



### Identification of Key Demand Clusters of Hydrogen in India

Examination of potential demand centers of hydrogen in India. The split shall be region wise, end use industry wise , transportation use wise, supportive infra and new industrial hubs wise.



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### Chapter 14 – Identification of key demand clusters of hydrogen in India

Across Indian industry, there are considerable efforts to establish a hydrogen economy in India, not least , the work being taken forward by oil marketing companies such as Indian Oil

#### 14.1 – Identification of key demand clusters of hydrogen in India by region & end use

Hydrogen is a promising energy carrier which has the potential to address several energy sector related challenges and technically from the application point of view can substitute the conventional fuels. Hydrogen can provide linkages between energy supply and demand in both a centralized or decentralized manner, thereby enhancing the overall energy system flexibility. The low carbon energy can be connected to sectors like transport and buildings or even hard to abate sector like steel and cement industry.

Presently, demand of hydrogen in India is 6 mt/year and is mainly driven from the industrial sectors such as chemical and petrochemical units. Further, it is also extensively used in India mainly as an industrial feedstock in the creation of ammonia-based fertilizers. These sectors will continue to make up a large part of the demand with volumes, expected to surge with new demand coming from the steel industry as it seeks to decarbonize. Hydrogen is also likely to play significant role in the transport sector, particularly in heavy duty and long-distance segments.

By 2050, India intends to produce three-fourths of the hydrogen from renewable resources. R&D projects in India are focusing on improving the efficiency of water –splitting reaction and finding newer materials, catalysts and electrodes and electrodes to accelerate the reaction. "

India is committed to the rapid expansion of the hydrogen economy , ensuring the cost– effective deployment of low carbon technologies across the transport, industry and power sectors by 2030

– Hydrogen Mission Statement, India

## Clear recognition of hydrogen's cross-economy role in India, outlines for scaling up use in transport, industrial applications and power

Presently, more than 100 research groups are focusing on fuel cell technology. There are a number of international and domestic companies in India that are involved in hydrogen production, storage and its distribution- including Praxair (USA), Linde (global member of hydrogen council ), Inox (Indo-US joint venture), Air Liquide (France), SAGIM (France), Air Products (USA), Fuel cell energy (USA), H2Scan (USA), ITM Power (UK), Heliocentris (Germany), Aditya Birla Group, Bhoruka Gases Limited, Gujarat Alkalies and Chemicals Limited, Gujarat Heavy Chemicals Limited, Air Science Technologies and Sukan Engineering Private Limited.

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For India to guarantee its role as a technology leader in the next phase of the energy transition, it will need to greatly increase activity across the public and private sectors to develop a hydrogen economy

- Hydrogen Mission Statement, India

#### Market Research 2021

### Identification of potential demand clusters for hydrogen in India – end use industry



Market Research 2021

## Identification of potential demand clusters for hydrogen in India – end use industry (contd.)

#### End use industry – Urea and Ammonia (Contd.)

Potential demand hubs across the urea producing clusters



Note – LMT indicated Lakh Metric Tonnes per annum

Newly commissioned fertilizer units in India during

2021 in addition to the existing plants

Market Research 2021

## Identification of potential demand clusters for hydrogen in India – end use industry (contd.)

#### End use industry – Urea and Ammonia (Contd.)



Sou

Source: Eninrac research, MoC&F, Channel Checks

## Identification of potential demand clusters for hydrogen in India – end use industry (contd.)

#### End use industry – Steel Manufacturing



# Identification of potential demand clusters for hydrogen in India – end use industry (contd.)



Source: Eninrac research, MoS, State's Industry Profile, Channel Checks

#### Market Research 2021

# Identification of potential demand clusters for hydrogen in India – end use industry (contd.)

#### End use industry – Steel Manufacturing (Contd.)



Potential demand hubs for hydrogen

### Identification of potential demand clusters for hydrogen in India – end use industry (contd.)

#### End use industry – Refineries & Chemical Units Potential demand clusters for hydrogen w.r.t

#### Number of refineries in India





Source: Eninrac research, MoPNG, Channel Checks

### Identification of potential demand clusters for hydrogen in India – end use industry (contd.)

End use industry – Refineries & Chemical Units (contd.)





J&K – Jammu &

Kashmir

#### Source: Eninrac research, MoC&F, Channel Checks

#### Market Research 2021

# Identification of potential demand clusters for hydrogen in India – end use industry (contd.)

End use industry – Food Processing

Number of Operational Mega Food Parks



Potential demand hubs for hydrogen across the mega food park segment



Market Research 2021

# Identification of potential demand clusters for hydrogen in India – end use industry (contd.)



#### End use industry – Food Processing (contd.)



#### Market Research 2021

## Identification of potential demand clusters for hydrogen in India – end use industry (contd.)

End use industry - Gas Fired Power Plants



Potential demand hubs for hydrogen across gas power segment

State wise gas fired installed capacity in India (GW)



MH- Maharashtra GU- Gujarat

RJ - Rajasthan

HR – Harvana

Source: Eninrac research, MoP, Channel Checks

## Identification of potential demand clusters for hydrogen in India – end use industry (contd.)



# Identification of potential demand clusters for hydrogen in India – end use industry (contd.)

#### End use industry - Solar & Wind Power (Contd.)

Potential demand hubs for hydrogen across solar power segment w.r.t large capacity (above 500 MW) solar parks



Source: Eninrac research, MoS, Channel Checks

## Identification of potential demand clusters for hydrogen in India – end use industry (contd.)



Source: Eninrac research, MNRE, Channel Checks

# Identification of potential demand clusters for hydrogen in India – end use industry (contd.)



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### 14.2 – Transportation Ease

Hydrogen is already playing a vital role in the transport sector across the globe, India too is anticipating major transformation

#### ROLE OF HYDROGEN IN TRANSPORTATION

Hydrogen has already played a transformative role in many global economies. For instance, the US transport sector has witnessed a significant role of hydrogen in the material handling of goods at distribution centers in all continental states and Canadian provinces. The next sectors of interest include light-, medium- and heavy-duty road transport, heavy and urban light rail, and ships. Altogether, the transport sector accounts for 35 percent of US carbon emissions and is a key contributor to local air pollution, making a transition to zero emissions options a priority. The two primary options for zero emission transportation are electric drive trains powered by hydrogen fuel cells in FCEVs and batteries in BEVs.

Both are used for light-, medium-, and heavyduty vehicles, but FCEVs store energy as hydrogen (15 kWh per kg) and convert it to electricity - as needed - via a fuel cell, while a BEV stores energy as electricity in a battery. In India also, a lot of development work has been initiated by the government for usage of hydrogen in the transport sector. The Ministry of Road Transport and Highways, India has already notified hydrogen fuel cell vehicles in automotive industry standard (AIS) 157. Also, in September 2020, its has been notified that 18% of the hydrogen to be blended with CNG to make HCNG as an automotive fuel. Various hydrogen powered vehicles have been developed and demonstrated under projects supported by the Indian government. These include 6 fuel cell buses (by Tata Motors Ltd.), 50 hydrogen enriched CNG (H-CNG) buses in Delhi (by Indian Oil Corporation Ltd. in collaboration with government of NCT of Delhi), 2 hydrogen fuelled internal combustion engine buses (by IIT Delhi in collaboration with Mahindra & Mahindra),

"

Hydrogen can also be used as a feedstock to produce low carbon fuels like synthetic fuel for aviation and marine shipping

- Hydrogen Roadmap, US

# Hyundai, Tata Motors, Toyota eyeing NTPC's hydrogen fuel cell vehicle project

15 hydrogen fuelled 3 wheelers (by IIT Delhi in collaboration with Mahindra & Mahindra), 2 hydrogen –diesel dual fuel cars (by Mahindra & Mahindra) and 1 fuel cell car (by CSIR – National Chemical Laboratory , CSIR- Central Electrochemical Laboratory and CSIR – National Physical Laboratory).

Further, as a part of the pilot project, NTPC may run super- luxury hydrogen buses between Delhi and Jaipur, one of the busiest routes in north India. Initially, a total of 10 buses and 10 cars for Leh and Delhi is expected to be rolled out.

In December 2021, Pune based Sentient Labs launched a 32 seater hydrogen fuel cell bus that shall provide a range 450 kilometers by utilising 30 kg of hydrogen. Satient Labs has designed and developed the hydrogen bus in collaboration with CSIR. Further, there are plans to convert 5 lakh buses from the total of 20 lakh running on roads into fuel cell powered vehicles.

### Fuel cell system costs in the US for the transportation sector decrease with greater production



Source: Eninrac research, US Department of Energy, Channel Checks

## Low carbon fuel pathways for aviation and shipping segment in the US – Potential Case Study for India

Low carbon fuel pathways tested in the US			Production Process	Source of carbon/main feedstock	Level of maturity
<b>Aviation</b> (Low carbon jet fuel)	Biofuel	HVO biokerosene	Hydrotreatment	Vegetable oil (virgin and recycled), inedible animal fats, municipal solid waste if oil can be extracted (in research)	
		Alcohol to jet fuel	Anaerobic fermentation/ aqueous phase reforming	Edible or inedible biomass (wood, grass, waste), biogas	
		Kerosene equivalent	Metabolic pathway for biomass to kerosene conversion	Biomass	
	Synthetic Fuel	Biomass to liquids	Fischer-Tropsch	Biogas, inedible/edible biomass (wood, grass, waste), municipal solid waste	
		Power to liquids	Fischer-Tropsch	CO2 (CCU)	



## Low carbon fuel pathways for aviation and shipping segment in the US – Potential Case Study for India (Contd.)

Low carbon fuel pathways tested in the US			Production Process	Source of carbon/main feedstock	Level of maturity
Ships (Low carbon bunker fuel)	Biofuel	HVO renewable diesel	Hydrotreatment	Vegetable oil (virgin and recycled), inedible animal fats, municipal solid waste if oil can be extracted (in research)	
		Biodiesel (Fatty acid esters)	Transesterification	Vegetable oil (virgin and recycled), inedible animal fats	
		Biocrude	Pyrolysis	Inedible biomass (forest, sludge, straw), plastics	
		Compressed/ liquified biogas	Anaerobic digestion	Biogas	
		Solid biomass	Palletization gasification	Biomass	
	Synthetic Fuel	Biomass to liquids	Fischer-Tropsch	Biogas, inedible/edible biomass (wood, grass, waste), municipal solid waste	
		Power to liquids	Fischer-Tropsch	CO2 (CCU)	
		Methanol	Synthesis from syngas	CO2 (CCU)/natural gas, biogas with low carbon hydrogen	
		Dimethyl ether	Dehydration synthesis	Methanol, carbonaceous feedstocks	

Commercially produced

In pilot

ln research

Hydrogen to upgrade /improve yield

Pathway uses hydrogen feedstock

## Low carbon fuel pathways for aviation and shipping segment in the US – Potential Case Study for India (Contd.)



### Identification of potential demand clusters for hydrogen powered vehicles



Source: Eninrac research, CEEW, Channel Checks

### 14.3 – Development of support infrastructure index



### 14.3 - Development of support infrastructure index (Contd.)



### 14.4 – Potential demand of hydrogen by industrial hubs

**C** Industrial zones

identified in India

Industrial zones that have high concentration of industrial segments – agro based & food processing, pharma, chemicals, secondary steel, textile, engineering & assembly etc.

Industrial zones that have high concentration large industrial segments – refineries, chemicals, petrochemicals, fertilizers, power generation, automobile, textiles, heavy engineering, secondary steel etc.

Industrial zones that have high concentration of industrial segments – steel, secondary steel, engineering etc.



Source: Eninrac research, State's Industry Profile, Channel Checks





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