### 3. USD 100 MILLION GREEN HYDROGEN INVESTMENT FUND TO BE RAISED, FOR DEPLOYMENT OVER NEXT FIVE YEARS

Funding is a key for building out large, demonstration projects at an early stage of green hydrogen ecosystem development. Moving beyond R&D spending in hydrogen, India should raise a USD 100 million Green Hydrogen Investment Fund, supported by bilateral and multilateral agencies, to take the first step towards scoping, funding and executing large development stage projects, over the next five years.

The USD 100 million fund corpus for five years (about USD 20 million per year) is indicative amount for identifying and implementing at least 4-5 of the identified 10 national hydrogen demonstration projects. The corpus for following five years, possibly five-fold, to meet 2030 ambitions and increasing scale of the first set national demonstration projects.

The Green Hydrogen Investment Fund can fit within the existing institutional framework for Climate Change funds, governed by the Climate Change Finance Unit in the Ministry of Finance (MoF) or under the Ministry of Environment and Forests. An alternative would be to create a co-funded mechanism (with global pension, climate change funds, multi-lateral funding agencies) within the National Infrastructure and Investment Fund (NIIF), formed by the Government of India (governed by Ministry of Commerce or Ministry of Heavy Industries), to be deployed for national hydrogen projects.

### 4. NATIONAL ASPIRATION FOR FOUR PERCENT HYDROGEN SHARE IN NATIONAL ENERGY MIX BY 2030

India should put forward an aspirational H2 economy target of four percent energy share by 2030 – this works out to a little over 50 percent of natural gas share in 2018. In volume terms, this would represent about 13 MMT of hydrogen demand by 2030 and is comparable to the 17 MMT being targeted by US and 15 MMT by EU.

A national hydrogen demand of 13 MMT by 2030 represents about 10 percent of India's total hydrogen potential by 2040 (as per ERISA 2019 study, India's total hydrogen potential in 2040 is estimated to be 600 MMTOE or 127 MMT of hydrogen).[10]

### 5. INTER-MINISTERIAL GREEN HYDROGEN GOVERNMENT CELL TO ENSURE FOR GLOBALLY HARMONISED STANDARDS

Creation of an inter-ministerial green hydrogen government agency or department will be important to ensure coordination between new energy policies, national demonstration projects that will require strong centre-state collaboration, Climate Change funding, Make-In-India domestic manufacturing initiatives with the FAME and Renewables expansion initiatives.

A central agency will also ensure adherence to globally harmonised and safety standards that are critical for commercialisation of hydrogen technologies in India.

#### INTENDED OUTCOMES BY 2030

1. New 'Hydrogen-focused' Climate Change Funding – estimated USD 100 million for five-year period, potentially grow to USD 500 million till 2030
2. Increase H2 demand – through H20 blending in gas by 2030, new and scalable H2 use cases
3. Provide policy clarity to sectors, public and private investors, citizens– charting out a clear green hydrogen roadmap that aligns EV-New Energy investments, with Renewable Energy plans, to move India towards net-zero carbon.
4. Encourage co-funding, consortia formation for large national demonstration-stage projects
5. Bring in global hydrogen investors to create domestic manufacturing capability, bring in critical electrolyser and FCEV technology know-how
6. Create new green hydrogen economy jobs, create momentum for energy transition in different sectors

10 Chapter 4 'The Potential and Costs of Hydrogen Supply', Demand and Supply Potential of Hydrogen Energy in East Asia, ERISA Research Project Report (2019)

## National Green Hydrogen Demonstration Projects and Use Cases

### 6. GREEN HYDROGEN PRODUCTION COUPLED WITH USE-CASES, H20 HYDROGEN BLENDING IN NATURAL GAS

The white paper emphasises that India should develop the national green hydrogen ecosystem by evaluating and implementing large green hydrogen demonstration projects in regions with high solar or wind energy potential. This mirrors the approach taken by EU and avoids expensive hydrogen transportation across large distances. The renewable-energy rich states of Rajasthan, Gujarat, Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu will emerge as natural destinations for hydrogen projects and will require capacity building at the state department level.

Some blue and grey hydrogen production (using Steam Methane Reformation) could be considered, as an interim step, and encouraged to evaluate unique Indian use-cases in coal-gasification, or urban/municipal biogas, with the long-term intent of transitioning them towards zero-carbon.

Hydrogen-blended Compressed Natural Gas (H-CNG) is already being evaluated for mainstream adoption as a clean fuel automotive alternative and interim step. The government is currently working on 18 percent hydrogen blending and the Bureau of Indian Standards (BIS) is developing domestic specifications for it after due testing. Globally, hydrogen-blending of 20 percent in natural gas is being considered and this could be the aspirational target for India by 2030. This is the fastest route to increase hydrogen demand without investing in expensive hydrogen infrastructure.

### 7. TEN NATIONAL H2INDIA INFRASTRUCTURE PROJECTS FOR LARGE SCALE DEMONSTRATION

The white paper proposes that India should explore ten potential large-scale demonstration projects, across different use-cases – from long-haul, heavy duty transport (trucking, trains), to industrials clusters (ports, logistics hubs), sectoral clusters (steel, fertiliser, cement, mining) and urban municipal (waste). These are based on hydrogen use-cases in other parts of the world and have to be evaluated further for techno-commercial and financial viability before they are designated national hydrogen projects.

#### a. H2Bharat Long-Haul Trucking project - 10,000 H2 truck fleet and infrastructure on DMIC

Green hydrogen-powered long-haul and heavy duty-trucking has been growing within the transport segment, working in tandem with battery-powered EVs passenger cars, light-transport and buses. The white paper proposes an aspirational H2 trucking corridor, as part of the Delhi-Mumbai Industrial Corridor (DMIC), with at least 10,000 hydrogen truck-fleet (in two phases) and 10 hydrogen refuelling stations along this corridor by 2030 (based on the 1:1000 ratio between fleet size and refuelling infra, as planned in EU and California). This avoids the challenges of a nation-wide initiative that would require hydrogen re-fuelling infrastructure to be built nationally. This is akin to the EU H2Haul and EU HyAMMED1 project in Europe.

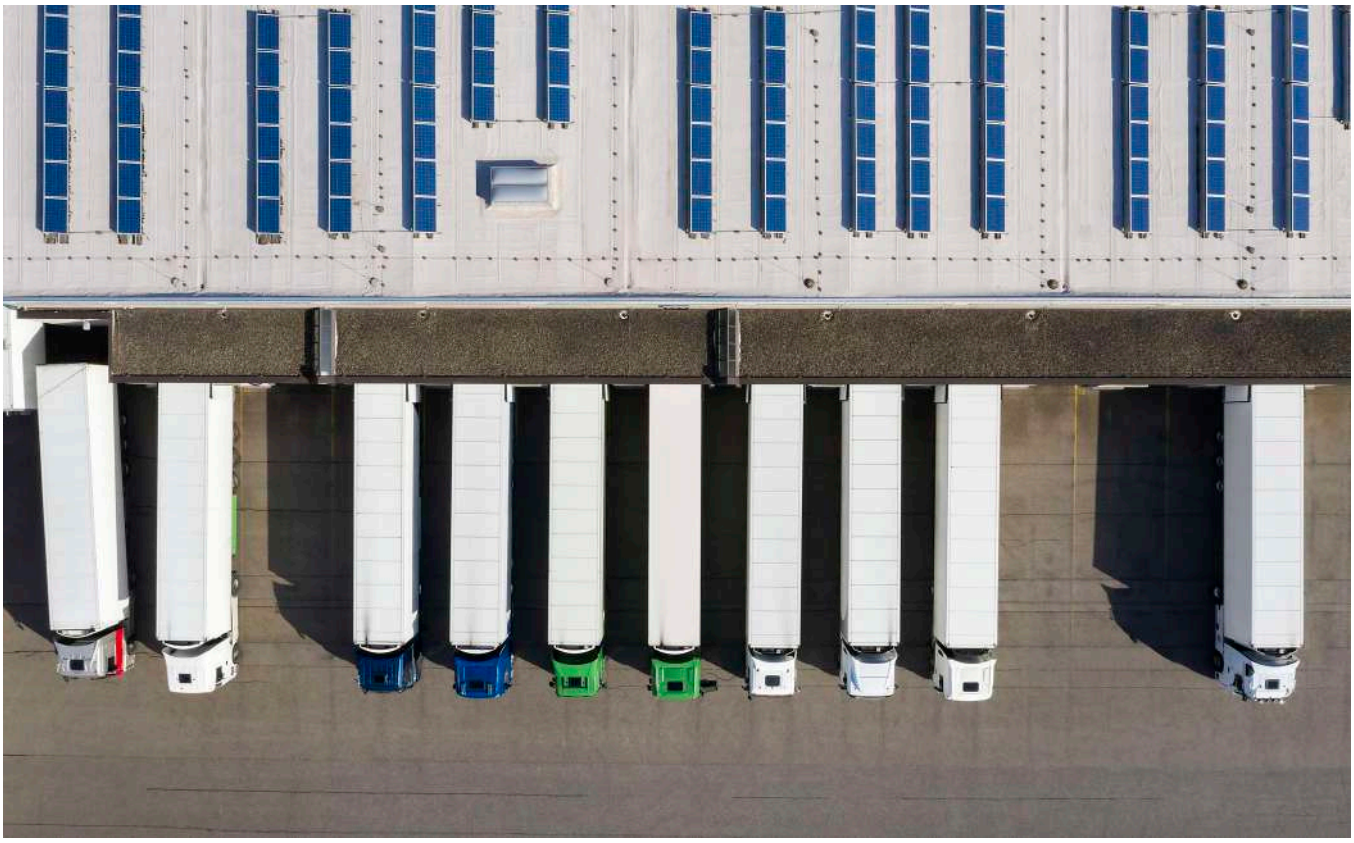
The industry and government should work together to grow H2 truck fleet along this corridor, to target conversion of about 10 percent of long-haul trucking along the DMIC route to be hydrogen-fuelled truck FCEVs. This would allow existing truck manufacturers as well as new FCEV truck manufacturing players, plan for new investments and take focused, informed decisions to manufacture mobile FCEV stacks for heavy, long-haul trucking, thereby bringing FCEV costs down. With an aspirational H2 truck fleet of 10,000 vehicles by 2030, India would have 25 percent of planned H2 trucks in EU by 2030 (and three percent of the global 350,000 H2 trucks estimates[11] by 2030 as per the Hydrogen Council; 10,000 trucks represents one percent of new truck sales in 2019).

The white paper is working with the hypothesis that that industry will be able to come together, to form an H2Bharat Trucking consortium, that works with the government to implement a national project of this scale and ambition, necessitated by the risk profile and economic costs associated with such a project.

*EV-hydrogen bi-mode Freight Trains along the DMIC – a possibility*

*A similar H2Bharat Rail Consortium (starting with rail freight) along the same corridor, bringing together India Railways and other private operators could also be explored. Bi-mode trains that run on both electric/batteries and hydrogen have already been launched in Europe. India could aspire to have an aspirational 10 electric-hydrogen bi-mode freight trains within the next decade.*

11 https://hydrogencouncil.com/wp-content/uploads/2017/11/Hydrogen-scaling-up-Hydrogen-Council.pdf



### b. H2Bharat Port and Logistics Clusters – linked to H2India Trucking project along DMIC

Two major seaports (Mundra and Nhava Sheva) and multiple logistics clusters along the DMIC provide an organic link to any proposed H2India Trucking project and use diesel-powered machinery (fork-lifts, cranes, trucks) to move heavy equipment, containers and freight within their periphery. Decarbonizing such fleets, swapping diesel with locally produced hydrogen (with small/ midsized electrolysers or natural-gas powered production plants) and incorporating hydrogen-powered heavy equipment could create 'green ports' and 'green logistics hubs' over time.

Starting with modest targets such as swapping 30 percent of heavy-equipment and fleets to be hydrogen-powered by 2030 is one to start with this transition – supported by fiscal incentives for achieving these targets. Port Authorities and Logistics Cluster Concessionaires/ Authorities that choose to adopt and increase hydrogen use should be designated H2Bharat Ports and Logistics Clusters, and on submission of their hydrogen plans, supported with fiscal incentives by the government. Once successful, this can be replicated in other major ports (including on the east coast) as well as at other logistics clusters.

### c. H2India Industrial Clusters– in high-priority sectors (steel, fertilisers, cement, mining)

The above approach (b) can be replicated in other specific sectors, particularly large plants in steel and fertiliser sectors, linked to the sectoral energy transition roadmaps. Given the current high costs of hydrogen, sectoral adoption should be encouraged by larger players or industrial plants first, offering them incentives for putting up small and midsized electrolysers or H2 production plants within their premises and adding hydrogen-powered FCEVs and heavy equipment within plant premises. This could start with a similar 30 percent target across the plant by a 2030 timeline, with fiscal incentives for achieving such a plan.

The choice of production technology, plant size or hydrogen type (green, blue/grey) should be left to the plant owners/leads so that they can make an informed choice based on suitability, with the highest fiscal incentives for green hydrogen production and use. Detailed sectoral studies have been prepared by TERI for India use-cases in steel and the fertiliser industries, with recommendations on the hydrogen adoption paths that could be pursued by key players.

Leveraging India's coal reserves in Eastern India, and its proximity to iron ore deposits and steel plants, it may be prudent for India to evaluate blue or grey hydrogen production in the eastern region, using brown-coal and coal-gasification. Blue or grey hydrogen that is produced in the region can be consumed at the steel plants and mines (mine equipment, heavy earth-moving evacuators) close to the production centres. While this merits further study, it could open the possibility of a coal/synthetic-gas powered Grey Hydrogen Valley in the eastern states of Odisha-Jharkhand-Chattisgarh. To be effective, state-owned and private players will have to come together to invest and co-build such grey hydrogen production facilities, and pledge to targets such as transitioning 20 percent H2 heavy mining equipment (earth-movers, excavators, dampers, trucks) in the ore mines belts by 2030 or introducing in 2000 FCEVs heavy vehicles in the mining belts.

### d. Municipal-level H2Maharashtra / H2Gujarat Urban Bio-Gas projects – solid waste, dairy cluster

Green hydrogen production from bio-waste or bio-gas reformation is being explored in some parts of the world and can be evaluated by certain large municipal bodies that can guarantee a significant and steady supply of solid waste input for a bio-gas reformation plant.

From a structuring and financing point, municipal bodies in specific states may have an advantage to be able to finance and fund such a green hydrogen production plant and find local use cases in industries or industrial clusters close to the city/municipal area. Given past success with green bonds by municipal bodies from Gujarat and Maharashtra, the white paper has proposed that the demonstration projects should include possibly one such green hydrogen production plant. A similar approach can be taken with small/medium green hydrogen production centres that are linked to large dairy clusters that can guarantee an assured and sustained supply of biogas.

#### INTENDED OUTCOMES BY 2030

1. Case for domestic manufacturing of 12,000 heavy-duty FCEVs by 2030, FCEV capex costs expected to come down significantly (TCO differential between H2 and diesel expected to come down from 3x currently to 1.2x by 2030)
    a. Domestic manufacturing opportunity for 10,000 FCEV systems/ stacks, 10 H2 re-fuelling stations, storage and H2 system components – estimated as a direct result of H2India Trucking Project, by 2030
    b. 1000 Mobile FCEVs for heavy-duty machinery/ equipment in ports and logistics clusters estimated, by 2030
    c. 1000 Mobile FCEVs for heavy-duty machinery/ equipment, plant fleet/trucks in steel, fertiliser, mining clusters
2. Aspiration to build GW-scale electrolyser capacity by 2030 for key use cases and develop the domestic supply chain
3. 10 percent of Coal Gasification 2030 target (100 MMT) to be converted for H2 production
4. 75,000 hydrogen-related direct and indirect jobs to be created (25,000 direct, 50,000 indirect) – H2 trained operations personnel, FCEV drivers and systems engineers, electrolyser and FCEV manufacturing and design

## Green Hydrogen Public-private Partnerships, Industry Consortia

Reviewing how green hydrogen ecosystems have developed in other countries, availability of public funding, large-scale demonstration projects and the formation of partnerships / industry consortia are three key imperatives. India lacks both at present and should prioritize them if it wants to develop a green hydrogen ecosystem to develop.

### 8. FISCAL INCENTIVES FOR LARGE-SCALE NATIONAL H2 PROJECTS; PARTNERSHIPS AND INDUSTRY CONSORTIUMS

The white paper recommends the formation of an India Green Hydrogen Taskforce, comprising of public and industry representatives, as part of the policy interventions. While this will be useful for public-private collaboration.

India can take a leaf out of the practice in Japan and Korea to create an industry consortium that is committed to building a green hydrogen ecosystem in India. The government should encourage the formation of such an industry consortium and can play an enabling role by extending fiscal incentives to industry consortia-led hydrogen demonstration projects. This is a critical intervention to address the current gap in the ecosystem. Such consortia should be represented by multiple players that operate across the hydrogen value chain, rather than a single part or use-case. Sectoral or production-focussed players can form work-groups to ensure expertise is pooled but the benefits should accrue to the entire ecosystem e.g. a long-haul H2 trucking project should be connected to industrial clusters that are serving by the trucking route as well as seaports (seeing trucking in isolation as part of automotive will be counter-productive).

The Government of India as well as industry consortia, once formed, should focus on the following priorities:

- Promote electrolyser and FCEVs domestic manufacturing - systems, components
- Work towards creating Global Tier I supplier relationships between Indian players and global H2 OEMs within five years, with a clear target for what needs to be achieved by 2030 and grown as H2 exports.
- Leverage strategic G2G partnership for green hydrogen development - partnerships with Japan (DMIC), Korea (H2) – to attract inward H2 investments from lead companies in those countries.
- Develop local policy and industry capacity – this would include training and awareness about green hydrogen, the energy transition imperative, how green energy fits with EV/battery tech and renewable as well as ensuring that Indian stakeholders are well equipped to take hydrogen related decision (for projects or capital allocations).

#### INTENDED OUTCOMES BY 2030

1. Draw the interest of global FCEV truck/heavy duty transport players to India, invite investments and create incentives by offering them economic incentives, opportunity to scale.
2. Encourage industry to invest in local manufacturing, research/testing and implementing large demonstration-stage projects.
3. Commercialise indigenous GH2 tech, systems and explore its export potential.

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