INTERNATIONAL PARTNERSHIP FOR
HYDROGEN AND FUEL CELLS IN THE ECONOMY

Regulatory Gaps Compendium Summary

IPHE Regulations, Codes, Standards and Safety Working Group (RCSSWG)

Background

The IPHE Regulations, Codes, Standards and Safety Working Group (RCSSWG) was established by the IPHE Steering Committee in 2003 according to the following principles:

- IPHE initiatives should identify gaps, provide guidance, and provide a forum for facilitating progress towards common regulations, codes and standards, and safety protocols. IPHE activities should be initiated only when they provide clear added value and do not duplicate work already completed or currently in progress by member countries.
- IPHE is neither a regulatory nor a standardization body. Therefore, the IPHE and its points of contact do not have any direct function or responsibility, on behalf of the IPHE, in drafting standards or regulations or in their harmonization.

Based on these two principles, the RCSSWG developed the following functions:

- Act as a catalyst for cooperation and for facilitating harmonization of IPHE member activities.
- Provide a forum where the RCSSWG can discuss potentially controversial or challenging regulatory issues and forward subsequent recommendations to IPHE members.

Under these guiding directives, the IPHE RCSSWG performed a survey of its participant countries to determine regulatory gaps in critical areas for hydrogen and fuel cell deployment, in support of the primary objectives of the IPHE: *to facilitate and accelerate the transition to clean and efficient energy and mobility systems using hydrogen and fuel cell technologies across applications and sectors.*

Results

Under this activity, RCSSWG participants provided input on key focal areas within two topic areas: Hydrogen Infrastructure and Hydrogen for Mobility/Transportation. Descriptions of the topic areas and sub-topic areas are given below:

Topic Area 1: Hydrogen Infrastructure

- Hydrogen Injection at Transmission Level: regarding the connection/injection of hydrogen into the gas grid

- Hydrogen Injection at Distribution Level: regarding the transmission of hydrogen or hydrogen/natural gas mixtures via the gas grid
- Hydrogen Refilling Station: regarding requirements for siting, permitting, safety, and fuel quality at hydrogen refuelling stations
- Maritime Infrastructure: regarding off-shore and on-shore storage and utilization of hydrogen in maritime/port settings
- Methanation and Injection of Methane via Methanation from Hydrogen at Transmission/Distribution Level: regarding regulation of injection of methane produced via methanation from hydrogen into the gas grid

Topic Area 2: Hydrogen for Mobility/Transportation

- Heavy Duty Vehicles: regarding type-approval, incentives, maintenance requirements, and classification for trucks, trains, aircraft, and maritime vessels
- Hydrogen and Hydrogen-Based Fuel Vessels (Maritime): regarding permissions, safety requirements, and on-board storage for maritime vessels
- Mobility Infrastructure: regarding operation of hydrogen vehicles (including LDV, HDV, etc.) in tunnels, underground parking, ferries, trains, etc.

The RCSSWG created a multi-page template with these topic areas and distributed it to participants, asking them to provide details for each area, focusing on the current legal or regulatory framework in their respective countries. Participants were also asked to identify whether an area is a barrier, the type of barrier (operational barrier, regulatory gap, etc.), and the severity of the barrier.

Given that there is a degree of subjectivity to the inputs provided, the RCSSWG leadership utilized the inputs of the participants to develop a heat map of the most critical areas (Figure 1). The intent of the heat map is to provide a qualitative overview of the areas of most need, or gaps.

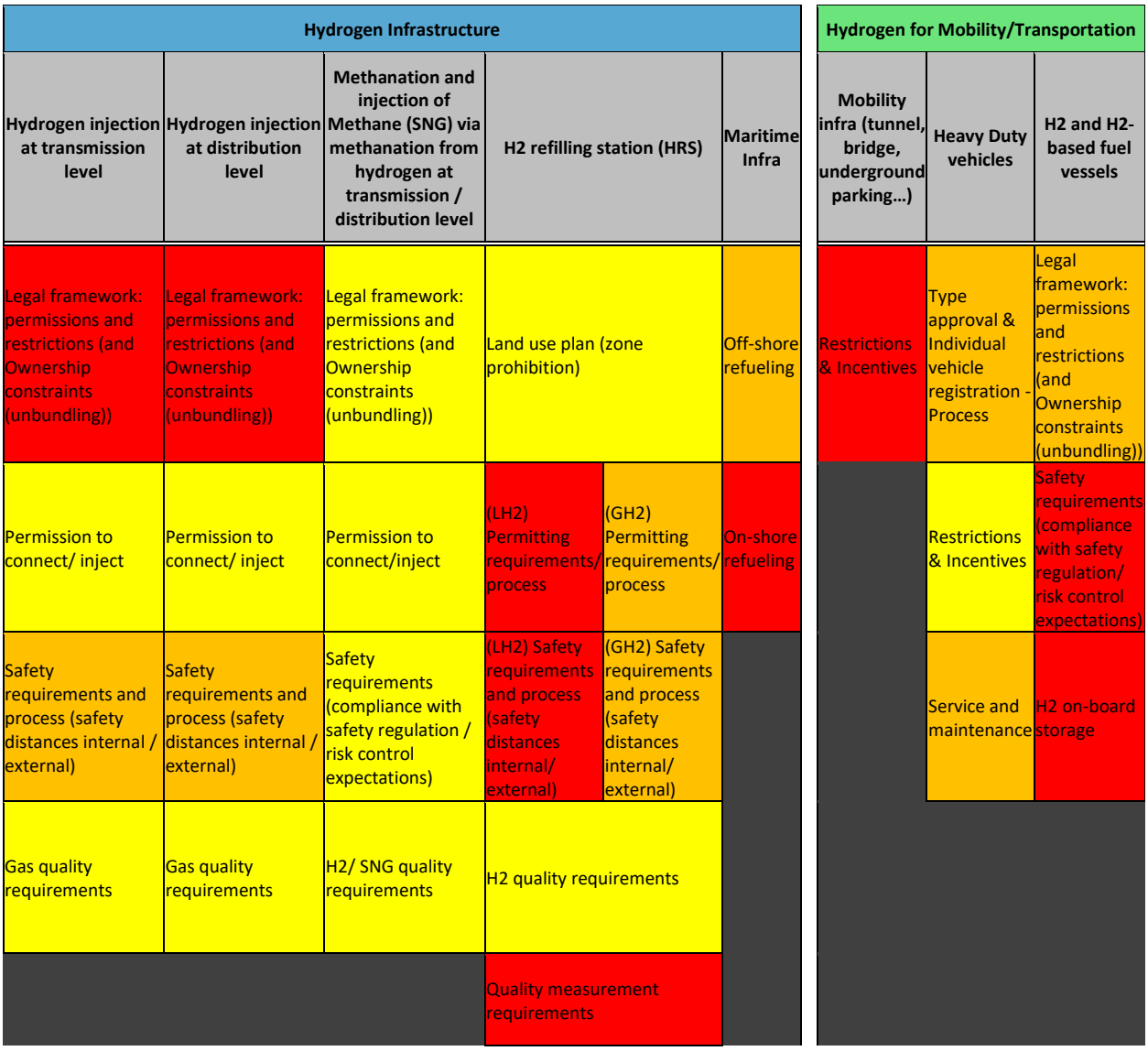

Figure 1. Heat map of critical areas as identified by the RCSSWG (red is considered most critical, orange is moderately critical, and yellow is less critical)

Tables 1 and 2 below provide detailed descriptions of the gaps identified through this process. These gaps are grouped according to their topic areas and are categorized as regulatory gaps, research & development (R&D) gaps, or both. The topic areas are organized by sub-topic priority in accordance with the heat map in Figure 1.

Table 1. Summary of Gaps Identified for Hydrogen Infrastructure

Hydrogen Infrastructure			
Topic Area	**Sub-Topic**	**Gap Description**	**Type of Gap**
Hydrogen Injection at Transmission Level	Legal Framework: Permissions and Restrictions	Hydrogen injection into the natural gas pipeline is not even considered in some countries. The maximum hydrogen allowable is inconsistent and is set on a country by country basis. Allowable hydrogen injection levels are not yet well understood.	Regulatory
	Safety Requirements and Process	End-use constraints must be identified, as they are the limiting factor across the network. Some end uses will not tolerate blends, requiring hydrogen to be separated. Regulations relating to the safe operation and handling of hydrogen injection are, where they exist, related to existing national industrial regulations (e.g., operational safety, pipeline regulations, hazardous material handling).	Both
	Permission to Connect/Inject	This item relates to international interconnection (i.e., with neighboring countries). Individual country regulations are insufficient to properly inform this space.	Regulatory
	Gas Quality Requirements	Acceptable gas quality ranges may differ locally and are often fixed by law.	Both
Hydrogen Injection at Distribution Level	Legal Framework: Permissions and Restrictions	Little to no national regulation information is available regarding injection at distribution level.	Regulatory
	Safety Requirements and Process	End-use constraints must be identified, as they are the limiting factor across the network. Some end uses will not tolerate blends, requiring hydrogen to be separated. Regulations relating to the safe operation and handling of hydrogen injection are, where they exist, related to existing national industrial regulations (e.g., operational safety, pipeline regulations, hazardous material handling). Participants also noted gaps related to leak detection requirements/capabilities.	Both
	Gas Quality Requirements	Where information is available, the expectation for quality management lies with the operator.	Both
	Permission to Connect/Inject	This item relates to international interconnection (i.e., with neighboring countries). Individual country regulations are insufficient to properly inform this space.	Regulatory

Topic Area	Sub-Topic	Gap Description	Type of Gap
Hydrogen Refilling Station	Liquid Hydrogen (LH2) Permitting Requirements/ Process	Permitting is performed at the regional level in most cases. While most countries report a consistent procedure in place, interpretation of specific regulations is at the discretion of the local jurisdiction. Similarly, commissioning of completed stations involves interpretation/approval by the local jurisdiction. Gaps relating to storage and delivery of LH2, as well as siting requirements, are generally considered more significant than for GH2.	Both
	LH2 Safety Requirements/Process	For several responding countries, setback distances are regulated at the national level. For others, it is handled at a regional level. In all cases, certain safety elements are inconsistent (risk assessment, personnel safety requirements) and whether they were required. In many cases, there are substantial R&D gaps regarding the setback distances for LH2 installations. Large scale on-site storage poses R&D and regulatory gaps.	Both
	Quality Measurement Requirements	Little to no national requirements exist for the monitoring of hydrogen quality. All responding countries identified this as a barrier. Fuel quality assurance processes/equipment (largely for GH2) are still in development.	Both
	GH2 Permitting Requirements/ Process	Permitting is performed at the regional level in most cases. While most countries report a consistent procedure in place, interpretation of specific regulations is at the discretion of the local jurisdiction. Time to obtain permit was reported to average between 3 and 15 months. Similarly, commissioning of completed stations involves interpretation/approval by the local jurisdiction. Additional gaps exist for deployment of large-scale storage of hydrogen.	Regulatory

Topic Area	Sub-Topic	Gap Description	Type of Gap
Hydrogen Refilling Station (ctd.)	GH2 Safety Requirements/ Process	For several responding countries, setback distances are regulated at the national level. For others, it is handled at a regional level. In all cases, certain safety elements are inconsistent (risk assessment, personnel safety requirements) and whether they were required. A framework for indoor installation does appear to consistently exist under certain cases (e.g., forklifts). High-flow refueling processes and procedures are still under development.	Both
	Land Use Plan	In the case of some countries, the land use/zoning requirements are handled at the local/regional level. For a few respondents, there are national requirements that HRSs be built according to the local long-term building/use plan. Respondents consistently indicated that HRSs were often restricted to certain land-use zones (industrial, commercial, etc.). Ultimately, the local/regional municipality is the authority for permitting land use for all responding countries.	Regulatory
	Hydrogen Quality Requirements	Most responding countries indicated that hydrogen quality requirements follow ISO 15687 (or the corresponding SAE J2719).	Regulatory
Methanation and Injection of Methane via Methanation from Hydrogen at Transmission/ Distribution Level	Legal Framework: Permissions and Restrictions	For some responding countries, there is clear legislation regarding injection of methane via methanation from hydrogen. For other, the incumbent technology is natural gas and therefore natural gas requirements form the basis of the regulations.	Regulatory
	Permission to Connect/Inject		Regulatory
	Hydrogen/SNG Quality Requirements		Both
	Safety Requirements and Process		Regulatory

Table 2. Summary of Gaps Identified for Hydrogen for Mobility/Transportation

Hydrogen for Mobility/Transportation			
Topic Area	**Sub-Topic**	**Gap Description**	**Type of Gap**
Heavy Duty Vehicles	Type Approval & Individual Vehicle Registration (process)	Type approval process is inconsistent. While not seen as a critical gap, there is opportunity to leverage learnings from countries with clear approval processes. Some countries report specific approvals for hydrogen vehicles, while other countries report that the same regulations for non-hydrogen vehicles apply. More gaps exist for type approval of vehicles for non-road transportation (aircraft, rail, etc.).	Both
	Service and Maintenance	Maintenance and testing requirements are inconsistent for trucks and nonexistent for other heavy-duty vehicle applications. In many reported cases, the vehicle OEM sets maintenance requirements (in the case of trucks). Most countries reported the existence of a national framework for truck inspection (sometimes performed by an independent body).	Both
Heavy Duty Vehicles (ctd.)	Restrictions and Incentives	Very few countries indicated the presence of incentives for adoption of heavy-duty hydrogen vehicles.	Regulatory
Hydrogen and Hydrogen-Based Fuel Vessels (Maritime)	Safety Requirements and Process	Safety guidelines for maritime vessels appear to be nonexistent in national regulations.	Both
	Hydrogen On-Board Storage	On-board storage for maritime vessels was identified as a gap here as well as at the 2020 Research Priorities Workshop. Few regulations were reported in this space.	Both
	Legal Framework: Permissions and Restrictions	Participants identified several regulatory gaps around the legal framework for the adoption of hydrogen maritime vessels. Coordination with IMO was identified as a key priority. Several countries identified which regulatory bodies would have authority for such vessels.	Regulatory
Mobility Infrastructure	Restrictions and Incentives	Most countries reported some level of restriction for operation of FCEVs in tunnels, with varied regulatory frameworks (national versus regional). Fewer countries reported restrictions on parking these vehicles in covered places (e.g., garages). Tunnel and bridge access continue to be inconsistent at the global scale. There is a consistent need to distinguish between hydrogen as a fuel and hydrogen as a cargo to enable access.	Both

It should be noted that the RCSSWG members have contributed heavily to the development of knowledge resources for some time and there are existing resources addressing the specific content areas identified in the tables above in further detail. A partial list of these resources is provided in Appendix A.

Summary

In general, the results of this survey 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 LH2, 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.

Members of the RCSSWG represent a diverse collection of R&D organizations whose priorities include many of the research gaps identified within the tables above. The RCSSWG looks forward to continuing in its role as a connection between the R&D community and the efforts of the IPHE Steering Committee to inform regulatory changes based on these gaps.

Appendix A. Additional References

- HyLaw database of legal and administrative procedures in EU member states: https://www.hylaw.eu/database and policy reports https://www.hylaw.eu/info-centre
- Research Priorities Workshop Reports (https://hysafe.info/activities/research-priorities-workshops/)
- Database of Hydrogen and Fuel Cell Standards (https://h2tools.org/fuel-cell-codes-and-standards?search_api_fulltext=)
- Baird, A., B. Ehrhart, A. Glover, C. LaFleur. (2021). Federal Oversight of Hydrogen Systems (SAND2021-2955). https://energy.sandia.gov/wp-content/uploads/2021/03/H2-Regulatory-Map-Report_SAND2021-2955.pdf