NET ZERO SUMMITS 2024

WHITE PAPER
GH2 LED DECARBONISATION FOR BOTTOM OF PYRAMID INDIAN H2 INDUSTRY

Prepared By

DEESHA POWER SOLUTIONS PVT. LTD.

Deesha
TOWARDS NET ZERO

August 2024

About Authors

Shardul Kulkarni

Clean Energy Enthusiast | GH2GNH3 Expert

Shardul (Hydrogenwala) is MD & CEO of Deesha Power Solutions Pvt Ltd. He is an energy transition professional with ~23+ years of experience in power and renewable energy. During this tenor, he facilitated investments in energy transition projects with cumulative investment of USD 1 billion+ across multiple geographies viz South East Asia and Western Africa.

In the past, he worked with blue chip organisations like SBICAP, Crisil Infra, Singapore PE Advisory and Tata Strategic. Now he is advising multiple clients for their foray in GH2GNH3. Among others, he is associated as GH2 Expert for a Singaporean Fund.

He has been invited at many industrial events to share his unique point of view in the areas of Green Hydrogen, Net Zero, Energy Transition, waste to energy, Energy Efficiency & Managing Cost of Energy, ash management, coal gasification, etc

Further, he has authored 15+ thought leadership articles on various energy matters including GH2 and Energy Transition arena. In addition to this, he has a YouTube channel "Hydrogenwala" to spread awareness about green hydrogen and green ammonia to industry at large.

Manish Panchal

Strategic Thinker | Business Leader | Investor |
Author of the Book 'DEFINE YOUR ORBIT'

Manish is an Executive Director – Investment Banking Business at Equirus Capital a leading Merchant Bank of India. He is also a Mentor at Deesha Power. He has overall 32 years of experience with equal mix of Industry and Strategy and Operation Consulting.

Prior to joining Equirus he has served as Senior Leader at DuPont Sustainable Solutions (DSS)– a global leader in Operation Risk Management and ESG Consulting. And, prior to DSS he has worked as Sr. Practice Head Chemicals & Energy practice at TATA Strategic Management Group, India's leading Strategy Consulting Firm where he helped 50+ large and medium size corporations for Sustainable Business Growth.

Manish is a 'NEW ENERGY' enthusiast and his area of expertise is Strategy Development, Operationalizing Strategy Execution (Organic & Inorganic), M&A, Turnaround Management and Operation Excellence.

He also has to his credit 50+ business articles published in various industry journals. He has been member of FICCI Chemicals & Petrochemicals Task Force and Think Tank Committees.

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

Introduction

- ✓ India's National Hydrogen Mission is a clarion call to world about its commitment to Net Zero by 2070
- ✓ GH2 is the biggest business disruption of the century
- ✓ Green Hydrogen is key for decarbonization of hard to abet sectors such as glass, cement, steel
- ✓ Global H2 demand is likely to reach to ~400 to 470 MMTPA with share of cleaner H2 in range of ~85-90% as per McKinsey global report.
- ✓ Sixty-two countries have adopted Net Zero commitment, mostly by 2050, either through regulatory (18) or policy (44)

India H2 Demand & Bottom of Pyramid Consumption

- ✓ India – A Consumption driven Economy is aspiring to rightfully gain back it's past economic glory
- ✓ In 2023, H2 market is estimated ~7.2 MMTPA
- ✓ With Cross Border Adjustment Mechanism (CBAM) definitive implementation by 2026 many Indian Industries exporting in EU will need an alternative source of green energy and greener solutions to reduce product carbon footprint and fulfill ESG Scope 2 & 3 emission requirements for the principal importers.
- ✓ This can give rise to opportunities beyond designated energy intensive industries demand for Clean Hydrogen. And, Bottom of Pyramid (BoP) H2 opportunity (comprising of chemical, methanol, steel, glass, pharma, food semiconductors, etc) can be in the range of ~ 800,000 to 900,000 MTPA

GH2 Led Decarbonisation of BOP H2 Industries

- ✓ H2 applications for chemical industry include hydrogenation, H2O2 production and H2 as carrier gas
- ✓ Steel sector uses H2 primarily for annealing ; DRI making could be a gamechanger
- ✓ Pharma industry uses H2 for API manufacturing
- ✓ Glass industry uses H2 for annealing and surface finishing purposes
- ✓ Food production uses H2 for hydrogenation of edible oils and modified alternate packaging
- ✓ Semiconductor industry uses H2 for cleaning & surface preparation
- ✓ Decarbonisation levers include Energy Efficiency, Renewable Energy, Green Hydrogen, Carbon Capture & Utilisation (CCU), Process Optimisation, Supply Chain Optimisation and Circular Economy

Challenges & Opportunities

- ✓ Challenges include RE Round The Clock (RTC) sourcing, landed RE prices, contract demand charges and Permits & approvals which will eventually settle as industry matures
- ✓ Opportunities include presenting a H2 supply solution addressing present risks for the BOP H2 consumers such as availability, tenure, price variation etc
- ✓ In monetary terms, BOP H2 consumption is valued between ~Rs 28,000 Cr p.a. to ~Rs 32,000 Cr p.a. Hardly anyone can ignore such a huge potential.
- ✓ CBAM and Net Zero (NZ) movement may accelerate attractiveness of the economical option for BOP H2 industry

2. INTRODUCTION

2.1 Introduction

India's National Hydrogen Mission is a clarion call to world about its commitment to Net Zero by 2070

"National Green Hydrogen Mission (NHM) is a landmark step towards sustainable development and creating investment opportunities for our youth."

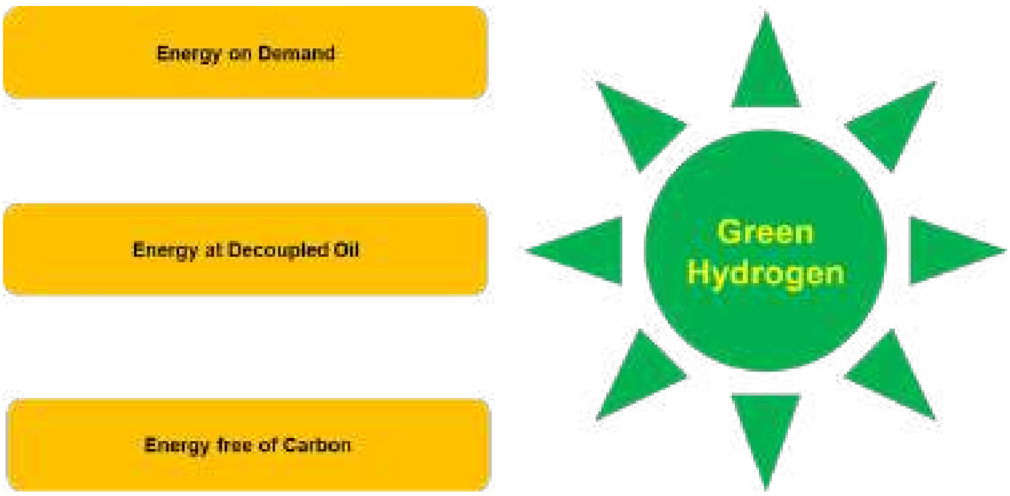
- Prime Minister Narendra Modi

NHM talked about creating GH2 economy of 5 MMTPA with an aggregate investment of ~USD 100 billion or ~INR 8 trillion. That calls for serious deliberation on who will fund this massive requirement. And, how would it get priced offering bankability of the energy transitions projects. While this deliberation may continue longer, EU has announced CBAM definitive implementation effective 2026. And it will be imperative for large section of Indian export-oriented business to consider newer and greener solutions to bring down Carbon footprint and achieve Net Zero.

With this background, Deesha Power Solutions through this Whitepaper is making an attempt to deliberate the opportunity of GH2 usage in bottom of the application industries . This white paper would also ponder upon opportunities and challenges for adoption of this new energy solution as not just fuel but also as a Feedstock for certain processes.

2.2 GH2 – A Business Disruption

Gh2 is the biggest business disruption of the century due to three reasons as mentioned in the figure below:

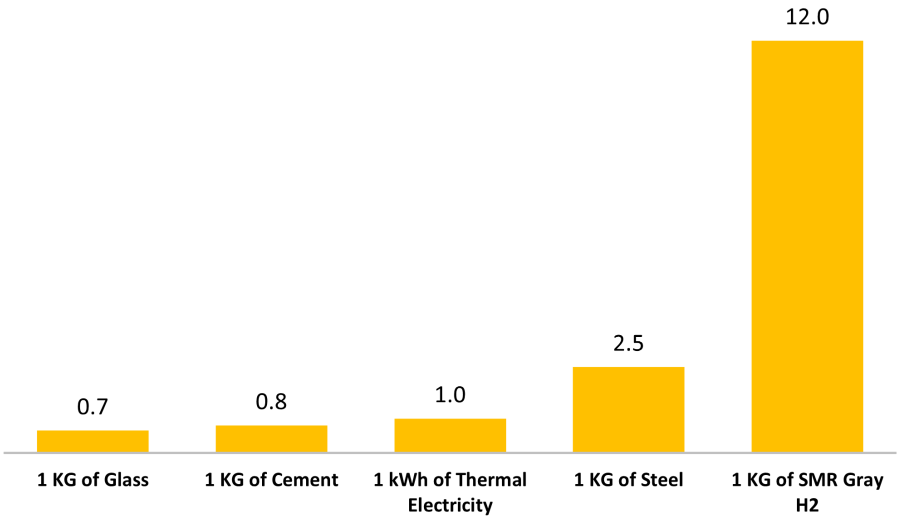


Source: Deesha Power Perspective

The beauty of GH2 is that it brings a democratic access to energy "on demand" in a decentralized manner. Plus, being a new entrant, it does not have clutches of oil pricing and hence its completely decoupled from vagaries of oil pricing (hence inflation) being often witnessed due to whims and fancies of a few oligarchs. Most importantly, GH2 is far less carbon intensive. Hence its touted as the biggest business disruption of this century.

2.3 Emission Intensity of Various Commodities

Green Hydrogen is key for decarbonization of hard to abet sectors such as glass, cement, steel, gray H2 as mentioned in the figure below:

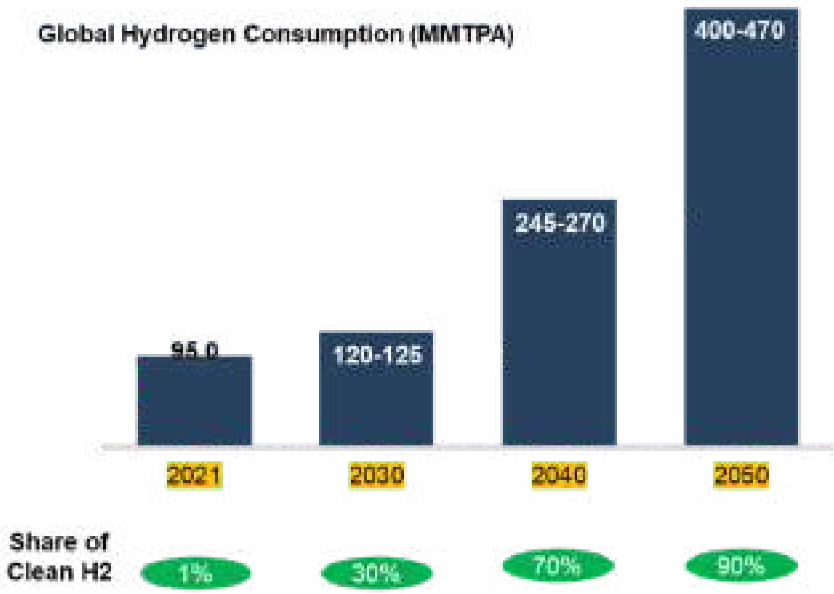


Source: Secondary Research by Deesha Power

Let's first look at emission intensity of various building blocks for the infrastructure. To produce 1 kg of float glass, we end up emitting 0.6 to 0.7 Kg of CO2. Cement is a notch higher to 0.8 KG of CO2/KG of Cement. Thermal electricity is ~1 KG/kWh. We end up making double the CO2 while making a kg of steel. Gray H2, which is getting used in refineries/fertilizers/chemical industries, results into emission of 10-14 KG of CO2. And hence GH2 led Energy Transition will be the key to global decarbonization.

2.4 Global H2 Demand

Expected global H2 volumes and share of clean H2 in it is shown in the figure below:



Source: Secondary Research by Deesha Power

Applications with existing demand will likely account for the majority of clean hydrogen demand throughout the 2020s, potentially driving the increase in clean hydrogen's share of total hydrogen demand from less than 1 percent today to around 30 percent by 2030

By 2040, clean hydrogen could play a larger role in new applications—especially in mobility and DRI, which is expected to be the largest "newcomer" for clean hydrogen demand by 2040

By 2050, in the Further Acceleration scenario, mobility applications are projected to remain the largest drivers for clean hydrogen uptake, with road transport accounting for around 80 MMTPA and aviation around 50 MMTPA, with the remaining 15 MMTPA coming from maritime

2.5 Net Zero Race

Sixty-two countries have adopted Net Zero commitment, mostly by 2050, either through regulatory (18) or policy (44). The same is depicted in a table below:

Commitment to NZ	2030	2035	2040	2045	2050	2055	2060	2065	2070	Total
In Regulation				2	16					18
In Policy	2	1	2	1	38	1	3	1		49
In Pledge							3		2	5
In Disc	2				39		1			42
Total	4	1	2	3	93	1	7	1	2	114

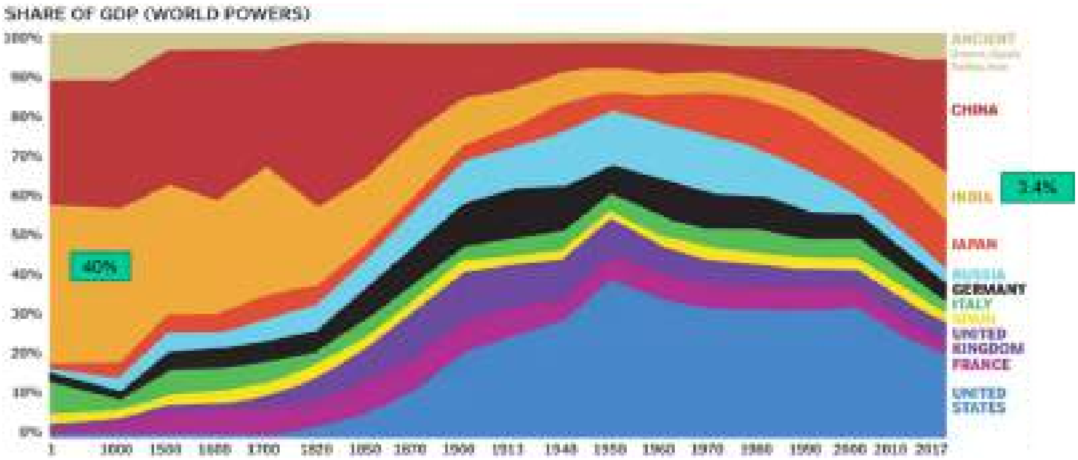
Source: Energy & Climate Intelligence Unit

- Good news is 103 countries have agreed / likely to agree to Net Zero by 2050
- 8 countries have agreed / likely to agree to Net Zero by 2060
- Considering its developing status and size of economy ~USD 3.5 trillion, India has taken a pragmatic target of NetZero by 2070
- However, proactive Net Zero actions have already started in most of the countries including India

3. INDIA H2 DEMAND & BOTTOM OF PYRAMID CONSUMPTION

3.1 India – Aspiring to rightfully gain back it's past economic glory

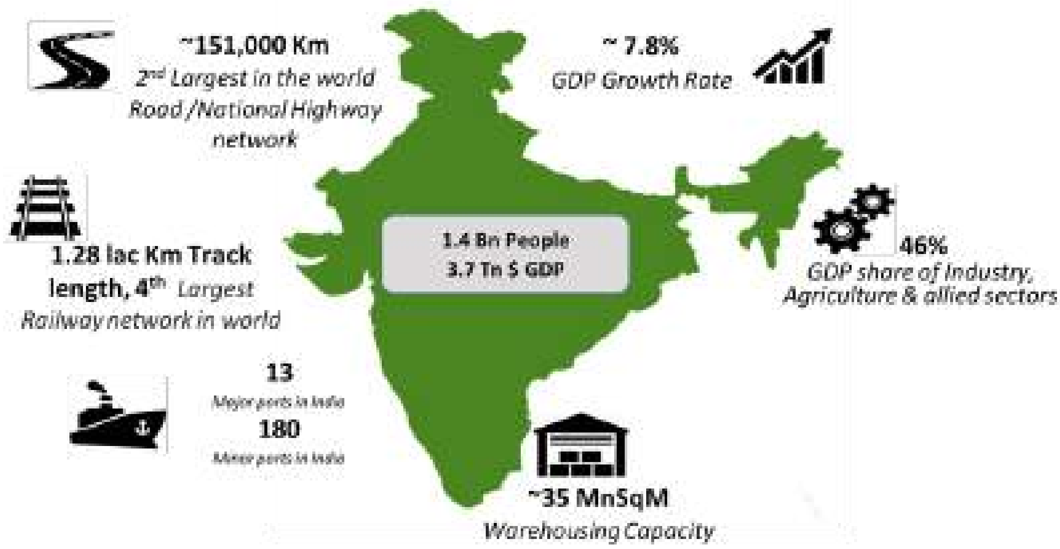
AAiming USD 10 Tn economy by 2030 and USD 40 Tn by 2047 as mentioned below:



Source: IMF , WB, Secondary Research by Deesha Power

India is aspiring to gain back it's rightful position. We all know 1000 years back India was No. 1 global economy with 40% share of world economy, followed by China. US was nowhere to be seen till 1700. Though on global scale today India's share little over 3% with our aspirations to achieve USD 10 Trillion we should become No. 3 economy by 2030 and if we achieve USD 40 Trillion, we should become No. 2 by 2050.

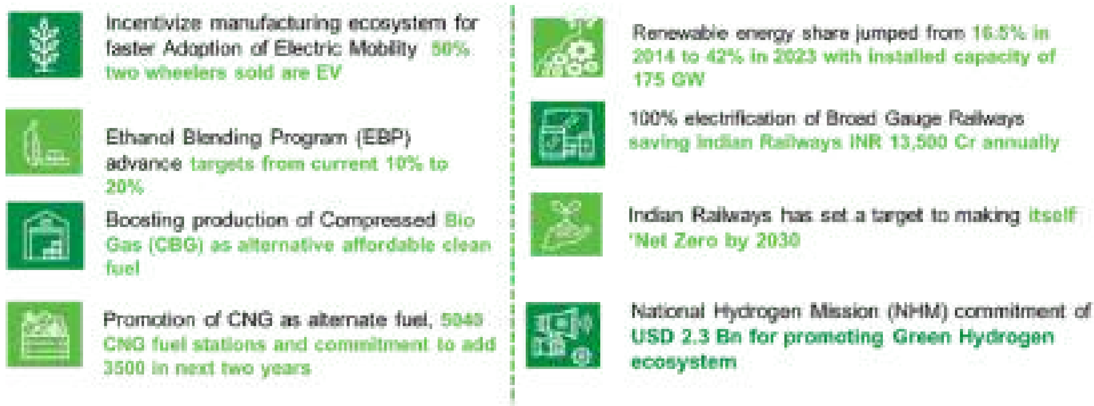
India is on course to build a robust infrastructure as mentioned below:



Source: IMF , WB, Secondary Research by Deesha Power

- Economic Growth Rate, which is currently growing in the range of 7-8% p.a.
- Manufacturing sector Push, Currently Nonservice sector share to GDP is approx. 46% and Manufacturing Share is approx. 17%,
- Demographics in terms of population and socio-economic behavior. We all know recently India has become No. 1 in the world with 1.41 Bn people.
- On Infrastructure front, our Railway infra we are at No. 4th Position in the world, on Road infrastructure we are No. 2 position in the world and on Ports & Water ways lot of development happening, warehousing we have great scope ahead.

Various initiatives to accelerate decarbonization, thrust on Environment Friendly & Cheaper Fuel



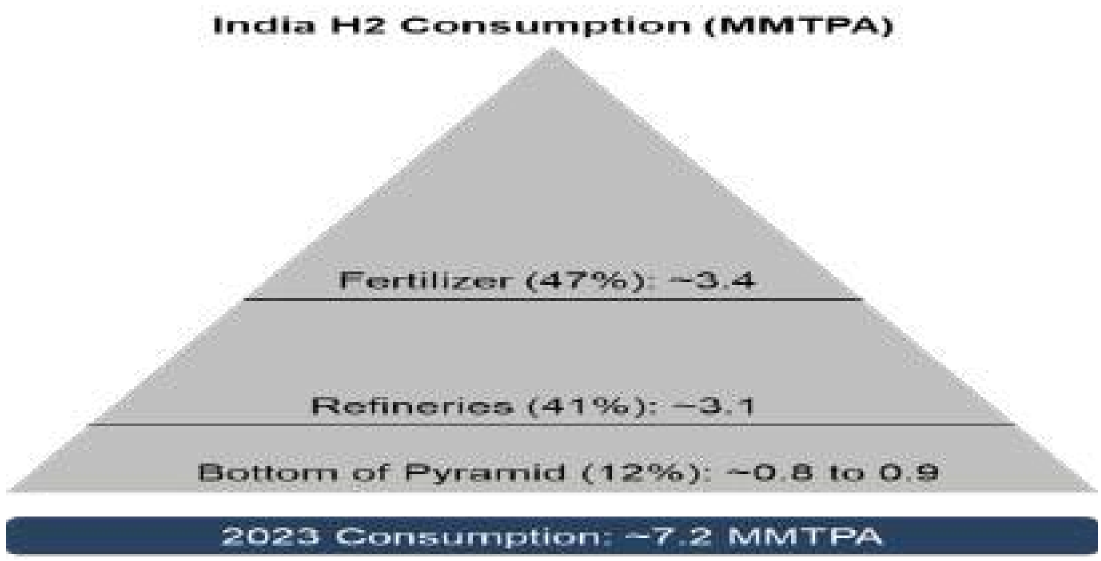
Source: Secondary Research by Deesha Power

Under the able leadership of Prime Minister Shri Narendra Modi, Indian Government is committed to goal Net Zero, Some prominent initiatives to accelerate decarbonization are.

- Renewable energy share jumped from 16.5% in 2014 to 42% in 2023 with installed capacity of 175 GW
- Ethanol Blending Program (EBP) advance targets from current 10% to 20%
- Indian Railways has set a target to making itself 'Net Zero by 2030
- Boosting production of Compressed Biogas (CBG) as alternative affordable clean fuel
- National Hydrogen Mission (NHM) commitment of USD 2.3 Bn for promoting Green Hydrogen ecosystem

3.2 India H2 Demand

India H2 demand is presented below:

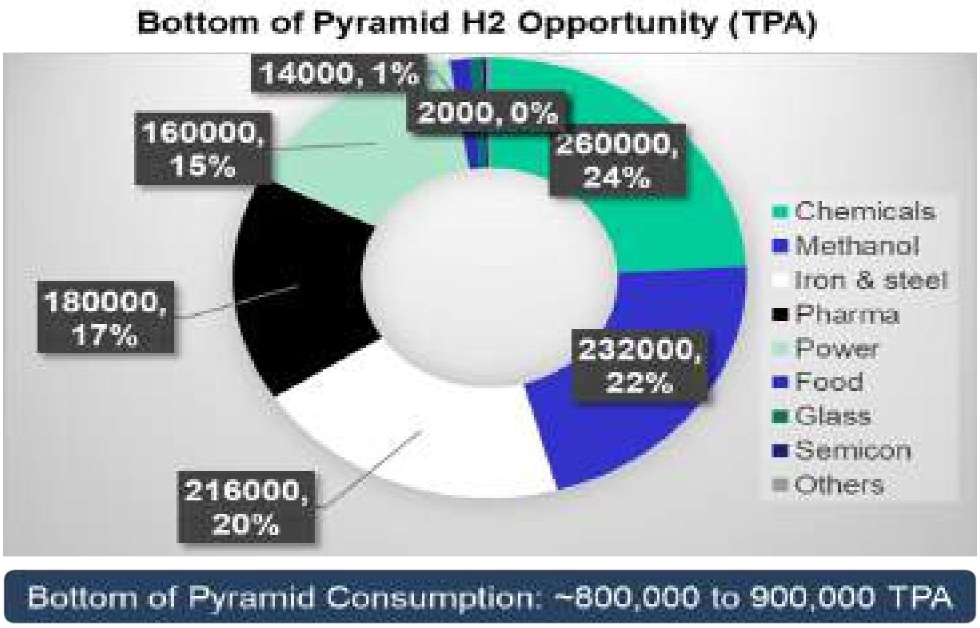


Source: Primary & Secondary Research by Deesha Power

In 2023, the Demand market for hydrogen in India was majorly contributed by Fertilizers i.e., 3400 KMT followed by Oil & Refineries 3110 KMT. Remaining demand from bottom of pyramid consuming industries is mentioned in subsequent section.

3.3 Bottom of Pyramid H2 Consumption

Bottom of pyramid H2 consumption is presented below:



Source: Primary & Secondary Research by Deesha Power

In 2023, Chemicals consumed ~260 KTPA of Hydrogen. This was followed by Methanol ~232 KTPA and Steel ~216 KTPA. Some key insights are mentioned below:

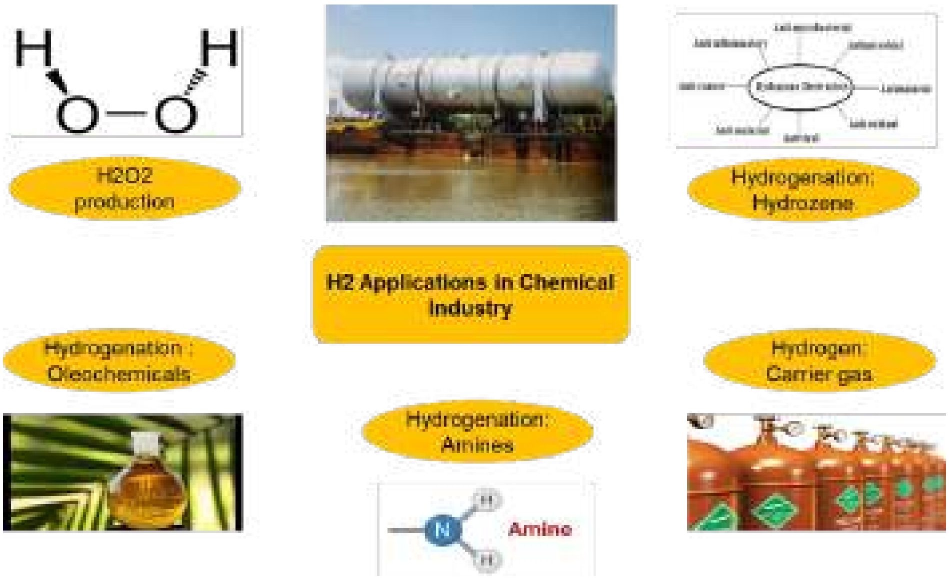
- Quantity consumption & its sourcing is very peculiar to given process and geographical location
- It is sourced through cylinders/bulk tankers owned by external local parties, mostly a regional play
- Most of them pay a huge premium for transportation of H2 with a great exposure to two risks namely
  - Availability
  - Spot pricing
- Very few places, there is a luxury of pipeline. But pricing variation risks persists, however in a smaller variation band as compared to cylinders/bulk tankers
- Almost entire H2 consumption is grey in nature
- In absence of options, H2 sourcing is a regional play
- Majority of the consumption is in batches
- Desired purity level varies from 99% to 99.9999%
- Single location H2 consumption varying between ~50 MTPA to ~4,500 MTPA
- Interesting data points from primaries with BoP industries indicate landed price of H2 in the range ~Rs 240/KG to 2,500/KG

4. GH2 LED DECARBONISATION IN BOP INDUSTRIES

4.1 Chemical

4.1.1 H2 Applications

H2 applications in Chemical industry are presented in the figure below:



Source: Secondary Research by Deesha Power

Hydrogen has numerous applications in the chemical industry due to its versatility as a feedstock, reducing agent, and energy carrier. Here are some key ways hydrogen is used in the chemical industry:

1. **Hydrogen Peroxide Production:** Hydrogen is used in the direct synthesis of hydrogen peroxide (H2O2), which is a versatile oxidizing agent used in bleaching, disinfection, and chemical synthesis.
2. **Hydrogenation of Nitrogen to Produce Hydrazine:** Hydrogenation of nitrogen is used in the production of hydrazine (N2H4), which is used as a rocket propellant, in the manufacture of pharmaceuticals, and as a reducing agent in various chemical processes.
3. **Hydrogen as a Carrier Gas:** Hydrogen is used as a carrier gas in gas chromatography, a common analytical technique used in chemical analysis and quality control laboratories.
4. **Hydrogenation of Organic Compounds:** Hydrogen is used in the hydrogenation of organic compounds to produce alcohols, amines, and other saturated compounds.
5. **Hydrogenation Reactions:** Hydrogen is used as a reducing agent in hydrogenation reactions to saturate unsaturated compounds, such as converting vegetable oils into margarine or converting nitrobenzene into aniline.

These are just a few examples of the many applications of hydrogen in the chemical industry. With growing interest in sustainable and low-carbon technologies, the use of hydrogen as a feedstock and energy carrier is expected to increase in the future.

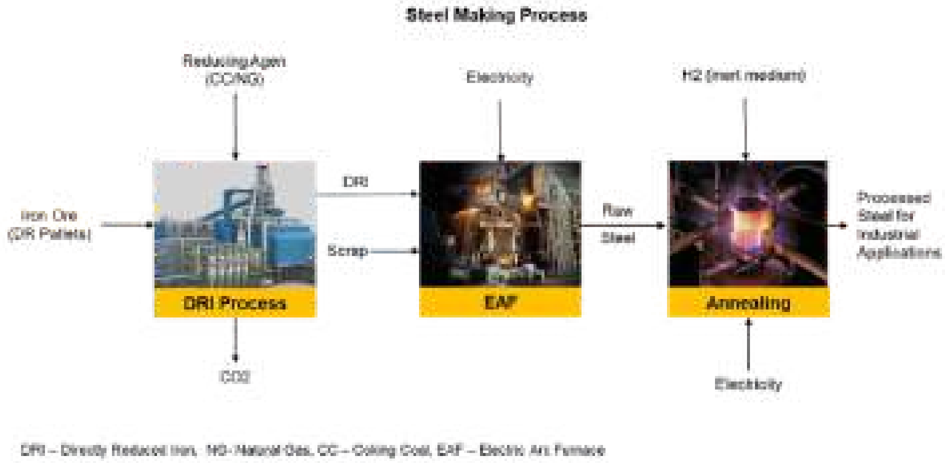
4.1.2 Carbon Footprints

As per International Energy Agency, carbon intensity of primary chemicals is 1.3, meaning we produce more CO2 than the primary chemicals. As per McKensy, In 2021, the chemical industry's global emissions totalled approximately 925 million metric tons (MT) of CO2, accounting for around 2 percent of total emissions.

4.2 Steel

4.2.1 H2 Applications

H2 applications in steel industry are presented in the figure below:



Source: Secondary Research by Deesha Power

Hydrogen (H_2) has several promising applications in the steel industry, primarily focused on improving sustainability and reducing carbon emissions. Here are some key areas where hydrogen is making an impact:

1. **Direct Reduction of Iron (DRI):**
   - Traditional steelmaking relies on blast furnaces that use coke (a carbon-rich material) to reduce iron ore into molten iron. This process emits a significant amount of Co_2
   - Hydrogen can be used in place of coke in the direct reduction of iron ore. In this process, hydrogen reacts with iron ore to produce direct reduced iron (DRI) and water vapor instead of CO_2. This method can significantly reduce carbon emissions.

2. **Hydrogen-Based Steelmaking:**
   - In combination with DRI, hydrogen can be used in electric arc furnaces (EAFs) to produce steel. This method is often referred to as hydrogen-based steelmaking.
   - The hydrogen used in the DRI process can be generated from renewable sources, making the overall steel production process much greener.

3. **Reducing Emissions from Existing Processes:**
   - Existing steel mills may use hydrogen to partially replace fossil fuels used in various stages of the steelmaking process. This can help lower emissions while transitioning towards more sustainable methods.

4. **Hydrogen as a Fuel for Heat Treatment:**
   - Hydrogen can be used as a cleaner alternative to natural gas in heat treatment processes, such as annealing and tempering, which are used to alter the properties of steel.

5. **Hydrogen in Steel Mill Operations:**
   - Hydrogen can also be used in other mill operations, such as providing energy for various auxiliary systems or as a feedstock for chemical processes associated with steel production.

6. **Hydrogen for Reduction of CO2 Emissions:**
   - In the broader context, using hydrogen can help steel manufacturers meet stringent environmental regulations and targets for CO2 reduction, thus enhancing their sustainability credentials.

7. **Integration with Renewable Energy:**
   - Steel plants can integrate hydrogen production with renewable energy sources, such as wind or solar, to generate "green hydrogen" which can further decrease the carbon footprint of steel production.

The adoption of hydrogen in the steel industry is still in its early stages, with several pilot projects and ongoing research aiming to address technical, economic, and infrastructure challenges. However, the potential benefits for reducing emissions and promoting sustainability make it a key area of interest for the future of steelmaking.

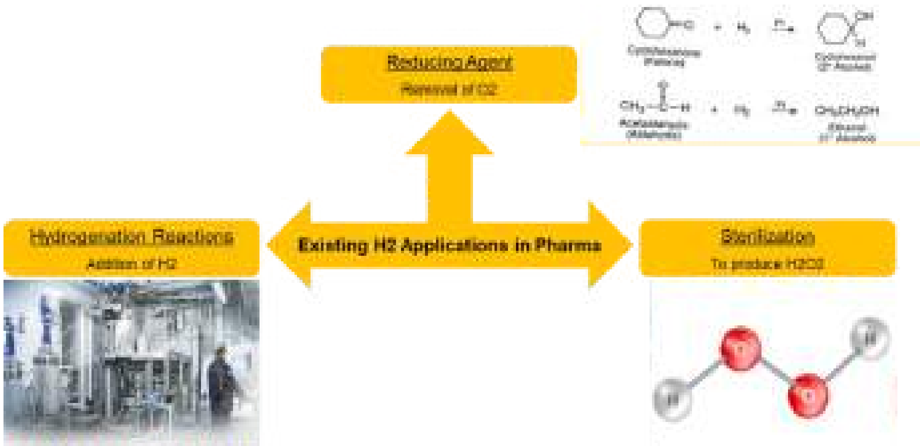
4.2.2 Carbon Footprints

Actually, we make more CO2 than steel during steel production. Typically , production of one MT of steel results into emission of ~2 to 2.2 MT of CO2 and it accounts for ~9% of global carbon emissions.

4.3 Pharma

4.3.1 H2 Applications

H2 applications in pharma industry are presented in the figure below:



Source: Secondary Research by Deesha Power

Hydrogen has several applications within the pharmaceutical industry due to its unique properties. Here are a few key ways in which hydrogen is utilized:

1. **Hydrogenation Reactions:** - Hydrogen is commonly used in hydrogenation reactions in pharmaceutical manufacturing. These reactions involve the addition of hydrogen to unsaturated compounds under specific conditions, often catalyzed by metals like palladium or platinum. This process is crucial for synthesizing various pharmaceutical compounds.
2. **Reducing Agent:** Hydrogen also serves as a versatile reducing agent in pharmaceutical processes. It can facilitate the reduction of functional groups within organic molecules, leading to the creation of specific intermediates or final products.
3. **Sterilization:** Hydrogen peroxide, a compound derived from hydrogen, is employed as a sterilizing agent in the pharmaceutical industry. It is used to disinfect production environments, equipment, and packaging materials to maintain the sterility of pharmaceutical products.

Overall, the use of hydrogen in API synthesis is a growing area of research and development that holds promise for more sustainable and efficient pharmaceutical production.

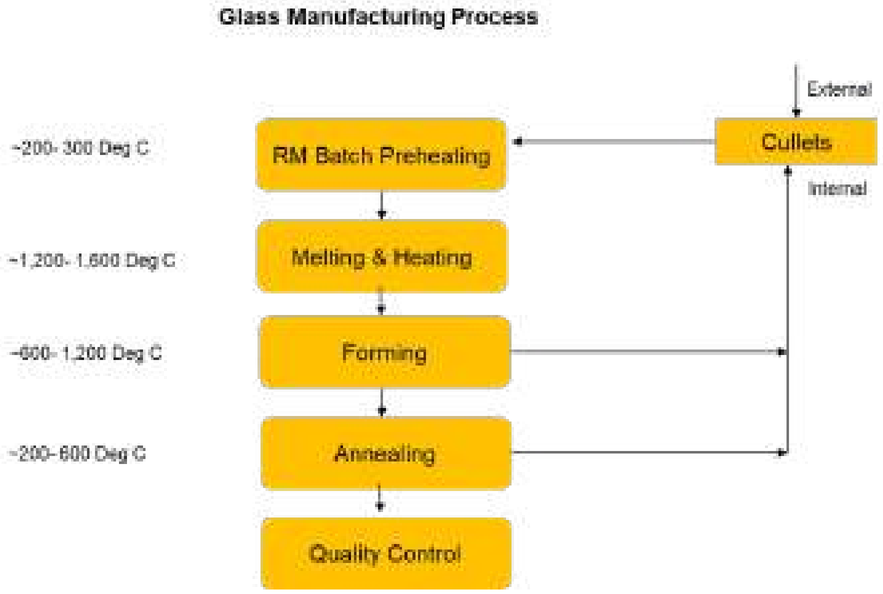
4.3.2 Carbon Footprints

The pharma industry has been estimated to generate around 52 megatons of CO2e annually, with analysis suggesting it is far more emissions-intensive than the automotive sector. By 2025, it needs to reduce its emissions intensity by an estimated 59% from 2015 levels to meet the goals of the Paris Agreement.

4.4 Glass

4.4.1 H2 Applications

Glass manufacturing process is presented in the figure below:



Source: Secondary Research by Deesha Power

Hydrogen (H_2) is increasingly being explored for its applications in the glass industry, primarily due to its potential for improving sustainability and reducing greenhouse gas emissions. Here are some key areas where hydrogen is being applied or has potential in the glass industry:

1. **Hydrogen as a Fuel in Glass Melting:**
   - The glass melting process is energy-intensive, traditionally relying on natural gas or other fossil fuels. Hydrogen can be used as a clean alternative fuel for melting glass. When hydrogen is used in this process, it can significantly reduce CO_2 emissions because the primary byproduct of burning hydrogen is water vapor, rather than Co_2.

2. **Hydrogen in Combustion Systems:**
   - Hydrogen can be used to replace or supplement natural gas in the combustion systems of glass furnaces. This substitution can lower the carbon footprint of glass production and contribute to achieving regulatory and sustainability goals.

3. **Hydrogen for Reducing Emissions:**
   - The glass industry can use hydrogen to replace carbon-based fuels in various processes, thereby reducing overall CO_2 emissions. By integrating hydrogen into different stages of production, glass manufacturers can make their operations more environmentally friendly.

4. **Hydrogen for High-Temperature Processes:**
   - The glass industry requires high temperatures for melting and forming glass. Hydrogen's ability to burn at high temperatures makes it suitable for these applications, potentially offering a cleaner alternative to conventional fuels.

5. **Hydrogen in Glass Recycling:**
   - Hydrogen can be used in the recycling process of glass to enhance efficiency and reduce emissions. By using hydrogen in the re-melting process of recycled glass, the industry can further decrease its carbon footprint.

6. **Hydrogen for Generating High-Temperature Heat:**
   - Glass production processes often require extremely high temperatures. Hydrogen can be used to generate high-temperature heat for these processes, offering a cleaner option compared to traditional fuels.

7. **Integration with Renewable Energy:**
   - Hydrogen can be produced using renewable energy sources through electrolysis. Glass manufacturers can integrate hydrogen production with renewable energy systems to achieve "green hydrogen," further reducing their carbon emissions and contributing to a more sustainable energy mix.

8. **Energy Storage and Grid Balancing:**
   - Hydrogen can act as an energy storage solution. Glass plants with fluctuating energy needs can produce and store hydrogen when energy is plentiful and use it during peak times or when renewable energy sources are not available.

The transition to hydrogen in the glass industry is still in the development and pilot stages, with ongoing research and technological advancements necessary to make these applications commercially viable. However, the potential benefits in terms of reduced emissions and increased sustainability are driving interest and investment in this area.

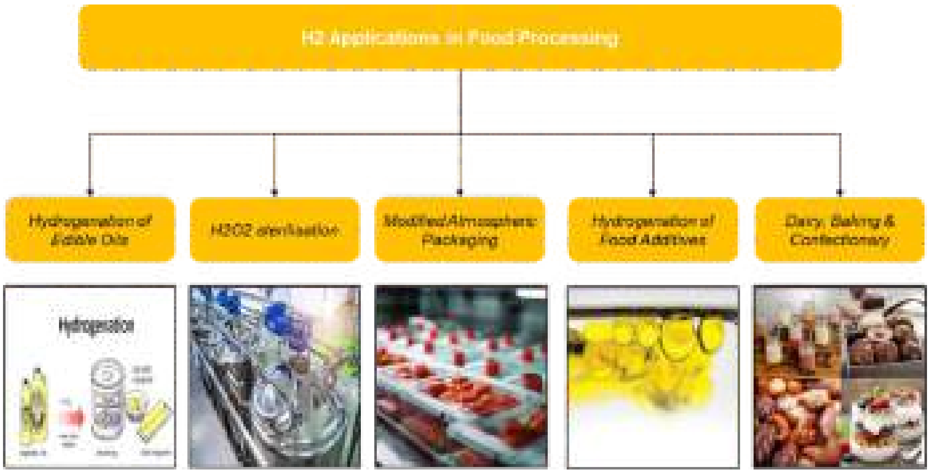
4.4.2 Carbon Footprints

Actually, we make 1 MT CO2 for every 2 MT production of glass. In 2022, global glass sector emitted ~95 Million MT of CO2 which is really a concern.

4.5 Food Processing

4.5.1 H2 Applications

H2 applications in food processing industry are presented in the figure below:



Source: Secondary Research by Deesha Power

1. **Hydrogenation of Edible Oils:** Hydrogenation is a chemical process used to convert unsaturated fats found in vegetable oils into saturated fats. This process increases the stability and shelf life of oils, making them suitable for frying, baking, and other food preparation methods.

2. **Hydrogen Peroxide Sterilization:** Hydrogen peroxide (H2O2) is used as a sterilizing agent in food processing facilities to disinfect surfaces, equipment, and packaging materials. It is effective in killing bacteria, viruses, and other microorganisms without leaving harmful residues.
3. **Modified Atmosphere Packaging (MAP):** Hydrogen is used as a component of gas mixtures in modified atmosphere packaging to extend the shelf life of perishable foods. By replacing oxygen with hydrogen and other inert gases, MAP inhibits the growth of spoilage microorganisms and slows down food deterioration.
4. **Hydrogenation of Food Additives:** Hydrogenation is used to modify the properties of food additives such as flavors, colors, and emulsifiers, improving their stability, texture, and functionality in processed foods.
5. **Hydrogenation in Baking:** Hydrogenated fats and oils are commonly used in baking to improve the texture, volume, and shelf life of baked goods such as cookies, pastries, and crackers. Hydrogenation helps create a desirable crumb structure and enhances the flavor and aroma of baked products.

These are some of the key applications of hydrogen in the food processing industry, demonstrating its importance in ensuring food safety, quality, and sustainability throughout the food supply chain.

4.5.2 Carbon Footprints

As far as GHG emissions are concerned, food processing industry is no behind than that of process industries. Please see image below showing food supply chain starting from production of grain and going upto disposal of unconsumed food.

Source: Secondary Research by Deesha Power

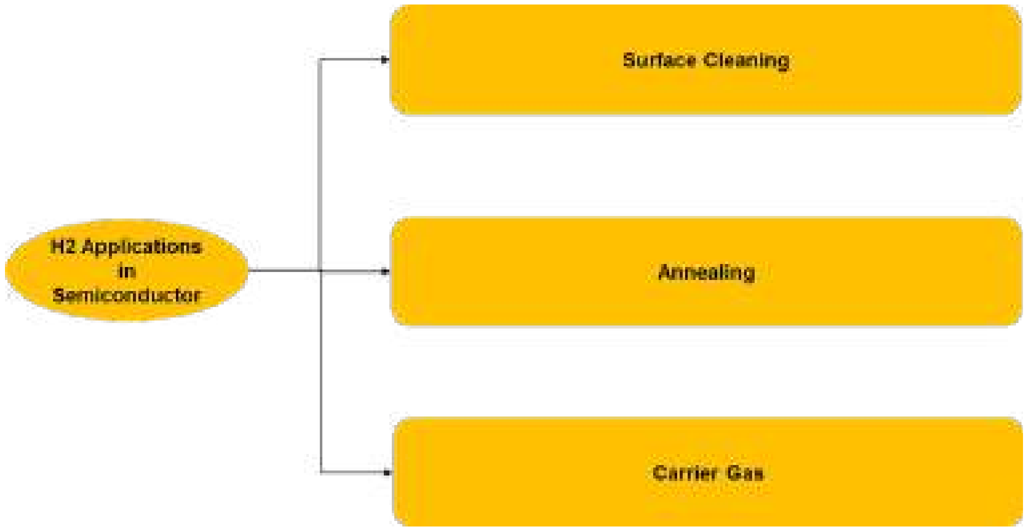
As per one study, about 10–17 billion tonnes of CO2 was emitted via the food supply chain, which was ~20-25% of global anthropogenic GHG emissions of 2021. This is as serious an emission volume which any sustainability lover can't ignore.

4.6 Semiconductor

4.6.1 H2 Applications

Development of specialty industrial gases economy is prerequisite for successful proliferation of Semiconductor industry. Developed economies have done that. While India is in process of doing through production driven incentive. Big H2 consumer is in making process.

H2 applications in semiconductor industry are presented below:



Source: Secondary Research by Deesha Power

Hydrogen has several potential applications in the semiconductor industry, primarily in semiconductor manufacturing processes and as a clean energy source for powering operations. Here are some key areas where hydrogen can be utilized:

1. **Cleaning and Surface Preparation:** Hydrogen is used in various cleaning processes within semiconductor manufacturing, particularly for surface preparation before deposition or etching. Hydrogen can effectively remove oxides and other contaminants from silicon wafers and other semiconductor surfaces.
2. **Annealing and Annealing Ambients:** Hydrogen is used as an annealing ambient in certain semiconductor processes, particularly for annealing silicon wafers to repair crystal lattice damage caused by ion implantation or other manufacturing steps. Hydrogen can help to passivate defects and improve electrical properties.
3. **Hydrogen as a Carrier Gas:** Hydrogen is often used as a carrier gas in gas chromatography-mass spectrometry (GC-MS) analysis, which is a common analytical technique used in semiconductor research and quality control laboratories.

4.6.2 Carbon Footprints

As per BCG, Semiconductor devices manufactured in 2021 will have a lifetime CO2e footprint of nearly 500 megatonnes (Mt). 15% from materials and equipment which are Scope 3 upstream emissions), 20% are from device design and manufacturing which are Scopes 1/ 2 and remaining 65% are from device processing, use, and disposal which are Scope 3 downstream.

4.7 Decarbonisation Levers

Decarbonisation levers for BOP H2 industry are shown below:

Source: Secondary Research by Deesha Power

Decarbonization levers involves reducing carbon emissions associated with various processes, including manufacturing, packaging, distribution, and energy consumption. Here are some decarbonization levers for the industry:

1. **Energy Efficiency:** Improving energy efficiency in the manufacturing facilities through the adoption of energy-efficient equipment, processes, and building design can significantly reduce carbon emissions. This includes upgrading to more efficient tools, optimizing process flows, and implementing advanced cooling and HVAC systems.
2. **Renewable Energy:** Transitioning to renewable energy sources such as solar, wind, or hydroelectric power for powering can reduce the carbon footprint associated with electricity consumption. Installing on-site renewable energy systems or sourcing renewable energy from off-site providers can help achieve this goal.
3. **Green Materials (Gh2):** Developing and using environmentally friendly raw materials like GH2 with lower carbon footprints can help reduce emissions throughout the supply chain. This includes researching and adopting sustainable alternatives to traditional materials and chemicals used in the production process.
4. **Carbon Capture and Utilization (CCU):** Investing in carbon capture and utilization technologies to capture and reuse carbon emissions generated during the processes can help mitigate the industry's environmental impact. This includes capturing carbon dioxide emissions for use in other industrial processes or converting them into valuable products.
5. **Process Optimization:** Optimizing manufacturing processes to minimize resource consumption, waste generation, and emissions can contribute to decarbonization efforts. This includes implementing advanced process control technologies, reducing material waste, and optimizing process parameters for efficiency.
6. **Supply Chain Sustainability:** Promoting sustainability throughout the supply chain by working with suppliers to reduce emissions, improve resource efficiency, and minimize environmental impacts can help drive decarbonization efforts industry-wide.
7. **Circular Economy Practices:** Embracing circular economy principles by designing products for longevity, reuse, and recycling can reduce the carbon footprint over their lifecycle. This includes implementing take-back programs, designing for disassembly, and promoting the reuse of components and materials.

By implementing these decarbonization levers, the BOP H2 industry can reduce its environmental impact and contribute to global efforts to combat climate change while continuing to innovate and drive technological progress.

5. CHALLENGES & OPPORTUNITIES FOR GREENIFICATION OF H2 CONSUMPTION IN BOP INDUSTRIES

5.1 Challenges

5.1.1 RE Sourcing

Getting NOC from discom for sourcing RE power on RTC basis is one of the challenges being faced. To promote, in-situ production of green hydrogen, a timebound approval will help the industry.

5.1.2 Landed RE price

RE power forms ~70% of cost of electrolytic GH2. Hence landed RE RTC price sub Rs 4.50 can add to viability of such in-situ GH2 production units. Many states have announced waiver on ED, STU charges, wheeling charges to make landed price for GH2 production more attractive. But it seems , many places landed RE price is still Rs 5.15+/kWh. One needs to seriously address these incremental components one by one.

5.1.3 Contract Demand

In-situ GH2 production would require installation of electrolyzes at GH2 consumer's premises resulting in increase of electrical load. Who in turn needs to apply to local discom for enhancement in contract demand which results into enhanced monthly CD charges. Current contract demand charges result into additional payments ~Rs 0.5 Cr p.a./MW of electrolyzer installed. This adds at least ~10-15% to current cost of generation of GH2 nullifying all savings for GH2 consumer. Matter has been raised and hopefully, we will have amicable solution for this.

5.1.4 Permits & Approvals

H2 storage, transportation and usage requires Petroleum Explosive Safety Organization (PESO) approval. Time bound approval process will add to ease of installation of such in-situ units.

5.2 Opportunities

5.2.1 Present Gaps in Sourcing by H2 Consumers

There lies an opportunity to present a supply solution addressing present gaps in H2 sourcing.

5.2.1.1 Availability Risk

Almost entire H2 sourcing by these BOP industries is on spot basis. Plus there could be supply interruption risk if there is a shut down in mother chlor alkali plant as that's the only available H2 source at the moment. To address availability risk, such industries tend to order more, thereby blocking their precious working capital. There exists an opportunity to generate and supply H2 as per requirement.

5.2.1.2 Tenure Risk

Since entire H2 sourcing is on spot basis at the moment, there is no concept of medium/long term contract in sourcing utility like H2. Hence there could be an opportunity to offer a solution addressing tenure risk

5.2.1.3 Pricing Variation Risk

H2 consumers in BOP are exposed to risk of variation in pricing. Hence there could be an opportunity to offer a solution addressing fixed price contract.

5.2.1.4 Economic to Present Option

Due to ever increasing logistics cost, H2 pricing is too on rise. Hence, H2 consumers in BOP are in look-out of economic options for H2 sourcing.

5.2.2 Huge Untapped Potential

In monetary terms, BOP H2 consumption is valued between ~Rs 28,000 Cr p.a. to ~Rs 32,000 Cr p.a. Going to grow by atelast 7-8%. By 2030, it is expected to touch ~Rs 45,000 Cr p.a. to Rs 50,000 Cr p.a. Hardly anyone can ignore such a huge potential.

5.2.3 CBAM

Cross Border Adjustment Mechanism (CBAM) in EU is likely affect many exporting entities in BOP industries. Such entities could consider greenfication of their H2 consumption at an earlier date.

5.2.4 Net Zero Movement

With many leading Indian conglomerates and MNCs declaring their sustainability visions to become Net Zero by 2030-35-40-50 timelines. This presents an additional reason for greenification of H2 consumption other than the economics.

6. ANNEXURES

6.1 About Deesha Power

6.1.1 GH2 Led Energy Transition Consulting Offerings

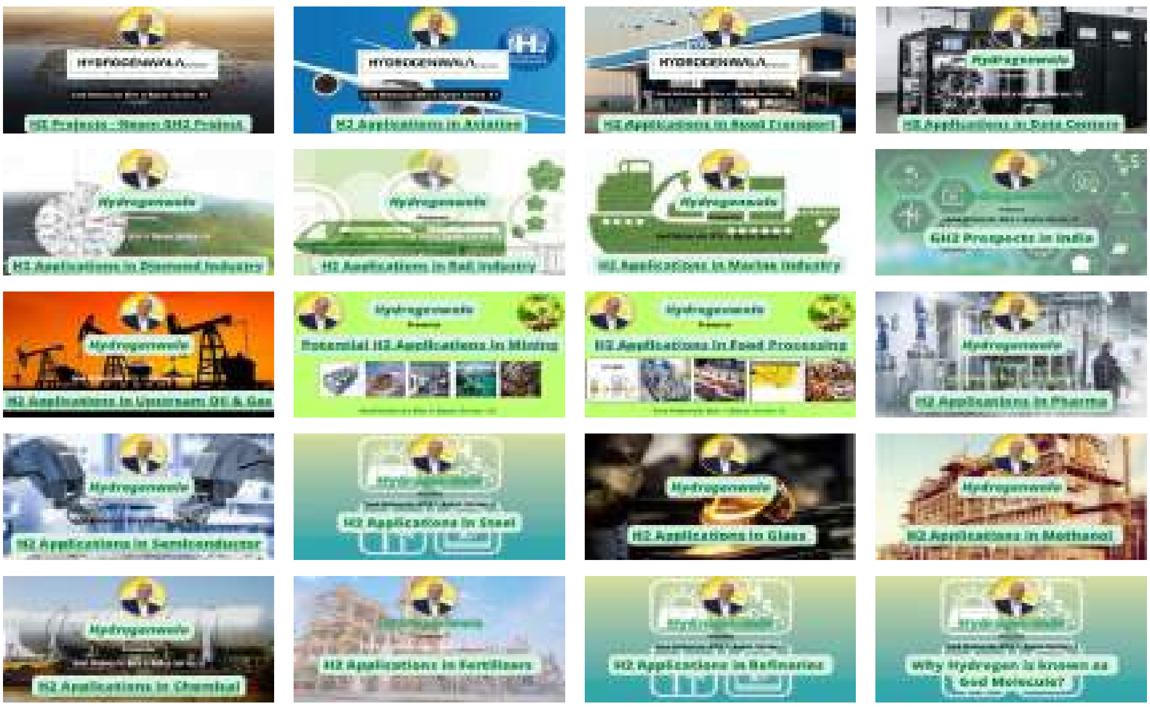
6.1.2 Growing Clients List

6.2 About Hydrogenwala

Hydrogenwala, a global aspirant with Indian roots, is pleased to present novel God Molecule Bits n Bytes series. Objective of this initiative is to spread awareness about hydrogen and its larger-than-life implications.

Our social media handles-
Youtube: https://www.youtube.com/@hydrogenwala
Instagram: https://www.instagram.com/hydrogenwala/
LinkedIn: www.linkedin.com/in/shardul-kulkarni-78736125

"Hydrogenwala – You Tube Channel for Promotion of H2 Economy"



Industry/Project/Topic	Link
Hydrogenwala Presents: Why Hydrogen is known as God Molecule?	https://youtu.be/2k7EJVNEVjA
Hydrogenwala presents GH2 Prospects for India	https://youtu.be/0RZ-4R7bcBY
Hydrogenwala Views on Financing of GH2 Projects	https://youtu.be/BqqN2XLCMKA
H2 Applications in Refineries by Hydrogenwala	https://youtu.be/mUY4garcwkk
H2 Applications in Fertilizer by Hydrogenwala	https://youtu.be/Wxp71LJlrds
H2 Application in Steel by Hydrogenwala	https://youtu.be/ihx5IfoU94I
H2 Applications in Glass Industry by Hydrogenwala	https://youtu.be/CKXTDBqZC7s
H2 Applications in Methanol by Hydrogenwala	https://youtu.be/fagOJaAHyAU
Hydrogen Applications in Pharma by Hydrogenwala	https://youtu.be/jK18Nq30CCU
H2 Applications in Semiconductor by Hydrogenwala	https://youtu.be/Lsn8-8SIdDo
H2 Applications in Chemical by Hydrogenwala	https://youtu.be/RWfK4W8zvvc
H2 Applications in Food Processing by Hydrogenwala	https://youtu.be/KqyfvJ45Zqs
H2 Applications in Mining by Hydrogenwala	https://youtu.be/3-1h0zf7E-U
H2 Applications in Upstream Oil & Gas	https://youtu.be/9X3s-SzRLVE
H2 Application in Marine Industry	https://youtu.be/C9Td-I4fWXk
H2 Applications in Rail Industry	https://youtu.be/h9fVG8gixls
H2 Applications in Diamond Industry by Hydrogenwala	https://youtu.be/z7uagKOk_fY
H2 Applications in Data Centers by Hydrogenwala	https://youtu.be/k6G3g-nG9C8
H2 Applications in Road Transport by Hydrogenwala	https://youtu.be/fEK_CqoMsq4
H2 Applications in Aviation by Hydrogenwala	https://youtu.be/2-UiLejoLD4
Neom GH2 Knowledge Snippet by Hydrogenwala	https://youtu.be/2k7EJVNEVjA

Deesha
TOWARDS NET ZERO

DEESHA POWER SOLUTIONS

303, Gardina, 8th Road, TPS V, Prabhat Colony, Santacruz East, Mumbai 400055
E: contact@deeshapowersolutions.com
W: www.deeshapowersolutions.com

God Molecule – A Solution

Been asking a solution to ever growing pollution?
Been wondering how can I pass environment to my sons & daughters without a degradation?
Been thinking are we the victims of industrial revolution?
Been fearing about vocally sustainable, but locally taking actions towards collective self-destruction?
And suddenly a God like voice came to me from unknown..
My dear I am there from the time of big explosion..
Transgress the fear, I am already with you as solution..
Remove the "C" in CH, I am there as "HYDROGEN".

Hydrogenwala