This report is based on data gathered as part of the Fuel Cells and Hydrogen Observatory as at 31 December 2019. The authors believe that this information comes from reliable sources, but do not guarantee the accuracy or completion of this information. The Observatory and information gathered within it will continue to be revised. These revisions will take place annually and can also be done on a case by case basis. As a result, the information used as of writing of this report might differ from the changing data in the Observatory.

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This report was prepared for the Fuel Cells and Hydrogen 2 Joint Undertaking as part of the Fuel Cells and Hydrogen Observatory. Copies of this document can be downloaded from https://www.fchobservatory.eu/

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Executive Summary

*Summary of the patents report is shown as follows:*

| **Purpose:** | The Standards module of the FCHO presents a large number of standards relevant for the deployment of hydrogen and fuel cells. The standards are categorized in order to enhance ease of access and usability. The development of sector-relevant standards facilitates and enhances economies of scale, interoperability, comparability, safety, and many other issues. |
| **Scope:** | The database presents European and International standards. Standards from the following standards developing organizations are included: CEN, CENELEC, ISO, IEC, OIML. The report spans January 2019 – December 2019. |
| **Key Findings:** | The development of sector relevant standards on an international level continued to grow in 2019, on European level many standards are still in the process of being drafted. The recently established CEN-CLC JTC 6 (Hydrogen in energy systems) has not published standards yet, but is working on drafting standards on, for example, Guarantees of Origin. |
1. Standards

1.1. Introduction

The Standards data stream aims to provide users of the Fuel Cells and Hydrogen Observatory with all relevant European and international European Standards and other technical specifications for a wide range of fuel cell and hydrogen related applications. Standards are voluntary jointly applicable agreements on any given topic between all parties concerned. Standardization refers to the consensus-driven processes outside of government which solve a myriad of problems, from safety to compatibility. A standard can address a process, a product or a service. An agreement on any topic is reached when all stakeholders at the table reach a consensus. All relevant stakeholders can participate in the process of drafting the standard. Standardization occurs on a national level, regional (e.g. European) level and international level.

1.2. Recent developments & trends

This paragraph describes relevant standardization-related developments on a European level, it includes:

- CEN / CLC / JTC 6 “Hydrogen in energy systems”
- Standardization Request from the European Commission to CEN / CENELEC Management Center for Hydrogen
- CEN Project “Pre normative research on hydrogen in natural gas and natural gas infrastructure”

For an up to date and current overview of all Working Programs and all published standards per relevant Technical Committee, please consult the table below and use the hyperlinks:

<table>
<thead>
<tr>
<th>Standardization Organization</th>
<th>Technical committee</th>
<th>Committee title</th>
<th>Link to TC Work Programme</th>
<th>Link to TC Published standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEN</td>
<td>CEN/TC 23</td>
<td>Transportable gas cylinders</td>
<td>CEN/TC 23 Work Programme</td>
<td>CEN/TC 23 Published Standards</td>
</tr>
<tr>
<td>CEN</td>
<td>CEN/TC 49</td>
<td>Gas cooking appliances</td>
<td>CEN/TC 49 Work Programme</td>
<td>CEN/TC 49 Published Standards</td>
</tr>
<tr>
<td>CEN</td>
<td>CEN/TC 62</td>
<td>Independent gas-fired space heaters</td>
<td>CEN/TC 62 Work Programme</td>
<td>CEN/TC 62 Published Standards</td>
</tr>
<tr>
<td>CEN</td>
<td>CEN/TC 69</td>
<td>Industrial valves</td>
<td>CEN/TC 69 Work Programme</td>
<td>CEN/TC 69 Published Standards</td>
</tr>
<tr>
<td>CEN</td>
<td>CEN/TC 109</td>
<td>Central heating boilers using gaseous fuels</td>
<td>CEN/TC 109 Work Programme</td>
<td>CEN/TC 109 Published Standards</td>
</tr>
<tr>
<td>CEN</td>
<td>CEN/TC 185</td>
<td>Fasteners</td>
<td>CEN/TC 185 Work Programme</td>
<td>CEN/TC 185 Published Standards</td>
</tr>
<tr>
<td>CEN</td>
<td>CEN/TC 197</td>
<td>Pumps</td>
<td>CEN/TC 197 Work Programme</td>
<td>CEN/TC 197 Published Standards</td>
</tr>
<tr>
<td>CEN</td>
<td>CEN/TC 208</td>
<td>Elastomeric seals for joints in pipework and pipelines</td>
<td>CEN/TC 208 Work Programme</td>
<td>CEN/TC 208 Published Standards</td>
</tr>
<tr>
<td>CEN</td>
<td>CEN/TC 234</td>
<td>Gas infrastructure</td>
<td>CEN/TC 234 Work Programme</td>
<td>CEN/TC 234 Published Standards</td>
</tr>
</tbody>
</table>

1 Note: governmental institutions) can still be stakeholders of an issue, and therefore be part of the standardization process.

Last year the CEN-CENELEC Sector Forum Energy Management Working Group Hydrogen (SFEM WG Hydrogen) published an updated report. The initial 2015 report aimed to further support Research, Development & Innovation (RDI); to boost Pre-Normative Research (PNR) and identify standardization work with the objective to address this at the relevant standardization bodies. The 2019 update includes an update of the Executive Summary, the major improvements that have been made and new challenges, projects and relevant initiatives launched since the 2015 report.

The main objective of the CEN-CENELEC SFEM WG Hydrogen is to perform an analysis on the state-of-the-art technology and standardization, and a gap analysis on the main barriers including challenges and needs. A second objective is to establish contact with key stakeholders from the gas sector, electricity supply, mobility and the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) in order to perform the work in the most effective way and to have broad support from the stakeholders to identify the key challenges. Furthermore, the link to EC services (DG JRC, DG RTD, DG ENER and DG GROW) was seen as important. The final objective is to set a long term collaborative framework (liaison) with major bodies for strengthening cooperation between regulatory work, standardization work and RDI programs (e.g. European Commission, JRC, FCH 2 JU, IEA Task 38, ISO, IEC). There is a regular exchange of information with the RCS strategy coordination group of the FCH JU.

In the report you will be able to find a broad overview of the RDI, PNR and standardization developments. The information has been structured through tables and update of roadmaps for the Taskforces:

- Task Force 1/2: Electricity grid connection and electrolysers
- Task Force 3: Natural gas system and usage
- Task Force 4: Hydrogen system and usage

For Task Force 5 Cross-cutting issues (safety, training, policy, etc.) a roadmap is developed

- Task Force 5: Cross-cutting issues

Also included are the key near term actions including an overview of key near term standardization priorities, key near term action items including a near term actions roadmap and near-term standardization actions. Also, recommendations for next steps and future work of the platform are included.

CEN / CLC / JTC 6 “Hydrogen in energy systems”

At the CEN – CENELEC Joint Technical Committee for Hydrogen in energy systems (JTC 6), a number of working groups have been defined to explore and develop European level standards. The topics include, “Terms and definitions”; “Guarantee of Origin”; and, “Safety”. The working group on Guarantee of Origin is a joint effort with CEN / CLC / JTC 14 “Energy management and energy efficiency in the framework of the energy transition” for the revision of the standard EN 16325 “Guarantees of Origin for Electricity”. Hydrogen will be included in the overhaul. Experts from CEN / CLC / JTC 6 will participate in the contribution of hydrogen to this standard. This standard is included in the RED II in Article 19 (6) with the important mention that “Member States and designated competent bodies shall ensure that the requirements they impose comply with the standard CEN-EN 16325”. In the Safety working group, New Work Item is drafted on “Safe use of hydrogen in built constructions”.

Next step (1): Standardization Request from the European Commission to CEN / CENELEC Management Center for hydrogen

The Standardization Request (SR)² for hydrogen is a topic that was already included in the European Commission’s Annual Work Program for Standardization in 2017. DG ENER has indicated that the reason

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² Standardisation results from voluntary cooperation between industry, businesses, public authorities, and other stakeholders. About a fifth of all European standards are developed following a standardisation request (mandate) from the European Commission to the European Standardisation Organisations (ESOs). This is a request to draw up and adopt European standards or European standardisation deliverables in
this SR has not been further developed in the last years is due to the development of the Clean Energy Package and REDII, among other things. The current status is that a list has been drawn up by the SFEM WG Hydrogen in consultation with the secretary of CEN / TC 234 “gas infrastructure” on the basis of the SFEM / WG report 2015 and 2019 and input from CEN / TC 234. This list is the basis for further discussions to be included in the SR. An important extension of the scope is that in addition to hydrogen as a blend with natural gas transported and distributed through the natural gas networks, pure hydrogen through the natural gas infrastructure and pure hydrogen via a dedicated hydrogen infrastructure are now included in the scope.

Next step (2): CEN Project “Pre normative research on hydrogen in natural gas and natural gas infrastructure”

The CEN Project “Pre normative research on hydrogen in natural gas and natural gas infrastructure” is an EC funded project in preparation, which includes the following eight topics:

1. **Safety** (e.g. classification of leakages, sensors, tightness...)
2. **Gas quality** (e.g. relative density, H2-quality, Odourisation, energy density...)
3. **Underground storage** (> 2% porous storage, aquifers, subsurfaces)
4. **Centralised and de-centralised energy production** (>5%, turbines, CHP Gas engines)
5. **H2/H2NG in industry** (> 5% upta/incl. conversiontoH2, variations due to uncontinous H2injection)
6. **Steel pipes** (> 10%, corrosion, integrity, welding, embrittlement)
7. **Equipment and materials in the gas grid** (incl. variations due to uncontinous H2 injection)
8. **End-use applications** (>20%)

1.3. Used data and data-architecture

For the Standards data stream NEN set up an architecture to demonstrate the amount of data available from public sources, see below:
This online portal for standards offers two entry paths for finding the correct and relevant standards. The first entry path is through a free search, where users are able to search on standard codes, titles, or any terms used in the description of that standard. The second entry path is through an interactive menu, where users are able to select categories and go into further detail per click; from category to sub-category, and from sub-category to class. Having found the correct standard, users are able to click and open a pop-up with further details on that specific standard.

This image visualizes the structure of the database, and shows how standards are structured through various categories and subcategories.
1.3.1. Standardization Developing Bodies

For the purpose of this Observatory standards from the following Standardization Developing Organizations (SDO) have been included:

- International Organization for Standardization (ISO)
- International Electrotechnical Commission (IEC)
- European Committee for Standardization (CEN)
- European Committee for Electrotechnical Standardization (CENELEC)
- International Organization of Legal Metrology (OIML)

National standards were initially included but later removed due to language barriers and doubling of standards. Relevant national standards are often introduced into regional (European) and/or international standards drafting process. As the standard data stream also includes standards under development (being drafted), it ensures that no relevant developments are left out of the Observatory.

1.3.2. Data per standard

Publicly available data from the SDO portals included:

- Code or reference of the standard
- Title of the standard
- Description of the standard
- Status of the standard (published or being drafted)
- Hyperlink to specific standard
- Hyperlink to the SDO Technical Committee responsible for drafting the Standard
- Hyperlink to the SDO Technical Committee scope
- In some cases: related Legal EU Directive
- In some cases: related legal Mandate
- In some cases: Citation in the Official Journal of the European Union

Where possible hyperlinks were used in order to refer to the owner of the original data (i.e. the online portals of ISO, IEC, CEN, CENELEC, and OIML). This is a measure in order to avoid outdated information on the Observatory.

1.4. Scope

The ‘standards data stream’ used the Application List as provided by E4tech in order to determine the scope for the database. This Application List contained categories, sub-categories, classes, and in some cases sub-classes. An example; category: Transport (motive power); sub-category: Road vehicles; class: Heavy good vehicles; sub-class: 3.5-7.5t.

For the purpose of accessibility, the consideration for inclusion of standards in the Observatory is determined by their relevance to hydrogen-specific applications. When identifying relevant standards for passenger cars, for example, standards such as ISO 18164:2005 - Passenger car, truck, bus and motorcycle tyres — Methods of measuring rolling resistance were excluded.
Any given standard can apply to various categories, sub-categories, classes and even sub-classes. For the purpose of findability and user friendliness, standards have been tagged with all relevant categories to sub-classes.

### 1.5. Online presentation of data

On the online portal of the Observatory there are two entry paths for users for finding the correct and relevant standards. The first entry path is through a free search, where users are able to search on standard codes, titles, or any terms used in the description of that standard. The second entry path is through an interactive menu, where users are able to select categories and go into further detail per click; from category to sub-category, and from sub-category to class. Having found the correct standard, users are able to click and open a pop-up with further details on that specific standard (see 1.3.2. Data per standard).