2nd International Conference on
Green Hydrogen (ICGH 2024)


# Role of BIS in Standardizing the Hydrogen Value Chain in India

# Bureau of Indian Standards - Genesis

- The Indian Standards Institution (ISI) was set up in 1947 as a registered society, under a Government of India resolution.
- Bureau of Indian Standards (BIS) Act 1986 gave statutory status to BIS on 1 April 1987.
- The BIS Act of 2016 enforced on 12th October 2017 makes BIS the National Standards Body of India.

# BIS STANDARDS STRUCTURE

**GOVERNING COUNCIL**

**EXECUTIVE COMMITTEE**

**STANDARDS ADVISORY COMMITTEE**

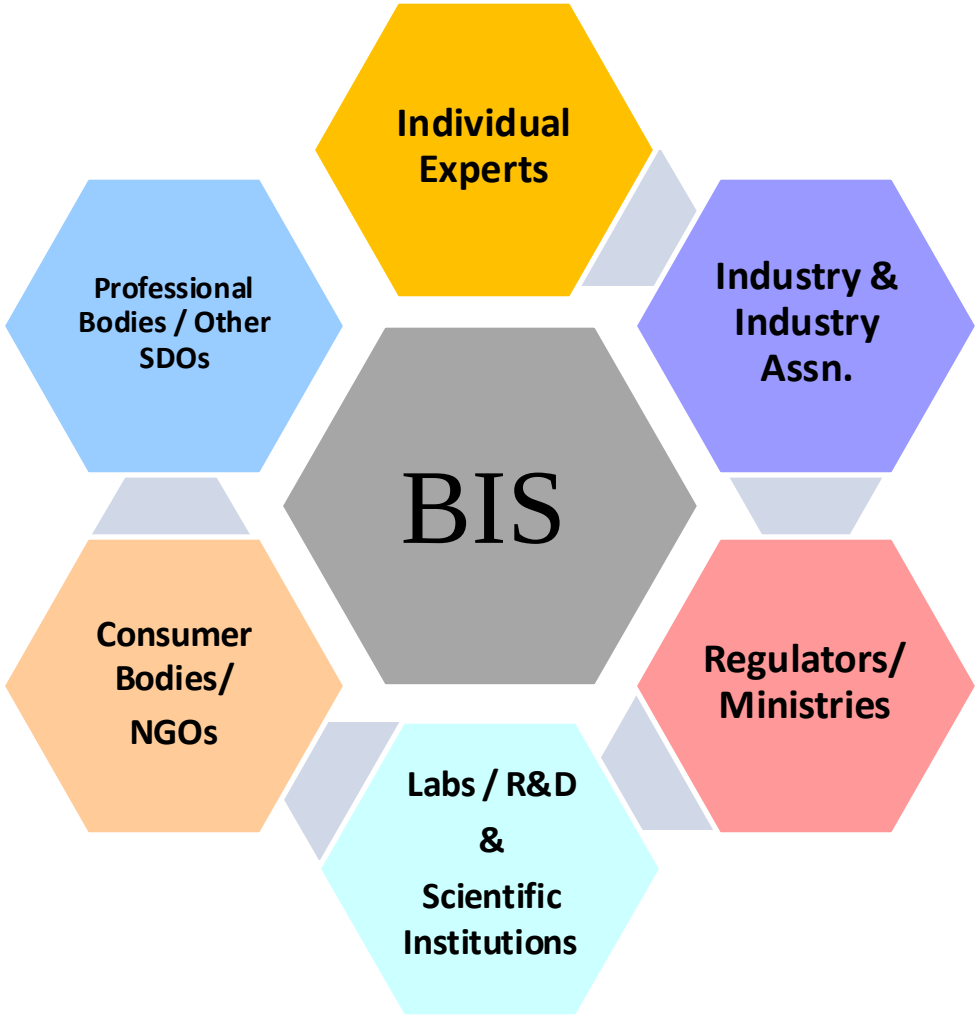
**DIVISION COUNCIL**

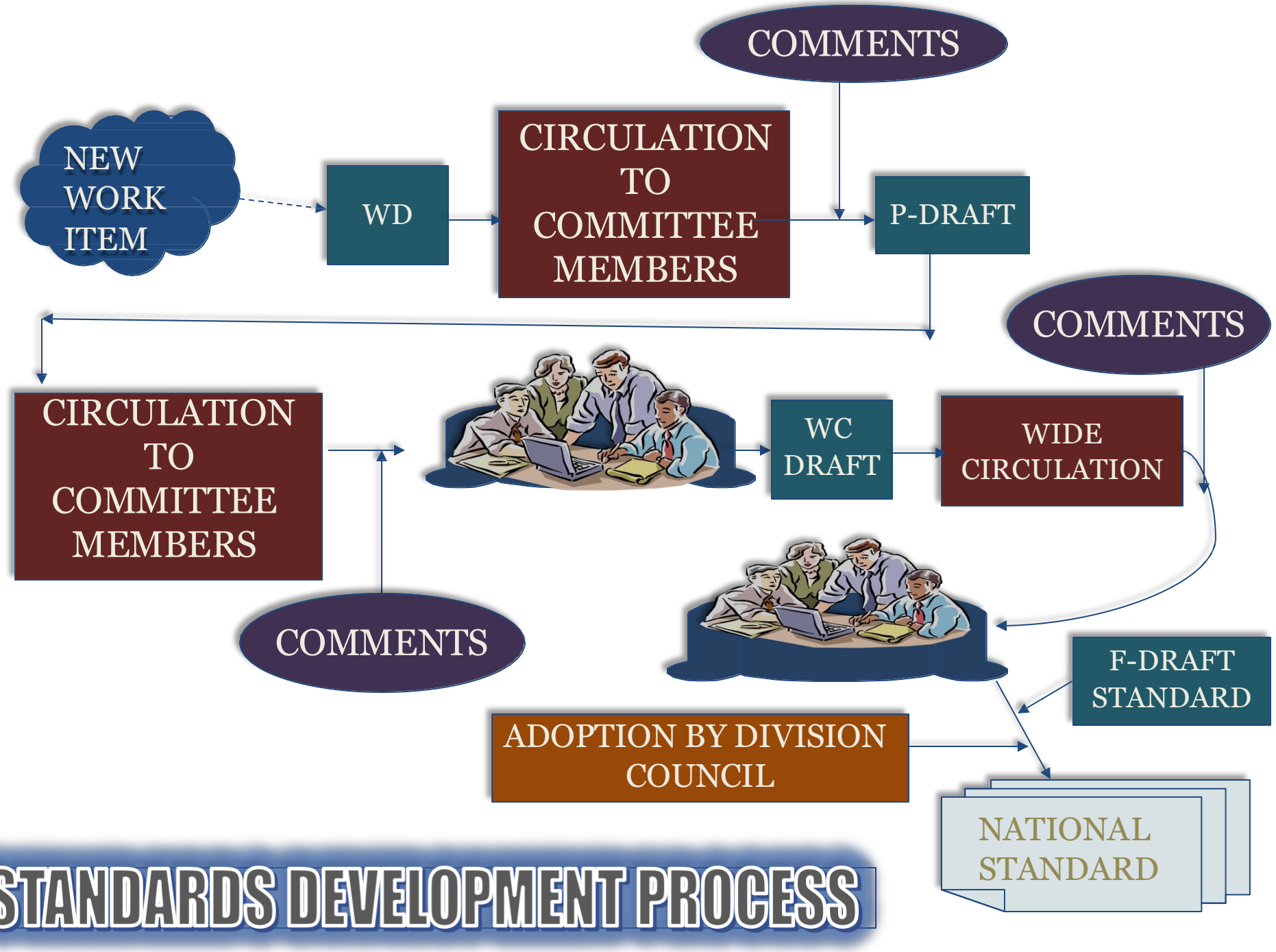
**SECTIONAL COMMITTEE**

**WORKING PANEL**

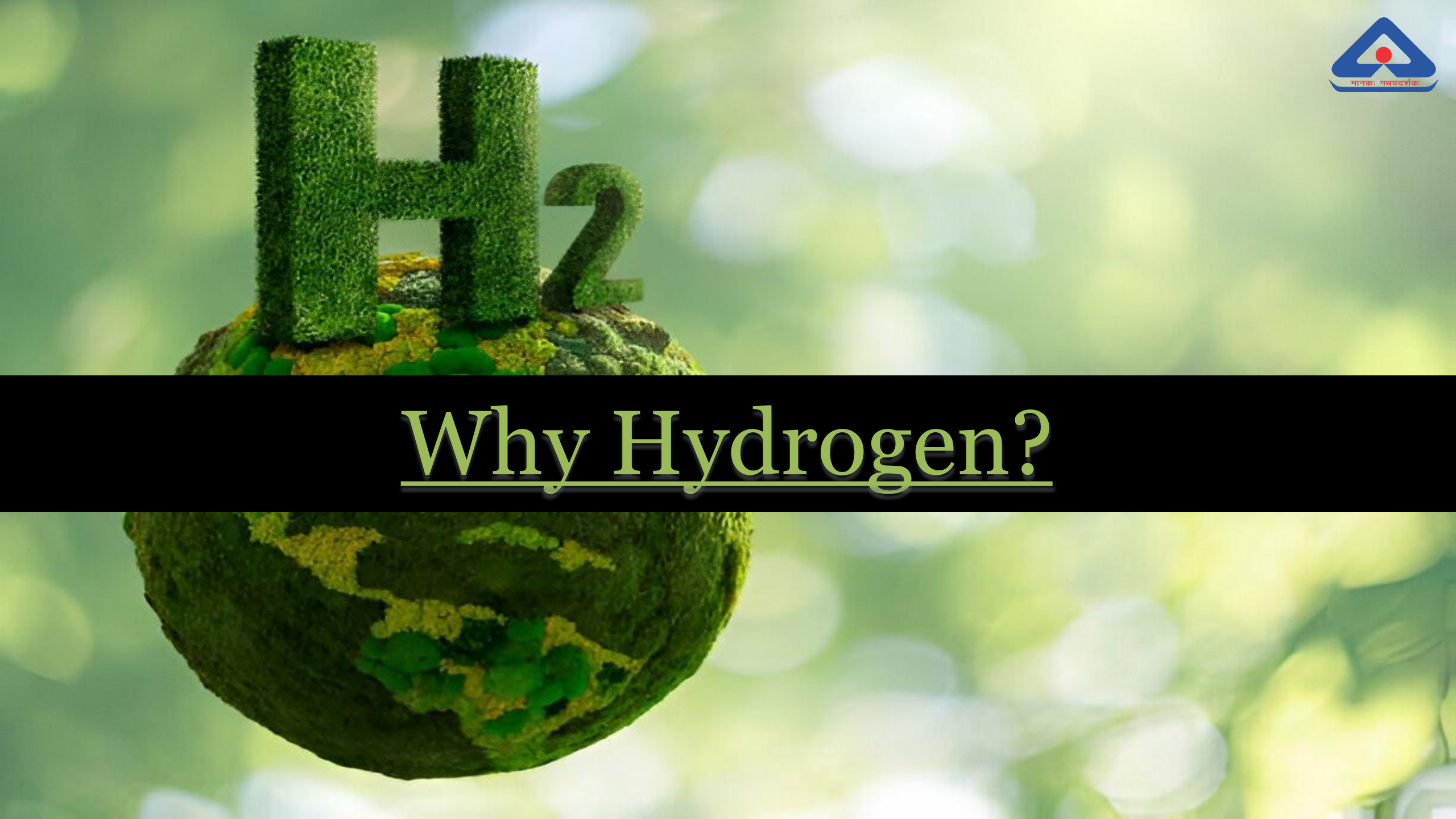
**WORKING GROUP**

# Stakeholders






# STANDARDS DEVELOPMENT PROCESS




# Why Hydrogen?

**Climate Change Mitigation**: Green hydrogen can significantly cut CO2 emissions.


**National Climate Targets**: India aims to reduce the emissions intensity of the economy by 45% by 2030 and achieve net-zero by 2070 . Green hydrogen is crucial for these goals.

**Energy Storage and Grid Stability**: India targets 500 GW of non fossil based energy by 2030. Green hydrogen can store excess renewable energy.

**Decarbonizing Heavy Industries and Transportation**: Green hydrogen can reduce the emissions caused in Heavy Industries like Steel and Transportation Sector.


**Energy Security and Independence**: India imports Significant amount of crude oil for its energy needs, making it vulnerable to global supply disruptions. Domestic green hydrogen production can enhance energy security.

**Economic Opportunities and Job Creation**: The National Hydrogen Mission aims to make India a global hub for green hydrogen production and export. This transition is expected to create jobs.

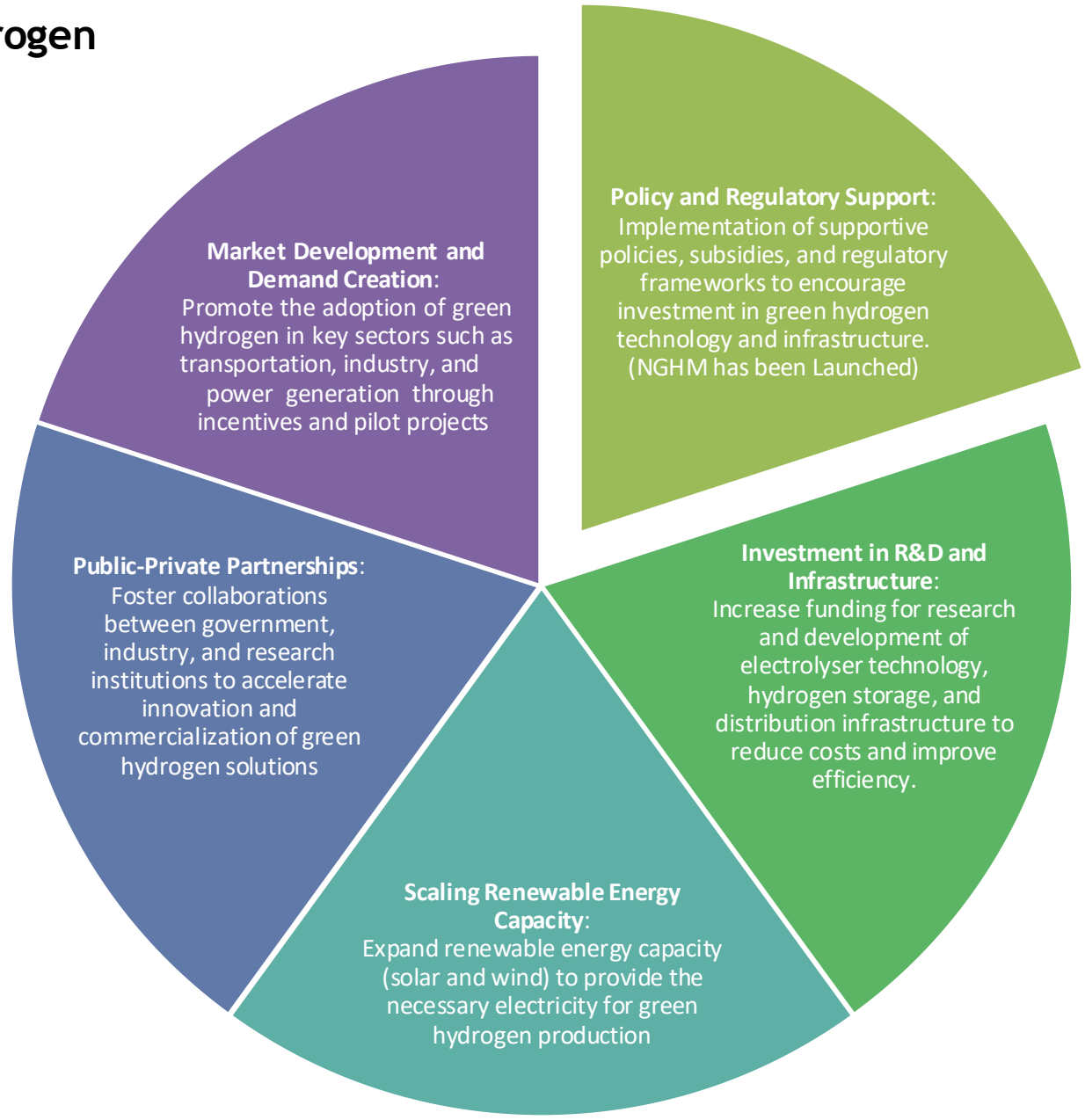
**Technological Advancements and Cost Reductions**: India is investing in electrolyzer technology and renewable energy to reduce green hydrogen production costs.

# India's Stand at COP-26 (Nov. 2021)

1. Reach 500GW Non-fossil energy capacity by 2030.
2. 50 percent of its energy requirements from renewable energy by 2030.
3. **Reduction of total projected carbon emissions by one billion tonnes from now to 2030.**
4. **Reduction of the carbon intensity of the economy by 45 per cent by 2030, over 2005 levels.**
5. **Achieving the target of net zero emissions by 2070.**

(*Source : PIB*)

# Transition to Green Hydrogen Based Economy



# Challenges in Hydrogen Value Chain and Role of Standards to counter them

# Challenges in Standardization of Hydrogen Value Chain


**Challenge:**
Significantly High **Purity** of Hydrogen needed for Fuel Cell Applications

**Solution:**

IS 16061 and IS 18538 Series of Standards have been formulated to Ascertain Quality of Hydrogen in line with International Counterparts (ISO 14687 and ISO 19880)

# Challenges in Standardization of Hydrogen Value Chain

Challenge:

High Working Pressure for Hydrogen (700 bars)

Solution:

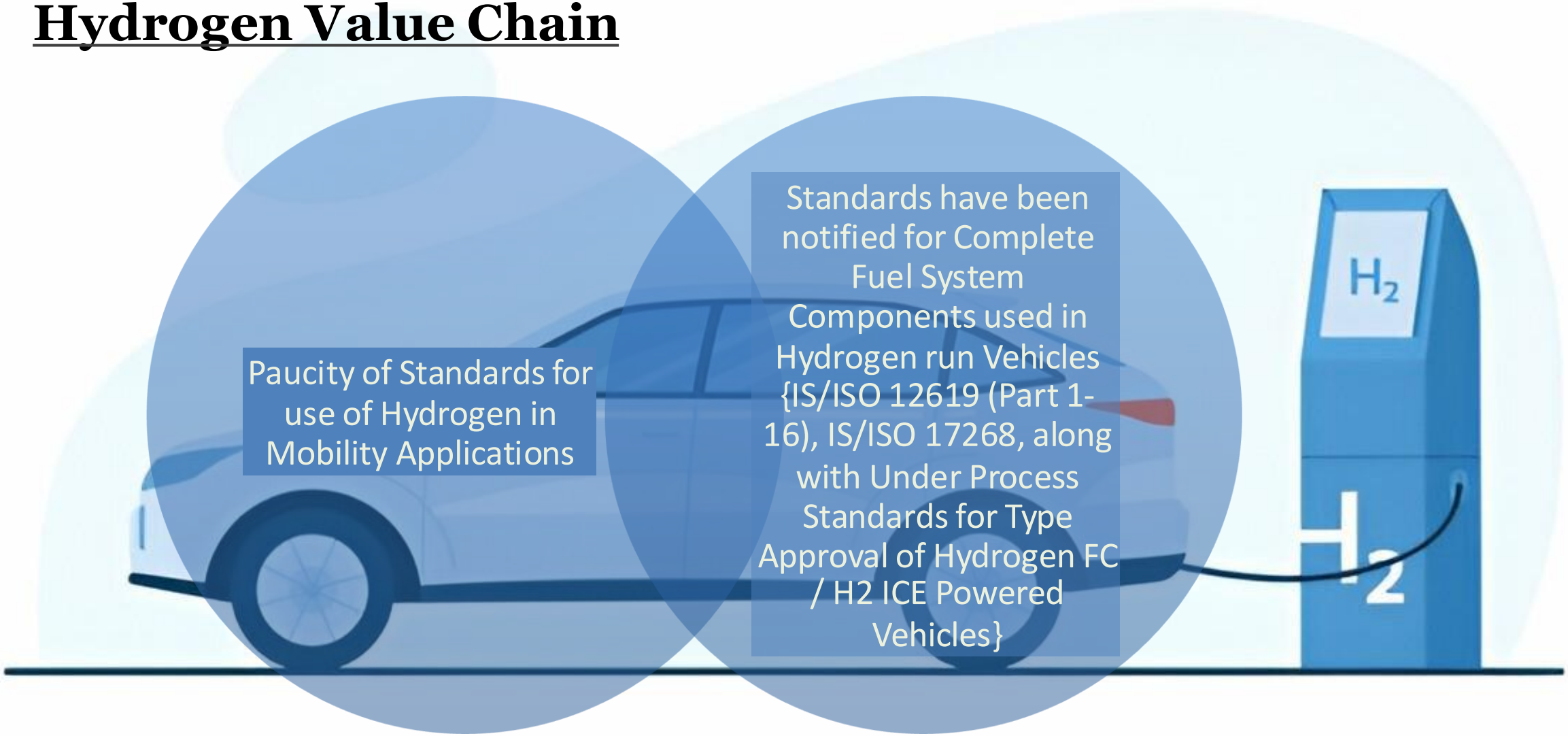
Standards for Storage of Hydrogen as well as it's dispensation have been formulated keeping in mind the requirements for 700 Bar Pressure

# Challenges in Standardization of Hydrogen Value Chain

Inherent Nature of Hydrogen for Causing Embrittlement in steels and other metals

Pre and Post Coating Standards have been Formulated along with Standards for Testing Hydrogen Embrittlement Resistance of Metals

# Challenges in Standardization of Hydrogen Value Chain

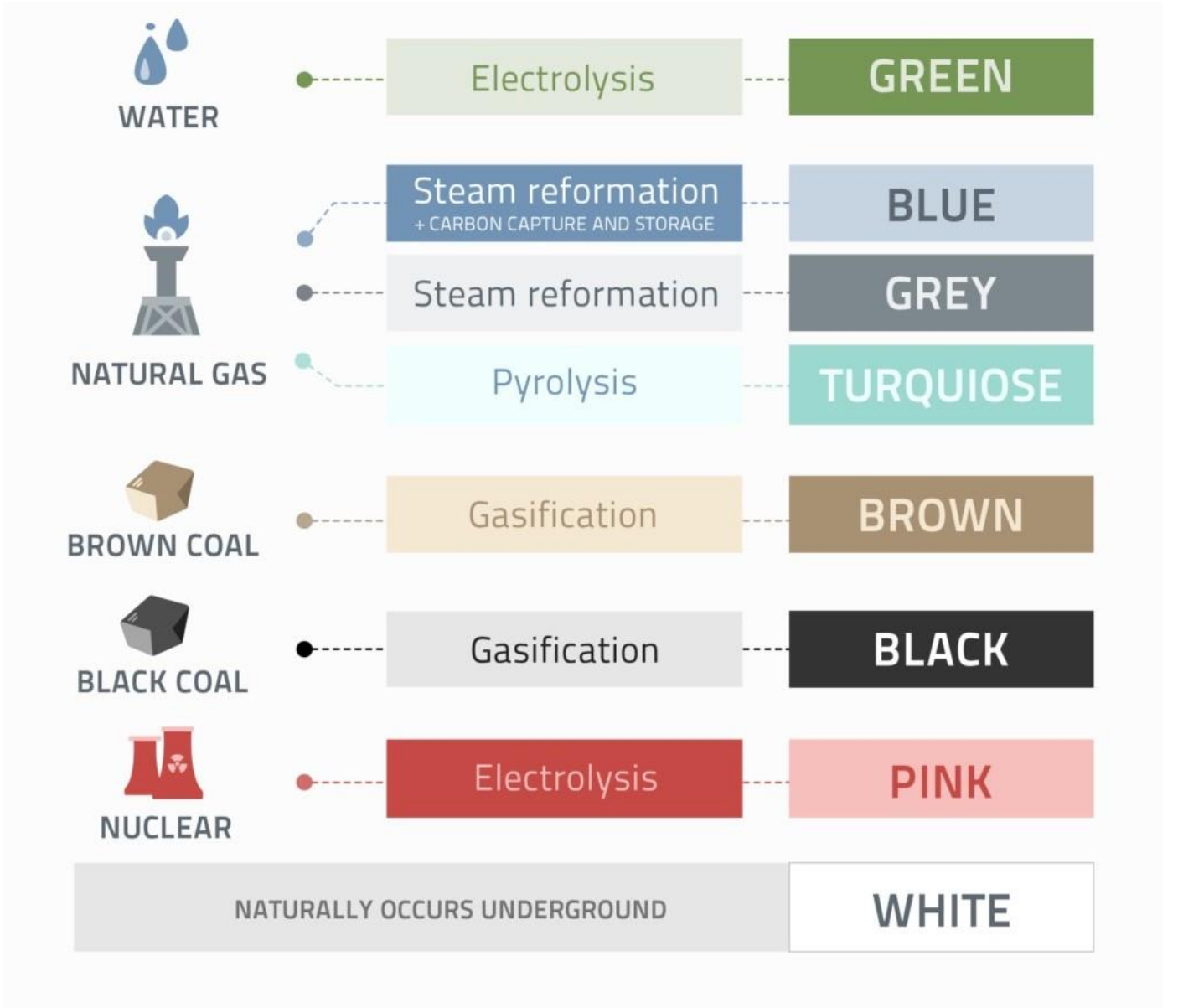


# Safety Standards related to Hydrogen Infrastructure

| *Indian Standard* | *Title* |
| --- | --- |
| IS 16512 (Part 1) : 2016 | Hydrogen generators using fuel processing technologies — Part 1: Safety |
| IS 16509 : 2020 | Hydrogen generators using water electrolysis — Industrial, commercial, and residential applications |
| IS 16061: 2021 | Hydrogen Fuel Quality Product Specification |
| IS 16253 : 2016 | Hydrogen detection apparatus — Stationary applications |

| *Indian Standard* | *Title* |
| --- | --- |
| IS 16749 : 2018 | Basic considerations for the safety of hydrogen systems |
| IS 19036 : 2023 | Fuel cell road vehicles Safety specifications Protection against hydrogen hazards for vehicles fuelled with compressed hydrogen |
| IS/IEC 62282-3-100: 2019 | Fuel Cell Technologies Part 3 Stationary Fuel Cell Power Systems Section 100 Safety |

# Generalized Colour Coding of Hydrogen in Industry



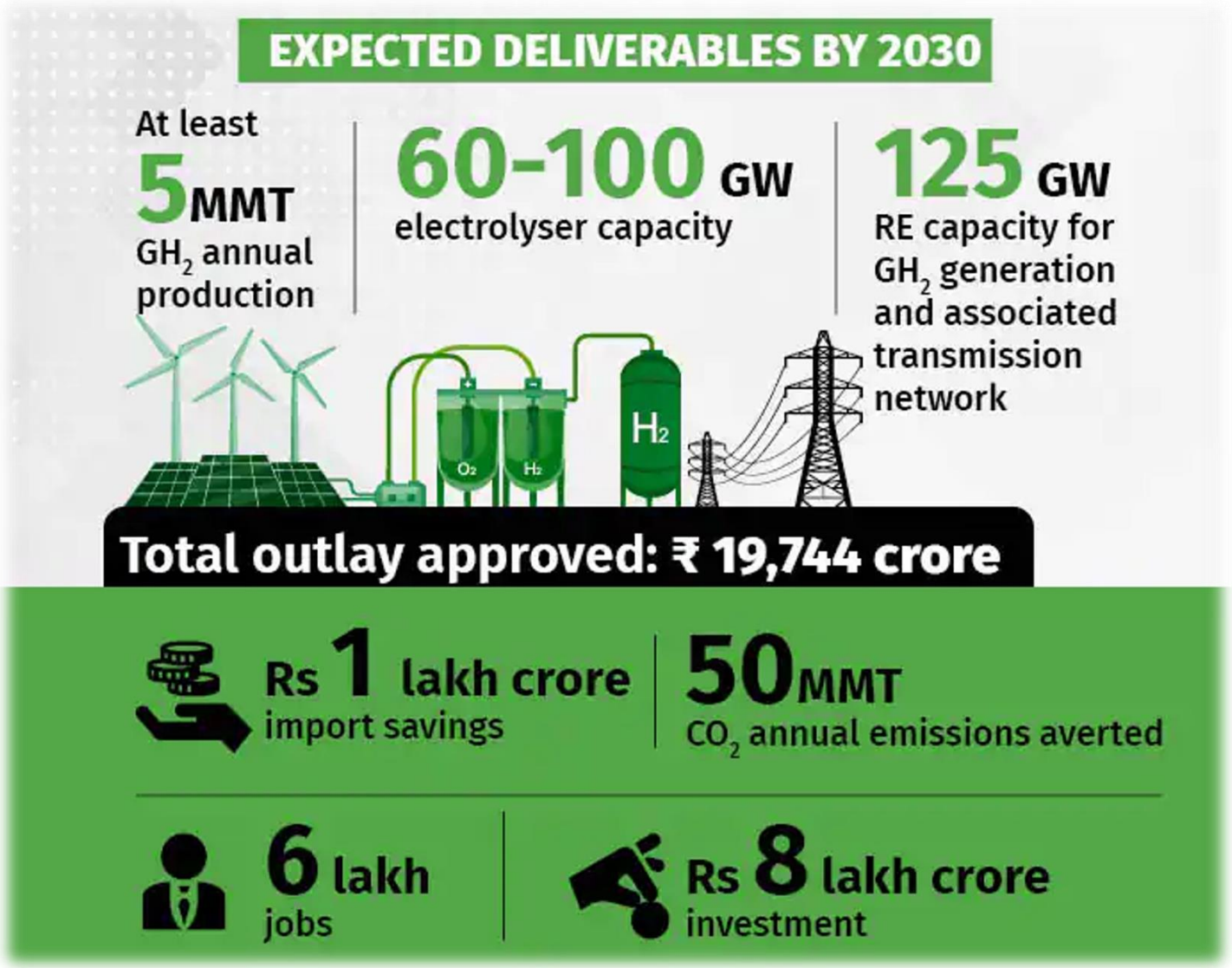
# The hydrogen value chain


Hydrogen Production


Hydrogen Storage & Distribution

Hydrogen Utilization

# National Green Hydrogen Mission



# Gap Analysis Exercise Under Guidance of MNRE

## Sub-Group-I

**Hydrogen production and use**

**Convener: CII**

Members: IOCL, GAIL, NTPC, BIS, Avaada, ACME, L&T, Renew Power, Ohmium

## Sub-Group-II

**Storage and Transportation of Hydrogen**

**Convener: FICCI**

Members: BIS, DPIIT, PESO, IOCL, GAIL, Linde, Shell, Adani, RIL, JSW.

## Sub-Group-III

**Hydrogen-fuelled mobility applications**

**Convener: SIAM**

Members: BIS, MoRTH, DPIIT, PESO, ARAI, NTPC, Daimler Commercial Vehicle, Bajaj, Tata Motors, Cummins.

Development of Standards and regulations for **hydrogen safety** in all three vertical components

# A Total of 49 Subjects were Recommended by MNRE to BIS for Formulation of Indian Standards in 1st Phase

Ayush Division Council (AYDC)

Chemical Division Council (CHDC)

Civil Engineering Division Council (CEDC)

Electronics and Information Technology Division Council (LITDC)

Electrotechnical Division Council (ETDC)

Food and Agriculture Division Council (FADC)

Management and Systems Division Council (MSDC)

Mechanical Engineering Division Council (MEDC)

Medical Equipment and Hospital Planning Division Council (MHDC)

Metallurgical Engineering Division Council (MTDC)

Petroleum, Coal and Related Products Division Council (PCDC)

Production and General Engineering Division Council (PGDC)

Service Sector Division Council (SSDC)

Textiles Division Council (TXDC)

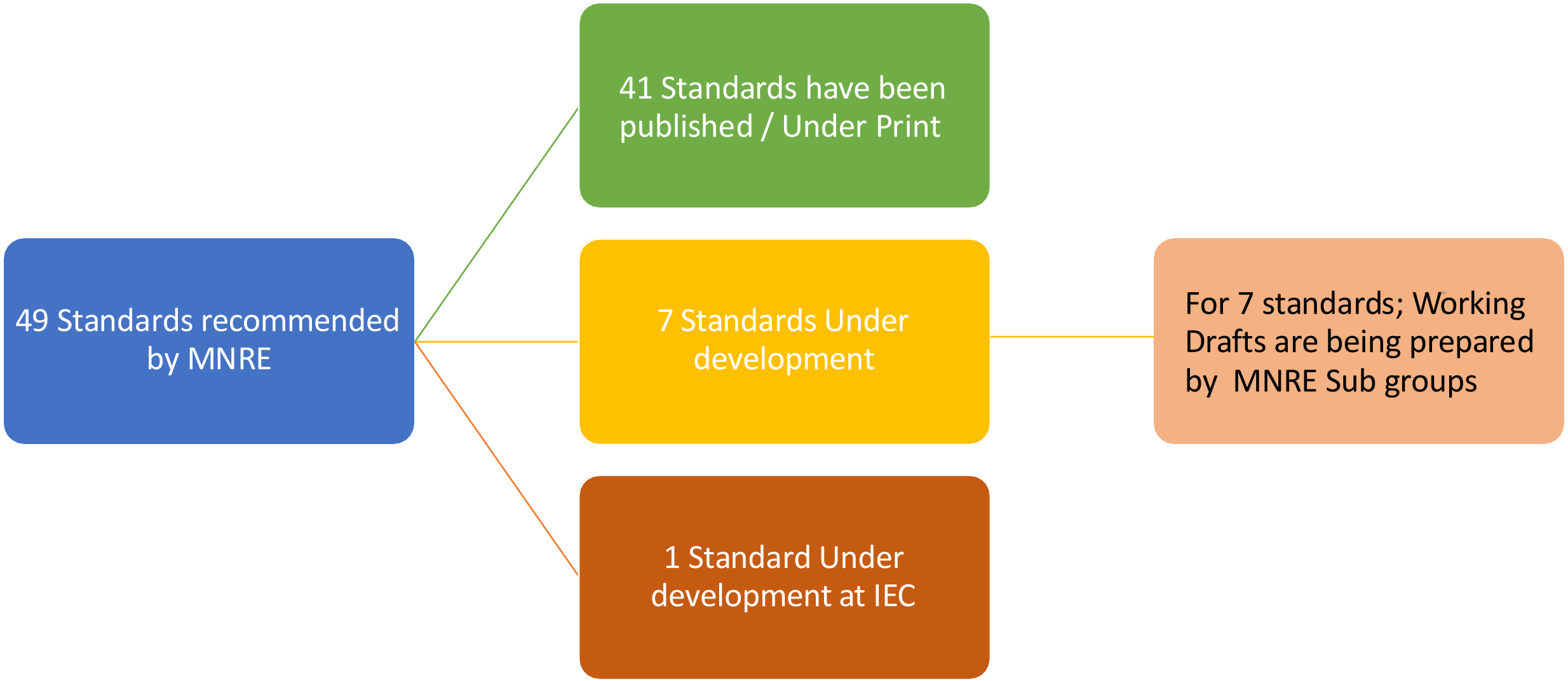
Transport Engineering Division Council (TEDC)

Water Resources Division Council (WRDC)

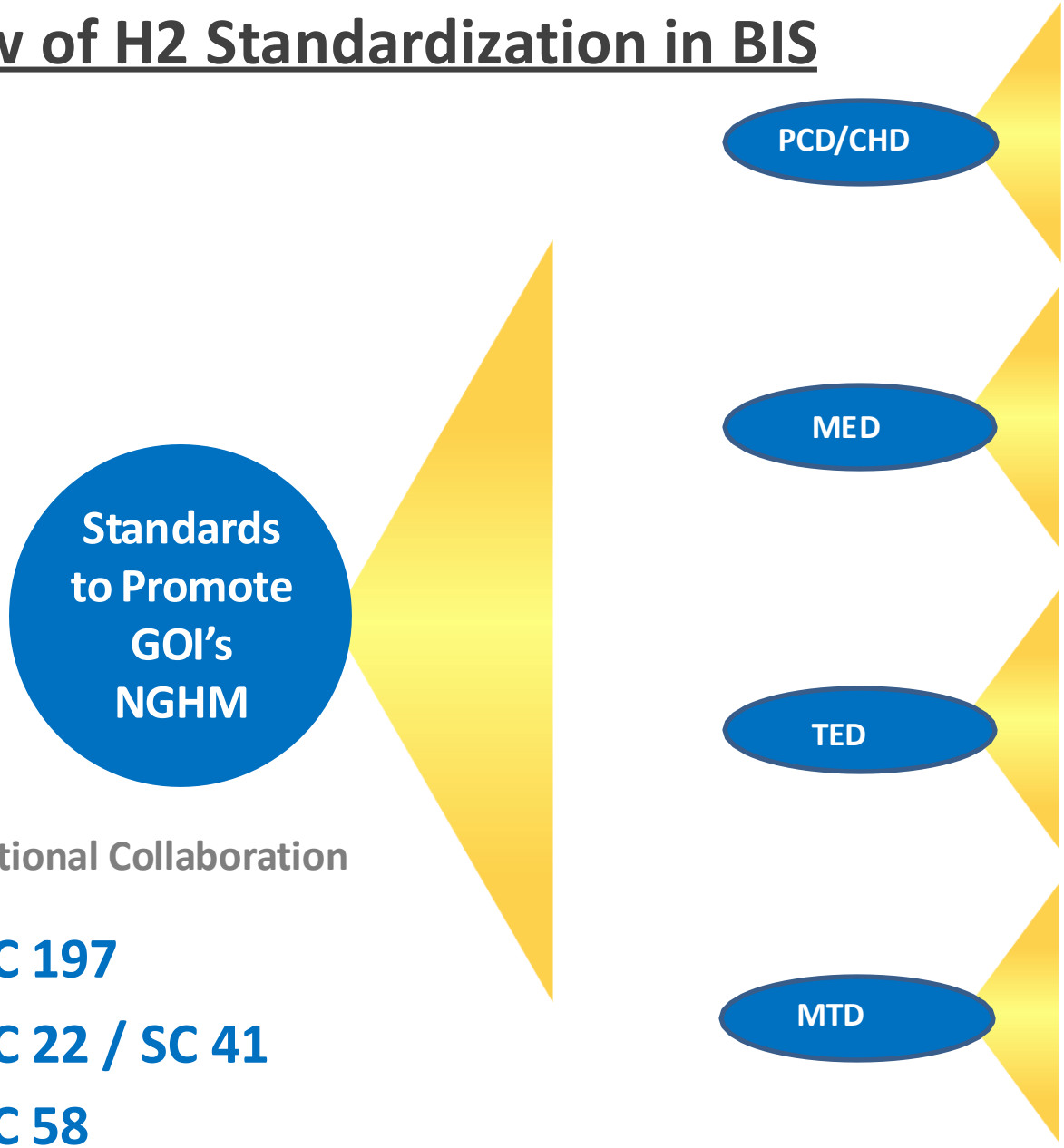
# Division Councils

Departments Involved in Hydrogen Related Standardization work

Other Departments


49 Standards recommended by MNRE
41 Standards have been published / Under Print
7 Standards Under development
1 Standard Under development at IEC
For 7 standards; Working Drafts are being prepared by MNRE Sub groups

# Overview of H2 Standardization in BIS




International Collaboration

**ISO TC 197**

**ISO TC 22 / SC 41**

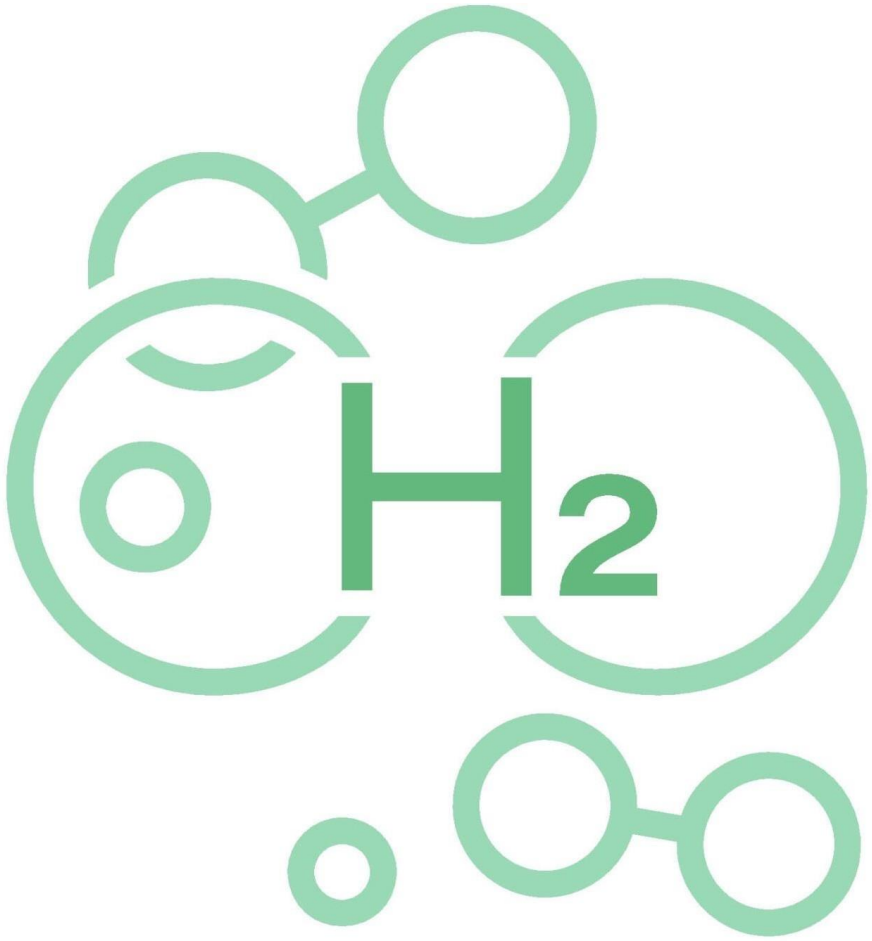
**ISO TC 58**

- Hydrogen Fuel Quality
- Hydrogen generators
- Hydrogen detection apparatus

- Storage and Tank Standards for Liquid and Compressed Hydrogen
- Dispensing of Hydrogen Fuel

- Hydrogen Fuel System Components
- Refuelling connection devices
- Fuel cell road vehicles — Energy consumption measurement
- Type Approval of Compressed Gaseous Hydrogen Fuel Cell Vehicles

- Pre Treatment and Post Coating of Steel to reduce the risk of Hydrogen Embrittlement
- Selection of Steel




# Standards on Production & Quality of Hydrogen

# Standards on Production & Quality of Hydrogen

IS 16061: 2021

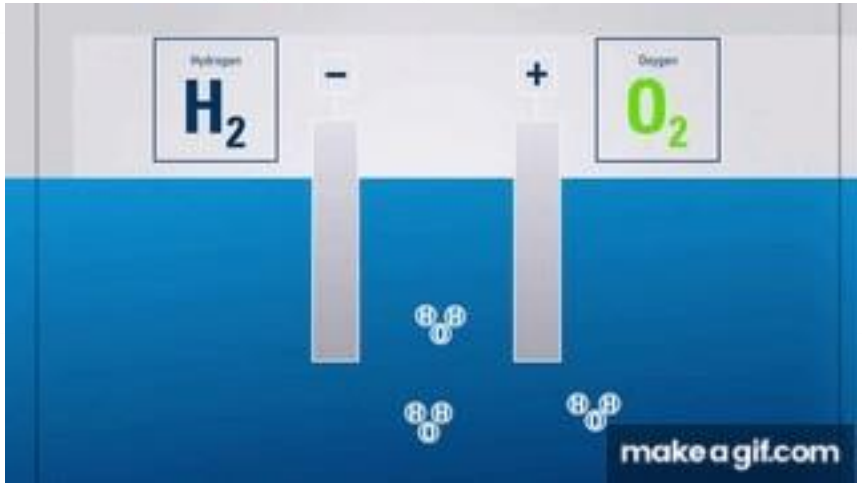
HYDROGEN **FUEL QUALITY** PRODUCT SPECIFICATION

(ISO 14687:2019)

# Standards on Production & Quality of Hydrogen

IS 16509 : 2020 HYDROGEN GENERATORS **USING WATER ELECTROLYSIS** — INDUSTRIAL, COMMERCIAL, AND RESIDENTIAL APPLICATIONS

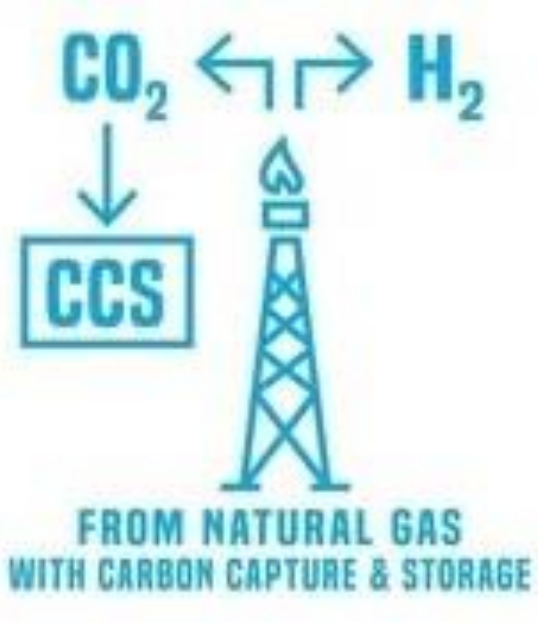
(ISO 22734:2019)



# Standards on Production & Quality of Hydrogen

IS 16512 : 2016 HYDROGEN GENERATORS USING **FUEL PROCESSING TECHNOLOGIES** — PART 1: SAFETY

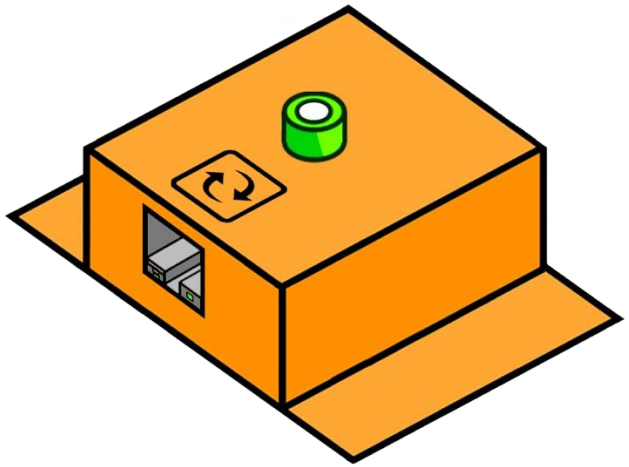
(ISO 16110-1 : 2007)



# Standards on Production & Quality of Hydrogen

IS 16253 : 2016 **HYDROGEN DETECTION APPARATUS** — STATIONARY APPLICATIONS

(ISO 26142 : 2010)

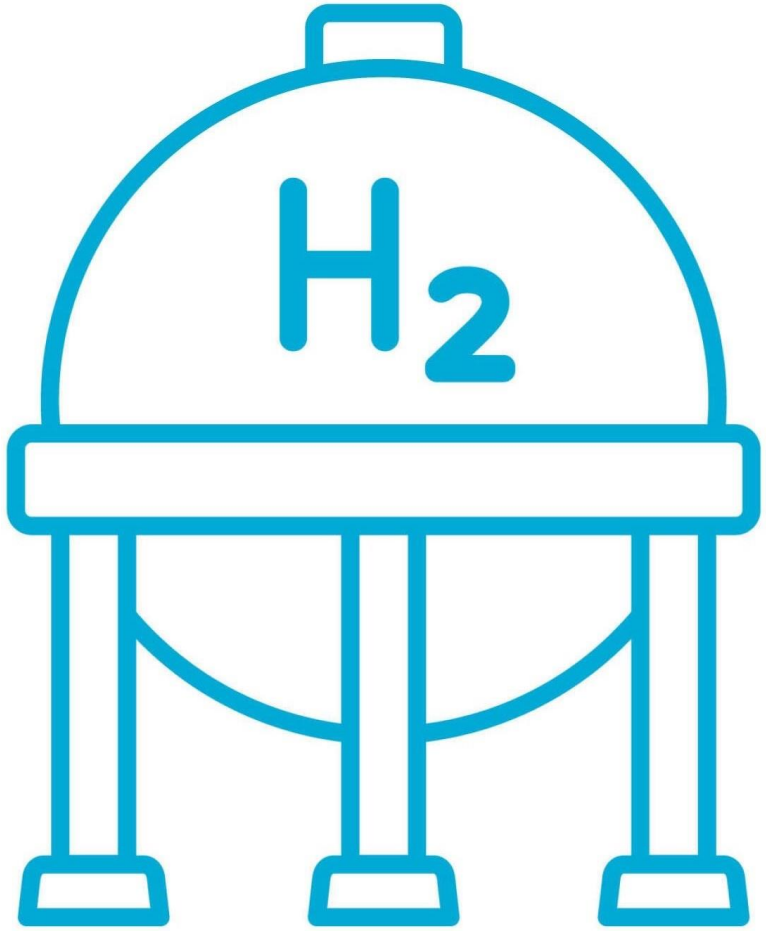


# Standards on Production & Quality of Hydrogen

IS 16749 : 2018

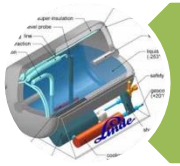
BASIC CONSIDERATIONS FOR THE
**SAFETY OF HYDROGEN SYSTEMS**

(ISO/TR 15916:2015)




# Standards on Storage of Hydrogen

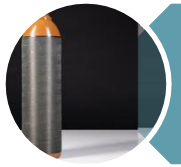
# Storage of Hydrogen



IS 18719 (Part 1) : 2023 - Cryogenic vessels — Transportable vacuum insulated vessels of not more than 1000 liters volume-part 1: Design, fabrication, inspection and tests (ISO 21029-1:2018)

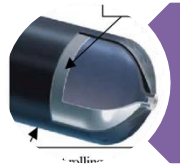
IS 18719 (Part 2) : 2023 - Cryogenic vessels — Transportable vacuum insulated vessels of not more than 1 000 liters volume — Part 2: Operational requirements (SO 21029-2:2015)

IS/ISO 13985 : 2006 Liquid hydrogen — Land vehicle fuel tanks



IS/ISO 11119-1:2020: Gas cylinders — Design, construction and testing of refillable composite gas cylinders and tubes — Part 1: Hoop wrapped fiber reinforced composite gas cylinders and tubes up to 450 l

IS/ISO 11119-2 : Part 2: Fully wrapped fibre reinforced composite gas cylinders and tubes up to 450 l with load-sharing metal liners



IS/ISO 11119-3 : Part 3: Fully wrapped fibre reinforced composite gas cylinders and tubes up to 450 l with non-load-sharing metallic or non-metallic liners or without liners

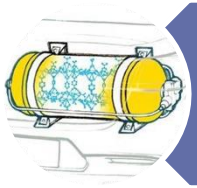
# Storage of Hydrogen

IS/ISO 11515 : 2022 Gas Cylinders — Refillable Composite Reinforced Tubes of Water Capacity between 450 L and 3 000 L — Design, Construction and Testing

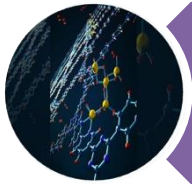
IS 7285 : 2018 Refillable seamless steel gas cylinders - Specification: Part 1 normalized steel cylinders (In line with ISO 9809-3) {0.5-400 Lit. Water Capacity}

IS 7285 : 2017 Refillable seamless steel gas cylinders - Specification: Part 2 quenched and tempered steel cylinders with tensile strength less than 1100 MPa (In line with ISO 9809-1) {0.5-400 Lit. Water Capacity}

IS/ISO 9809 : 2019 Gas Cylinders — 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 1100 MPA (Up to 450 L Water Capacity)



IS 16735 : 2018 - Cylinders for on - Board Storage of Compressed Gasesous Hydrogen and Hydrogen Blends as a Fuel for Automative Vehicles - Specification



IS 19037: 2023 Transportable Gas Storage Devices Hydrogen Absorbed in Reversible Metal Hydride (ISO 16111:2018) {Internal Shell volume < 150 l; maximum developed pressure (MDP) < 25 MPa}

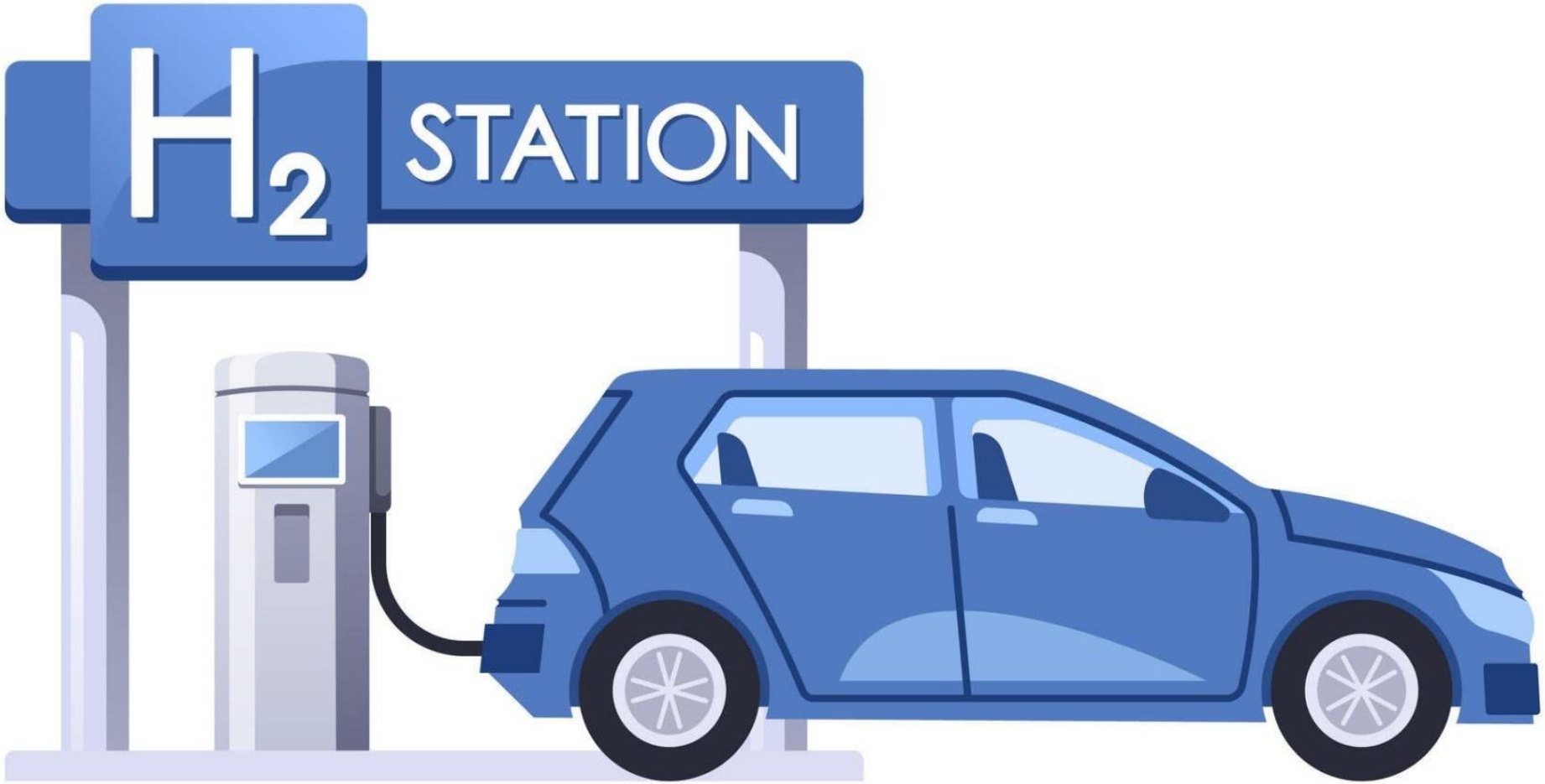
# Standards for Dispensing of Hydrogen

IS 18538 : 2023 Gaseous Hydrogen — Fueling Stations Part 1 **General Requirements** (ISO 19880-1)

IS 18538 : 2023 Gaseous Hydrogen - Fueling Stations Part 3 **Valves** (ISO 19880-3)

IS 18538 : 2023 Gaseous Hydrogen - Fueling Stations Part 5 **Dispenser Hoses and Hose Assemblies** (ISO 19880-5)

IS 18538 : 2023 Gaseous Hydrogen - Fueling Stations Part 8 **Fuel Quality Control** (ISO 19880-8)




# Standards for Mobility Applications

# Standards for Mobility Applications

## 1. IS/ISO 12619-1:2014

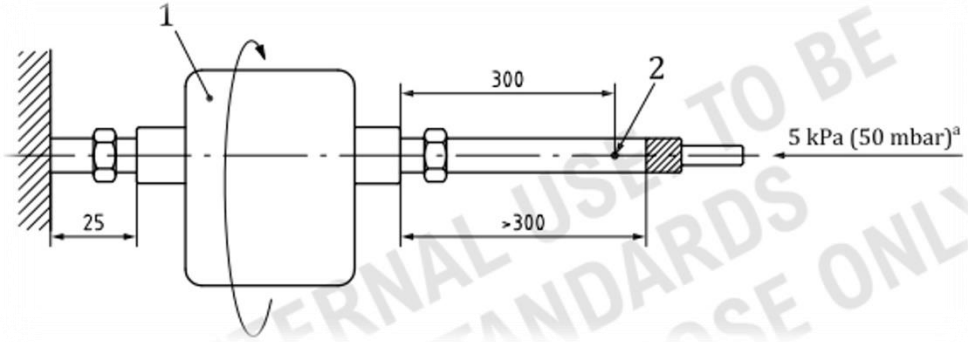
Road vehicles — Compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blends fuel system components — **Part 1: General requirements and definitions**

- Gives General Requirements and Definitions for CGH2 and hydrogen/natural gas blends fuel system components
- Construction and assembly requirements , Electrical Equipment and Wiring and General Instruction Details have also been Provided.

## 2. IS/ISO 12619-2:2014

Road vehicles — Compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blends fuel system components — **Part 2: Performance and general test methods**

- A Total of 18 Test Methods have been prescribed for Components. Eg. Bending Moment Test, Leakage Test, Excess Torque Resistance test etc.



# Standards for Mobility Applications

| Test Methods Mentioned in IS/ISO 12619 – 2 : 2014 Road vehicles — Compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blends fuel system components — Part 2: Performance and general test methods |
|---|
| Hydrostatic strength Test |
| Leakage Test |
| Excess torque resistance Test |
| Bending moment Test |
| Continued operation Test |
| Corrosion resistance Test |
| Oxygen ageing Test |
| Ozone ageing Test |
| Electrical over-voltages Test |
| Non-metallic immersion Test |
| Vibration resistance Test |
| Brass material compatibility Test |
| Non metallic material compatibility to hydrogen Test |
| Metallic material compatibility to hydrogen Test |
| Pre-Cooled Hydrogen Exposure Test |
| Insulation resistance Test |
| Ultraviolet resistance of external surfaces Test |
| Automotive fluid exposure Test |

## Standards for Mobility Applications

| Sl. No. | IS No. | Title |
|---|---|---|
| 3 | IS/ISO 12619-3 : 2014 | Road vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen / Natural Gas Blend Fuel System Components — **Pressure Regulator** |
| 4 | IS/ISO 12619-4: 2016 | Road vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen / Natural Gas Blend Fuel System Components — **Check Valve** |
| 5 | IS/SO 12619-5: 2016 | Road Vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen / Natural Gas Blends Fuel System Components — **Manual Cylinder Valve** |
| 6 | IS/ISO 12619-6: 2017 | Road Vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen / Natural Gas Blends Fuel System Components — **Automatic Valve** |
| 7 | IS/ISO 12619-7: 2017 | Road Vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen / Natural Gas Blends Fuel System Components — **Gas Injector** |

## Standards for Mobility Applications

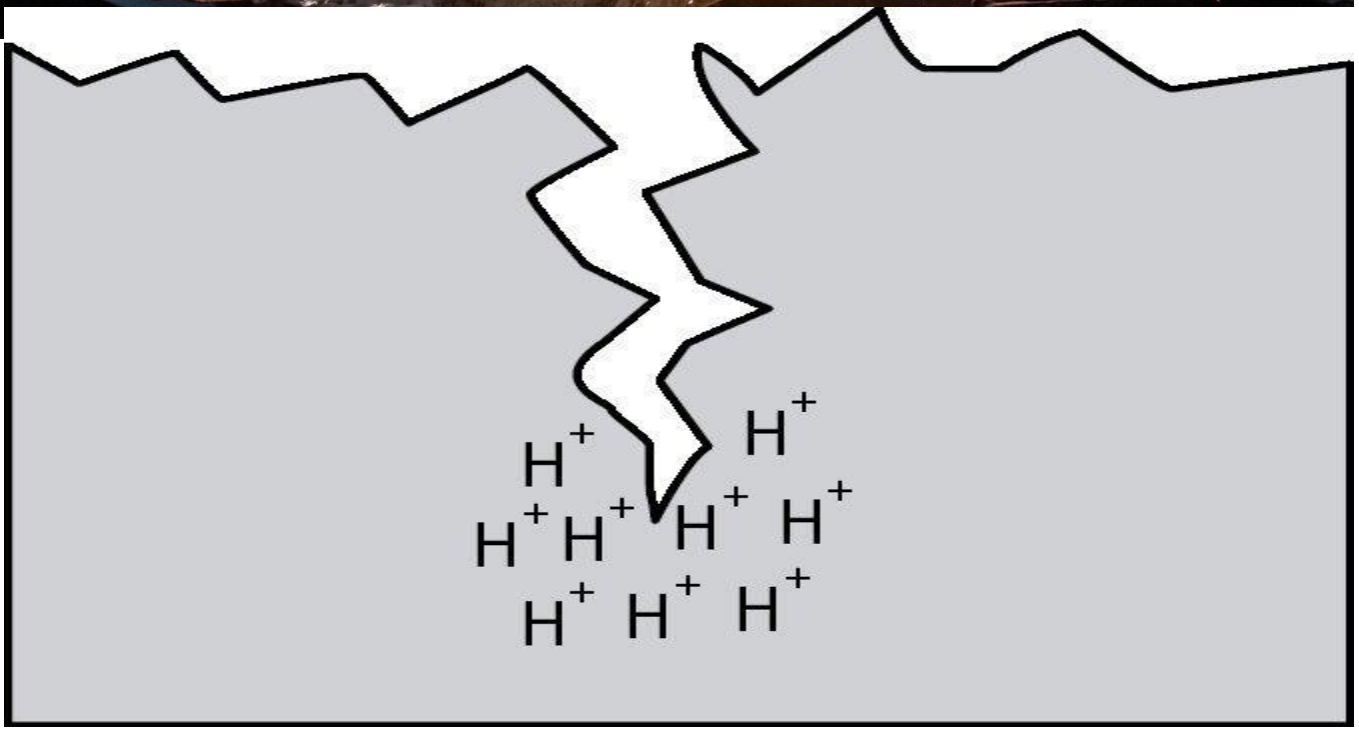
| Sl. No. | IS No. | Title |
|---|---|---|
| 8 | IS/ISO 12619-8: 2017 | Road Vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen / Natural Gas Blends Fuel System Components — **Pressure Indicator** |
| 9 | IS/ISO 12619-9: 2017 | Road Vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen / Natural Gas Blends Fuel System Components —**Pressure Relief Valve (PRV)** |
| 10 | IS/ISO 12619-10: 2017 | Road Vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen / Natural Gas Blends Fuel System Components – **Pressure Relief Device (PRD)** |
| 11 | IS/ISO 12619-11: 2017 | Road Vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen / Natural Gas Blends Fuel System Components – **Excess Flow Valve** |
| 12 | IS/ISO 12619-12: 2017 | Road Vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen / Natural Gas Blends Fuel System Components – **Gas-tight Housing and Ventilation Hoses** |

## Standards for Mobility Applications

| Sl. No. | IS No. | Title |
|---|---|---|
| 13 | IS/ISO 12619-13 : 2017 | Road vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen / Natural Gas Blend Fuel System Components — **Fuel Line In Stainless Steel** |
| 14 | IS/ISO 12619-14: 2017 | Road vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen / Natural Gas Blend Fuel System Components — **Flexible Fuel Line** |
| 15 | IS/SO 12619-15: 2017 | Road Vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen / Natural Gas Blends Fuel System Components — **Filter** |
| 16 | IS/ISO 12619-16: 2017 | Road Vehicles — Compressed Gaseous Hydrogen (CGH2) and Hydrogen / Natural Gas Blends Fuel System Components — **Fittings** |

## Standards for Mobility Applications

| Sl. No. | IS No. | Title |
|---|---|---|
| 17 | IS/ISO 17268 : 2020 | Gaseous hydrogen land vehicle **refueling connection devices** |
| 18 | IS/ISO 23828: 2013 | Fuel Cell Road Vehicles – **Energy Consumption Measurement** – Vehicles fueled with Compressed Hydrogen |
| 19 | IS 19036 : 2023 | Fuel cell road vehicles Safety specifications **Protection against hydrogen hazards for vehicles fuelled with compressed hydrogen** |
| 20 | IS 19035 : 2023 | Gas Cylinders **Flexible Hoses Assemblies** Specification And Testing |




# Standards on Material Compatibility to counter Hydrogen Embrittlement

# Standards on Material Compatibility to counter Hydrogen Embrittlement

IS/ISO 11114 Part 4 : 2017 Transportable Gas Cylinders - Compatibility of Cylinder and Valve Materials with Gas Contents Part 4 **Test Methods for Selecting Steels Resistant to Hydrogen Embrittlement**

IS 18463 : 2023 Metallic and other inorganic coatings **Pre-treatment** of iron or steel to reduce the risk of hydrogen embrittlement (ISO 9587)

IS 18436 : 2023 Metallic and other inorganic coatings **Post-coating** treatments of iron or steel to reduce the risk of hydrogen embrittlement (ISO 9588)

IS 18435 (Part 11) : 2023 Corrosion of Metals and Alloys — Stress Corrosion Testing Part 11 **Testing the Resistance of Metals and Alloys to Hydrogen Embrittlement and Hydrogen-Assisted Cracking** — Guidelines (ISO 7539-11)

# 2nd Set of MNRE Recommendations

**58 Subjects Recommended to DoCA**

**37 Subjects Related to BIS**

- 12 IS Published
- 25 Remaining are under Examination / development

**21** Related to Other Departments like DPIIT, MoPNG and Others or withdrawn

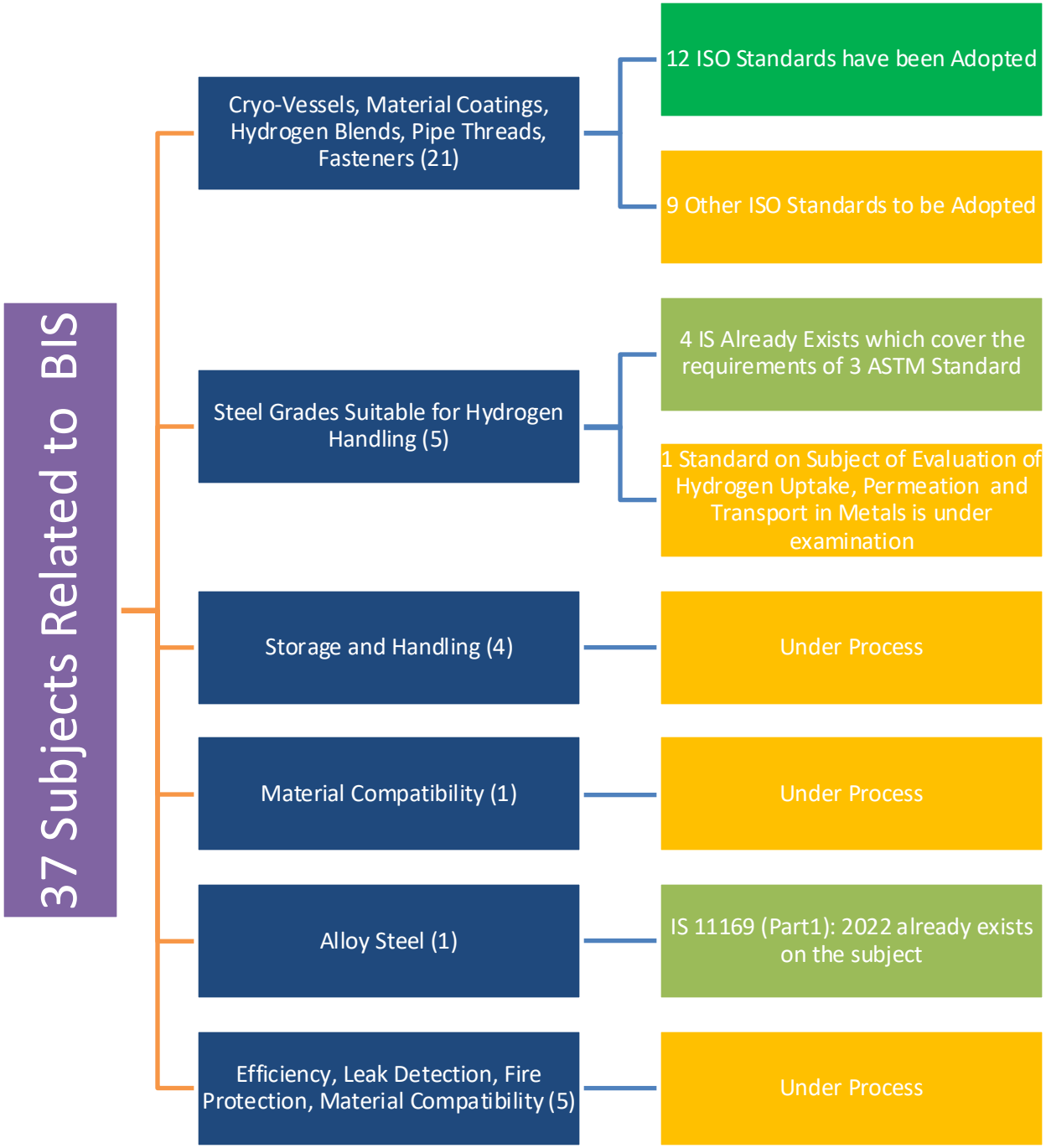
नवीन एवं
नवीकरणीय ऊर्जा मंत्रालय
MINISTRY OF
NEW AND
RENEWABLE ENERGY

सत्यमेव जयते

पेट्रोलियम एवं प्राकृतिक गैस मंत्रालय
MINISTRY OF
PETROLEUM AND
NATURAL GAS

DPIIT

PESO


37 Subjects Related to BIS
Cryo-Vessels, Material Coatings, Hydrogen Blends, Pipe Threads, Fasteners (21)
12 ISO Standards have been Adopted
9 Other ISO Standards to be Adopted
Steel Grades Suitable for Hydrogen Handling (5)
4 IS Already Exists which cover the requirements of 3 ASTM Standard
1 Standard on Subject of Evaluation of Hydrogen Uptake, Permeation and Transport in Metals is under examination
Storage and Handling (4)
Under Process
Material Compatibility (1)
Under Process
Alloy Steel (1)
IS 11169 (Part1): 2022 already exists on the subject
Efficiency, Leak Detection, Fire Protection, Material Compatibility (5)
Under Process

# Important Subject for Standardization in Future


Efficiency of Fuel Cells & Electrolysers

Type approval of Fuel cell/$H_2$ ICE run vehicles

Pipelines for Bulk Transport of Hydrogen


Cryogenic vessels


Thank You