NITI AAYOG – IH2A Workshop

FUNDING INDIA'S HYDROGEN CLUSTERS & PROJECTS

February 17 2022

NOTE: Information presented in this deck is indicative and for discussion purpose only. They do not represent official figures or national targets.

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Welcome Speakers & Participants

AGENDA (IST)	
4:00 – 4:07 pm	**Opening Remarks** Amitabh Kant, CEO, NITI Aayog
4:07 – 4.40 pm	**SESSION ONE – Funding H2 Clusters and Projects** – Replicating global experience **International Perspective (View from Europe) –** Gordon McIntosh - Aberdeen International Associates **Multilateral Funding' Perspective –** Donal Cannon – EIB John Dulac – OECD Vivek Jha - IFC Pim van Dijke – FMO Dr. Winfried Damm – GIZ Sameer Usgaonkar - CDC
4:40 – 5:25 pm	**SESSION TWO – Funding Gen1 GW-Scale National H2 Projects and Clusters –** Public and Private Funding, Consortia Approaches for first 5 GW scale GH2 Projects and Clusters Rajnath Ram – NITI Aayog, Govt of India Dr. Anurag Pandey – Reliance Industries Limited (RIL) Dr. Vandana Kumar – Ministry of New and Renewable Energy (MNRE), Govt of India Jill Evanko - Chart Industries KR Jyothilal – Government of Kerala Prabodha Acharya – JSW Steel Srivatsan Iyer – Hero Future Energies **Next Steps**
5.25-5.30 pm	ReCap and Closing Remarks – IH2A Representative

GOVERNMENT PARTICIPANTS

NITI Aayog
Ministry of New and Renewable Energy (MNRE)
Ministry of Power (MoP)
Ministry of Petroleum and Natural Gas (MoPNG)
Ministry of Steel (MoS)
Govt of Kerala
Govt of Gujarat

MULTILATERAL AGENCIES, SOVEREIGN AGENCIES

European Investment Bank (EIB)
OECD
CDC
GIZ
FMO
IFC
UNIDO
UK & Scottish Govt
Dutch Govt

INDUSTRY PARTICIPANTS

Reliance Industries (RIL)
JSW Group
Chart Industries
ThyssenKrupp
Hero Future Energies
Tata Group
NTPC
IOCL
Adani Group
ACME
L&T
Siemens
Bloom Energy
Ohmium
KPIT
Linde
Equinor
H2e Power
FTI Consulting

Opening Remarks

Shri Amitabh Kant
CEO,
NITI Aayog

The Hon'ble PM's announcement of a five-point agenda to deal with the challenge of climate change at COP26 has put India at the forefront of driving climate change. India has for the first time targeted a timeframe to achieve net zero carbon – by 2070. This is only possible by giving a major push to green hydrogen and developing its related infrastructure.

It is our aim to bring down the cost of hydrogen to $2.5/kg by 2025 and $1/kg by 2030. This is possible only by increasing size and scale of hydrogen manufacturing.

Demand for hydrogen is projected to grow to 11.7 million tonnes by 2030 from 5.6 million tonnes today. India's core competence lies in green hydrogen sector because it has the potential for renewable energy, private sector initiative, and support from government. With rapidly falling renewable energy costs, India's green hydrogen production cost is expected to be amongst the lowest in the world.

Funding H2 Clusters and Projects – replicating the global experience

View from Europe and Multilateral Funding Perspective

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H2 ABERDEEN CLUSTER

1) **Aberdeen Bus Project**
2) **EU-funded HyTransit**
3) **HyTrEc**
4) **FC Train**
5) **TheAcornProject**
6) **Part of HyER – region, EU/UK linkages**

TAKEAWAYS FOR INDIA

a) Benefits and synergies of a cluster approach – different use-cases
b) Municipal, regional and national collaborations
c) Link co-located projects/ clusters into a larger hub

SEAH2LAND & NORTH2 CLUSTERS

1) **Orsted - SeaH2Land GH2 project** - 2 GW offshore-wind, 45-km pipeline between Netherlands and Belgium. **Supported by ArcelorMittal, Yara, Dow Benelux, Zeeland Refinery, North Sea Port and Smart Delta Resources**
2) **NortH2 (10GW, Netherlands)** - Offshore Wind, Shell, Equinor, RWE, Gasunie, Groningen Seaports

TAKEAWAYS FOR INDIA

a) Public and private co-development of projects
b) National showcase projects key for first-generation GW-scale H2 projects
c) Regional cluster approach along the coast

H2 CLUSTER REMIT – PRODUCTION + CONSUMPTION

FUNDING MECHANISM & PROJECT DEV

PRIVATE + PUBLIC ACTORS, COLLABORATION

European Investment Bank

CDC Investment works

IFC International Finance Corporation WORLD BANK GROUP

OECD

FMO Entrepreneurial Development Bank

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Aberdeen Bus Project, HyTransit, AcornProject – Aberdeen (Scotland)

Aberdeen Bus Project

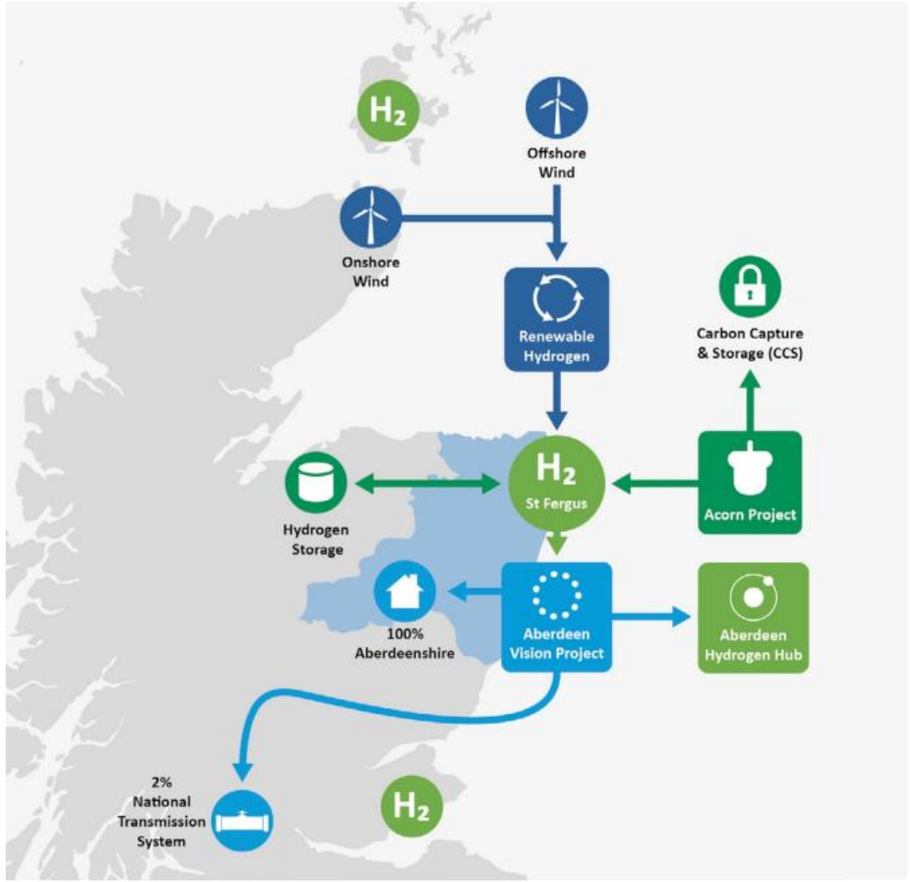
- Started with - 10 x Buses, 2 x Fuelling Stations, Service Garage
- Today - 25 x Double Decker Buses, 58 Vehicles in total, Aberdeen Hydrogen Hub
- £19million demonstration project

HyTransit and High V.Lo City (separate EU funded projects)

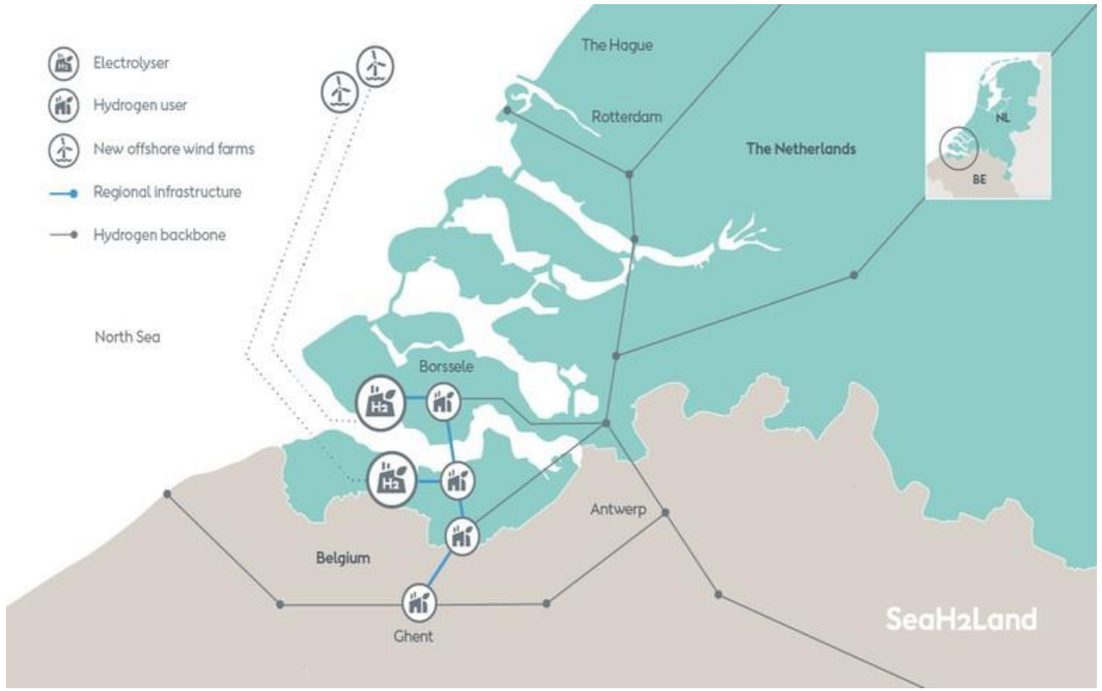
- Hydrogen production & re-fuelling station
- Dedicated bus maintenance facility
- Use hydrogen storage as a means of managing electrical grid constraints
- New website developed under HighVLOCity in collaboration with other bus projects

Other Key Projects

- **The Acorn Project**
- **Highland Hydrogen Highway (H-3)**
- **Cromarty Firth**



1 GW Electrolyser Plant and Project – SeaH2Land (Netherlands)



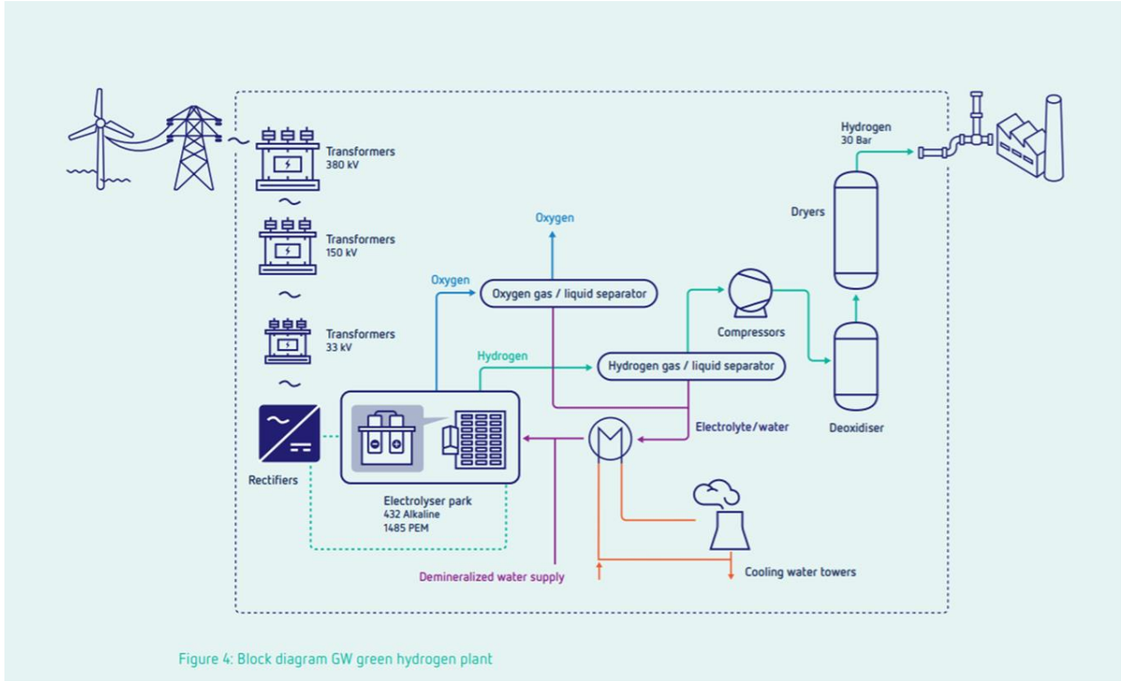


Figure 4: Block diagram GW green hydrogen plant

Key Interventions

Acting as the catalyst for, Cross border collaboration was imperative for development of a Hydrogen Strategy and Action Plan for Aberdeen City Council. 50% of the £19m funding was provided by the FCH JU at EU level, with other half coming from Innovate UK, The Scottish Government and Scottish Enterprise.

It took ~10 years for the H2 Aberdeen project to move from inception to completion. India should plan for similar planning and project development horizons.

Gordon McIntosh, Aberdeen International Associates

Over past eight years, EIB has provided over €2 billion in advisory and financial support to projects, primarily RDI projects with private sector organisations and pilot schemes in public transport. It has a strong pipeline ~€6 billion of hydrogen projects… The majority of projects seen so far are in the 10 – 200 MW range. The largest proposal to date is Hydrogen Europe's 2x40GW Green Hydrogen Initiative. They are proposing to install 40 gigawatts of renewable hydrogen electrolyser capacity in the EU by 2030 and import a further 40 gigawatts from electrolysers in neighbouring countries, in particular North Africa. However, this proposal is still at an early stage of its development.

Industrial clusters have a big role to play in the clean energy transition. Europe is home to 3,000 such industrial clusters. Hydrogen and other industry clusters allow for production and consumption to happen at the same place, eliminating the need to invest in long-distance infrastructure. The fact that India is considering H2 clusters and hubs for commercialisation in its mission document will help address some of the key risks that lie between GH2 producers and off-takers and will help accelerate its development.

Donal Cannon, European Investment Bank (EIB)

SeaH2Land (Netherlands) is an ambitious vision, linking GW-scale electrolysis to the large industrial demand in the Dutch-Flemish North Sea Port cluster through an envisaged regional cross-border pipeline. Danish energy major Ørsted, who has been tasked to build the project has proposed to directly connect to 2 GW of new offshore wind power in the Dutch North Sea with the goal to create a regional network for large hydrogen consumers… A 500-MW Electrolyser would be built in the first phase followed by another 500 MW before 2030. The SeaH2Land network could convert about 20% of the current consumption to renewable hydrogen. India should be looking at similar H2 hub projects and we would be happy to support such projects.

Pim van Dijke, FMO

Hydrogen is not a traded product currently and most of the largest users of hydrogen are producing it themselves, so market is almost non-existence.

From a long-term lending perspective, bringing down the cost of hydrogen is of utmost importance for commercialisation. In the period leading up to this, capital that is able to take higher risk will be required.

Sameer Usgaonkar, CDC

OECD and NRDC are in the process of developing a clean energy finance and investment roadmap with the government. Partnerships are important for both production and scaling the hydrogen ecosystem, which is also visible from some of Europe's hydrogen projects and clusters.

John Dulac, OECD

Key Interventions

The World Bank Group (that is, IFC and the World Bank) is working across multiple analytical pieces in green hydrogen with an aim to support an investment of ~$1Bn in India. The World Bank is undertaking a GIS based exercise to map out key resources (such as, water, infrastructure, etc.), production and consumption centres/clusters, potential transportation hubs, etc. The idea is to create a tool leveraged to identify areas/resources necessary to build hydrogen infrastructure while also prioritizing the early investments.

The World Bank Group looks forward to supporting the government and industry in development of H2 clusters and hubs.

Vivek Jha, World Bank Group

German Govt is aiming to become climate neutral by 2045 latest. Coal exit has to be finalized by 2038 latest. Until 2030, 5 GW of national green hydrogen production capacities are planned which are able to cover around 10% of Germany's entire green hydrogen demand by 2030. Therefore Germany's National Hydrogen Strategy, which provides €7bn to ramp up domestic production and related value chains also provides €2bn to establish international partnerships for hydrogen production and import, supporting strategic partner countries to scale up their renewable energy capacities and green hydrogen production.

Several funding opportunities are offered by Government of Germany in case India would be interested to supply green hydrogen to Germany. Example 1: If India is supplying green hydrogen at $5/kg and German industry is willing to buy at $1/kg then the difference will be offset by Government funding (more on mechanism similar to the Contracts for Difference (CfD) approach 2: Green hydrogen viability gap funding of up to 15 Mio. EUR per project (see also https://www.ptj.de/en/project-funding/international-hydrogen-projects-bmwk-module-1) Example 3: Official technical (through GIZ, PTB) and financial (through KFW) cooperation based on bilateral cooperation agreements (under Indo-German Energy Forum) between both Governments to support the development of industry roadmaps, industry clusters and hubs, international standards for safety in production, transport and storage, introduction of required certification for export, storage terminals etc.

Germany believes in India's capability to manufacture globally cost-efficient green hydrogen. While Germany certainly is aiming for technological leadership in green hydrogen, the aim to bring the cost for green hydrogen down globally is even more important for Governent of Germany (remaining an energy net-importer also in a renewable energy based green hydrogen economy). Germany welcomes the discussion on H2 clusters and hubs as it is an important route to develop the hydrogen economy in India and is willing to support pre-feasibility studies if requested by Govt. of India. India may want to avoid future land conflicts related to increased solar and wind capacity additions for green hydrogen production and specifically focus on projects involving GW-scale Agri photovoltaics and Offshore Windfarms when focusing on the export market.

Tobias Winter, GIZ

Funding Gen1 GW-Scale National H2 Projects and Clusters

- **Public Funding and Policy Support for Gen1/National Projects** – Central and State Govt. Perspective
- **Private Funding to GW-Scale H2 Projects** – Private and Consortia Approaches for first 5 GW Scale Projects/ Clusters

FTI CONSULTING™

Funding GW-scale Green Hydrogen Clusters and Projects in India

Govt and Industry Perspectives – Public and Private Funding, Consortia Structures and Support

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Shri Rajnath Ram
Advisor – Power & Energy
NITI Aayog, Govt of India

Dr. Anurag Pandey
R&D Lead,
Reliance Industries (RIL)

Dr. Vandana Kumar
Joint Secretary, MNRE,
Govt of India

Jill Evanko
CEO & President
Chart Industries

Shri KR Jyothilal
Principal Secretary,
Govt of Kerala

Prabodha Acharya
Chief Sustainability Officer
JSW Steel

Srivatsan Iyer
Global CEO,
Hero Future Energies

Key Interventions

India is in a unique position due to its rich RE resources to address a significant portion of this demand. The government is considering a wide range of policy frameworks to bring down the cost of Green H2.

Interstate transport charge waivers, open access to renewable power, waivers at discom/distribution level, and land aggregation measures are all being considered.

Rajnath Ram, NITI Aayog

The cluster approach is valuable as it allows for planned and coordinated development of projects where bulk demand exists. Given the strong export potential of green H2, we are also exploring setting up such clusters/hubs close to ports. The private sector should take the lead on mobilizing funds for large commercial projects. Project de-risking with appropriate funding is key for sunrise sectors like hydrogen. Our targets for Green H2 are among the most ambitious in the world with a strong focus and reliance on mobilizing investments.

Dipesh Pherwani, Ministry of New and Renewable Energy (MNRE)

Kerala has developed a practical roadmap for developing green h2 resources. We have already deployed 10 H2 buses that are currently feeders to the local metro system, which would be increased to 70 H2 buses operating on intra and intercity routes. Our focus is on ultimately reducing the cost of green h2 to $1-$2 per kg. Over the short term, we are focusing on demand aggregation, and on reducing compression and distribution costs. We are therefore actively promoting h2 valleys and highways in the state. We are also engaged in a pilot project with Adani, Ashok Leyland and IIT-Madras to convert Green H2 into Green Methanol. This green methanol can be blended with existing diesel fuels (15-20%) for a cleaner emissions profile.

KR Jyothilal, Government of Kerala

A cluster led approach is important in the early years as it solves the problem of consumption of low density H2 in targeted applications. Clusters are also relevant over the long term because they facilitate the transition to larger integrated projects. Rapidly growing demand will expose bottlenecks in the value chain, as is apparent in the shortage of compressors already manifesting in the marketplace. It is therefore crucial for us to develop a practical and actionable roadmap for the development of a vibrant local hydrogen marketplace.

With an ultimate focus on Green H2, learnings from the production and use of grey and blue hydrogen must inform the policy frameworks that eventually drive this sector.

Dr. Anurag Pandey, Reliance Industries Limited (RIL)

Green Hydrogen is going to play a significant role in decarbonising sectors such as steel production. It is imperative that industry and government work together to implement practical and targeted demonstration projects, for eg in DRI steel making processes using Green H2. As an end user of hydrogen, we are focused on both the generation and utilization of h2 resources, and believe a cluster led approach is ideal for effective implementation of large commercial projects.

Prabodha Acharya, JSW Steel

A cluster led approach is incredibly valuable, as evident from the experience of H2 clusters in UK and EU. It is critical for India to get the economics right, as well as the experience curve. While economics will not be favourable in the beginning, we should consider this an investment in securing the future of this sector.

We must now start implementing dozens of projects nationwide and use the learnings to accelerate education in costs across the value chain. Over time, every step of the value chain will have to get leaner.

Srivatsan Iyer, Hero Future Energies (HFE)

Public & Private Funding for Gen1/National Projects

H2**Gujarat** Cluster, H2**Kerala** Cluster, H2**Maharashtra** Cluster

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H2**GUJARAT** CLUSTER

MASTER CLUSTER DEV PLAN & PROJECTS

1) Public-private H2 cluster blue-print and pre-feasibility study
2) Formation of dev consortia for cluster, projects
3) Policy support and special incentives for projects in cluster
4) Sharing learnings, data all agencies, industry players

CONSORTIA PARTNERSHIPS ACROSS VALUE-CHAIN*

a) **GH2 PRODUCTION** – RIL, Adani (with L&T, ThyssenKrupp)
b) **STORAGE & TRANSPORT** – Chart, IOCL, AirProducts
c) **INDUSTRIAL USE** – RIL (Refineries), JSW, TataSteel, ArcelorMittal (Steel), IFFCO (Fertilizer/ Ammonia)
d) **HEAVY TRANSPORT USE –** TataMotors, NTPC, IOCL, ForkLifts

H2**KERALA** CLUSTER

MASTER CLUSTER DEV PLAN & PROJECTS

1) Public-private H2 cluster blue-print, pre-feasibility study
2) Formation of dev consortia for cluster, projects
3) Policy support and special incentives for projects
4) Sharing learnings, data

CONSORTIA PARTNERSHIPS ACROSS VALUE-CHAIN*

a) **GH2 PRODUCTION** – RIL, Adani (with L&T)
b) **STORAGE & TRANSPORT** – Chart, IOCL, AirProducts
c) **INDUSTRIAL USE** – DeepakFert/ UPL (Fertilizer/ Ammonia)
d) **HEAVY TRANSPORT USE –** IOCL, HPCL, KPIT, Toyota, Hyzon, Port Infra/ForkLifts

H2**STEEL** CLUSTER/ MAHARASHTRA/ TAMIL NADU

MASTER CLUSTER DEV PLAN & PROJECTS

1) Public-private H2 cluster blue-print and pre-feasibility study
2) Formation of consortia for national H2 cluster development
3) Policy support and special incentives for national cluster
4) Sharing learnings, data

CONSORTIA PARTNERSHIPS ACROSS VALUE-CHAIN*

a) **GH2 PRODUCTION** – RIL, Adani (with L&T)
b) **STORAGE & TRANSPORT** – Chart, IOCL, AirProducts
c) **INDUSTRIAL USE** – DeepakFert/ UPL (Fertilizer/ Ammonia)
d) **HEAVY TRANSPORT USE –** IOCL, HPCL, KPIT, Toyota, Hyzon, Port Infra/ForkLifts

GH2 ECONOMY ENABLERS

POLICY SUPPORT

सत्यमेव जयते
Goverment Of India

KERALA

GUJARAT

MAHARASHTRA

FUNDING SUPPORT

European Investment Bank

OECD

IFC International Finance Corporation

CDC Investment works

FMO Entrepreneurial Development Bank

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

GH2 SUPPLY CHAIN & PROJECT DEVELOPERS*

GH2 PRODUCTION & SUPPLY SIDE

Reliance Industries Limited

adani

HERO FUTURE ENERGIES planet positive power

LARSEN & TOUBRO

thyssenkrupp

nel

STORAGE & TRANSPORT

CHART

इंडियनऑयल IndianOil

GH2 DEMAND SIDE/ OFFTAKERS

Reliance Industries Limited

JSW

adani

TATA

एनटीपीसी NTPC

IFFCO

names are indicative and for reference only

KEY TAKEAWAYS & RECOMMENDATIONS

FOR POLICY MAKERS, FUNDING AGENCIES & INDUSTRY

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1 GW-scale Green H2 clusters or hub projects are being planned with co-located Green H2 production and consumption, across different use cases in a single regional cluster or hub. Examples from UK and Europe were shared with all participants (specifically Aberdeen H2 Cluster in Scotland and SeaH2Land and NorthH2 clusters in Netherlands), and it was discussed that this replicating this hub approach would be a pragmatic way forward for commercializing Green H2 in India.

2 The first generation of green hydrogen projects require public funding and policy support. Taking a leaf out of the European experience, India should designate them national projects or 'Special Projects of National Importance' and extend special incentives, as they may not be commercially viable on a standalone basis. All such projects that receive public funding should also provide data and learning from the project back to the public, so that it helps design and implement the next generation of green hydrogen clusters/ hubs and accelerates maturity of the green hydrogen economy.

3 Close public-private collaboration is critical for successful commercialisation of an early-stage clean energy technology like green hydrogen. This requires new collaboration structures and frameworks – they have been essential for large-scale Green H2 commercialisation in Europe, and India should replicate the same by pooling together public and private efforts on green hydrogen. Formation of public-private consortiums for development of national green hydrogen hubs and project clusters is very important, to pool public and private resources and for de-risking early project development.

4 Sovereign green bonds and the use of global climate finance commitments can provide the necessary long-term funding for GW-scale Green Hydrogen projects and clusters/hubs in India. Multilateral and government agencies can play a catalysing role in early market development by part funding design and pre-feasibility studies for the national green hydrogen hubs.

5 Global climate finance commitments of USD 100 bn per annum (for next five years), made by developed economies for deployment in developing economies, and low-cost financing are important for green hydrogen commercialisation and achieving a net zero pathway. All participating multilateral and bilateral funding agencies, specifically EIB, OECD, IFC, GIZ, CDC and FMO, spoke about the availability of funding for GW-scale green hydrogen projects internationally. They also reiterated the lack of a pipeline of development projects as a key hurdle to funding being made available in India.

6 India should prioritize pre-feasibility studies for the first generation of GW-scale green hydrogen clusters and hubs and work towards putting a national hub development plan within the next 18 months. This will be the definitive step towards building a hydrogen economy in India. This is an important pre-requisite for attracting more private and public capital to GH2 projects as well. Pre-feasibility studies for the first set of GW-scale hydrogen hubs should start immediately with five national hydrogen hubs identified in next 18 months.

7 India should demonstrate global leadership in energy transition and Green H2 commercialisation efforts at scale, in 2022 and 2023 (India's G20 Presidentship Year). One way to do this is to form a public-private H2Bharat Hydrogen commercialisation taskforce, with a focus on national Green H2 hub development plan and target pre-feasibility studies for the first five GW H2 clusters/hubs in India within the next 18 months. IH2A, acting on behalf of the industry, proposes to work with NITI Aayog, MNRE and the Government of India, to constitute this joint public-private taskforce and bring together global expertise, capital and project development support to accelerate development of the green hydrogen economy and national green hydrogen hubs in India.

Thank you

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KEY CONTACTS:
IH2A SECRETARIAT: **Prasanto Roy** (Prasanto.roy@fticonsulting.com), **Amrit Singh Deo** (amrit.singhdeo@fticonsulting.com)

2030 Integrated India H2 Supply Chain – Indicative

15-25 GW Electrolyser Capacity, 3-5 MMT GH2 target, USD 25-45 bn funding

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PRODUCTION | STORAGE & TRANSPORT | USES

National Ambition of 3/5/7 MMT, 15/25/35 GW Electrolyser Capacity by 2030, USD 15/25/35 bn*

SCENARIO A - GREEN H2 15X10 –15 GW in 10 years
15 GW Electrolyser Capacity, 3 MMT of GH2 production

- Three 2 GW+, Six 1 GW+ 6-7 400-500 MW Electrolyser Installed Capacity – 8-9 National H2 Hubs/ Clusters
- 30 GW of RE
- USD 15 billion investment (public + private)

OR

SCENARIO B - GREEN H2 25X10 – 25 GW in 10 years
25 GW Electrolyser Capacity, 5 MMT of GH2 Production

- Eight 2 GW+, Eight 1 GW+, 8-10 400-500 MW Electrolyser Capacity – 12-16 National H2 Hubs/ Clusters
- 50 GW of RE (new H2-dedicated RE capacity + 20-22 GW from RE excess capacity)
- USD 25 billion investment (public + private)

OR

SCENARIO C - GREEN H2 35X10 – 35 GW in 10 years
35 GW Electrolyser Capacity, 7 MMT of GH2 Production

- **Ten 2 GW+, Ten 1 GW+, 10-12 400-500 MW** Electrolyser Installed Capacity – 20 National H2 Hubs/ Clusters
- **70 GW of RE**** (new H2-dedicated RE capacity + 20-22 GW from RE excess capacity)
- **USD 35 billion**** investment (public + private)

3-5 MMT Green H2 Storage & Transport Infra

LIQUID

H2 Curdles (tanks/ cylinders), Compressed H2 (CH2) Trailers & Liquified H2 Tanks Hydrogen Carriers (Ammonia), **Liquid Organic Hydrogen Carriers** (Chemical Hydrides) – standards & domestic manufacturing opportunity, EPC/installation, skills & training

GAS PIPELINE

H2 only pipelines, re-using existing or planned Natural Gas pipeline networks – standards, manufacturing, EPC/ installation, skills/training

NEAR-MEDIUM TERM - 2021-30

USD 10-20 bn funding requirement*

INDUSTRIAL H2 OFFTAKE (NEAR TERM)

Refineries (Crude Refining & Gas Blending)
Fertilizers & Green Ammonia Exports,
Miscellaneous small applications
(Glass Making, Semi-Conductors)

INDUSTRIAL H2 OFFTAKE (MEDIUM TERM)

H2 DRI in Steel, Reduction of Ore & Heating

TRANSPORT H2 OFFTAKE (MEDIUM TERM)

Electric fuels (methanol),
Pilots: Mobile Fuel Cells - Multi-modal transport for heavy-duty freight (road, rail, shipping)

LONG-TERM - 2030-50

Additional USD 45 bn (estimated)*

POWER H2 OFFTAKE

Long duration storage, power generation and diesel power-back-up

HEAVY DUTY TRANSPORT OFFTAKE

Mobile Fuel Cells - Multi-modal transport for heavy-duty freight (road, rail, shipping)

NOTE: Information presented here is indicative and for discussion only. They do not represent official figures or national targets.

**all assumptions and investment numbers are indicative*