustainability, and safety challenges in green hydrogen production and trade – which is a key output of this project.

[1] IRENA report, January 2023 - Creating a global hydrogen market: Certification to enable trade (azureedge.net)

Annex V – More details on legal and technical framework for mobility modalities

The following table contains an overview of all the legal and regulatory framework of maritime (M) and heavy-duty (HD) related topics. The first column shows important directives and policy publications (shown in light blue). Out of these publications goals and programs can be formulated (shown in white). The second column shows related directives and other programs for the directives, policy publications, goals, and programs. For the road map, the start and finish dates are given in the last two columns for all goals and programs.

Roadmap activity	Related legislation	Start	End
Alternative Fuels Infrastructure Directive (AFID) - **HD**	-Directive 2014/94/EU, -Proposal for a Regulation on the deployment of alternative fuels infrastructure -Fit for 55		
-Hydrogen refueling points accessible to the public to ensure the circulation of hydrogen-powered motor vehicles, including fuel cell vehicles	AFID (directive)	2026	tba
-Hydrogen refueling points accessible to the public to ensure the circulation of hydrogen-powered motor vehicles, including fuel cell vehicles	Fit for 55 (legislature)	ongoing	2030
CO2 emission performance standards for new **heavy-duty vehicles** - **HD**	-Regulation (EU) 2019/1242 -Regulation (EU) 2018/956		
-Review of regulation Regulation (EU) 2019/1242: • 2030 target and possible targets for 2035 and 2040; • inclusion of other types of heavy-duty vehicles, including buses, coaches, trailers, vocational vehicles and considerations of EMS (European modular system); • the ZLEV incentive mechanism; • real world representativeness of the CO2 emission and energy consumption values; • role of synthetic and advanced alternative fuels produced with renewable energy; • possible introduction of a form of pooling; • level of the excess emission premium; • the possibility of developing a common methodology for the assessment and reporting of the full life-cycle CO2 emissions of heavy-duty vehicles.	Regulation (EU) 2019/1242	2023	tba
-Targets for reducing the average (fleet-wide) emissions from new trucks and other heavy goods vehicles for 2025 and 2030	Regulation (EU) 2019/1242	ongoing	2025
		ongoing	2030
-The CO2 emission standards for new heavy-duty vehicles regulation will see average emissions of trucks and heavy goods reduced by 15% by 2025	Regulation (EU) 2018/956, Regulation (EU) 2019/1242	already ongoing	2025
-Financial penalties in case of non-compliance with the CO2 targets are planned. The level of the penalties is set to €6,800 per gCO2/tkm in 2030.	Regulation (EU) 2018/957	2025	tba
-The CO2 emission standards for new heavy-duty vehicles regulation will see average emissions of trucks and heavy goods reduced 30% by 2030	Regulation (EU) 2018/958, Regulation (EU) 2019/1242	ongoing	2030
-Financial penalties in case of non-compliance with the CO2 targets are planned. The level of the penalties is set to €6,800 per gCO2/tkm in 2030.	Regulation (EU) 2018/959	2030	tba
-Super-credits system for early uptake of ZLEV	Regulation (EU) 2019/1242	2019	2024

-Benchmark-based crediting system for uptake of ZLEV	Regulation (EU) 2019/1243	2025	tba
EU Emission Trading System (ETS) - **HD/M**	-Directive 2003/87/EC -Council Directive 96/61/EC		
-Reduction of overall CO2 emission by 40% by 2030 (compared to 1990 levels) in the EU, through an ETS-covered CO2 emission reduction target set at 43% (by 2030 compared to 2005 levels).	-Directive 2003/87/EC -Council Directive 96/61/EC	ongoing	2030
-ETS II	-Directive 2003/87/EC -Council Directive 96/61/EC	tba	tba
-In 2024, the obligation imposed would be to hold a GHG emission permit and report fuels placed on the market.	-Directive 2003/87/EC -Council Directive 96/61/EC	2024	tba
-From 2026 onwards, regulated entities would have to surrender the corresponding allowances, based on the carbon intensity of the fuels placed on the market.	-Directive 2003/87/EC -Council Directive 96/61/EC	2026	tba
-The cap would be set, based on the Effort Sharing Regulation and it would gradually decrease to 43% in 2030, compared to 2005 levels. No free allowance allocation is envisaged by the Commission.	-Directive 2003/87/EC -Council Directive 96/61/EC	ongoing	2030
EU Green Deal - **HD/M**	'-EU Green Deal Communication COM (2019) 640 final -European Climate Law -European Industrial Strategy -Clean Hydrogen Alliance -European Circular Economy Action Plan -Communication on European Green Deal Investment Plan COM(2020)		
-Proposal to force alternative fuel use for commercial vessels of 5,000 gross tonnes+, while the ship is at an EU port, on a voyage between EU ports and 50% of the energy when departing from or arriving to an EU port.	EU Green Deal	2025	tba
-Proposal to decrease annual average carbon intensity by 2% in 2025 and by 6% by 2030 and then further by 5-year periods until 2050. The final target is to have a 75% reduction of carbon intensity in comparison with 2020.	EU Green Deal	2025	tba
		2030	tba
		ongoing	2050
-Full climate neutrality in EU, implementation of H2 infrastrucutre for maritime & heavy duty	EU Green Deal	ongoing	2050
EU Energy System Integration Strategy under the EU Green Deal - **HD/M**	-Powering a climate-neutral economy: An EU Strategy for Energy System Integration - European Commission Communication COM(2020) 299 final -European Parliament resolution on a European strategy for energy system integration		
-to be updated	x	x	x
EU Hydrogen Strategy under the EU Green Deal - **HD/M**	-Hydrogen Strategy – European Commission Communication COM(2020) 301 final		
-Hydrogen refueling station deployment- for 1 million recharging and refueling stations in the EU for sustainable transport fuels	Hydrogen Strategy	2025	tba
European Climate Law - **HD/M**	-EU Green Deal Communication COM (2019) 640 final -European Climate Law -Communication on European Green Deal Investment Plan COM(2020) 21 final		

-Commission has ongoing a wide legislative review process in July 2021. This review includes the adoption of new legislation and revisions of significant parts of the existing legislation in the fields of energy, climate and transport. Regulation on Alternative Fuels Infrastructure (instead of the current directive) and new legislation relating to: Fuel EU Maritime Regulation	EU Green Deal Communication COM (2019) 640 final European Climate Law	2021	tba
Industrial Policy and State Aid - **HD/M**	-EU Green Deal Communication COM (2019) 640 final -2020 Industrial Strategy -European Clean Hydrogen Alliance -European Hydrogen Strategy		
-In 2022 ECH2A will launch two specific working groups on H2 martime and heavy duty related topics.	2020 Industrial Strategy	2022	tba
-The Commission is launching the Renewable and Low-Carbon Fuels Alliance currently under preparation and which focuses on giving access to aviation and waterborne transport to these fuels.	European Clean Hydrogen Alliance European Hydrogen Strategy	2022	tba
Innovation Fund (Financed by the EU ETS) - **HD/M**	-Commission Delegated Regulation (EU) 2019/856 of 26 February 2019 supplementing Directive 2003/87/EC		
-The Innovation Fund is one of the world's largest funding programmes for demonstration of innovative low-carbon technologies. The Fund may amount to about €25 billion up to 2030. Relating to martime and Heavy-duty H2 projects. Expected at least 8 rounds of funding.	Commission Delegated Regulation (EU) 2019/856	ongoing	2030
Public procurement for clean vehicles - **HD**	-Directive 2009/33/EC on the promotion of clean road transport vehicles in support of low-emission mobility (amended by Directive (EU) 2019/1161) -Directive 2014/24/EU on public procurement -Directive 2014/25/EU on procurement by entities operating in the water, energy, transport and postal services sectors -Directive 2014/23/EU on the award of concession contracts -EU Green Deal Communication COM (2019) 640 final -European Industrial Strategy -European Circular Economy Action Plan -Green Public Procurement		
-The Clean Vehicle Directive (CVD) (Directive 2009/33/EC, amended in 2019 by Directive (EU) 2019/1161) sets procurement targets expressed as minimum percentages of clean vehicles in the total number of road transport vehicles covered by the aggregate of all contracts referred to in Article 3.	Directive 2009/33/EC	2-aug-21 1-jan-26	31-dec-25 31-dec-30
Renewable Energy Directive - **HD/M**	Directive (EU) 2018/2001 of The European Parliament and of The Council of 11 December 2018 on the promotion of the use of energy from renewable sources		
-to be updated	x	x	x

Sustainable and Smart Mobility Strategy - **HD/M**	-EU Green Deal Communication COM (2019) 640 final -Taxonomy: Final report of the Technical Expert Group on Sustainable Finance (March 2020) -Commission Delegated Regulation amending Delegated Regulation (EU) 2021/2139 as regards economic activities in certain energy sectors and Delegated Regulation (EU) 2021/2178 as regards specific public disclosures for those economic activities		
-The Sustainable and Smart Mobility Strategy was published by the European Commission on 9th December 2020.EU transport greenhouse gas emissions will have to be cut by 90% by 2050. The Strategy lays out the European Commission roadmap to achieve these goals in the next ten years. With transport as a major end-use for hydrogen, the Strategy is therefore highly relevant for the hydrogen sector.	Sustainable and Smart Mobility Strategy Fit-for-55 package FuelEU Maritime Regulation	ongoing	2050
-As part of the Fit-for-55 package, the Commission proposed a new regulation for maritime fuel. The FuelEU Maritime Regulation proposal is to stimulate fuel switching to alternative fuels. From January 2030, container ships and passenger ships at EU ports would also have to connect to onshore power supply and use it for all energy needs while at berth, with some exceptions. The proposed timetable sets a decrease of average carbon intensity by 2% in 2025, 6 % in 2030 and then further by 5-year periods till 2050. In 2050, the carbon intensity should be 75% compared to the 2020 base year.	Fit-for-55 package FuelEU Maritime Regulation	2020	2050
-For hydrogen refueling stations: 500 in 2025 and 1,000 in 2030, up from 144 currently. Whereas the need identified by the industry is larger, 1,500 HRS would be needed by 2030 for the heavy-duty sector, as stated by the industry, target-based rolling out of hydrogen refueling infrastructure across the TEN-E will help incentivise the switch to hydrogen mobility solutions and tackle the chicken-and-egg-problem. The Strategy also forecasts a substantial share of hydrogen (31-40%) and of e-fuels (10-17%) in the road transport sector in 2050.	Sustainable and Smart Mobility Strategy	2025	2050
Sustainable finance (incl. R&D) under the EU Green Deal - **HD/M**			
-to be updated	x	x	x
Taxation - **HD/M**	-EU Green Deal Communication COM (2019) 640 final -Directive 2003/96/EC1 ('Energy Taxation Directive') -Proposal for a Directive restructuring the Union framework for the taxation of energy products and electricity (recast)		
-to be updated	x	x	x
CESNI - **M**	CESNI/PT (21) 43 – Com. FR CESNI/PT (21) 44 – Com. DE		
-To draft requirements for the use of alternative fuels on inland navigation vessels, with the support of the temporary working group CESNI/PT/FC storage of hydrogen (liquified and gaseous)	CESNI/PT (21) 43 – Com. FR CESNI/PT (21) 44 – Com. DE	2022	2023
ES-TRIN - **M**			
-Update Of ES-TRIN related to H2 topics		2023	tba
Related directives - **HD/M**			

-Directive 2014/90/EU makes the minimum SOLAS requirements mandatory in the EU. Several countries outside the EU area also automatically approve and accept products with M.E.D. 96/98/EC authorization. This Directive applies to equipment placed or to be placed on board an EU ship and for which the approval of the flag State administration is required by the international instruments, regardless of whether the ship is situated in the Union at the time when it is fitted with the equipment. The directive covers types of marine equipment that fall under following International Conventions developed by the International Maritime Organization (IMO): •SOLAS 1974: Life–saving appliances/navigation equipment/radio equipment •MARPOL 1973: Marine	Directive 2014/90/EU of the European Parliament and of the Council of 23 July 2014 on marine equipment	2014	tba
-Directive 2009/45/EC introduces uniform rules on new and existing passenger ships and high-speed passenger craft, when both categories of ships and craft are engaged on domestic (intra- EU) voyages. Article 6 defines the general safety requirements for passenger ships. Article 9, introduces Additional safety requirements, equivalents, exemptions. The Directive also states that member states may adopt additional measures and adopt measures allowing equivalents for the detail requirements laid down in Annex 1 to the Directive, according to a stated procedure. Chapter II–2 of Annex 1, is specifically on requirements with respect to fire protection, detection and extinction.	Directive 2009/45/EC of the European Parliament and of the Council of 6 May 2009 on safety rules and standards for passenger ships	2009	tba
-Directive 2009/16 introduces within the EU a port State control system based on the inspections performed within the Community and the Paris MOU. It's purpose is to increase compliance with international and relevant Community legislation on maritime safety, maritime security, protection of the marine environment and onboard living and working conditions of ships of all flags; It does so by establishing common criteria for control of ships by the port State and by harmonising procedures on inspection and detention	Directive 2009/16/EC on port State control and Directive 2013/38/EU amending Directive 2009/16/EC on port State control	2009/2013	tba
-The Directive covers situations where dangerous substances may be present (e.g. during processing or storage) in quantities exceeding certain thresholds. It establishes. The Directive is relevant for both the approval of bunkering / landing installations as well as on board transport of hydrogen	Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances	2012	tba
-The Directive describes the rules and regulations for all actors in the value chain, with respect to ensuring that only safe equipment for use in potentially explosive atmospheres are sold and applied. It provides regulation of how the equipment shall be constructed, produced and documented, as well as the rules for CE-labelling. The Directive is relevant for the approval of landing / bunkering installations	ATEX Directive 2014/34/EU - covering equipment and protective systems intended for use in potentially explosive atmospheres	2014	tba
-The Directive applies to the design, manufacture and conformity assessment of pressure equipment and assemblies with a maximum allowable pressure greater than 0.5 bar. Technical requirement and classification according to an ascending level of hazard, depending on pressure, volume or nominal size, the fluid group and state of aggregation, as well as conformity assessment procedures are defined. The Directive is relevant for the approval of landing / bunkering installations	Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment.	2014	tba

-Directive 2007/46 establishes a framework for the type approval of motor vehicles classes M (passenger cars and busses), N (trucks), O (trailers), and of systems and components intended for such vehicles Specific technical requirements concerning the construction and functioning of vehicles is laid down in subsequent regulatory acts, the exhaustive list of which is set out in Annex IV. The UNECE Regulations5 listed in Part II of Annex IV are recognized as being equivalent to the corresponding separate directives or regulations in as much as they share the same scope and subject matter	Directive 2007/46/EC of the European Parliament and of the Council of 5 September 2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles	2007	tba
-Regulation (EC) No. 79/2009 (hydrogen regulation) amends Directive 2007/46 with the aim to specify harmonized safety requirements for hydrogen-powered vehicles based on an internal combustion engine or a fuel cell. Regulation 79/2009 lays down fundamental provisions on requirements for the type–approval of motor vehicles with regard to hydrogen propulsion, for the type–approval of hydrogen components and hydrogen systems and for the installation of such components and systems.	Regulation (Ec) No 79/2009 Of the European Parliament and of the Council Of 14 January 2009 on Type-Approval of Hydrogen-Powered Motor Vehicles, and Amending Directive 2007/46/EC	2009	tba
-Regulation 406/2010 contains detailed technical specifications and test procedures, including, but not limited to: • Administrative provisions for EC type-approval of a vehicle with regard to hydrogen propulsion (Article 2) • Administrative provisions for EC component type-approval of hydrogen components and systems (Article 3) • Requirements for the installation of hydrogen components and systems designed to use liquid hydrogen on hydrogen powered vehicles • Requirements for hydrogen containers designed to use compressed (gaseous) hydrogen • Vehicle identification requirements	Commission Regulation (EU) No 406/2010 of 26 April 2010 implementing Regulation (EC) No 79/2009 of the European Parliament and of the Council on type–approval of hydrogen–powered motor vehicles	2010	tba
-Regulation 692 / 2008 contains inter alia general requirements for type-approval and other provisions related to the application for EC type-approval of a vehicle with regard to emissions and access to vehicle repair and maintenance information Regulation 630/2012 extends the scope of Regulation (EC) No 692/2008 to hydrogen fuel cell vehicle	Commission Regulation (EC) No 692/2008 of 18 July 2008 on type-approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information Commission Regulation (EU) No 630/2012 of 12 July 2012 amending Regulation (EC) No 692/2008, as regards type–approval requirements for motor vehicles fuelled by hydrogen and mixtures of hydrogen and natural gas with respect to emissions, and the inclusion of specific information regarding vehicles fitted with an electric power train in the information document for the purpose of EC type–approval	2008	tba
-The AFID establishes a common framework of measures for the deployment of	Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure (AFID)	2014	tba

Interactions between IMO and hydrogen:

1. IMO only covers vessels – anything that takes place onshore – i.e. bunkering, fuel storage in ports is OUTSIDE THE SCOPE of IMO mandate
2. IMO doesn't do any standards on hydrogen itself - fuel quality/purity is not within the scope of IMO activities.

3. IMO releases technical regulations for the design of hydrogen ships – both ships carrying hydrogen as cargo as well using hydrogen as fuel (both in ICE and FC).
4. Carriage of chemicals in bulk is covered by regulations in SOLAS (international regulations addressing safety of life at sea) and MARPOL (pollution prevention). Both Conventions require chemical tankers built after 1 July 1986 to comply with the International Code for the Construction and Equipment of Ships carrying Dangerous Chemicals in Bulk (IBC Code).
5. Other constraints come from variable ship operation profiles, trading routes, weather conditions, ship payload, layout, volume, weight requirements and - of course – cost – effectiveness. Under such complex conditions, Flag Administrations, which have the jurisdiction to approve vessels for operation, are reluctant or unable to accept novel disruptive technologies such as FC and H2 without the clarity of a solid marine regulatory prescriptive framework (Regulations, Rules, Code and Standards) at International (IMO) level.
6. For ships carrying hydrogen as cargo, the relevant piece of 'guidelines' from IMO is **the IGC Code** (i.e.: International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk):
    a. The IGC Code currently does not specifically provide requirements for carriage of liquefied hydrogen in bulk by sea.
    b. This has been tacked by interim guidelines included in: "Recommendations for carriage of liquefied hydrogen in bulk" (see Resolution MSC.420(97) adopted on 25 November 2016).
    c. To mention that there is nothing for compressed hydrogen as cargo
7. For ships using hydrogen as fuel the key one is –*"**IGF Code** = International Code of safety for ships using gases and other low-flashpoint fuels"*. As hydrogen is a gaseous fuel, the general IGF code may apply. However, in the current version of this Code, regulations related to functional requirements are intended only for natural gas. It is nevertheless of utmost importance for the shipbuilding industry to have instruments for the use of other low-flashpoint fuels and Fuel Cells. The IGF Code provides general indications for a goal-oriented approach for the approval of such installations, to introduce novel technologies, designers and operators can only rely upon a performance-based technology qualification process, supplemented by complex safety assessment methodologies.
8. According to the IGF code, in the absence of specific normative provisions, the use of other low flash point fuels, including hydrogen, can be approved on the basis of an alternative design. This approach means that safety, reliability and dependability of the systems shall be proven equivalent to that achieved with traditional fuels and machineries.
9. Alternative design assessment is governed by the Life at Sea Convention (SOLAS II-1/55). Alternative design is the process by which the safety and reliability of systems must be demonstrated to be equivalent to that achieved by comparable new and conventional machines (main and auxiliary) that use fuel oils. It requires that extensive safety assessment methodologies (e.g. HAZID, risk assessments and explosion analyses) are carried out and that several functional requirements are fulfilled. Unfortunately the entire approval process is lengthy and costly, and relies on individual Flag State interpretations of the requirements.
10. There have been some recent developments in the right direction – as in September 2021 IMO has adopted "*Interim Guidelines for the Safety of Ships using Fuel Cell Power Installations*". However , this power installation does not cover the part of hydrogen storage This is a huge step forward for ships using fuels cells – H2 + ICE is still a problem though.
11. This is the extent of direct IMO activities related to hydrogen. Yet there are also several others indirect, including:

a. Recommendation on safety measures for existing vehicle carriers carrying motor vehicles with compressed hydrogen or natural gas in their tanks for their own propulsion as cargo (SOLAS regulation II-2/20-1)
b. Guidelines affecting other alternative fuels based on hydrogen – such as ammonia for example (e.g. standards on use of low-flashpoint fuels).

Standardisation projects in aviation:

There are two standards developments on the use of hydrogen in aviation:

1. SAE AIR6464; EUROCAE/SAE WG80/AE-7AFC Hydrogen Fuel Cells Aircraft Fuel Cell Safety Guidelines, STANDARD by SAE International, 02/05/2020:

"The document defines the technical guidelines for the safe integration of Proton Exchange Membrane (PEM) Fuel Cell Systems (FCS), fuel (considered to be liquid and compressed hydrogen storage types only), fuel storage, fuel distribution and appropriate electrical systems into the aircraft.

Note: Today PEM systems and fuel storage represent the most mature FCS technology and currently forms the basis for this standard. Other types of fuel cell systems and fuels (including reforming technologies and electrolyzes), may be covered by a further update to the document."

2. AS6858 "Installation of Fuel Cell Systems in Large Civil Aircraft", This is a joint SAE/EUROCAE development. The document will be released as both an SAE Aerospace Specification (AS) and a EUROCAE Minimum Aviation System Performance Standard (MASPS):

"This document defines the technical requirements for the safe integration of gaseous hydrogen fueled Proton Exchange Membrane (PEM) Fuel Cell Systems (FCS) within the aircraft. Most of the technical concepts and approaches covered by this document represent current industry "best practice". Others require specific approval from the procuring activity before use. This requirement for approval is not intended to prohibit their use; but rather to ensure that the prime contractor has fully investigated their capability to perform reliably and to be sufficiently durable under the required conditions and that the prime contractor can present substantiating evidence for approval before the design is committed to."

Annex VI – Pre-normative research (PNR) activities in the Clean Hydrogen Partnership

The Fuel Cells and Hydrogen Joint Undertakings (FCH JU, FCH 2 JU[37]) have been supporting since 2008 the development of hydrogen-specific RCS through different activities. The JU has been supporting projects, through research grants, performing PNR activities along the hydrogen chain, from the hydrogen production to end-uses, covering also cross-cutting issues where needed (e.g., safety-related aspects). More than 24 project,s with a total cost of more than 64 million euros and a total EU contribution of more than 43 million euros, have encompassed both research activities and desk research activities in view of supporting RCS developments.

A special place is taken by project HYLAW, which has provided an analysis of the legal and administrative barriers blocking the widespread commercialisation of hydrogen technologies in Europe in general and in 18 EU member States, while recommending solutions to overcome the challenges.

Another relevant initiative has been conducted by the CERTIFHY project and follow up initiatives which have assessed the necessary market and regulatory conditions to develop the complete design and initiate a unique European framework for renewable and low-carbon hydrogen guarantees of origin.

Furthermore, the FCH 2 JU set up the Fuel Cells and Hydrogen Observatory (FCHO)[38], an observatory that provides data (statistics, facts and analysis) and up to date information about the entire hydrogen sector, which includes a Policy & Incentives and Regulation, Codes and Standards module that provides users with a comprehensive overview of the most relevant policies, rules and standards that directly or indirectly affect the development and deployment of the hydrogen technologies covered by the FCHO.

The Clean Hydrogen Partnership or Clean Hydrogen JU[39] is the successor of the FCH2 JU under Horizon Europe programme for research and innovation and will continue supporting projects performing PNR activities within its Horizontal area 1: Cross-cutting issues. Moreover, the CleanH2 will set up a Regulations, Codes and Standards Strategy Coordination (RCs SC) Task Force which will coordinate and monitor the strategy related to RCS within the JU Programme with the ultimate goal of increasing the EU impact in RCS development in Europe (and beyond), with the main focus but not limited to Standards.

List of PNR projects, ongoing in 2021, supported by the FCH 2 JU.

	HySEA	2015-18	Improving Hydrogen Safety for Energy Applications (HySEA) through pre-normative research on vented deflagrations
Safety, PNR/RCS	**HYDRAITE**	2018-21	Hydrogen delivery risk assessment and impurity tolerance evaluation
	ID-FAST	2018-21	Investigations on degradation mechanisms and definition of protocols for PEM FC accelerated stress testing

[37] https://wayback.archive-it.org/12090/20220602144358/https://www.fch.europa.eu/

[38] https://www.fchobservatory.eu/

[39] https://www.clean-hydrogen.europa.eu/index_en

	PRESHLY	2018-21	Pre-normative research for safe use of liquid hydrogen
	AD ASTRA	2019-21	Harnessing degradation mechanisms to prescribe Accelerated Stress Tests (AST) for the realization of SOC lifetime prediction algorithms
	HYTUNNEL-CS	2019-22	PNR for safety of hydrogen driven vehicles and transport through tunnels and similar confined spaces
	THYGA	2020-22	Switching homes from natural gas to hydrogen
	PRHYDE	2020-22	Protocol for heavy duty hydrogen refuelingrefueling
	MULTHYFUEL	2021-23	Removing the barriers that impede commercialization of hydrogen technologies
	e-SHYIPS	2021-24	Eco-systemic knowledge in standards for hydrogen implementation on passenger ship

The standardisation issues, gaps, challenges, and priorities along the entire hydrogen chain identified by the WG will, on many occasions, require pre-normative research activities. The need for R&I and coordination actions to support the development of RCS can be further developed by the CEN-CENELEC SFEM WG H2, as the long-term collaborative framework with major bodies for strengthening cooperation between regulatory work, which then will be addressed through the different EU instruments, also so-called implementing bodies, such as the Clean Hydrogen. Therefore, there will be a need to ensure a communication channel between the work of the WG, the CEN-CENELEC SFEM WG H2, and implementing bodies such as the Clean Hydrogen.

Annex VII – Pre-normative research (PNR) in the European Partnership on Metrology

The European Partnership on Metrology (the 'Metrology Partnership')[40], is an Institutionalised Public-Public European Partnership as referred to in Article 10(1), point (c), of Regulation (EU) 2021/695, jointly undertaken by Austria, Belgium, Bosnia and Herzegovina, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Lithuania, the Netherlands, Norway, Poland, Portugal, Slovenia, Slovakia, Spain, Sweden and Türkiye (the 'Participating States').

The Metrology Partnership is managed by EURAMET, the European Regional Metrology Organisation and a non-profit association under German law. EURAMET also coordinates the European Metrology Networks with one of them focusing on 'Energy Gases' and in particular hydrogen.

Standardisation framework

EURAMET and The European Metrology Network for Energy Gases provide measurement science expertise to society and industry to support the implementation of the energy transition to renewable gaseous fuels.

EURAMET identified priorities in hydrogen

Topic	Measurement - challenge	Rationale
- Non-conventional gas injected in grid - H2NG	• Traceable standards for flow metering • Determination of calorific value (and gas composition) • Online measurement of hydrogen	Injection of hydrogen and gases in variable amount/composition in the gas grid need to be monitored → safety, trade and billing
Hydrogen for transport/mobility	• High pressure mass flow metering for vehicles at HRS (light and heavy duty/maritime)	Comply with regulation (e.g. OIML R139)
Hydrogen quality along supply chain	• Inline hydrogen analyser/sensor with suitable high sensitivity for impurities • Gas reference materials and intercomparisons • Validated online analysers • Validated sampling methods	Guarantee safety, quality and sample integrity in offline/online measurement techniques to measure hydrogen quality and guarantee comparability → support to testing laboratories
Quality control and quality assurance (fuel cells, electrolysers, material compatibility)	• Novel measurement and modelling techniques for characterisation of performance • Online techniques for real-time quality control of manufactured components	Support to development of next generation materials for industry → Innovation
Energy gases quality assurance (hydrogen, liquified hydrogen, LOHC)	• Validated temperature and pressure measuring equipment • Validated flow meters	Guarantee reliability and robustness of quantitative measurements along the hydrogen supply chain from import/production to end use → support to industry/trade/billing
Hydrogen leakage and release	• Detection/quantification/modelling • Testing and modelling pipeline corrosion	Prevent or monitor leaks for hydrogen manufacturing and transport/ storage and release in the atmosphere as indirect GHG gas. Understanding how pipeline materials behave with different gas composition/conditions, for safety and to prevent leaks
Hydrogen odorisation	• Odorants measurement methods	Evaluate the impact of odorant in hydrogen applications (fuel cell/ pipeline transport)

The involvement of EURAMET's EMN Energy Gases on hydrogen standardisation is currently the following:

- Close cooperation between EURAMET and CEN-CENELEC (STAIR EMPIR platform): within the context of metrology research, **STAIR (joint strategic Working Group to address**

[40] https://www.euramet.org/research-innovation/metrology-partnership)

Standardisation, Innovation and Research) co-operates with EURAMET by identifying metrology research needs with impact on standardisation

- Normative calls under EMPIR (European Metrology Programme for Innovation and Research) or the Metrology Partnership with topics focused on measurement methods, reference materials and metrological requirements.

Activities related to hydrogen include standardisation in the EMN for Energy Gases' Strategic Research Agenda:

- Participation in SFEM CEN-CENELEC WG Hydrogen workshops and brainstorms on standardisation needs –
- Outcomes of metrology research projects are fed into appropriate CEN and ISO TCs dealing with hydrogen standardisation
- Recent contribution to Vocabulary of Hydrogen in Energy Systems (CEN/CLC JTC 6 and ISO TC 197)

Concrete examples of hydrogen-related projects funded within EURAMET's European Metrology Research Programs and the Metrology Partnership include:

Flow metering of renewable gases (biogas, biomethane, hydrogen, syngas and mixtures with natural gas) - Short Name: NEWGASMET.

Development of renewable energy sources is encouraged by the European Renewable Energy Directive 2009/28/EC and by the European Green Deal. Renewable gases like biogas, biomethane, hydrogen or syngas can be used for this purpose. As they have characteristics that are slightly different from well-known natural gas, the industry needs to study their impact on available flowmeters and to demonstrate their compliance with the Measuring Instruments Directive 2014/32/EU. The objective of the present project is to publish reliable data that is needed by the metrological and industrial community, and to provide recommendations on renewable gas measurement with adapted gas meter standards.

Metrology for Advanced Hydrogen Storage Solutions - Short Name: MefHySto.

This European project addresses the need of large-scale energy storage, which is required for a shift to renewable energy supply. Such storage is required to supply energy at peak times when renewable sources fluctuate. A possible solution for energy storage is large-scale use of hydrogen. Metrological traceability in the energy infrastructure for hydrogen storage is crucial. Thus, improved knowledge of chemical and physical properties of hydrogen as well as traceable measurements and validated techniques are imperative.

Metrology for hydrogen vehicles 2 - Short Name: MetroHyVe 2.

Current barriers to mass implementation of hydrogen in transport arise from European Directive 2014/94/EU and International organisation of legal metrology (OIML) recommendations that must be met by all European hydrogen refueling stations (HRS). This project will address these issues and will develop metrology that will enable hydrogen to become a conventional fuel and support the European energy transition. The project will tackle measurement challenges in hydrogen flow metering, hydrogen quality control and hydrogen sampling and fuel cell stack testing.

Metrology infrastructure for high-pressure gas and liquified hydrogen flows - Short Name: MetHyInfra.

This project is the first large-scale industry project that will provide the necessary metrological infrastructure (and traceability) required to address the measurement challenges that are currently faced by the hydrogen industry. This will support growth in several sectors (mobility, fuel cells, liquified hydrogen). The aim of this project is to ensure measurement traceability in the hydrogen distribution chain. Therefore, critical flow Venturi nozzles will be established as standards for use with high pressure gas and a traceability route for liquified hydrogen will be created. Without these measures, verifiable measurements are not possible, and hydrogen will not be accepted as an environmentally friendly fuel.

Metrology for decarbonising the gas grid – Short name: Decarb

The aim is to provide the primary standards, test facilities, validated methods and good practice that gas industry need to perform key measurements required to decarbonise the gas grid, including through 100% hydrogen and hydrogen enriched natural gas. Key measurements that the project focus on include flow metering, gas composition, physical properties and leak detection.

Metrology for the hydrogen supply chain' – Short name: Met4H2.

The aim of the project is to provide better standards for the safe application of hydrogen, flow measurement, hydrogen quality assessment and custody transfer. Together with outcomes from previous projects, an infrastructure will be established that provides measurement data that are fit for demonstrating compliance with regulations and contracts. These will help ramping up the use of hydrogen and society to adapt to using hydrogen instead of fossil fuels.

Annex VIII - Examples of hydrogen standardisation in ISO and IEC

ISO/TC 197 Hydrogen Technologies

One important ISO Technical committee on Hydrogen is ISO/TC 197 "Hydrogen Technologies". It is focused on standardisation in the field of systems and devices for the production, storage, transport, measurement and use of hydrogen.

Some relevant standardisation projects in this context are:

- **ISO 22734**: Hydrogen generators using water electrolysis — Industrial, commercial, and residential applications. In particular, two new parts:
  - Part 1, on dynamic performance/ safety.
  - Part 2, on testing for grid service.
- **ISO 19880**: Gaseous hydrogen — Fuelling stations. In particular, four new parts:
  - Part 5, update regarding dispenser hoses and hose assemblies.
  - Part 6, on fittings.
  - Part 7, concerning O-rings.
  - Part 9, on sampling.
- **ISO 19885**: Gaseous Hydrogen – Fuelling protocols for hydrogen-fuelled vehicles. In particular, three new parts:
  - Part 1, about general requirements.
  - Part 2, on communications.
  - Part 3, on high flow fuelling protocols for heavy duty road vehicles.
- **ISO 19887**: Gaseous Hydrogen — Fuel system components for hydrogen fuelled vehicles. Besides, a Joint Working Group (JWG) has been set up with TC 22/ SC41.
- **ISO/TR 15916**: Basic considerations for the safety of hydrogen systems. A revision is foreseen with regards to the (i) materials compatibility table, and (ii) a new chapter will be included on LH2 (as a result of FCH 2 JU Project PRELSHY).

A new Subcommittee has recently been created (ISO/TC 197/ SC1), focused on applications 'requirements of hydrogen technologies at large scale and in horizontal energy systems, where:

- Hydrogen plays a central or significant role and where overlap or blending with other fuels and energy carriers and systems is considered.
- Different expertise and approaches are required due to different global technical regulations.

IEC/TC 105 Fuel cell technologies

One important IEC Technical committee (International Electrotechnical Committee) on Hydrogen is IEC/TC 105 „Fuel cell Technologies". It is focused on standards regarding fuel cell (FC) technologies for all FC types and various associated applications such as stationary FC power systems for distributed power generators and combined heat and power systems, FCs for transportation such as propulsion systems (see note below), range extenders, auxiliary power units, portable FC power systems, micro FC power systems, reverse operating FC power systems, and general electrochemical flow systems and processes. (except applications in the field of road vehicles which are coordinated by ISO TC 22 and its relevant SCs using the cooperation modes defined in the ISO/IEC Directives).

This TC is currently very active and 13 standards or projects are now under development. Besides, it is worth to mention that the “new“ focus is on beyond road vehicles (on top of the classic performance testing methods):

- Safety of electrically powered industrial trucks
- Fuel Cell Power Systems for unmanned aircraft systems - Performance test methods (drones)
- Fuel cell and battery hybrid power pack systems performance test methods for excavators
- Railway applications

More information available on IEC Web-site: https://www.iec.ch/