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Study and Recommendations for Development of Internationally Compatible Green Hydrogen Standards in India

13th EU – India Smart Energy Workshop

13th March, 2024, Delhi

Study By

Introduction

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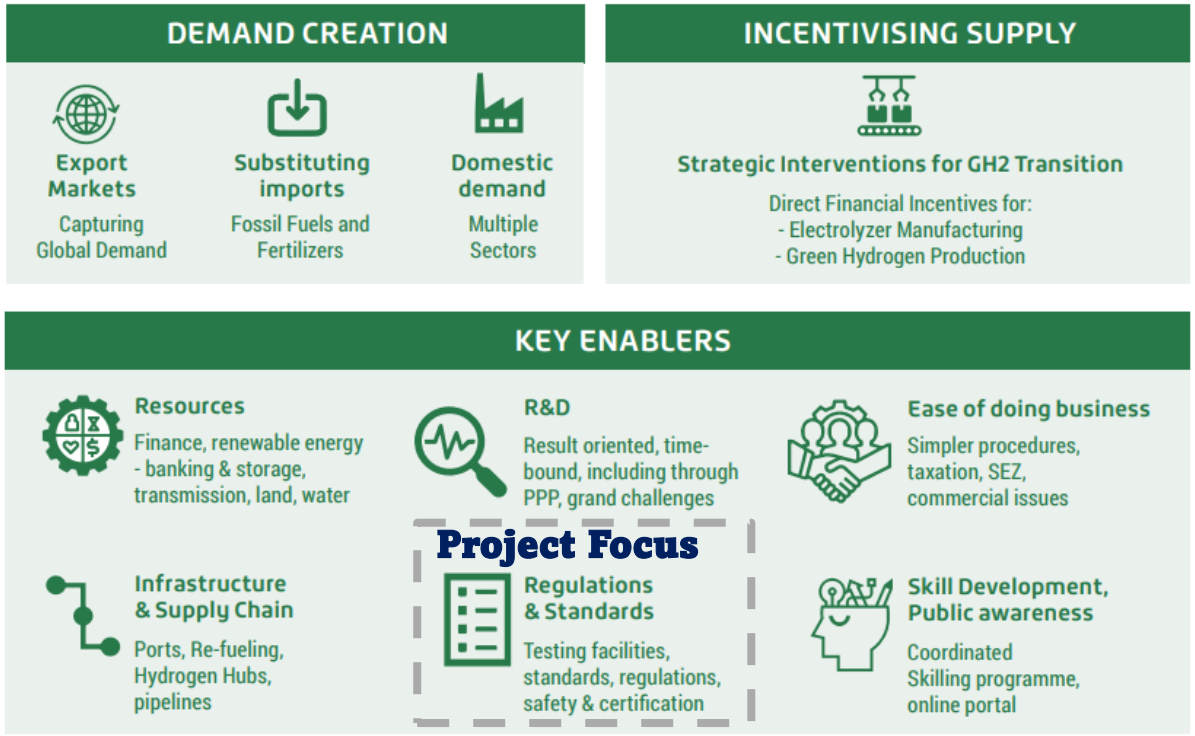
National Green Hydrogen Mission

- Make India the **Global Hub for production, usage and export** of GH2 and its derivatives
- Make India a **leader in technology and manufacturing of electrolysers and other enabling technologies** for GH2



Study Objective:

Identify and address existing gaps in Indian **Regulations, Standards, and Certifications (RSC)** encompassing the **Green Hydrogen (GH2), Green Ammonia (GNH3), and Green Methanol (GCH3OH) value chain** in India

Scope:

- Benchmark **global best practices** on GH2 RSC, with detailed review
- Conduct thorough **examination of Indian RSC** in the GH2 landscape
- Identify **gaps in the Indian GH2 RSC** ecosystem
- Recommend strategies for **development and adoption of internationally compatible standards and certifications** in the Indian GH2 ecosystem
- Consult relevant stakeholders for **validation** of the study

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India Green Hydrogen Value Chain

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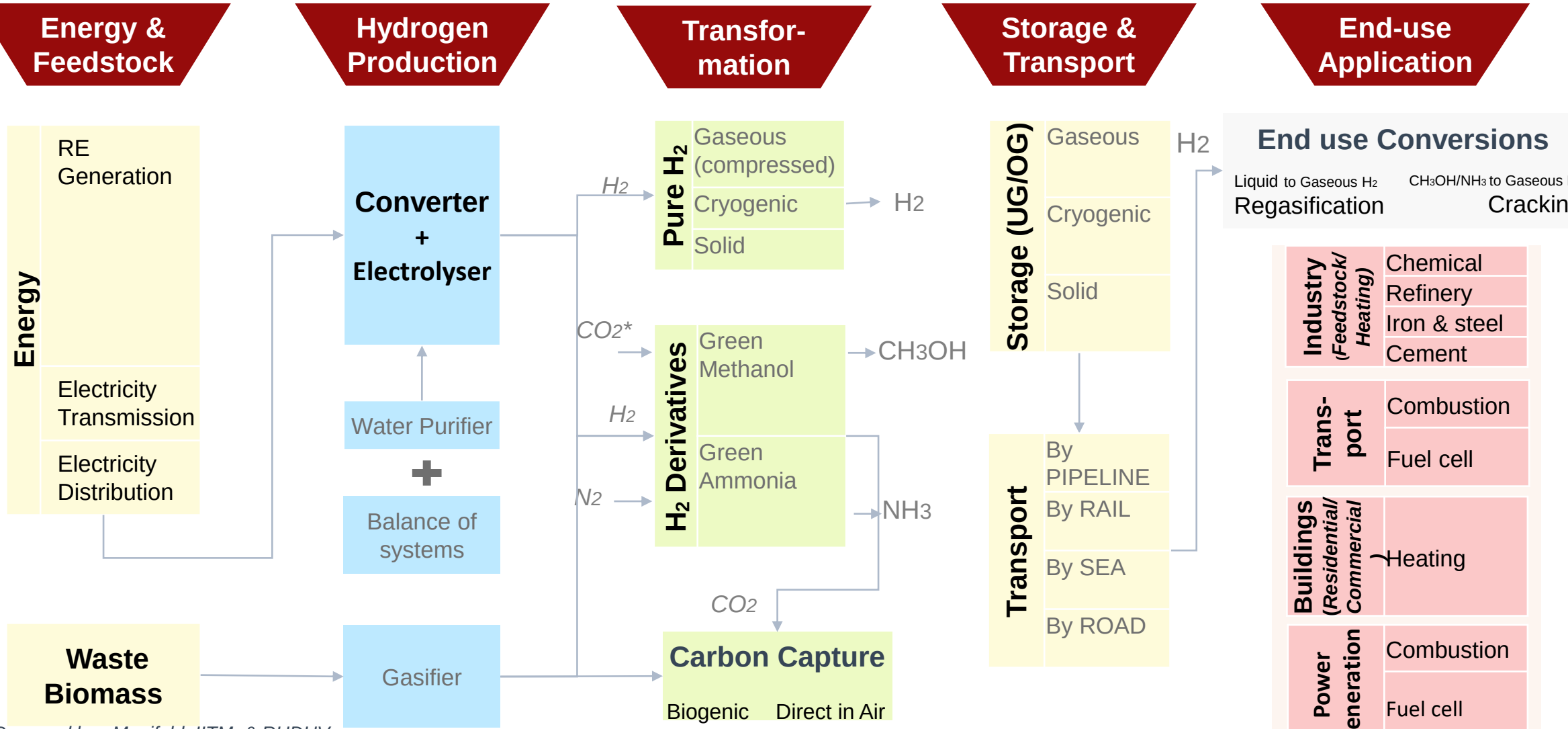

Source: Prepared by pManifold, IITM, & RHDHV

** Either directly captured or through sustainable biomass route*

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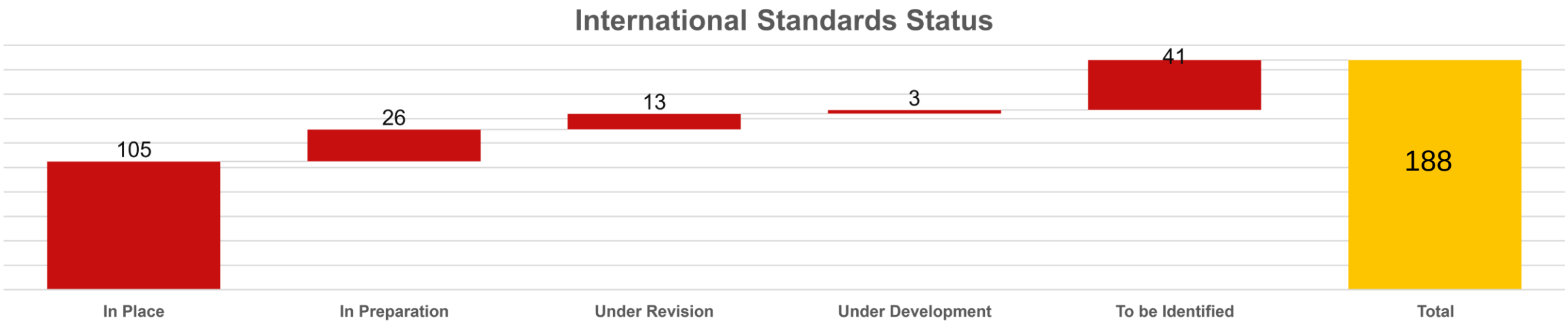
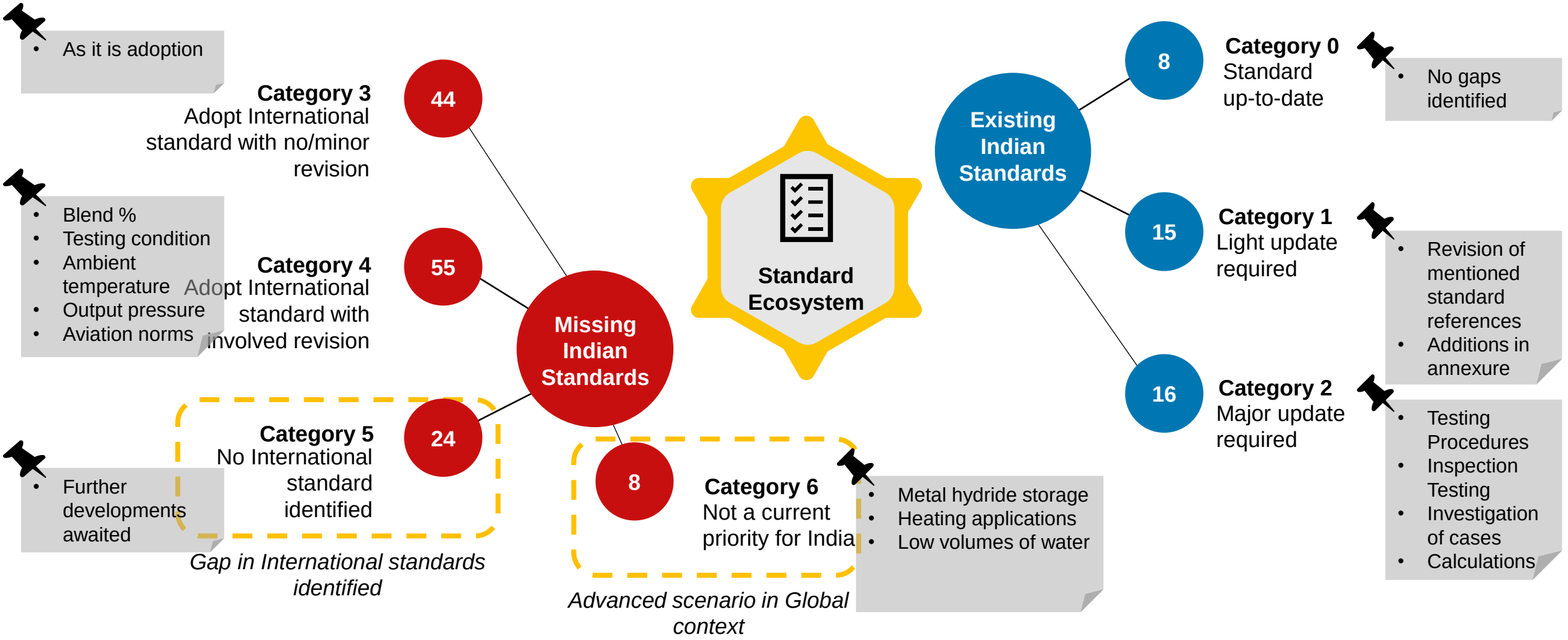
Benchmarking Global Standards

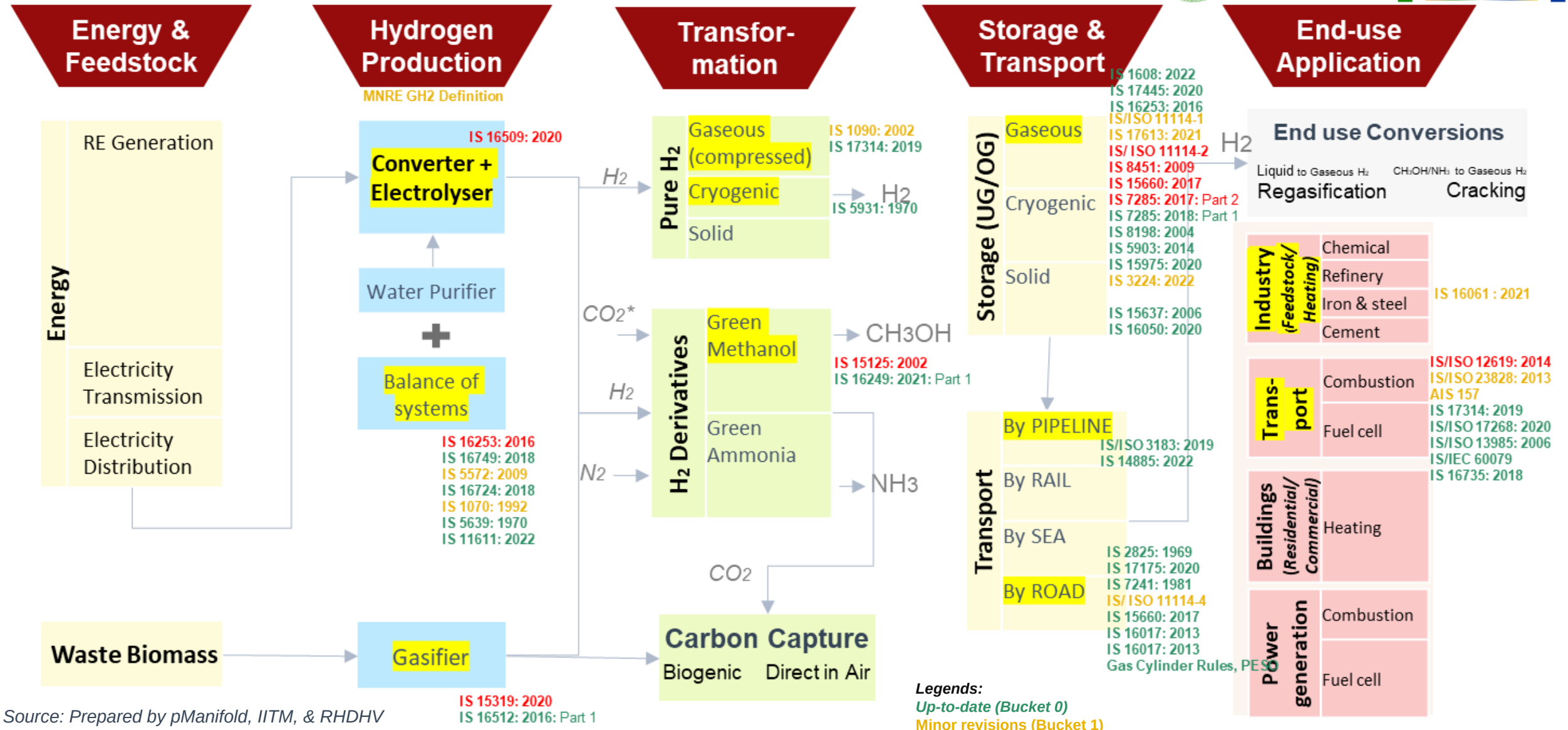
Country	International	EU	US	Japan	Total	India
Standardization Bodies	ISO, IEEE, IEC	CEN/CENELAC, VDI	ASME, ASTM, CGA, NFPA	JSA		BIS, PESO, ARAI, BEE
H2 Production	8	7	3	1	19	9
H2 Transform	7	6	1		14	5
H2 Storage & Transport	16	65	9	6	96	22
H2 End-use Applications	13	14	11	21	59	8
Grand Total	**44**	**92**	**24**	**28**	**188**	**44**



Recommendations on Standards



Existing relevant Standards



Legends:
Up-to-date (Bucket 0)
Minor revisions (Bucket 1)
Major revisions (Bucket 2)

Source: Prepared by pManifold, IITM, & RHDHV
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Recommendations on Standards

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	Hydrogen Production	Transfor-mation	Storage & Transport	End-use Application
Recommendations	• Framework addressing the **environmental footprint** of hydrogen facilities, likely modeled after NFPA 2. • The OISD piping standard should expand to contain **criteria for electrolyzer systems**, taking cues from the **ASME 31.12** hydrogen piping standard. • A new standard focusing on the **separation, drying, and purification** stages of hydrogen production	• **IS 5931: 1970**, which currently deals with cryogenic liquids management, should be adjusted to integrate the NFPA 55 codes, for improved guidelines on installation, storage, use, and handling. • Need for a new Indian standard that outlines the **gas quality traits, measures, and thresholds for hydrogen gases classified under group H**, **with adaptations from EN 16726** tailored to Indian context	• **Chemical composition and heat treatment standards** for materials in gas cylinders and valves • **Hydrogen permeation rates** on metal materials • **Impact of hydrogen on the welded components of cylinders and the susceptibility to stress corrosion cracking** in varying environments should be a priority, drawing from the insights of CGA G 5.5 standards.	• **Fuel quality specifications** and **hydrogen consumption tests** • Protocols for implementing a **breakaway device** during high-tension situations • Safety, performance, and environmental impact, as well as electromagnetic compatibility, fuel cell stack durability, hydrogen transport, fuel quality, and the design of fueling connectors.
Other Important Topics	• Measurement, testing procedures, and key performance benchmarks for **electrolysers** • **Compatibility of plastic materials** with low-pressure hydrogen pipes and fittings • Inclusion of **diversified GH2 production technologies** • **Protocols** for environmental management, assess efficiency, and standardize emissions, along with the **certification of hydrogen's origin**	• **Purification processes** for hydrogen fuel gases • **Safety protocols** concerning **liquid hydrogen** • Standards for the **management of hydrogen and its derivatives at terminals** and within the hydrogen grid • Criteria for the **certification of low carbon and green hydrogen**	• **Design guidelines for high-pressure composite hydrogen tanks**, considering the unique requirements of the Indian market • Safety and efficiency standards for **Maritime transport of hydrogen and its derivatives** • Establish comprehensive building norms concentrating on the **safety aspect of hydrogen storage infrastructures**	• Standards on **LOHC and LIHC safety in maritime transport** • Information and procedures for the periodic visual examination and inspection of **natural gas and hydrogen fuel containers and their installations** • Standards for **gas quality characteristics, electromagnetic compatibility, and fuel systems** in various applications

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Existing relevant Regulations

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Current legislation is Applicable | Current legislation need Adjustment to be applicable for Green H2 | New Specific legislation are needed | Not Applicable

			Power sector legislation	Gas sector legislation	Industry legislation	Environmental legislation	Land and water legislation	Transport legislation
			Electricity Act, 2003	Petroleum and Natural Gas Regulatory Board (PNGRB) Act	Pollution Control Acts (central and state level)	Environment Protection Act, 1986	Land Acquisition Act, 2013 & Water Protection Act	Central Motor Vehicles Rules, 1989
Energy & Feedstock	Energy	RE Generation						
		Electricity Transmission						
		Electricity Distribution						
Hydrogen Production	Converter + Electrolyser	H2 Generators						
	Balance of systems	Water Quality						
		Elec. Installation						
	Gasifier	H2 Generators						
		Odorization						
Transformation	Pure H2	Gaseous (compressed)						
		Cryogenic						
		Solid (Metal Hydrides)						
	H2 Derivatives	Green Methanol						
		Green Ammonia						
	Carbon Capture							
Storage & Transport	Storage (UG/OG)	Gaseous						
		Cryogenic						
		Solid						
	Transport	By PIPELINE						
		By RAIL						
		By SEA						
		By ROAD						
End-use Application	End use Conversions	Regasification						
		Cracking						
	Industry	Chemical						
		Refinery						
		Iron & steel						
		Cement						
	Mobility	Combustion						
		Fuel Cell						
		Maritime						
		Aviation						
		Off-Highway Applications						

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Recommendations on Regulations

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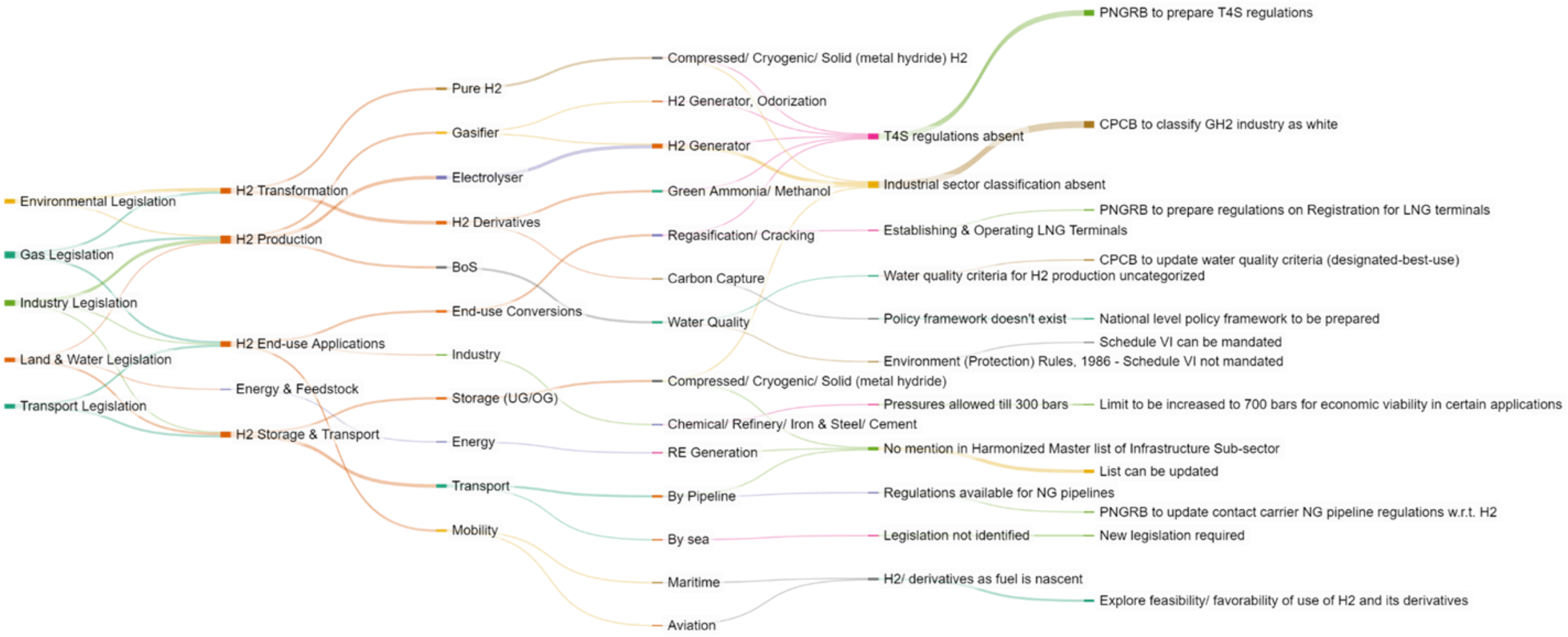
Legislation	Value Chain Stage (L0)	Value Chain Stage (L1)	Value Chain Stage (L2)	Gaps	Recommendations



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Recommendations on Regulations

- **Aligning regulations with clear guidelines:** Guidelines fulfilling essential elements, including the erection and operation of green hydrogen plants, regulatory compliance, approval acquisition, and incorporating renewable energy sources, are yet to be explicitly articulated.
  - For example, in the policy of Madhya Pradesh, banking of green hydrogen is not specifically addressed which will serve as a big limitation during approvals/ execution given severe limitations in both RE absorption capacity and excess firming capacity.
  - Formulation of SOPs is a need.

- **Simplification of approval processes:** The existing regulatory system can be optimized by streamlining the approval process for green hydrogen projects. At present, acquiring necessary permissions from multiple governmental agencies might involve potential complexities and delays.
  - For example, the registrations and approval for solar plants are provided by SECI and the respective State Nodal agency.
  - Similarly, for wind power projects, the necessary approvals are provided by NREDCAP in Andhra Pradesh.
  - Moreover, the developers need to obtain clearances from SPCB. Similarly, for hydrogen production plants, obtaining building plans, power and water connections, and clearances from the SPCB, export registrations to procure equipment from abroad, securing factory licenses, etc. are required.

- **Facilitating inter-agency coordination:** Enhanced cooperation between different governmental agencies is critical for achieving successful implementation of green hydrogen projects. Presently, gaps and challenges in coordination could lead to operational inefficiencies and delays.
  - The nozzle of dispensing equipment and the vehicle connecter are under purview of different agencies in the Indian ecosystem which without proper coordination can lead to similar experiences in the CNG sector.
  - Other areas are approval-execution agencies, RE data-Energy planning & policy making, Funding-Project Implementing, Regulations-compliance in industries, agencies developing GH2 infrastructure and agencies involved in RE generation/ transport & storage infrastructure.

- **Clarification of renewable energy sourcing mechanisms:** Green hydrogen production is fundamentally contingent on renewable energy sources like solar and wind power. India is actively working in this sector through provisions of interstate transmission charges waivers, open access contracts, power purchase agreements, round-the-clock renewable contracts, the development of green hydrogen hubs, and financial incentives for electrolyzer manufacturing and green hydrogen production.
  - Utility Green Pricing Mechanism, RECs, Unbundled Energy Attribute Certificates, and On-Site RE infrastructure for sourcing renewable energy for green hydrogen plants.

- **Institution of robust quality standards:** For the widespread adoption of green hydrogen, enforcing quality and safety standards is essential.
  - Standards are formulated for hydrogen production and fuel quality of hydrogen, but there is a lack of purity related standards pertaining to use of hydrogen as a feedstock. A need to quick implementation of ongoing efforts based on priority is required.

Benchmarking Global Certifications (Mandatory)

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Country	Mechanism	Status of regulatory mechanism	Boundary and scope (sectors)	GHG emissions threshold [gCO_{2eq}/MJ]	Power supply requirements for electrolysis	H2 production pathway
Regulatory Mechanism (Mandatory)						
EU	European Commission Renewable Energy Directive II (RED II)	Active	Transport, Energy: Upstream production to point of use	28.2	GO (Guarantee of Origin) and delegated act criteria additionality, solar wind, or hydro	Electrolysis
	European Commission EU Taxonomy	Active	Boundary not specified	28.2	GO required, grid, nuclear solar wind, or hydro	Electrolysis, Fossil SMR/ATR with CCS, Biogas SMR
US	US Department of Energy H2Hubs draft	Active	Transport, Energy: Point of production	16.67	No GO/additionality specified	Electrolysis, Fossil SMR/ATR with CCS, Biogas SMR
	California Air Resources Board Low Carbon Fuel Standard (California only)	Active	Transport: Upstream methane to point of use	No threshold (Certificate issued based on reduction from annual target)	GO required, grid, solar wind, or hydro	Electrolysis, Fossil SMR/ATR with CCS, Biogas SMR

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Benchmarking Global Certifications (Voluntary)

Country/Region | Organization & Title3	Labels	Chain of Custody model	GHG emissions threshold [gCO_{2eq}/MJ]	Power supply requirements for electrolysis	Qualification Criteria
Voluntary Mechanism					
European Union CertifHy	Green H2	Book & Claim	36.4	GO + additionality, solar wind, or hydro	GHG emissions, Electricity supply
	Low-carbon H2	Book & Claim	36.4	GO required, grid, nuclear	GHG emissions
	Green RFNBO	Book & Claim	36.4	GO + additionality, solar wind or hydro	GHG emissions, Electricity supply
International Sustainability and Carbon Certification (ISCC) ISCC PLUS	Green H2	Mass Balance	28.2	GO + additionality, solar wind, or hydro	GHG emissions, Electricity supply, Land use change, water use, safe working conditions
TÜV Süd CMS70	Green H2	Mass Balance	28.2	GO + additionality, solar wind, or hydro	GHG emissions, Electricity supply
	Green H2 +	Book & Claim	24	GO + additionality, solar wind or hydro	GHG emissions, Electricity supply
Japan Aichi Prefecture	Low-carbon H2	Book & Claim	Not specified	GO + additionality, solar wind, or hydro	GHG emissions, Electricity supply
International Green Hydrogen Organization	Green H2, in preparation	Not specified	8.3	GO required, solar wind, or hydro	GHG emissions, Electricity supply, Land use change, water use, safe working conditions

India GH2 Definition

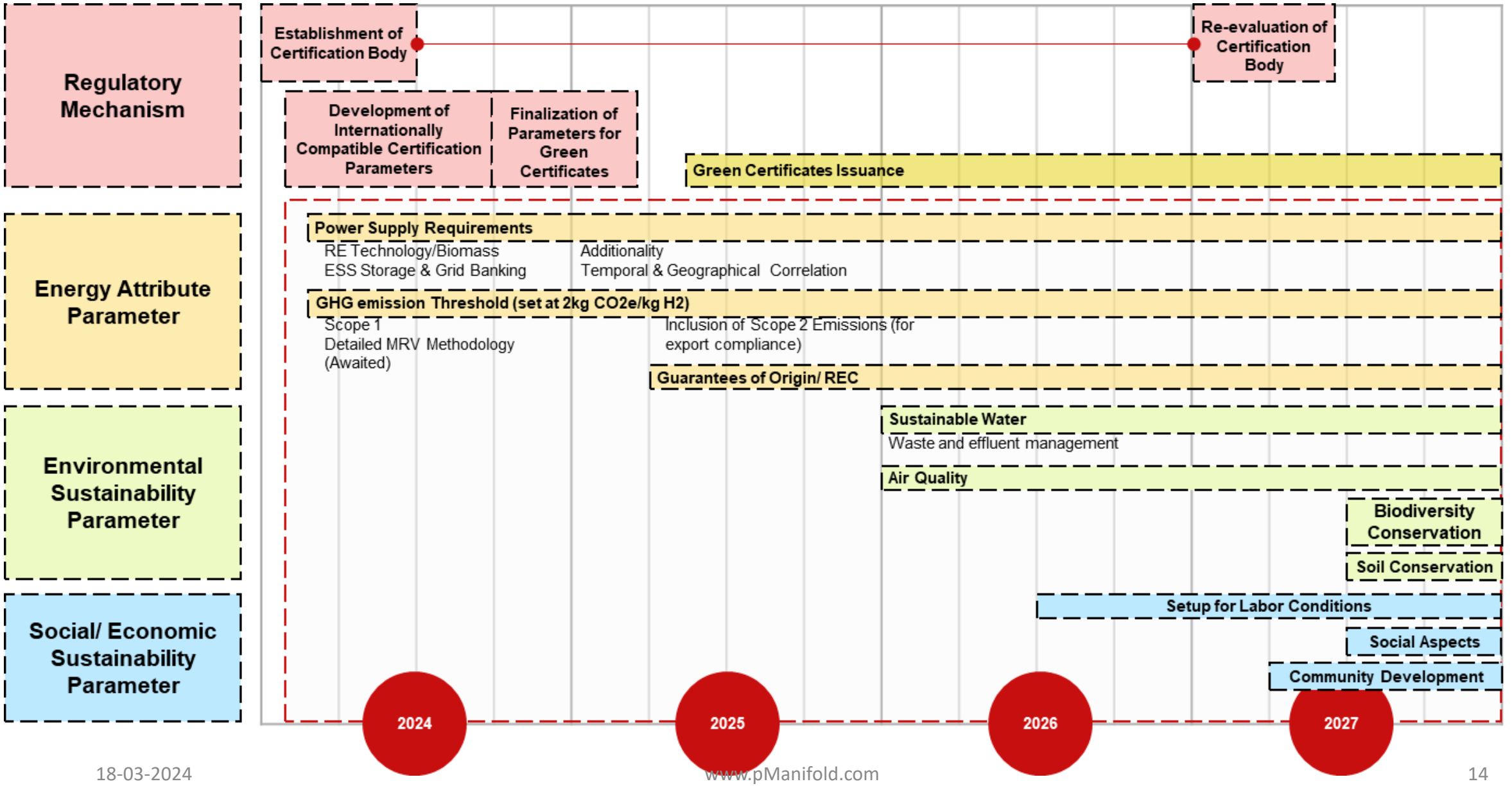
Definition

- GH2 Production Pathway through RE but not limited to electrolysis/ conversion of biomass keeps the **process open to cater future technologies**
- RE stored in ESS or banked with grid would help in meeting the intermittencies of the RE sources
- Well-to-Gate non-biogenic GHG Emissions of GH2 not exceeding 2kg of CO_2e/kg of hydrogen **complies with India's major objective of the PLI scheme**
- Emission Threshold taken as an average 12-month period can be a **reliable and effective method as it considers seasonal variations, allows for observation of long-term emission trends**

Observations

- **Scope of Emissions:** Ambiguity regarding whether the definition excludes GHG emissions associated with electricity/ biomass used in the process.
  - It is important to carefully consider the **electricity source, biomass choices, and emission allocation methods** to accurately assess and compare GHG emissions of GH2 Production to make informed decisions regarding impact of GH2
- **Usage of Gen 2 & 3 Biomass Feedstock for production of GH2: C**urrent definition does not restrict to usage of "Waste" biomass. The standard must clearly specify the source of biomass as waste biomass from sources such as municipal solid waste, agricultural & forest waste, etc.
- Methods to identify **specific emission sources or events that occur within shorter timeframes** may be a beneficial addition
- **Additionality, Temporal correlation & Geographical correlation** must be defined as these are central to all global definitions and especially EU, a potential import market

Recommendations on Certification



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