

# Potential Role of Hydrogen in decarbonizing Indian Economy

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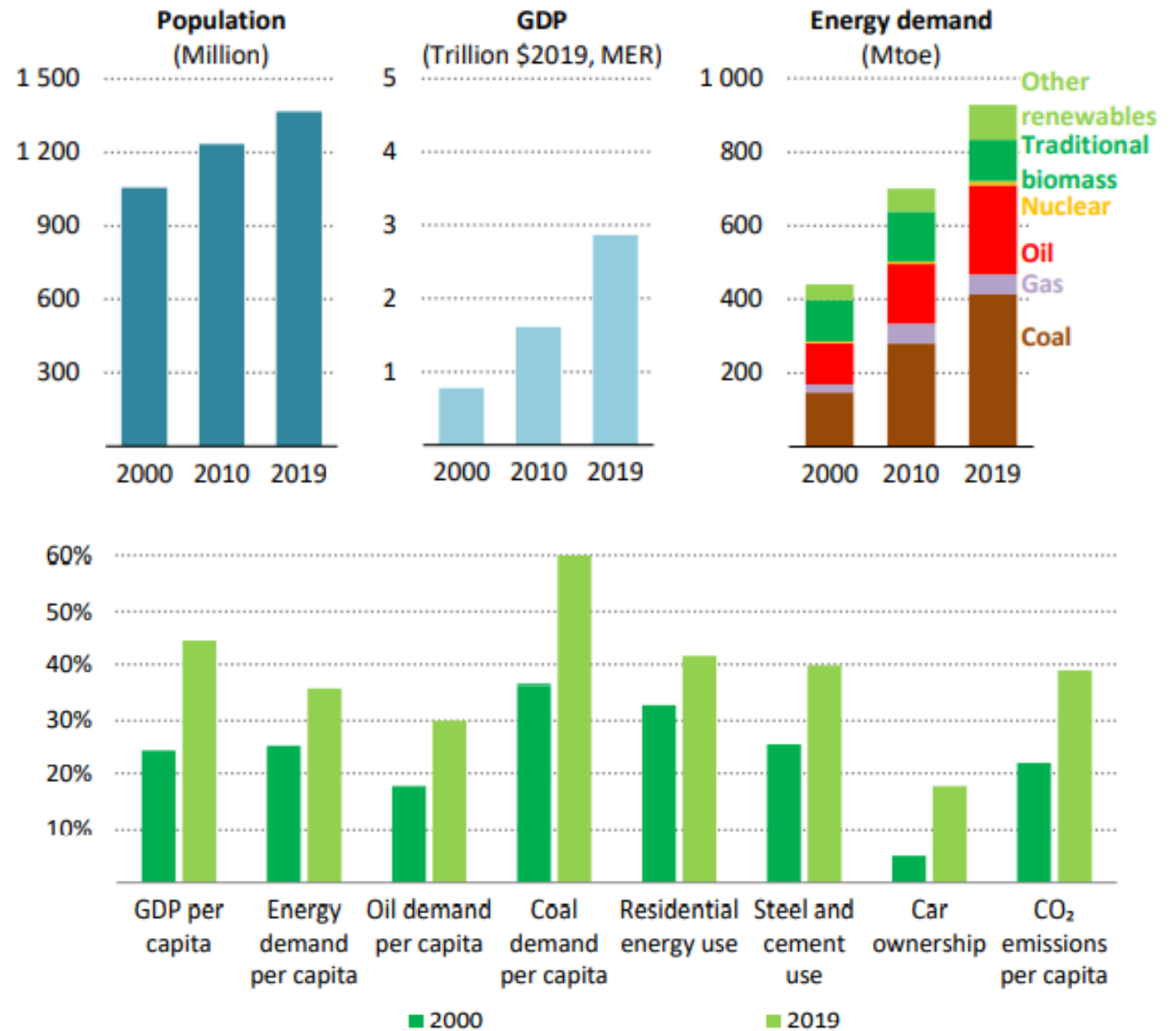


# Flow of the presentation

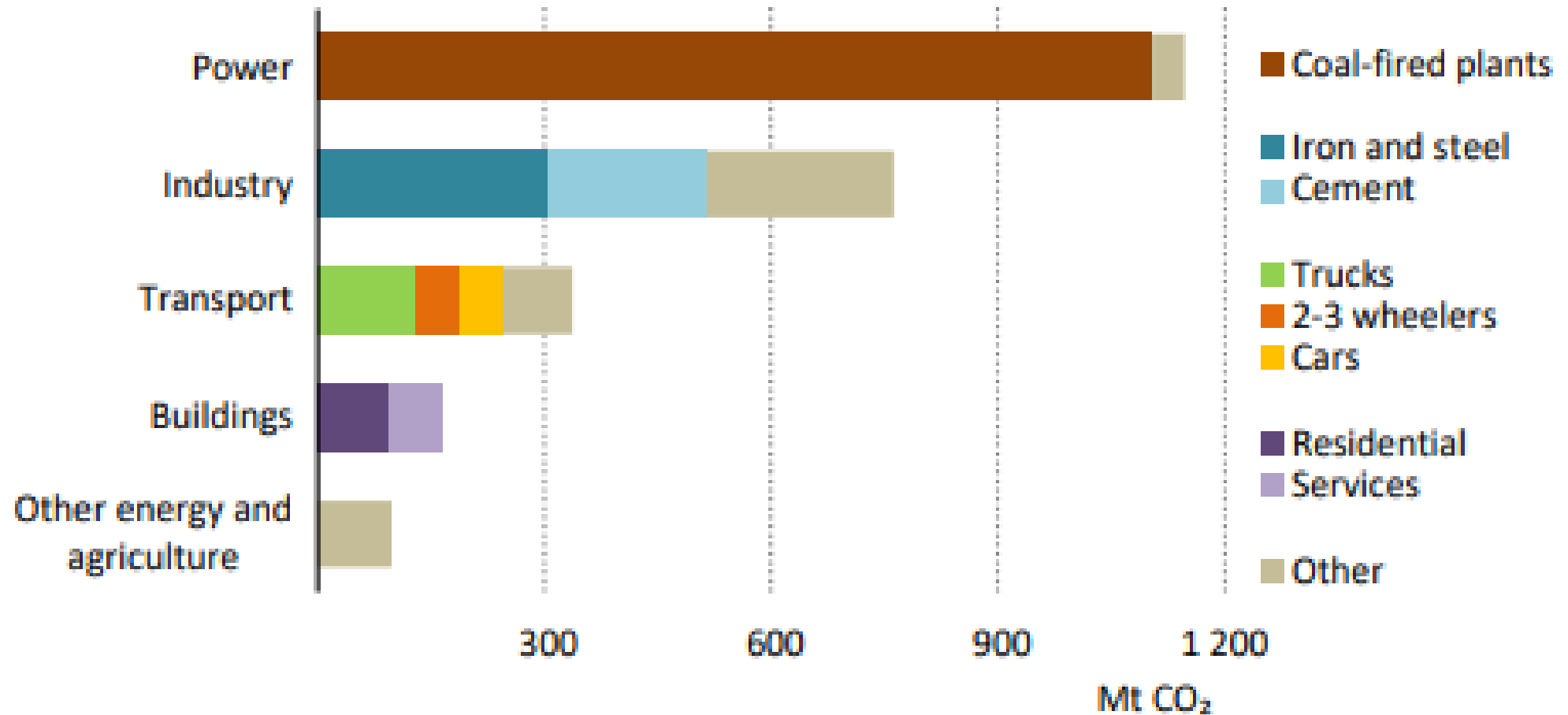
- Growth Indicators for India
- Sectorial demand prediction
- CO<sub>2</sub> Emissions trends
- Impact of Green Hydrogen on sectorial emissions
- Hydrogen Mission
- Recommendations

# Growth Indicators for India

- Rising population and incomes since 2000 have underpinned a doubling of energy use in India, but per capita energy use is still less than 40% of the world average.

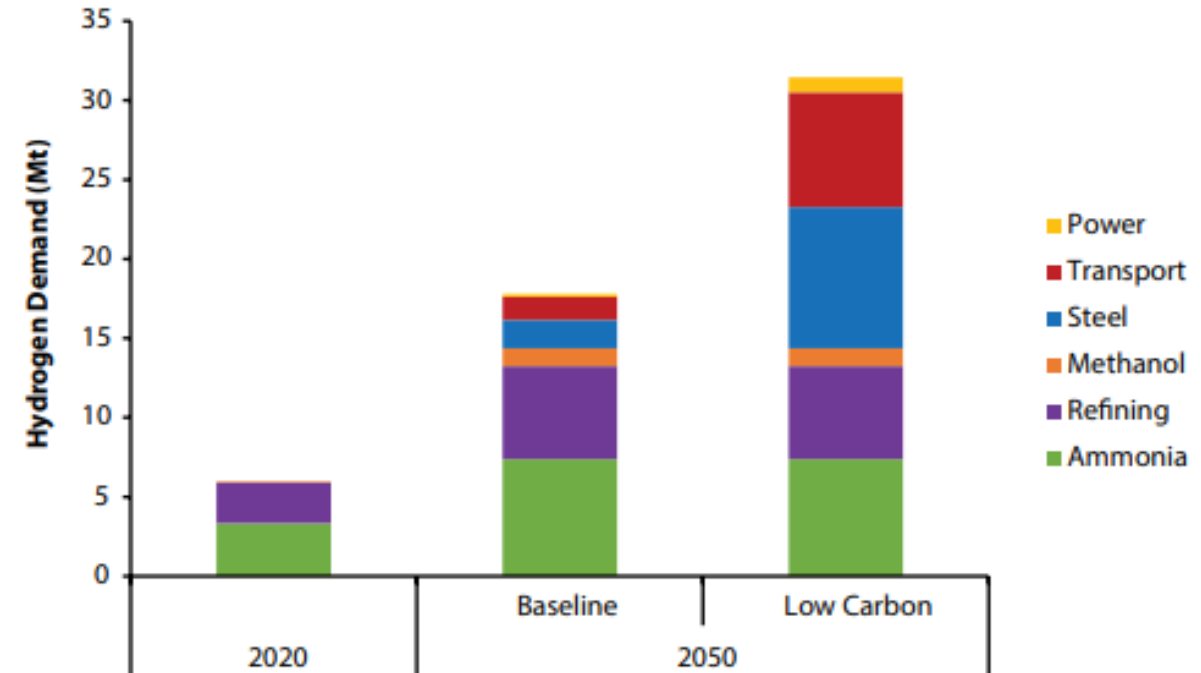
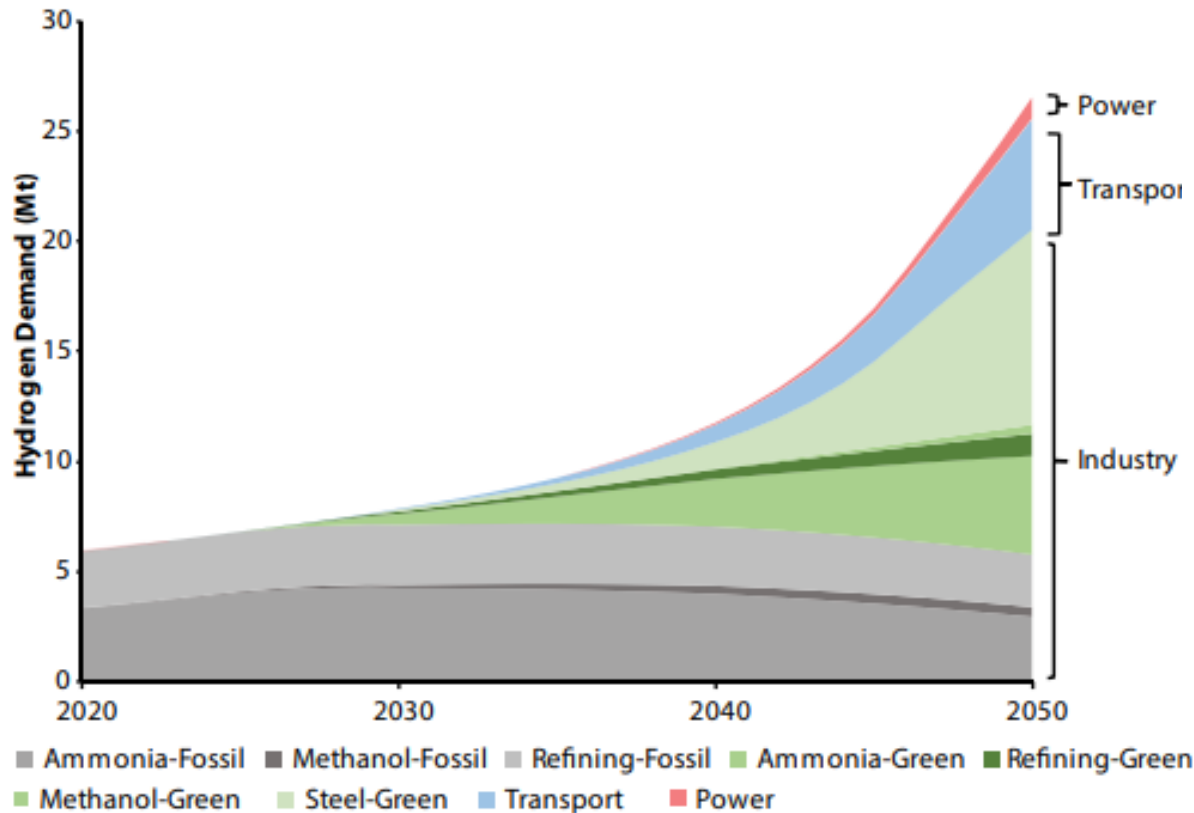


# CO<sub>2</sub> Emissions from Energy Sector



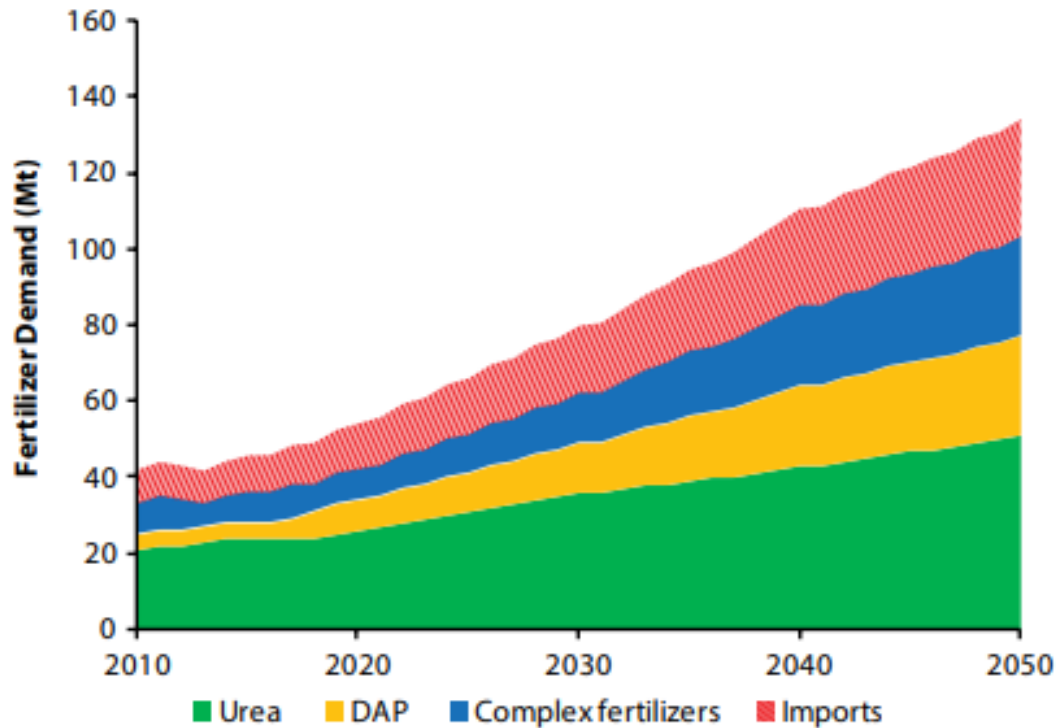
# Hydrogen Demand

- Demand for hydrogen today is at around 6 Mt per annum, coming solely from industry sectors, such as fertilizers and refineries.
- This can increase to around 28 Mt by 2050, driven by cost reductions in key technologies, as well as the growing imperative to decarbonize the energy system.

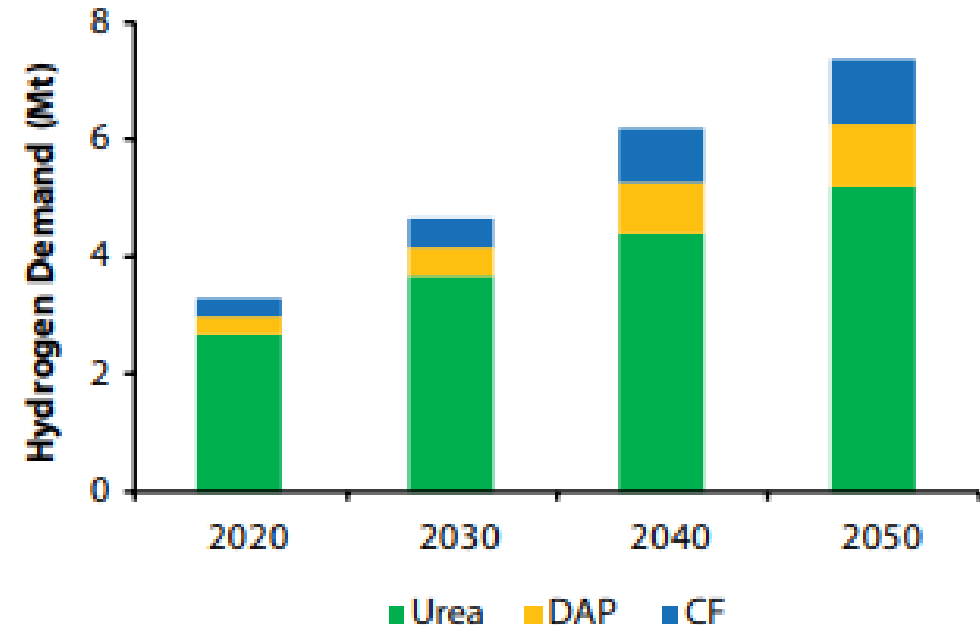


# Ammonia

- Fertilizer consumption is expected to increase from around 45 kg per capita today to 75 kg per capita by 2050.
- By 2050, the demand would increase from 3 Mt (which is around 50% of India's total hydrogen demand) of hydrogen to around 7.5 Mt in the Indian fertilizer industry.



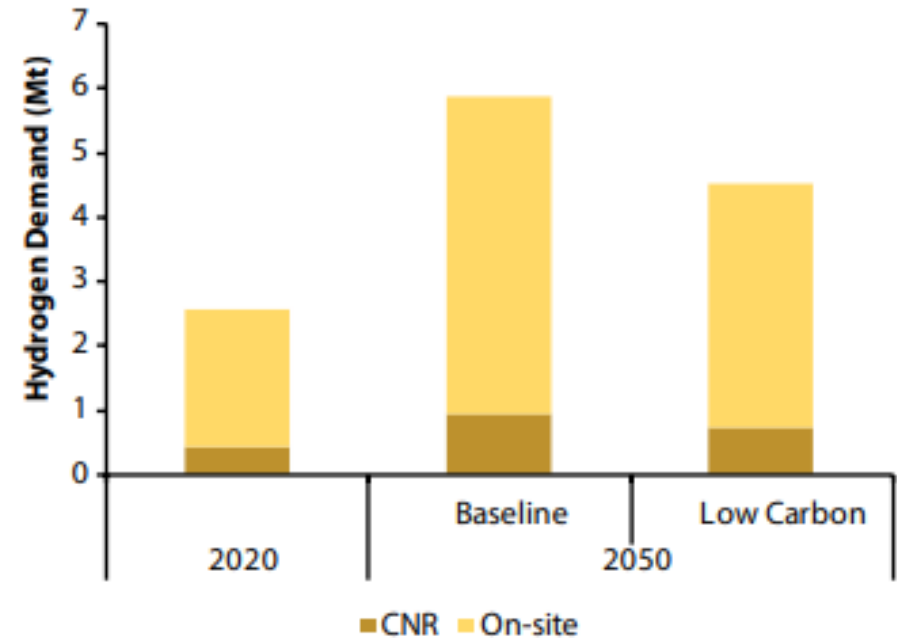
Demand for fertilizers – domestic production and import, 2010–2050



Hydrogen demand in the fertilizer sector, 2020–2050

# Refineries

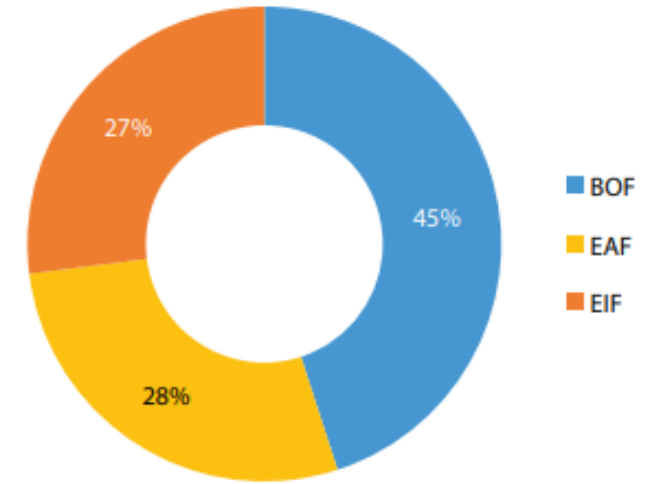
- In 2020, total refinery demand for hydrogen is 2.6 Mt, or around 40% of total hydrogen demand in India.
- In the Baseline scenario, this would increase to nearly 6 Mt, as demands for low sulphur fuels, such as diesel and motor spirit (petrol), continue to grow significantly.
- In the Low Carbon scenario, total hydrogen demand is around 5 Mt, reflecting the lower demands for low sulphur fuels with a growing shift to BEVs and FCEVs.



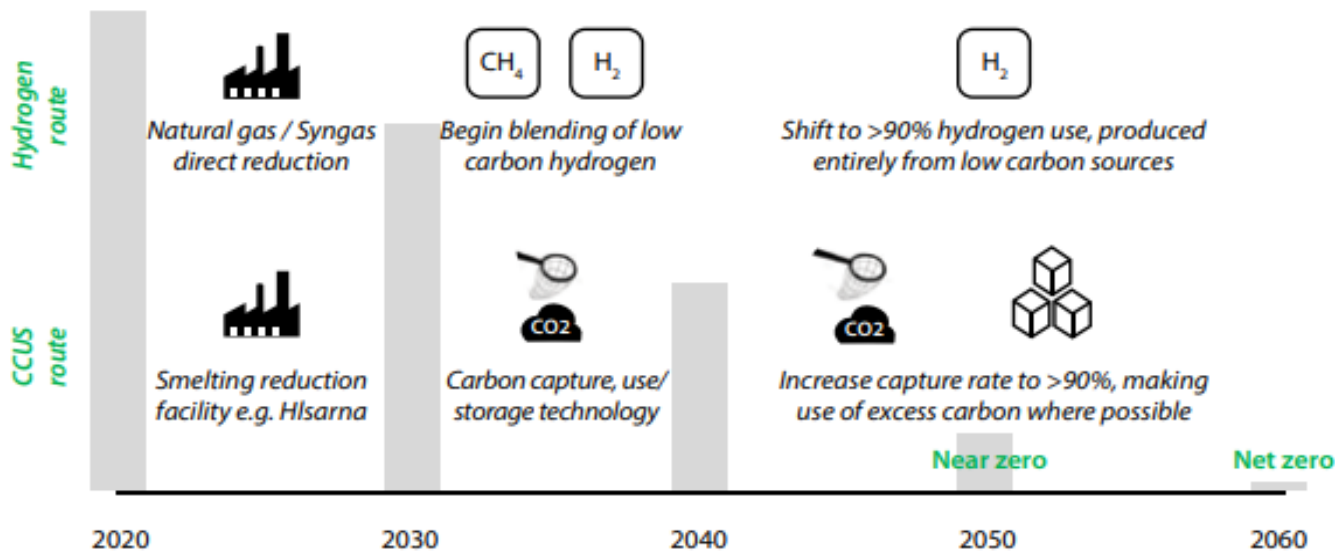
Hydrogen demand in refineries, 2020 and 2050

# Steel Industry

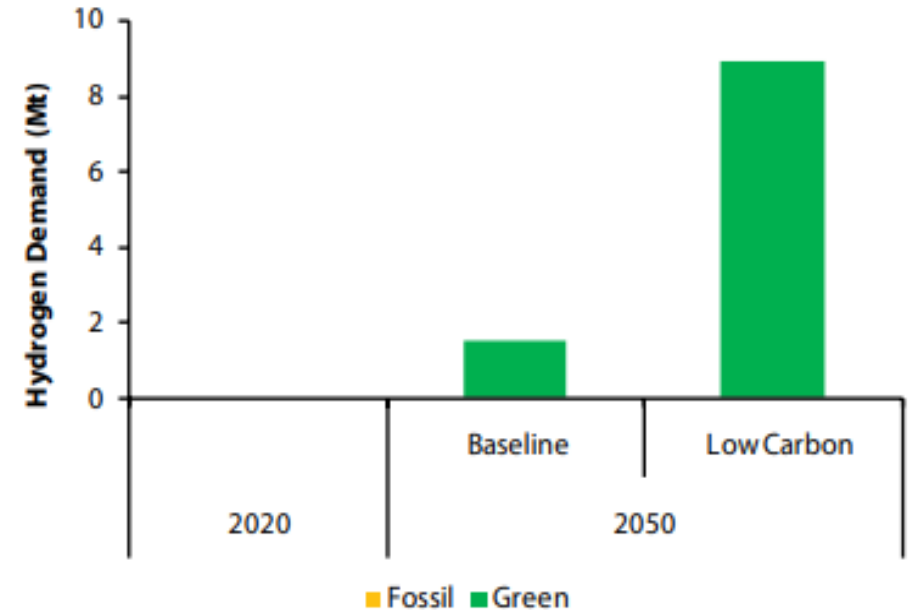
- Under the Low Carbon scenario, where supportive policies are brought in to accelerate the uptake of hydrogen direct reduction facilities, there can be growth in green hydrogen demand from 2030.
- This increases rapidly out to 2050, making up nearly all new primary capacity additions between 2030 and 2050.
- This results in around 50% of primary capacity using hydrogen direct reduction by 2050, requiring around 9 Mt of green hydrogen each year.



Route-wise crude steel production share, 2020-21



Pathways for decarbonizing primary steel production in India, 2020-2060

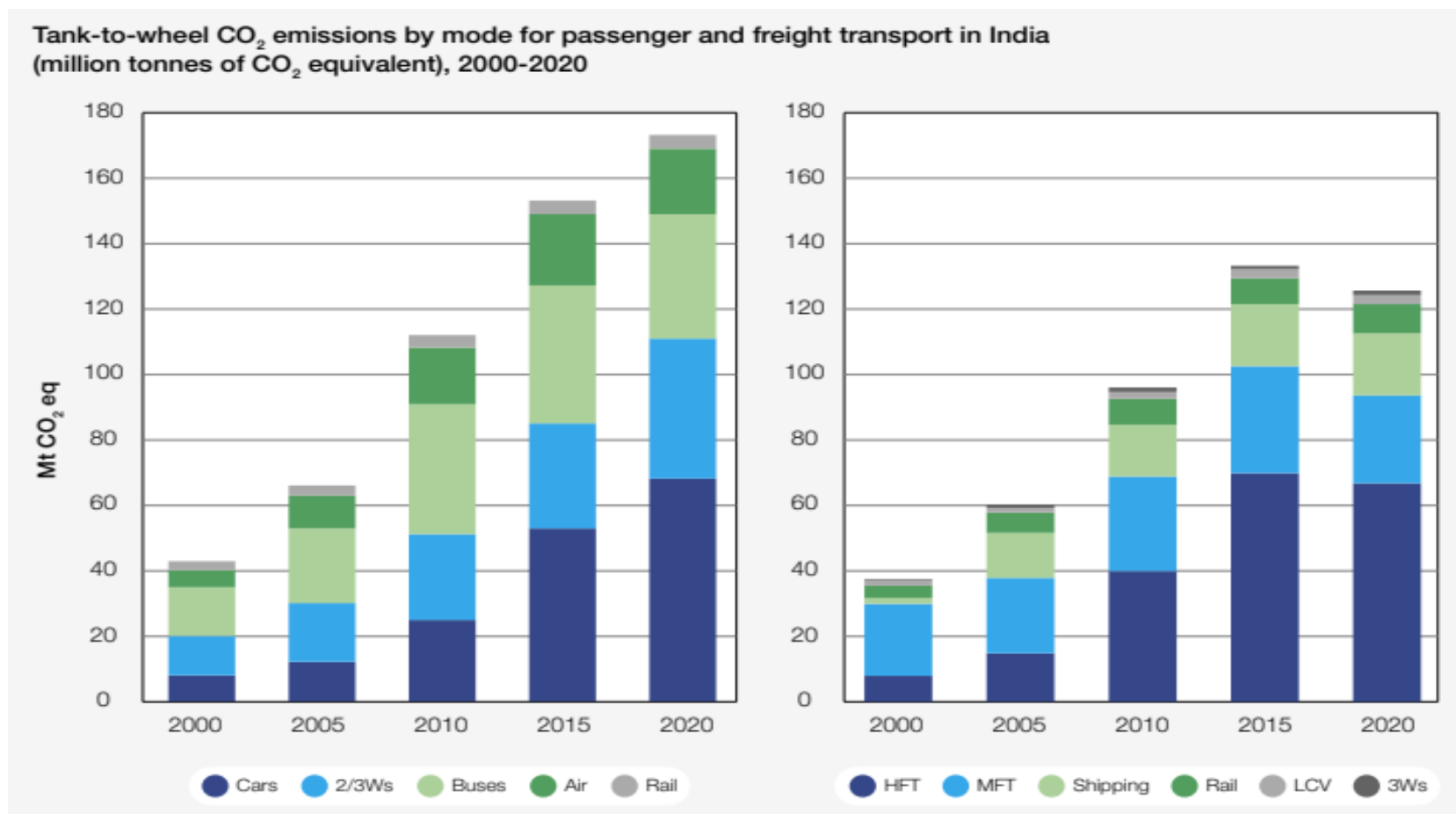


Hydrogen demand for the steel sector in the Baseline and Low Carbon scenarios



# Transport Sector...<sub>1</sub>

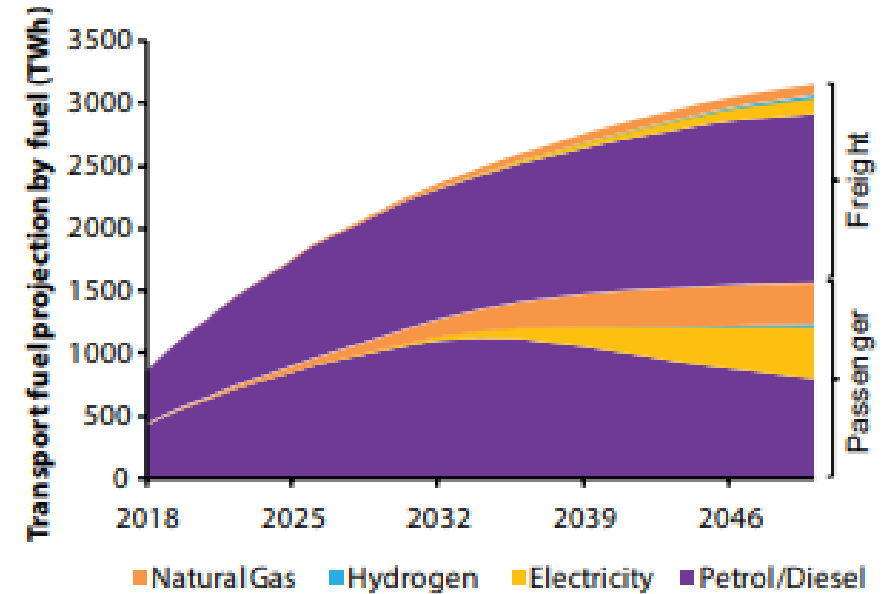
- India's transport sector contributes to ~10% of its GHG emissions. In 2020, an estimated 60% of India's final energy use in transport arose from passenger transport and 40% from freight transport.



CO<sub>2</sub> emissions have grown across transport modes over the past 20 years reaching over 300 MT CO<sub>2</sub> eq. in 2020.

# Transport Sector...<sub>2</sub>

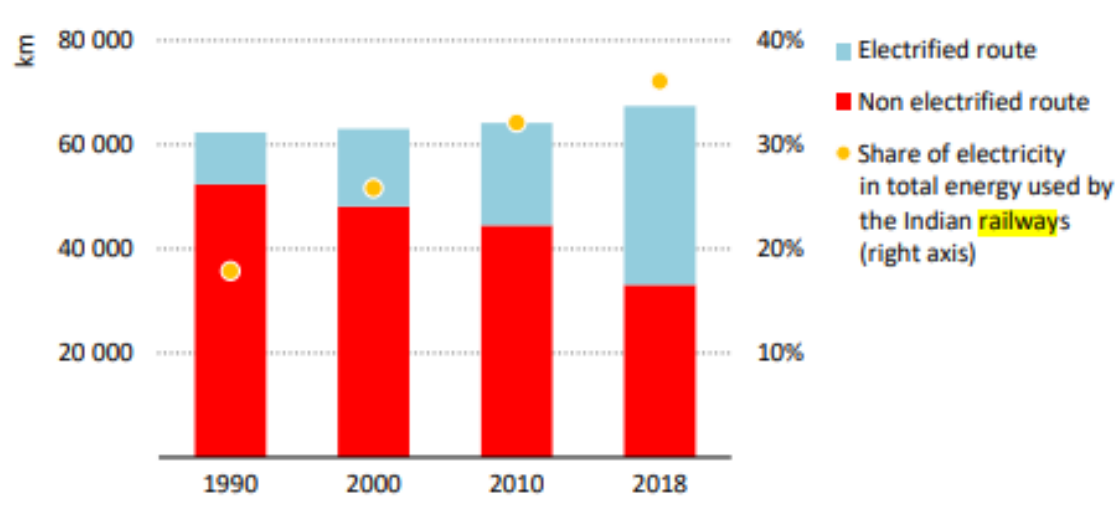
- Total transport demand is projected to grow to 3,150 TWh (270 Mtoe) by 2050.
- Petrol and diesel demand for freight transport continues to grow across the whole projection period, as the penetration of BEVs, FCEVs, and NGVs is not sufficient to halt the growth of diesel and petrol.
- This highlights the importance of the future of freight transport to India's oil product demand growth.
- The total petrol and diesel consumption is projected to reach 2,150 TWh (185 Mtoe) by 2050.
- Total electricity demand in transport would reach 540 TWh by 2050, a substantial amount compared to the 2018 level of total final consumption of electricity across all sectors of 1,200 TWh.
- Hydrogen demand is expected to reach just 59 TWh by 2050, as penetration is assumed to be negligible in light-duty transport, and modest in heavy-duty freight and passenger transport.
- Natural gas demand would reach 400 TWh.



Transport fuel projection by fuel (TWh)

# The Transformation of India's Railways

- India's railway network was for a long time largely fuelled by coal and diesel. However, the share of electrified tracks has increased in recent decades, rising from 24% in 2000 to just over 50% in 2019.

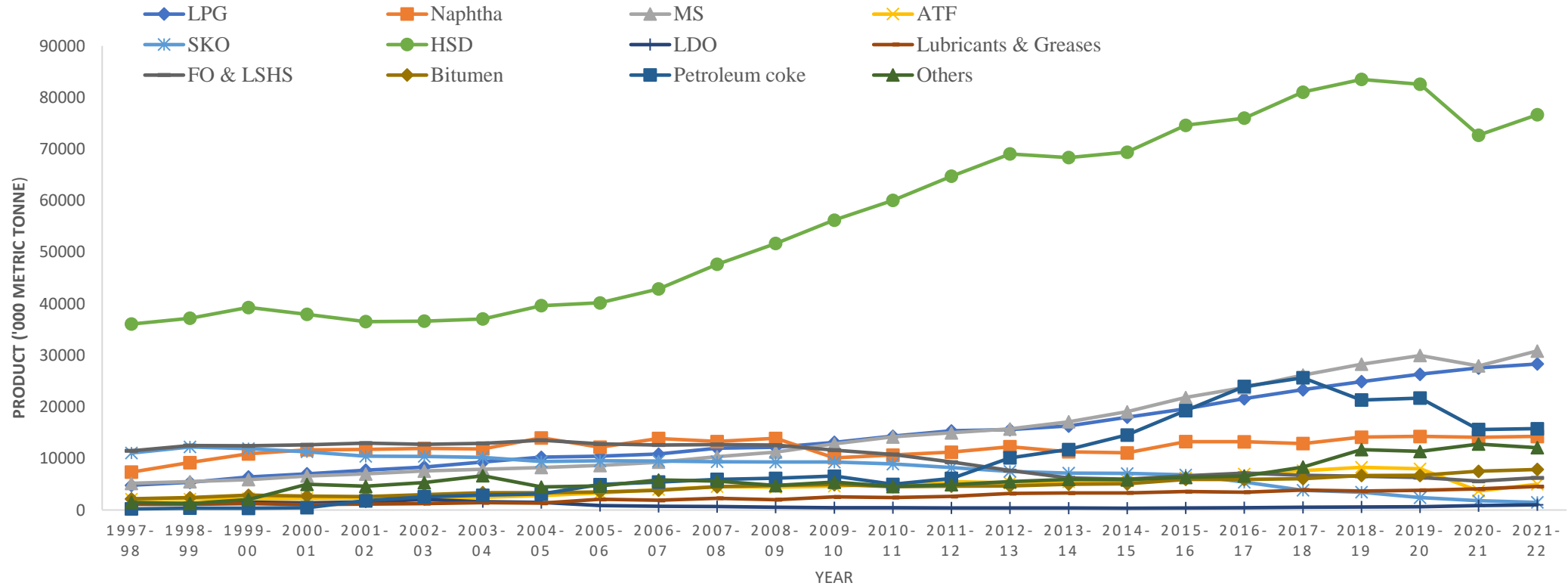


Electrification of railway routes and operations

Source : India Energy Outlook, IEA, 2021

- Railways are working on an ambitious project of using fuel cell in locomotives. Indian Railways plans to manufacture a 300 kW (with transient power well in excess of 1 MW) fuel cell based hybrid locomotive.

# Consumption of Petroleum Products



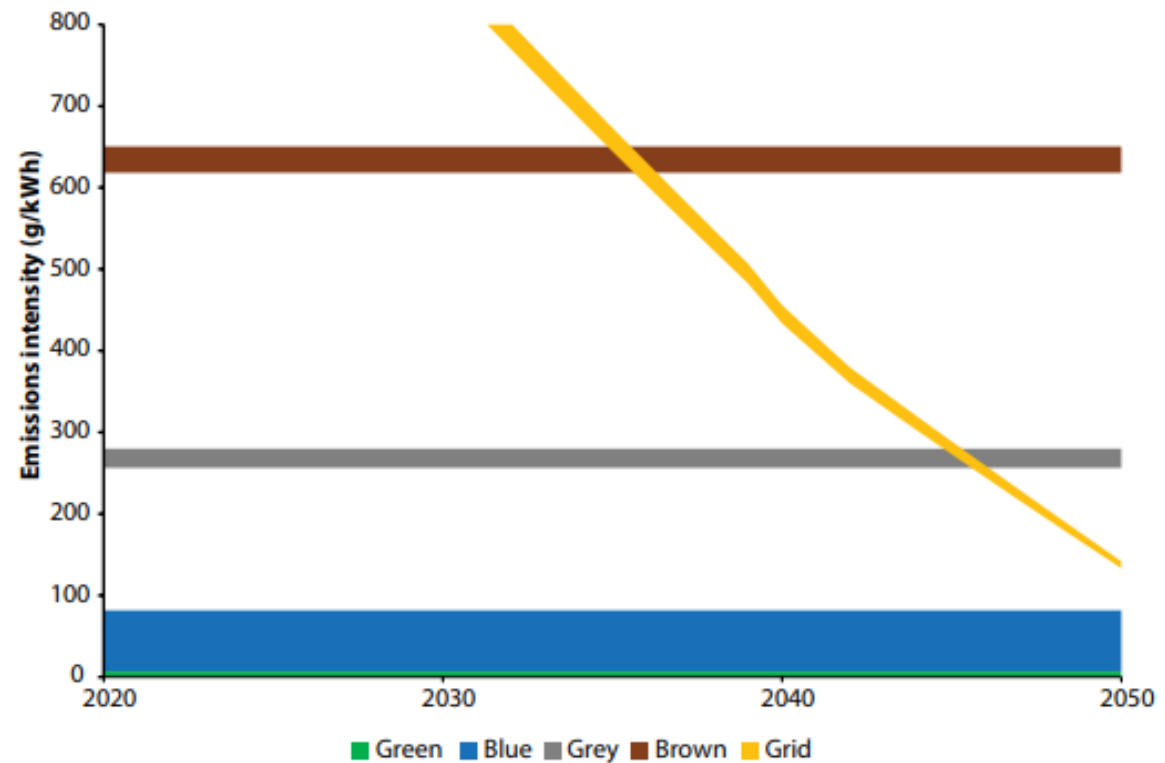
- MS - Motor Spirit
- ATF - Aviation Turbine Fuel
- SKO - Sarvottam Kerosene Oil
- HSD - High Speed Diesel
- LDO - Light Diesel Oil
- FO & LSHS - Furnace Oil & Low Sulphur & Heavy Stock

# National Hydrogen Mission

- Mission aims to make India a Global Hub for production, utilization and export of Green Hydrogen and its derivatives.
- Mission will help in India becoming energy independent and in de-carbonisation of major sectors of the economy.
- Development of green hydrogen production capacity of at least 5 MMT (Million Metric Tonne) per annum with an associated renewable energy capacity addition of about 125 GW in the country by 2030.
- Total Government contribution / investment INR 19,744 Crore by 2030
  - INR 17,490 Cr for site program
  - INR 1,466 Cr pilot projects
  - INR 400 Cr for R & D
  - INR 388 Cr towards other Mission components
  - Nearly 50 MMT per annum of CO<sub>2</sub> emissions are expected to be averted by 2030.

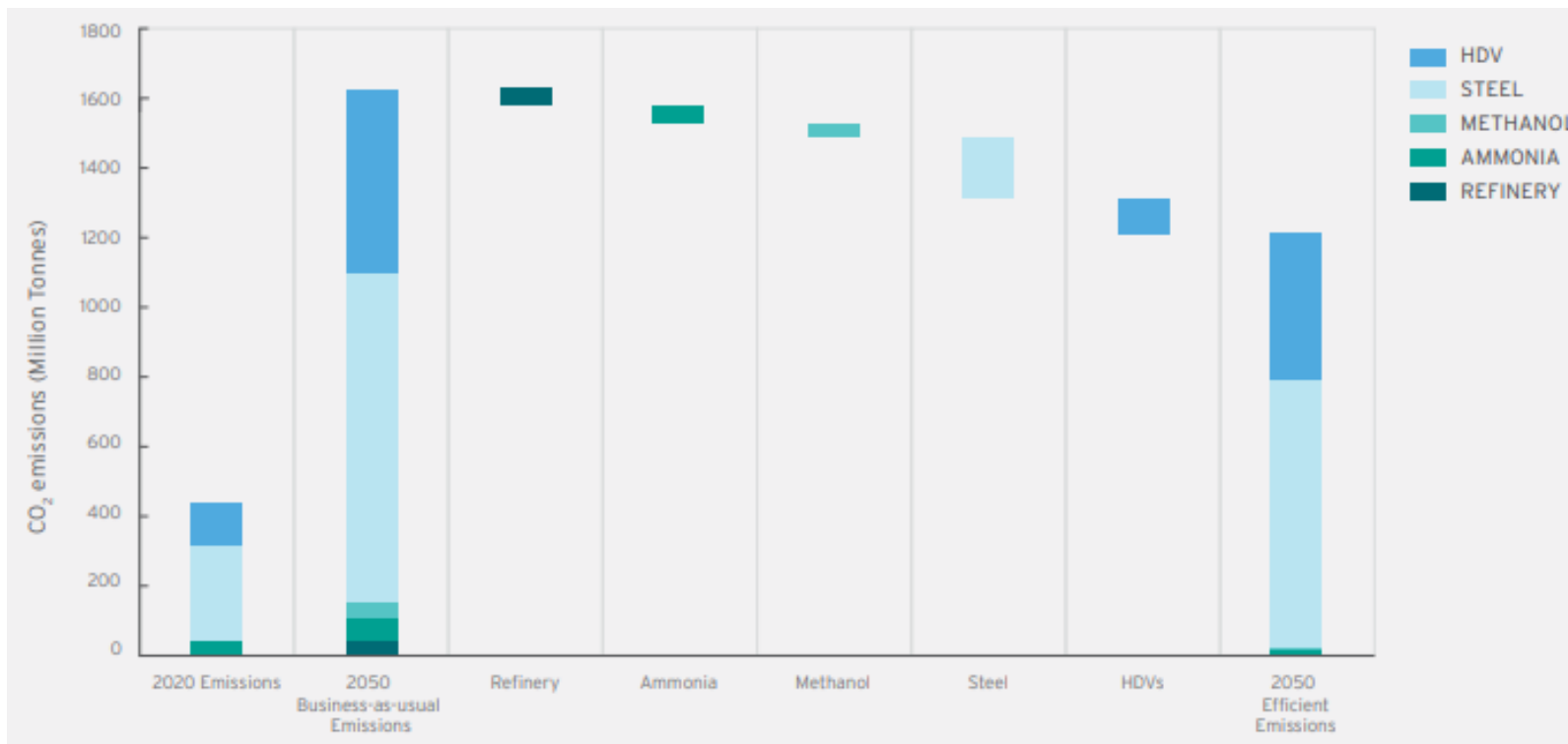
# Emissions intensity of hydrogen production

- Fossil fuels result in significant emissions from hydrogen production, with coal-based production (brown) exceeding 600 gCO<sub>2</sub> /kWh.
- The Indian electricity grid is currently at around 700 gCO<sub>2</sub> /kWh, although this is expected to decrease rapidly over the time period, in line with ambitious renewable energy targets. This reinforces the recommendation that electrolytic hydrogen should be constructed using dedicated renewables versus grid electricity, both for reasons of costs and emissions.



Emissions intensity of hydrogen production, 2020–2050

# CO<sub>2</sub> emissions reductions due to green hydrogen uptake in end use sectors



- Cumulatively, between 2020 and 2050, India can abate 3.6 Giga Tonnes of CO<sub>2</sub> emissions using green hydrogen.
- Green Hydrogen can translate to a net energy import savings of \$246 - \$358 billion between 2020 and 2050.

# Summing Up and Way Ahead

- India has announced The Hydrogen Mission with INR 19, 744 Cr budget.
- Target to manufacture 5MMT green Hydrogen and its derivatives by 2030 Almost close to current hydrogen production levels.
- R & D to commercialization shift has to happen faster.
- Hydrogen can play an important role in Carbon Trading Scheme being developed.
- Green Hydrogen targets for Major hydrogen consumers.
- Policies and frameworks for Mission Implementation has to be developed.



Thank You!

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