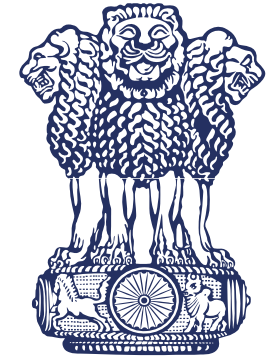




भारत 2023 INDIA

वसुधैव कुटुम्बकम्

ONE EARTH • ONE FAMILY • ONE FUTURE



सत्यमेव जयते

NITI Aayog

Hydrogen Strategies & Policies

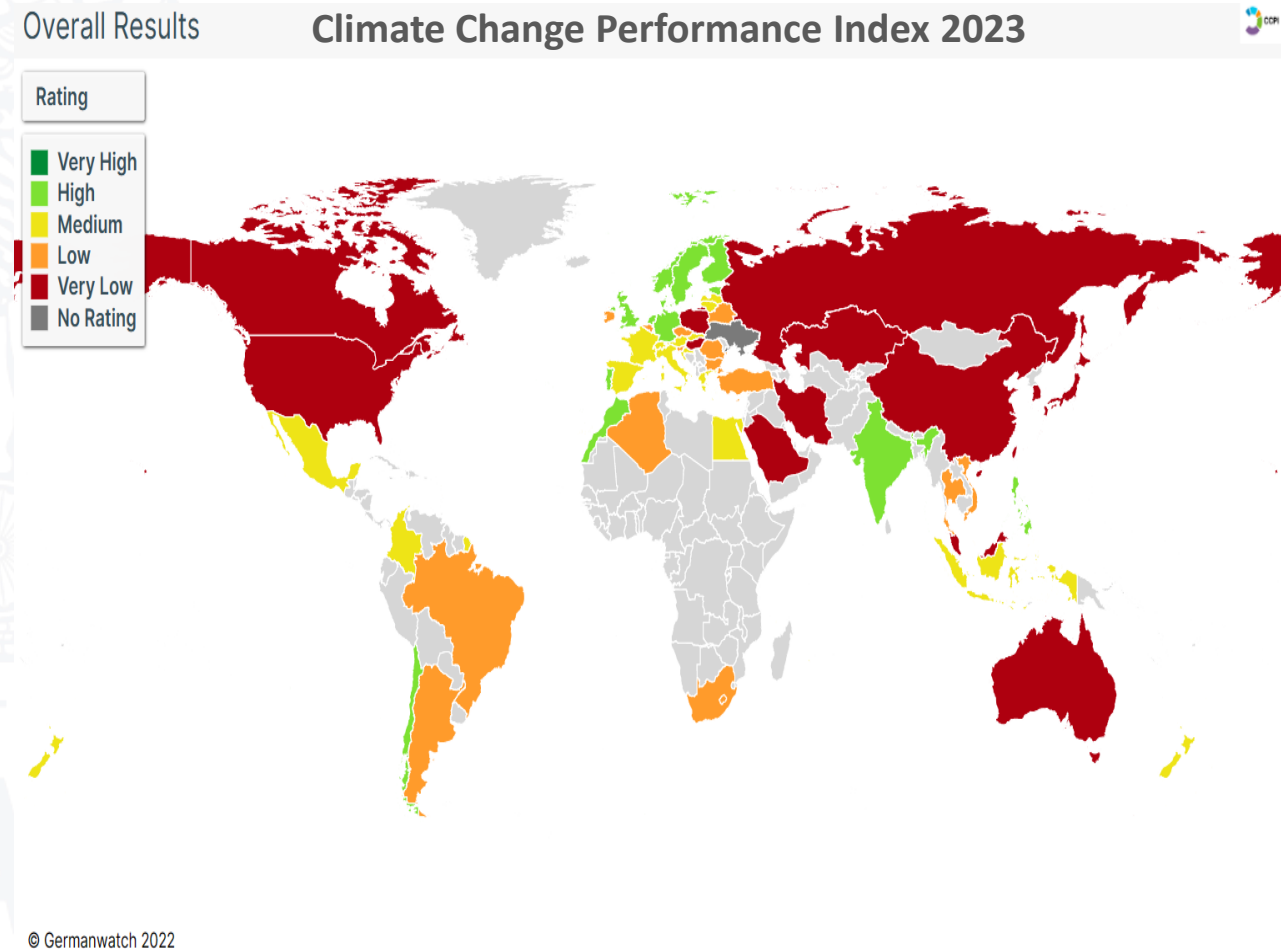
Sh. Rajnath Ram

Adviser (Energy/Natural Resources and Environment)

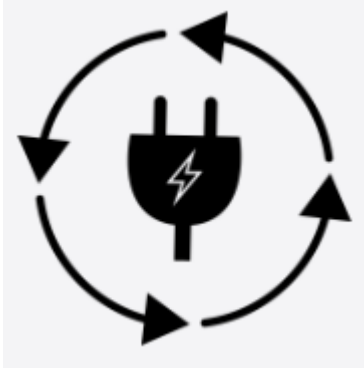
6th July 2023

India's Demonstrated Climate Action

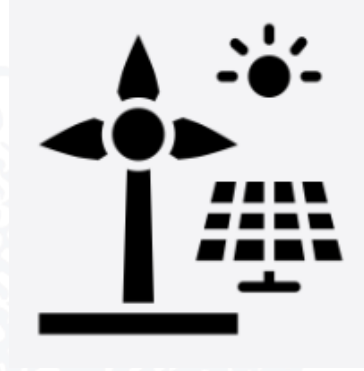
- Under Climate Change Performance Index (CCPI 2023) India's ranks 8th amongst in the world, and the best among the G20 countries.
- Emission intensity reduction on track: 24% between 2005 and 2016 (~28% by 2021).
- Non fossil installed power capacity >42%; ~25% of electricity generation in 2021-22.
- Achieved 11% ethanol blending before schedule & on track to achieve 20% by 2025



Energy Transition in India



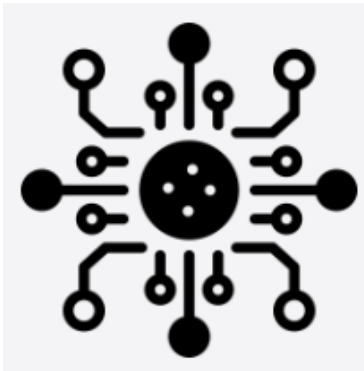
Increasing Electrification
(19%- 24% by 2030)



Penetration of Clean Energy in Primary Energy Mix



Energy Efficient Technologies



Digitalization



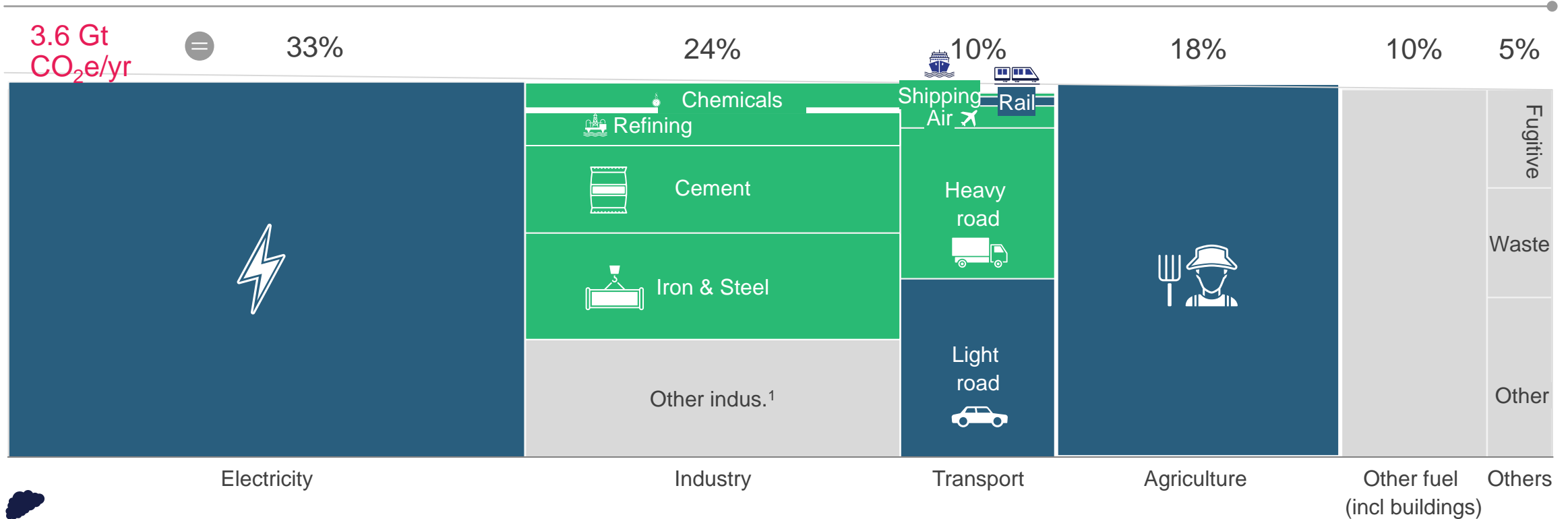
Circular Economy



Material Efficiency

Hard to abate sectors need Green Hydrogen

Green Hydrogen can make India Green product champion



 India's emissions map

 green H₂

Global Hydrogen Momentum

- More than 1000 hydrogen projects, out of which 795 may materialize by 2030
- Financial Investment Decision (FID) for about USD 29 bn, the expected investment USD 320 bn by 2030
- Investment commitment in JPN, South Korea and rest of Asia USD 17bn
- Clean hydrogen supply announcement 38 MTPA by 2030
- As per hydrogen council Report 23, assessment two types of hydrogen
 - Clean (low Carbon)- **Definition?**
 - Renewable **or Green? (why not nuclear – has the lowest LCE)**

There is need to harmonize the standards/definitions as the investment and trade are involved hugely

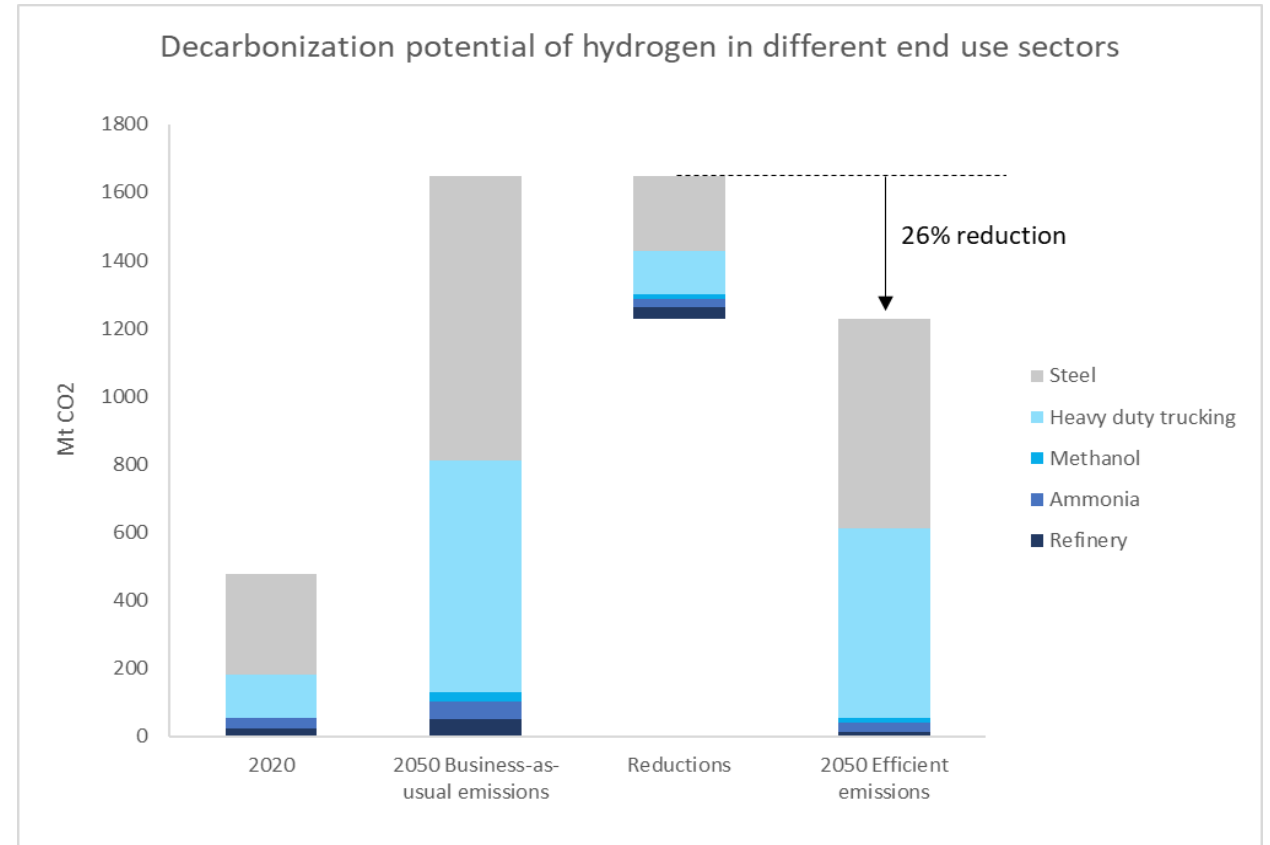
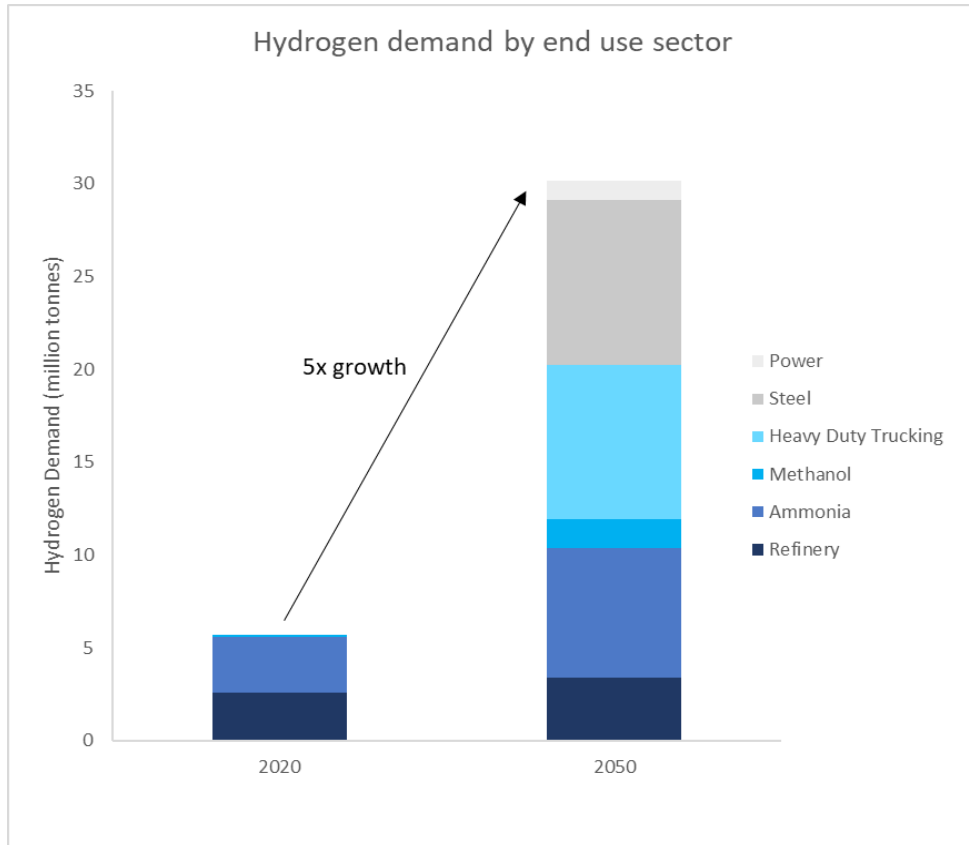
Global Hydrogen Momentum

- 700 MW electrolysis capacity deployed by end of 2022 (300 MW in china itself).
- Clean hydrogen supply capacity about 800 ktpa.
- OEMs have announced electrolysis manufacturing capacity 9 GW
- 12 GW fuel cell manufacturing capacity
- Fuel cell vehicles on the road (80,000)
- 120 ammonia terminals in place – 38 export and 88 import

-Investment decisions, harmonization of definition and regulatory framework

Source: Hydrogen Council Report 2023

India is going to experience 5 – 10 X increase in Hydrogen demand by 2050 : This will increase Indian gas imports



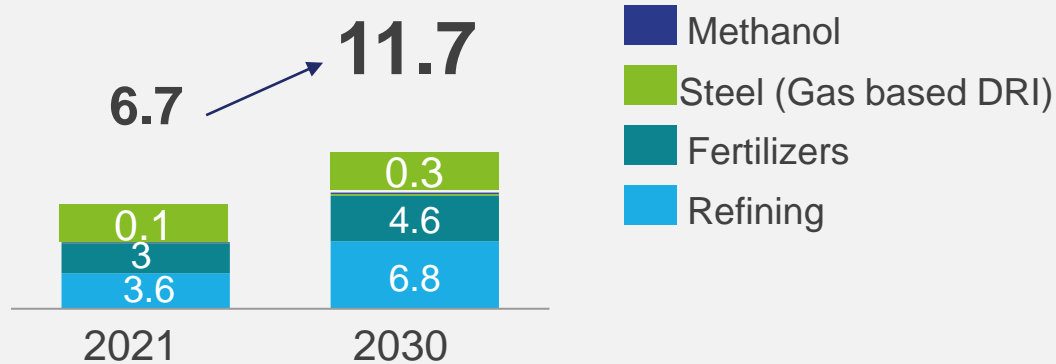
Current demand is concentrated around ammonia and refineries

.... however, steel and heavy-duty trucking will be the biggest hydrogen consumption sectors by 2050

India : 8-10% of global grey H2 demand

from **6.7 M.T 2021** likely to grow - **11.7 M.T 2030**

Total Hydrogen Market India (Million Tonnes)



Grey H2 depends on Imported Natural Gas

Natural Gas / LNG



- USD 17.1 Billion
- 26 Billion SCM

Total imports
2022-23

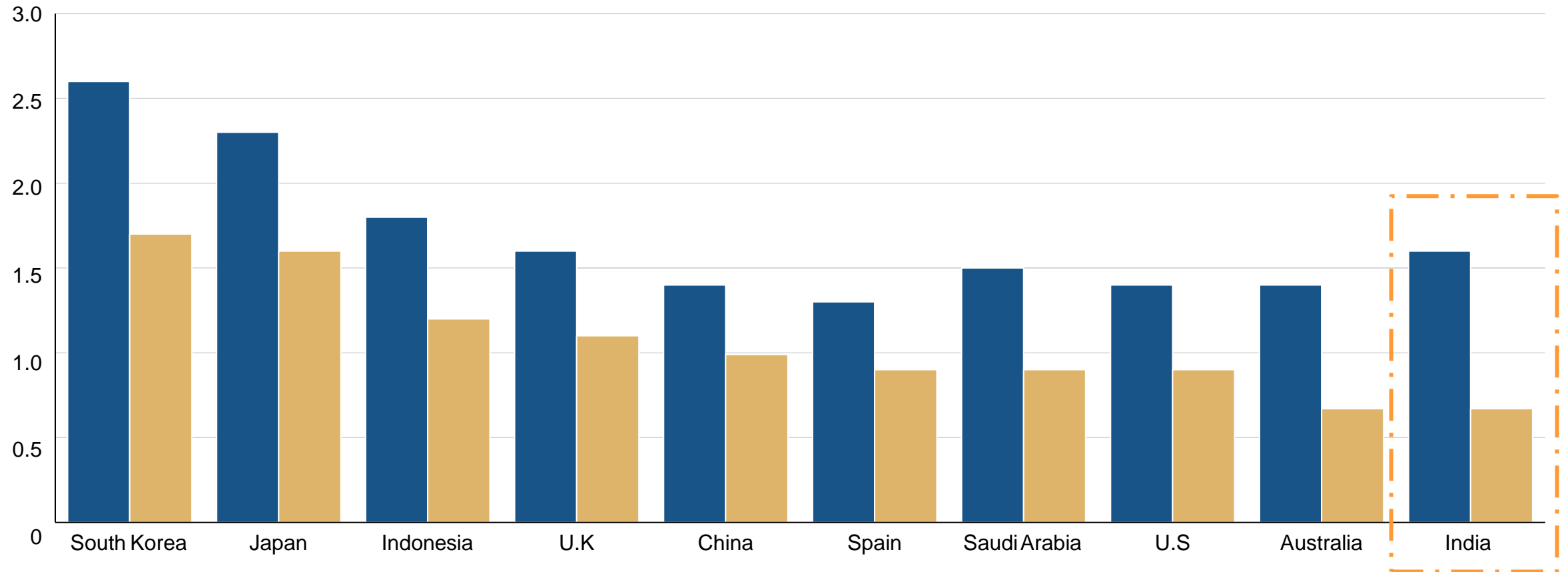
1 Report of the Sub-Group, constituted under the Standing Committee to develop National Hydrogen Energy Mission (Sub-Group on Sourcing of Hydrogen convened by Indian Oil Corporation)

India could be among the most competitive exporters of Green H₂

Comparison of levelized cost of green hydrogen in selected countries

LCOH (\$/kg)

2030 2050



National Green Hydrogen Mission – 2030 targets

- Incentive for green hydrogen production
- Incentive for electrolyzer manufacturing
- R&D and pilot funding



At least
5 MMT GH₂
Annual Production



60-100 GW
Electrolyser
Capacity



50 MMT
Annual Emissions
Averted



₹ 1 lakh cr
Cumulative Import
Savings



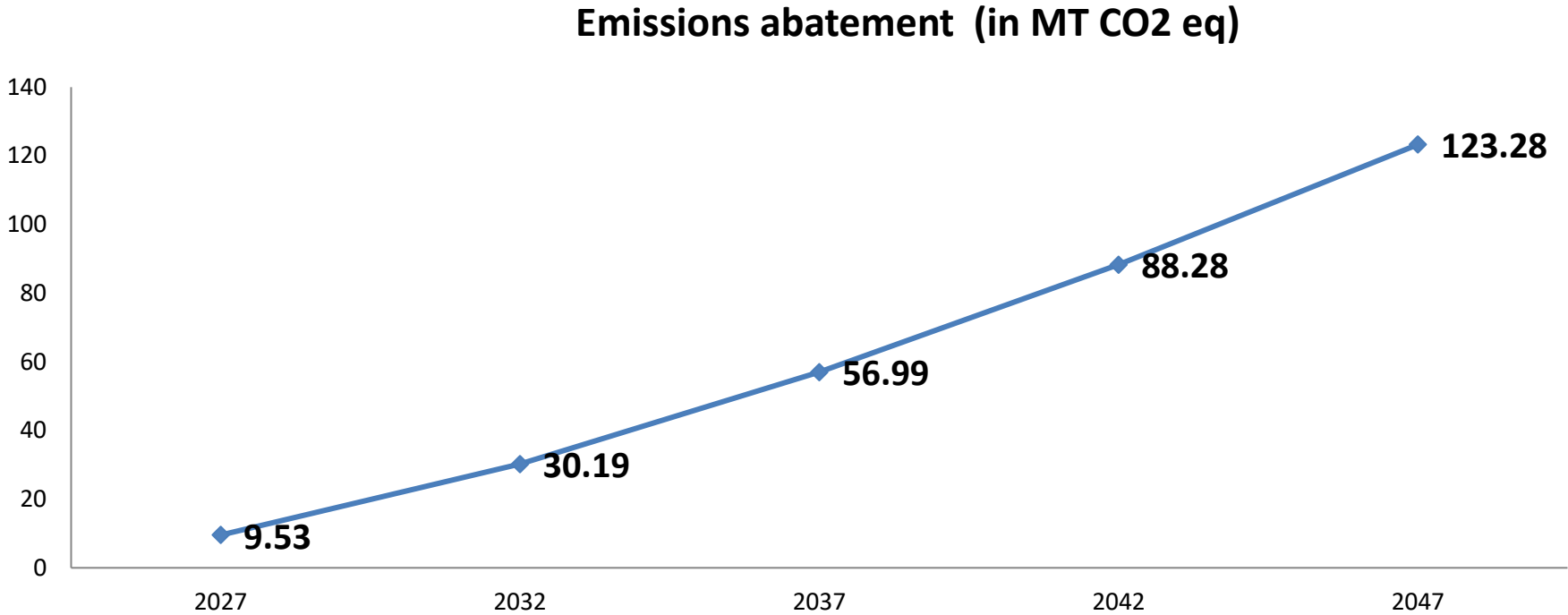
125 GW RE
Capacity for GH₂
Generation



₹ 8 lakh cr
Cumulative
Investment

10

Emissions abatement with adoption of Green Hydrogen



- Hydrogen penetration will largely be seen in Industry (Fertilizers, Oil refineries) in the short run; and Industry (Steel) and Transport in the long run.
- Above figure only accounts for domestic emissions avoided. Exported Hydrogen also result in reduction of global emissions.

Cost of Grey Ammonia

	Scenarios	Landed cost of natural gas USD/MMBtu	Cost of Hydrogen (USD/Kg H ₂)	Cost of Ammonia (USD/tonne NH ₃)
Grey Ammonia cost	6 USD/MMBtu	7.58	1.55	369.51
	16 USD/MMBtu	17.86	3.15	651.11
	18 USD/MMBtu	19.91	3.48	709.19
	20 USD/MMBtu	21.97	3.80	765.51
	22 USD/MMBtu	24.02	4.12	821.83
	24 USD/MMBtu	26.08	4.44	878.15
	38 USD/MMBtu	40.46	6.69	1274.15

NITI Aayog

Estimated Cost of Green Hydrogen & Green Ammonia



	Scenario	Delivery cost of Electricity INR/KWh	Cost of Hydrogen (USD/Kg H ₂)	Cost of Ammonia (USD/tonne NH ₃)
Electricity-based hydrogen (2022)	Decentralized - 100% Solar (@19% CUF)	2.43	4.2	797.53
	Decentralized Solar with storage (4 hr. storage)	5.08	4.02	787.29
	Banking – Solar Energy	2.53	2.29	461.97
Electricity-based hydrogen (2030)	Decentralized - 100% Solar (@23% CUF)	1.9	2.09	422.64
	Decentralized Solar with storage	3.34	2.51	506.78
	Banking – Solar Energy	1.97	1.58	332.96

Cost of Grey Ammonia@16 USD gas price is 651.11 USD. All the scenarios depicted above in 2030 favor shifting towards green ammonia.

Key challenges & Suggestions to scale the GH₂ economy

Demand creation for GH₂

Financing

Issue: Higher cost of capital

- Needs to be included in **infrastructure harmonized list**,
- **Low Cost Financing-** Bilateral/Multilateral Loan, Blending Finance, Green Bond, Pension Fund etc.
- Reforms in MDB

Supply - chain constraints
Issue: Critical minerals

- R&D in Membrane Technology (free from critical minerals)
- Geo-political tie up for supply chain
- Promote alternative Technology like SMR, CSP based GH₂ production etc.

Managing regulations
Issue- Harmonization on definitions, standards

- International Standard & Definition on GH₂
- Harmonization of the Banking Norms
- Establishing third party GH₂ testing & Certification norms
- Grid Code for GH₂ production from Grid based power

Building infrastructure
Issue-Costly storage/transportation

- Establishing Green Hydrogen Hub
- Green Hydrogen Valley
- Pilot Project for Bunker based storage
- R&D & Pilot project for GH₂ transportation

De-risking mega projects
Issue-sustained ROI

- Policy continuity for the sector.
- Demand Creation by assured offtake by Sectors (like Fertilizer & Refiner in India)
- G2G Agreement for GH₂ supply similar to Gas Sector
- G2B, supporting B2B agreement for GH₂ and its derivatives.



सत्यमेव जयते

NITI Aayog

Thank You