



GOVERNMENT OF INDIA  
MINISTRY OF NEW AND RENEWABLE ENERGY

# NATIONAL GREEN HYDROGEN MISSION

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JANUARY 2023

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## 1. INTRODUCTION

India's deep commitment to aspirational Climate Goals has been widely acknowledged in the comity of nations. Our achievements have matched our ambition. India has the fastest growing Renewable Energy capacity in the world. India has also emerged as one of the most attractive destinations for investments in Renewables. As India has set its sight on becoming energy independent by 2047 and achieving Net Zero by 2070, we recognise the critical role of Green Hydrogen. India, with its vast renewable energy resources, also has the opportunity to produce Green Hydrogen for the world. The National Green Hydrogen Mission aims to provide a comprehensive action plan for establishing a Green Hydrogen ecosystem and catalysing a systemic response to the opportunities and challenges of this sunrise sector.

## 2. BACKGROUND

- 2.1** India has declared the goal to achieve Net Zero emissions by 2070. As India's growth story unfolds, its demand for energy and resources is set to rise. Energy use has doubled in the last 20 years and is likely to grow by at least another 25% by 2030<sup>1</sup>. India currently imports over 40% of its primary energy requirements, worth over USD 90 billion every year. Major sectors like mobility and industrial production are significantly dependent on imported fossil fuels. This necessitates a shift towards technologies that enable enhanced share of renewable sources in the energy mix, and progressively reduce the reliance on fossil fuels.
- 2.2** Green Hydrogen, produced using renewable energy, has the potential to play a key role in such low-carbon and self-reliant economic pathways. Green Hydrogen can enable utilization of domestically abundant renewable energy resources across regions, seasons, and sectors, feeding multiple usage streams, either as a fuel or as an industrial feedstock. It can directly replace fossil fuel derived feedstocks in petroleum refining, fertilizer production, steel manufacturing etc. Hydrogen fuelled long-haul automobiles and marine vessels can enable decarbonisation of the mobility sector. Green Hydrogen can be particularly useful as a versatile energy carrier for meeting energy requirements of remote geographies, including islands, in a sustainable manner.
- 2.3** Many major economies have declared Hydrogen strategies as part of the broader climate and clean energy related actions. These national strategies largely seek to tackle the common underlying challenges of scaling up Green Hydrogen production, enhancing Hydrogen use across sectors, developing technologies, and designing enabling policies and regulations. There is clear focus on government funding and support for R&D, measures for demand creation and financial support for manufacturing and infrastructure development.
- 2.4** As the global consensus towards Net Zero gathers momentum, the demand for Green Hydrogen and its derivatives is set to rise. The asymmetries in expected demand and production capabilities for Green Hydrogen, in different countries and regions, are likely to result in

<sup>1</sup> <https://www.iea.org/reports/india-energy-outlook-2021>(NITI Aayog and International Energy Agency, India Vision Scenario)

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international trade of Green Hydrogen and its derivatives like Green Ammonia and Green Methanol. The sensitivity of fossil fuels to geopolitical upheavals and the experience of supply chain disruptions due to COVID have accelerated the transition towards green fuels and feedstock. This presents a unique opportunity for India to capitalize on its abundant renewable energy and land resources and the growing global demand for Green Hydrogen, to become a leading producer and exporter of Green Hydrogen and its derivatives.

- 2.5** Despite the unique possibilities and advantages, unfavourable cost economics, lack of harmonised standards and regulations, supply challenges, and costly enabling infrastructure have thus far held back the replacement of fossil fuels and fossil fuel-based feedstock with Green Hydrogen or its derivatives. However, recent trends and analysis indicate that, driven by technology advancements, reduction in costs of renewable energy and electrolysers and aggressive national strategies by some of the major economies, Green Hydrogen is likely to become cost-competitive in applications across industry, mobility and other sectors within a short span.
- 2.6** The Green Hydrogen pathway can be a key enabler for India's aspirations of building a low-carbon and self-reliant economy. It is therefore an opportune moment for India to launch the National Green Hydrogen Mission to scale up Green Hydrogen production and utilisation across multiple sectors and align with global trends in technology, applications, policy and regulation.
- 2.7** Rapid deployment of Renewable Energy and Electrolysers capacities will be required to achieve economies of scale. Associated infrastructure and regulatory ecosystem will need to be established for delivery of renewable power, and for storage, transportation and utilization of Green Hydrogen for various applications. Accelerated technology development to improve performance, efficiencies, safety and reliability would also be crucial. The global value chain for Green Hydrogen is in its nascency and international cooperation and engagements could further bolster the national efforts. There is, therefore, a clear need for coordinated efforts and diverse policy interventions across all domains.
- 2.8** Government of India will accordingly implement the Mission through a comprehensive and integrated approach through various Central and State Government agencies. The Ministry of New and Renewable Energy will be responsible for the overall coordination for implementation of the Mission. The other Ministries, Departments will undertake focused steps to ensure achievement of Mission objectives.

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### 3. MISSION OBJECTIVES

- 3.1** The overarching objective of the Mission is to make India the Global Hub for production, usage and export of Green Hydrogen and its derivatives. This will contribute to India's aim to become Aatmanirbhar (self-reliant) through clean energy and serve as an inspiration for the global Clean Energy Transition. The Mission will lead to significant decarbonisation of the economy, reduced dependence on fossil fuel imports, and enable India to assume technology and market leadership in Green Hydrogen.
- 3.2** To achieve the above objectives, the Mission will build capabilities to produce at least 5 Million Metric Tonne (MMT) of Green Hydrogen per annum by 2030, with potential to reach 10 MMT per annum with growth of export markets. The Mission will support replacement of fossil fuels and fossil fuel based feedstocks with renewable fuels and feedstocks based on Green Hydrogen. This will include replacement of Hydrogen produced from fossil fuel sources with Green Hydrogen in ammonia production and petroleum refining, blending Green Hydrogen in City Gas Distribution systems, production of steel with Green Hydrogen, and use of Green Hydrogen-derived synthetic fuels (including Green Ammonia, Green Methanol, etc.) to replace fossil fuels in various sectors including mobility, shipping, and aviation. The Mission also aims to make India a leader in technology and manufacturing of electrolyzers and other enabling technologies for Green Hydrogen.

### 4. SOURCING GREEN HYDROGEN

- 4.1** It is estimated that currently around 5 MMT (Million Metric Tonne) of Hydrogen is consumed annually in India for various industrial purposes like petroleum refining, manufacturing of ammonia for fertilizers, methanol production, treatment and production of metals etc. Most of this Hydrogen is currently sourced from fossil fuels through the process of steam reformation of natural gas, naphtha etc. and is referred to as Grey Hydrogen. The Chlor-alkali industry also produces Hydrogen gas as a by-product. Some Hydrogen is produced by electrolysis of water using grid electricity for specific applications.
- 4.2** In the recent years, pilot projects have been undertaken in India for production of Green Hydrogen through electrolysis of water using renewable electricity, and from biomass through thermochemical and biochemical routes. The Mission aims to develop and scale up Green Hydrogen production technology and make it affordable and widely accessible.
- 4.3** The costs of the electrolyzers and input renewable energy are the two major components of Green Hydrogen production cost. The costs of capital, supply and treatment of water, storage and distribution, conversion of hydrogen to suitable derivatives, and enabling infrastructure would also contribute significantly to the final delivered cost of Green Hydrogen for any particular application. The Mission seeks to undertake the necessary steps to enable cost reduction in all of these aspects.

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- 4.4** India has substantial experience in renewable energy deployment, contract mechanisms and policy frameworks. As a result, India has achieved some of the lowest long term levelized costs for solar and wind power generation. The downward trend is expected to continue. However, to ensure low cost of delivered renewable energy for electrolyser-based projects, the Mission proposes to extend various facilitative policy provisions for transmission, connectivity, banking, open access, and energy storage for Green Hydrogen production projects.
- 4.5** Another important intervention will be to upscale production and deployment of high-performance electrolysers in sufficient volumes. Currently, the global commercial electrolyser manufacturing capacity is estimated to be only about 2-4 GW/annum. During the past 3 years, various national governments and industrial organizations have announced deployment goals totalling to over 200 GW electrolyser capacity by 2030. With this, the global electrolyser manufacturing capacity is set to grow rapidly. However, to limit dependency on imports and ensure supply chain resilience in the sector, it is critical to develop a robust domestic electrolyser manufacturing ecosystem in India. The Mission proposes interventions to boost domestic manufacturing to ensure production of electrolysers in India at significantly lower costs. This will also enable competitiveness of Made in India Green Hydrogen in the international markets.
- 4.6** To further enhance cost-competitiveness of Green Hydrogen by reducing the cost of capital required to build projects, mechanisms for dollar denominated Bids for Green Hydrogen/ Ammonia will be explored.
- 4.7** Innovative models to source Green Hydrogen through use of decentralized renewable energy generation such as rooftop solar and small/micro hydel plants will also be explored. Decentralised Green Hydrogen production will be advantageous to reduce the requirement of its transportation for end-use. This would also allow for optimal utilization of various resources such as land, water, renewable energy potential etc. Decentralized production would be explored through:
- Biomass-based hydrogen production systems
  - Modular electrolysers connected to rooftop solar or other decentralized RE plants like small hydro etc.
- To optimize water requirements, the use of industrial or municipal wastewater for hydrogen production, wherever feasible, will also be emphasized.
- 4.8** For certain applications such as long-haul mobility, decentralized Green Hydrogen production would be essential. Hydrogen Refuelling stations in the cities and along highways could be connected to decentralized RE plants for in-situ production of Green Hydrogen.

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- 4.9** It will also be an endeavour to maximize the utilization of the renewable energy potential on various islands in India. Through appropriate connectivity, the renewable energy generated at islands in proximity to the mainland, could be transmitted and utilized for Green Hydrogen production and other end-uses. For remote islands, renewable energy can be utilized to produce Green Hydrogen in a decentralized mode to meet the local energy requirements. This would save the requirement of land for setting up RE capacities and also help in development of the island regions.
- 4.10** The Mission will also support and facilitate building of required infrastructure for storage and delivery of Green Hydrogen and its derivatives. Port infrastructure required to enable exports of Green Hydrogen derivatives, and pipelines to facilitate bulk transport of Green Hydrogen will also be developed. Further, the producers and consumers of Green Hydrogen and its derivatives will be encouraged to pool resources and develop projects in a coordinated manner in the form of large-scale Hydrogen Hubs.
- 4.11** With these targeted interventions to reduce input and capital costs, it is expected that Green Hydrogen will be competitive with Grey Hydrogen in the next few years.
- 4.12** Production of Green Hydrogen through biomass also holds potential for achieving scale and low costs. Different technological pathways, including biomass gasification and reformation of biogas etc. are in various stages of development and piloting. Achieving scale and building supply chains for biomass collection are key components for facilitating production of low-cost Green Hydrogen through these routes. These pathways can provide continuous hydrogen output which would enhance feasibility of hydrogen use for many end-use applications. The Mission, accordingly, aims to initiate focused pilots to arrive at workable models for biomass based Green Hydrogen production and its use in various applications. The Mission will focus on reducing the costs of biomass collection and delivery and the capital cost of equipment for conversion of biomass to hydrogen.

## **5. PHASED APPROACH**

- 5.1** Considering the nascent status of the sector and the rapidly evolving profile of the industry, the mission is proposed to be implemented in a phased manner, focusing initially on deployment of Green Hydrogen in sectors that are already using hydrogen, and evolving an ecosystem for R&D, regulations and pilot projects. The later phase of the Mission will build on these foundational activities and undertake Green Hydrogen initiatives in new sectors of the economy. The major thrust areas of each phase are identified below.

### **PHASE I (2022-23 TO 2025-26)**

- 5.2** The focus of Phase I will be on creating demand while enabling adequate supply by increasing the domestic electrolyser manufacturing capacity. In order to ensure Make in India from the inception stage, a bouquet of incentives aimed at indigenization of the value chain and increasing Green Hydrogen production and uptake will be developed. Utilisation in the

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refineries, fertilizers and city gas sectors will also create a sustained demand to support new investments in Green Hydrogen production.

- 5.3** The first phase will also lay the foundation for future energy transitions in other hard-to-abate sectors by creating the required Research and Development impetus. In this phase, pilot projects will be undertaken for initiating green transition in steel production, long-haul heavy-duty mobility and shipping. Parallely, work will commence on establishing a framework of regulations and standards to facilitate the growth of the sector and enable harmonisation and engagement with international norms.
- 5.4** The scale up of Green Hydrogen production and use, and the proposed measures under the Mission in the first phase, are expected to drive down costs, allowing for greater and wider Green Hydrogen deployment in the next phase.

### **PHASE II (2026-27 TO 2029-30)**

- 5.5** Green Hydrogen costs are expected to become competitive with fossil-fuel based alternatives in refinery and fertilizer sector by the beginning of the second phase, allowing for accelerated growth in production. Depending upon the evolution of costs and market demand, the potential for taking up commercial scale Green Hydrogen based projects in steel, mobility and shipping sectors will be explored. At the same time, it is proposed to undertake pilot projects in other potential sectors like railways, aviation etc. R&D activities will be scaled up for continuous development of products. The second phase activities would enhance penetration across all potential sectors to drive deep decarbonisation of the economy.

## **6. INTEGRATED MISSION STRATEGY**

- 6.1** All concerned Ministries, Departments, agencies and institutions of the Central and State Government will undertake focused and coordinated steps to ensure successful achievement of the Mission objectives.
- 6.2** Ministry of New and Renewable Energy (MNRE) will be responsible for overall coordination and implementation of the Mission. The Mission Secretariat, headquartered in MNRE, will formulate schemes and programmes for financial incentives to support production, utilization and export of Green Hydrogen and its derivatives. The Ministry will ensure planned deployment of renewable energy and green hydrogen capacities, support pilot and R&D projects, undertake capacity building and promote international cooperation efforts. The Ministry will also ensure holistic development of the Green Hydrogen ecosystem in the country through active coordination with various public and private entities responsible for other aspects of the Mission.
- 6.3** Ministry of Power (MoP) will implement policies and regulations to ensure delivery of renewable energy for Green Hydrogen production at least possible costs, including through

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development of the necessary power system infrastructure. MoP will also work with State Governments, Distribution Companies, Regulators and technical institutions to align the electricity ecosystem for large scale Green Hydrogen production.

- 6.4** Ministry of Petroleum and Natural Gas (MoPNG) will facilitate uptake of Green Hydrogen in refineries and city gas distribution through both Public Sector Entities and private sector. MoPNG will also enable development and facilitation of regulations through the Petroleum and Natural Gas Regulatory Board (PNGRB). New Refineries and city gas projects will be planned and designed to be compatible with maximum possible Green Hydrogen deployment, with a goal to progressively replace imported fossil fuels.
- 6.5** Ministry of Chemicals and Fertilizers will encourage adoption of indigenous green ammonia based fertilizers for progressively replacing imports of fertilizers and fossil fuel based feedstocks (natural gas and ammonia) used to produce fertilizers. This will enable decarbonization of the sector and reduce dependence on imports. The Ministry will enable procurement of green ammonia for its designated entities to create bulk demand.
- 6.6** Ministry of Road Transport and Highways will enable adoption of green hydrogen in the transport sector through regulations, standards, and codes, primarily for heavy commercial vehicles and long-haul operations. MoRTH will also facilitate technology development for adoption of green hydrogen in the transport sector through testing facilities, pilot projects, and provide support for infrastructure development.
- 6.7** Ministry of Steel will drive adoption of green hydrogen in the steel sector. The Ministry will identify and facilitate pilot projects for use of Green Hydrogen in steel production and undertake policy measures to accelerate commercial production of green steel.
- 6.8** Ministry of Ports, Shipping and Waterways (MoPSW) will play a crucial role in establishing India's export capabilities for green hydrogen and its derivatives. MoPSW will facilitate development of the required infrastructure including storage bunkers, port operations equipment, and refuelling facilities. MoPSW will also drive the adoption of hydrogen/derivatives (ammonia/methanol) as propulsion fuel for ships. The Ministry will also work towards making India as a green hydrogen/derivative refuelling hub.
- 6.9** Ministry of Finance will explore suitable fiscal and financial frameworks to promote production, utilization and export of Green Hydrogen and its derivatives.
- 6.10** Ministry of Commerce & Industry will encourage investments, facilitate ease of doing business, and implement specific industrial and trade policy measures for low-cost production and trade of hydrogen and its derivatives. The Ministry will undertake dialogue to facilitate global trade of hydrogen and its derivatives. The Ministry will also formulate necessary policies and programmes for development of an ecosystem for manufacturing

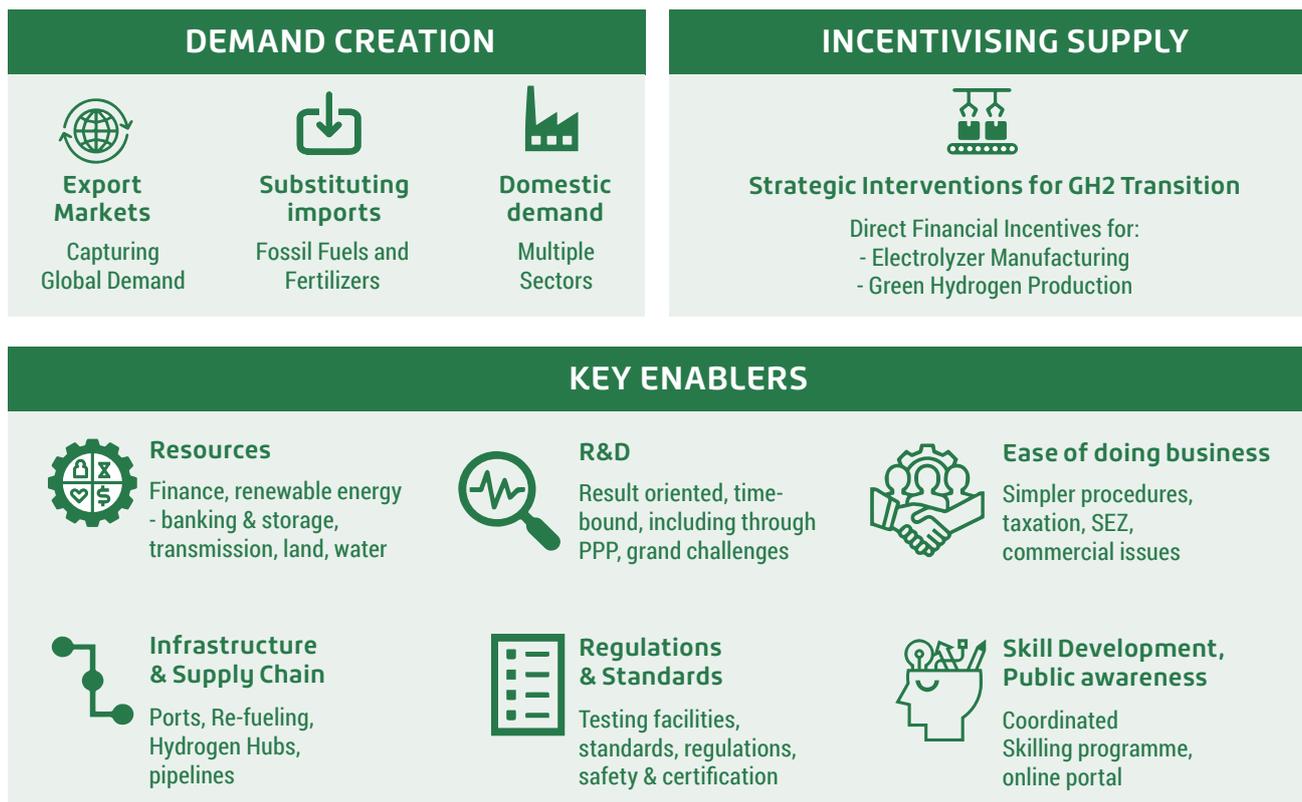
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of specialized equipment needed in the green hydrogen value chain.

- 6.11** Ministry of Railways will work on transitioning towards adoption of green hydrogen in their operations in view of its ambitious plans to reduce the carbon footprint. Accordingly, Railways is also expected to play an integral role for transporting green hydrogen and its derivatives. For this, the Ministry will put in place the necessary regulations and standards.
- 6.12** Coordinated efforts will be required to establish a robust ecosystem of regulations and standards to enable safe and rapid scaling up of projects for production, delivery, storage and use of hydrogen. MNRE will anchor this activity in partnership with Department for Promotion of Industry and Internal Trade, Bureau of Indian Standards, Ministry of Petroleum and Natural Gas, Ministry of Road Transport and Highways, and associated agencies.
- 6.13** Scientific Departments and agencies, including MNRE, the Office of the Principal Scientific Advisor to the Government of India, Department of Science and Technology, Department of Scientific and Industrial Research, Department of Space, Defence Research & Development Organisation, Ministry of Environment Forests and Climate Change, and other public research and innovation institutions will pool resources to build a comprehensive goal-oriented Research and Innovation programme in collaboration with the private sector.
- 6.14** Ministry of External Affairs (MEA) will be instrumental in building bilateral and multilateral partnerships for supporting the Green Hydrogen ecosystem development in India and abroad. MEA will also aid collaborations of Government agencies, institutions and industry with global partners.
- 6.15** The Ministry of Skill Development and Entrepreneurship will take steps in coordination with MNRE and other ministries for building skillsets ensuring employability in this sector. Suitable courses and programmes will be developed for skilling of manpower across the value chain, including manufacturing of equipment, Green Hydrogen project installation, and operations & maintenance.
- 6.16** Ministry of Education will work towards coverage of hydrogen technologies and latest developments in the pedagogy and curricula at various levels. Practical experience of technologies through guidelines for laboratory set ups in schools and higher education institutions will also be encouraged.
- 6.17** State governments and state agencies will also play an integral role in development of green hydrogen ecosystem. States will have an opportunity to establish themselves as front runners in this sunrise sector through project development, manufacturing, setting up renewable energy capacity, and promoting export of green hydrogen derivatives. For this, the States will be requested to put in place fair and rational policies for provision of land and water, suitable tax and duty structures and other measures to facilitate establishment of Green Hydrogen projects.

## 7. MISSION COMPONENTS

The achievement of Mission objectives requires a comprehensive strategy that coordinates efforts across multiple sectors. The Mission strategy accordingly comprises interventions for: (i) demand creation by making Green Hydrogen produced in India competitive for exports and through domestic consumption. (ii) addressing supply side constraints through an incentive framework, and (iii) building an enabling ecosystem to support scaling and development.



### 7.1 DEMAND CREATION – EXPORT MARKETS

- a. Considering the renewable energy potential and the enabling framework proposed under the Mission, India's Green Hydrogen production costs are expected to be among the lowest in the world. A global demand of over 100 MMT of Green Hydrogen and its derivatives like Green Ammonia is expected to emerge by 2030. Many countries are likely to rely on imports due to constraints on land and renewable resources required to produce Green Hydrogen domestically. Aiming at about 10 per cent of the global market, India can potentially export about 10 MMT Green Hydrogen/Green Ammonia per annum.
- b. The enabling framework created under the Mission and support for hydrogen hubs and port infrastructure will facilitate the development of a vibrant export market. Growth in export market will have a positive cascading effect on the domestic production as well. The Mission will facilitate development of strategic international partnerships to enable export of Green Hydrogen and its derivative products.

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## 7.2 DEMAND CREATION – DOMESTIC MARKETS

- a. About 5 MMT Grey Hydrogen is consumed annually in India, and about 99 percent of this quantity is utilized in petroleum refining and manufacture of Ammonia for fertilizers. In fertilizer production, Hydrogen is a key input for production of Ammonia (NH<sub>3</sub>), which is used to produce urea and other fertilizers. In petroleum refining, Hydrogen is mainly used for reducing sulphur content of fuels (desulphurization), and conversion of heavier feedstocks to more valuable products (hydrocracking). In both sectors, Grey Hydrogen can be substituted with Green Hydrogen, reducing carbon footprint and dependence on imported fossil fuels.
- b. Hydrogen can also be blended to a certain degree in most natural gas networks without requiring significant investments. Older networks will require retrofitting/upgradation of system components, but new and upcoming networks are likely to be compatible with high blend ratios of hydrogen.
- c. In order to create bulk demand and scale up production of Green Hydrogen, the Government of India will specify a minimum share of consumption of green hydrogen or its derivative products such as green ammonia, green methanol etc. by designated consumers as energy or feedstock. The year wise trajectory of such minimum share of consumption will be decided by the Empowered Group constituted under para 9.1 of this note, taking into account availability of resources for Green Hydrogen production, relative costs, and other economic factors.

## 7.3 COMPLIANCE MONITORING

- a. As per the targets decided by Empowered Group, MNRE in consultation with the Department of Fertilizers, Ministry of Petroleum and Natural Gas and other sectoral Ministries/Departments will develop guidelines and methodologies for monitoring and ensuring progress in respective sectors. The obligated corporate/public sector entities will submit periodic reports to the agency designated for monitoring. Technology interventions for online/real-time monitoring of targets will also be made for stringent monitoring and enforcement.
- b. A legal provision for ensuring enforceability of consumption targets for Green Hydrogen and its derivatives will be established through the Energy Conservation (EC) Act which will empower the Central Government to specify the minimum share of energy and feedstock consumption from non-fossil fuel-based sources that an industry must ensure.

## 7.4 COMPETITIVE BIDDING FOR PROCUREMENT

In early years of technology deployment, it is essential to aggregate demand through an enabling framework of bidding and procurement processes for achieving scale and stability in long term agreements. In this regard, MNRE will frame model guidelines for transparent competitive bidding for procurement of Green Hydrogen and its derivatives and develop a suitable regulatory framework for certification of Green Hydrogen and its derivatives as having been produced from RE sources. The bidding guidelines will be technology agnostic to allow both electrolysis and biomass-based generation of Green Hydrogen.

## 7.5 DOMESTIC MANUFACTURE OF FERTILIZERS USING GREEN AMMONIA

- a. In the year 2020-21, India imported about 10 MMT of Urea, 5 MMT Di-ammonium Phosphate (DAP) and 3 MMT of Ammonia. This translates into an annual import value of over USD 6 billion. With the expected reduction in the price of Green Hydrogen, there will be an economic rationale for producing these fertilizers domestically, using Green Hydrogen/Green Ammonia to substitute imports. Accordingly, it is proposed that the Government of India may call for competitive bids for establishing fertilizer plants based on Green Hydrogen/Green Ammonia.
- b. As part of the Mission, MNRE will formulate model bidding guidelines for procurement of Green Hydrogen based fertilizers, in consultation with the Department of Fertilizers. Two plants each for production of Green Hydrogen based Urea and Green Hydrogen based DAP are targeted to be set up through competitive bidding route. By 2034-35, it is targeted to substitute all Ammonia based fertilizer imports with domestic Green Ammonia based fertilizers.

## 7.6 STRATEGIC INTERVENTIONS FOR GREEN HYDROGEN TRANSITION (SIGHT)

- a. The Mission strategy will include a comprehensive incentive programme to facilitate growth of Green Hydrogen industry value chain in the country. A wide ranging and expansive bouquet of financial incentives and non-financial measures are proposed under the Mission to encourage production of low-cost Green Hydrogen and domestic manufacturing of related equipment and technologies. Depending upon the markets and technology development, specific incentive schemes and programmes will continue to evolve as the Mission progresses.
- b. At the initial stage, two distinct financial incentive mechanisms, targeted at support for domestic manufacturing of electrolyzers, and production of green hydrogen are proposed. To ensure quality and performance of equipment, the eligibility criteria for participation in competitive bidding for procurement of Green Hydrogen and its derivatives will specify that the project must utilize equipment approved by Government of India as per specified quality and performance criteria. An Approved List of Models and Manufacturers may also be notified by GoI in this regard from time to time.
- c. It is expected that the proposed incentives and interventions under the program will significantly reduce the cost of Green Hydrogen, enabling its uptake in emerging sectors and ensure establishment of a domestic manufacturing ecosystem by de-risking first movers and providing viability support for early innovators in the sector till the production of Green Hydrogen and its derivatives achieves scale and sustainability.

### INCENTIVES PROPOSED UNDER SIGHT



Support for Domestic Manufacturing of Electrolyzers



Incentives on Production of Green Hydrogen

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## 7.7 PILOT PROJECTS

For other hard to abate sectors, the Mission proposes pilot projects for replacing fossil fuels and fossil fuel-based feedstocks with Green Hydrogen and its derivatives. This includes sectors like steel, long-range heavy-duty mobility, energy storage and shipping etc. Pilot projects will help identify operational issues and gaps in terms of current technology readiness, regulations, implementation methodologies, infrastructure and supply chains. These will serve as valuable inputs for future scaling commercial deployment. Their outcomes will also help in understanding technology integration pathways, ascertaining viability gaps and level of government incentives/ policy support required, if any. Accordingly, detailed implementation and performance data will be compiled from pilot projects to serve as inputs for future projects and programmes. Wherever feasible, a competitive selection process could be adopted for implementing pilot projects.

### 7.7.1 GREEN STEEL

- a. Steel production is one of the potential sectors where Green Hydrogen can replace fossil fuels. The National Steel Policy 2017 states that Natural Gas is a greener alternative to meeting India's goal of reducing the carbon intensity of GDP under the Paris Climate Agreement.
- b. With the falling costs of renewable energy and electrolyzers, it is expected that Green-Hydrogen based steel can become cost-competitive in the coming decade. Provision of carbon credits and imposition of market barriers on carbon intensive steel are likely to further enhance the viability of Green Hydrogen based steel.
- c. The Mission will support efforts to enhance low-carbon Steel production capacity. Considering the higher costs of Green Hydrogen at present, Steel plants can begin by blending a small percentage of Green Hydrogen in their processes. The blending proportion can be progressively increased as cost-economics improves and technology advances. Further upcoming steel plants should be capable of operating with Green Hydrogen. This would ensure that these plants are able to participate in future global low-carbon Steel markets. Green field projects aiming at 100% green steel will also be considered.

### 7.7.2 TRANSPORT

- a. Considering Hydrogen's advantages for heavy-duty, long-haul vehicles, certain routes as Hydrogen Highways. The necessary Green Hydrogen production projects, distribution infrastructure and refuelling stations will be built along such highways. This will enable Hydrogen fuelled inter-state buses and commercial vehicles to ply on such routes.
- b. The Mission proposes to support deployment of FCEV buses and trucks, in a phased manner on pilot basis. Financial assistance will be provided to close the viability gap due to the relatively higher capital cost of FCEVs in the initial years. The learnings from the pilot projects will help inter-city bus and truck operators, (including State Transport Undertakings) in gaining experience with the deployment and usage of Hydrogen fuel cell vehicles and refuelling technologies. The Mission will also explore the possibility of blending Green Hydrogen based Methanol/Ethanol and other synthetic fuels derived from Green Hydrogen in automobile fuels.

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### 7.7.3 SHIPPING

- a. Shipping and Port operations are among the key sectors likely to drive the future Green Hydrogen demand and trade. Maritime transport and Ports have significant potential for decarbonisation through use of Green Hydrogen or its derivatives such as Green Ammonia and Green Methanol as fuel for propulsion and other operations. Prospects include development of Green Hydrogen/Ammonia refuelling hubs at Indian ports; development and operation of Green Hydrogen/Ammonia fuelled vessels; use of Green Hydrogen/Ammonia to fuel zero-emission technologies for vehicles and terminal equipment at ports; and development of supply chains and capabilities to support future export of Green Hydrogen/Ammonia from India.
- b. The Shipping Corporation of India or in case of its disinvestment, its successor private entity will retrofit at least two ships to run on Green Hydrogen or other Green Hydrogen derived fuels by 2027.
- c. India's oil and gas PSUs also currently charter about forty vessels for transport of petroleum products. In order to promote forays into Hydrogen powered shipping lines, these PSUs will be required to charter at least one ship each to be powered by Green Hydrogen or derived fuels by 2027. Thereafter, the companies will be required to add at least one ship powered by green hydrogen or its derivatives for each year of the mission.
- d. Green Ammonia bunkers and refuelling facilities will be set up at least at one port by 2025. Such facilities will be established at all major ports by 2035.

**7.7.4** Pilot projects will also be supported in other areas including emerging technologies for Green Hydrogen production (including from biomass), large scale storage of Hydrogen, energy storage etc. These pilot projects will be diversified across technology options to ensure capacity building and experience across the Green Hydrogen value chain.

### 7.8 GREEN HYDROGEN HUBS

- a. Given the technical and logistical challenges inherent in transporting Hydrogen over long distances, a cluster-based production and utilisation model would enhance viability of Green Hydrogen projects in the initial years. This would, in turn, enable economies of scale and convergence of key infrastructure requirements in geographically proximate areas.
- b. The Mission will accordingly identify and develop regions capable of supporting large scale production and/or utilization of Hydrogen as Green Hydrogen Hubs. Development of Trunk infrastructure for such hubs will be supported under the Mission. Projects in the Hubs will be planned in an integrated manner to allow pooling of resources and achievement of scale. It is planned to set up at least two such Green Hydrogen hubs in the initial phase.

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- c. Potential locations for such Hubs would be regions having clusters of refineries/ fertilizer production plants in close vicinity. Pilot projects in emerging applications such as steel production, mobility, ports development etc. will also be promoted within these Hubs to take advantage of the existing ecosystem. Corridors connecting such Hubs will be developed as Green Hydrogen mobility corridors by setting up sufficient refuelling infrastructure and Hydrogen supply arrangements along such routes.
  - d. The infrastructure, projects, and key resources will be mapped under the PM Gati Shakti to ensure optimal and coordinated development.
  - e. It is expected that Green Hydrogen projects will be drawn towards major ports. The Green Hydrogen Hubs and associated infrastructure will be planned in a manner that also promotes development in the coastal zones in the vicinity of such ports.

## 7.9 ENABLING POLICY FRAMEWORK

- a. In order to support affordable Green Hydrogen production, coordination across government departments and extension of maximum possible benefits under existing government policies will be required in a Whole of Government Approach. MNRE will liaise and coordinate across multiple departments at the federal and state levels in order to facilitate a nurturing ecosystem for development of Green Hydrogen projects in the country.
- b. To facilitate delivery of renewable power, various supportive policy provisions will be extended to Green Hydrogen Projects. This shall include waiver of Interstate transmission charges for renewable energy used for Green Hydrogen production; facilitating renewable energy banking; and time bound grant of Open Access and connectivity.
- c. For this purpose, Government of India will undertake integrated planning and implementation of renewable energy capacities, transmission infrastructure, facilities for suitable banking of power, energy storage, and the associated power system projects.
- d. Availability of land and facilitative policies for setting up of largescale production facilities for green hydrogen and associated products will be critical for the success of the Mission. Provisions of existing schemes such as Solar Parks, Manufacturing Zones, and SEZs could be extended to cover Green Hydrogen related activities.
- e. Various policy measures and initiatives will be explored to ensure access to low cost funds through international Green Finance, Green bonds, and other innovative financial mechanisms for Green Hydrogen projects.

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## 7.10 REGULATIONS, CODES AND STANDARDS

- a. Any sunrise industry requires a robust regulatory architecture, safety codes and relevant quality and performance standards. These will not only guide the technology developments but also anchor the long-term investment outlook for the private sector. The Mission will, thus, seek to coordinate various efforts for development of regulations and standards in line with industry requirements for emerging technologies. Existing statutory approvals and permissions procedures will be streamlined, and new processes will be established, as required. The imperative of Ease of Doing Business will be kept in view and efforts will be made for simplified processes and expeditious approvals leveraging technology. The effort will be to harmonise regulations and standards with internationally accepted norms to ensure inter-operability of technologies, and incorporation of global best practices.
- b. Significant efforts are already underway for building a standards and regulatory framework for enabling the Hydrogen ecosystem. The Bureau of Indian Standards has been developing and notifying standards to address many crucial aspects, including direct adoption of relevant international standards wherever feasible. Standards and Regulations specific to automotive applications are also being developed by the Ministry of Road Transport and Highways.
- c. An immediate area of action will be to put in place an ecosystem for time-bound approvals of pilot and demonstration projects under the Mission. All regulatory provisions (or amendments in existing regulations) to permit operation of Hydrogen fuelled vehicles and other applications will be notified within twelve months of the notification of the Mission. A web-based portal will be developed that will list out the database of all relevant regulations and standards pertaining to Hydrogen at the Central and State levels. The portal will also include options for online safety and regulatory approvals for various aspects of Hydrogen production, storage and use.
- d. Creation of suitable testing facilities to certify and validate technologies will be supported. Formulation and regular revision of testing protocols relevant to Indian conditions will be undertaken in collaboration with premier National and International research institutions. These will be updated periodically with emergence of new technologies and applications. Knowledge and experience gained from evaluation of established and new technologies will be disseminated appropriately. The aim will be to facilitate notification of all requisite standards and regulations by the end of 2023-24. Meanwhile, adoption of relevant international standards in critical areas will be encouraged. Testing facilities specific to Hydrogen and Fuel Cell technologies requirements will be established at existing National Testing Centres.
- e. To build greater public confidence in new technologies in the Green Hydrogen ecosystem, safety will be prioritized across the value chain and addressed as part of standards and testing protocols. Development of expertise on safety aspects of Hydrogen and Fuel Cell technologies will be facilitated. Safety regulations will be developed in consonance with globally accepted

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safety norms, to build trust among users with robust quality and performance requirements regarding safety.

- f. A regulatory framework to allow storage and dispensing of Hydrogen at par with international norms will be expeditiously established. Regulations governing Hydrogen storage will also be revisited to be at par with the global technology developments and industry requirements. It will also be necessary to align with globally prevalent standards and regulations to tap into the international market.
- g. To address the above issues, MNRE has constituted a Working Group comprising relevant Ministries, government agencies, standardization and certification bodies, and industry stakeholders to recommend a national framework for Standards and Regulations required for the Green Hydrogen ecosystem.

#### **7.11 RESEARCH AND DEVELOPMENT**

- a. Innovation will be supported with an aim to increase the affordability of Green Hydrogen production, storage, transportation, and utilization and to enhance the efficiency, safety and reliability of the relevant systems and processes. R&D projects will be goal-oriented, time bound, and suitably scaled up to achieve quantifiable returns.
- b. The proposed R&D programme has been detailed in consultation with Council for Scientific and Industrial Research (CSIR). Support is proposed for identified Mission Mode Projects with short term (0-5 years) horizon. The focus will be on end product development in partnership with the industry. An effort will be made to aggregate and leverage existing capabilities and infrastructure during this phase. Likely projects under this mode will include development of domestic modular electrolysers, Type III/Type IV compressed hydrogen tanks and PEM based fuel cells, with an intent to increase operational efficiencies. Biomass based Hydrogen generation will also be scaled-up for commercial applications.
- c. Grand Challenge Projects with a mid-term (0 - 8 years) impact horizon will be initiated parallelly with a focus on critical technologies to overcome licensing challenges and supply constraints. These projects are proposed to be taken up in consortium mode and would require augmentation of existing capabilities and infrastructure. Likely Grand Challenges will be built around manufacturing of critical electrolyser and fuel cell components like Membrane Electrode Assemblies (MEAs), electrocatalysts, Catalyst Coated Membranes (CCMs), Gas Diffusion Layers (GDLs), bipolar plates etc. Component-specific research focus will be critical to further upscale existing domestic manufacturing capabilities, improve efficiencies and drive down costs of critical technologies.
- d. Blue Sky Projects having a long term (0-15 years) horizon will be taken up with a focus on establishing global IP and competitive advantage for the Indian industry. Blue Sky Projects will aim to develop capabilities of the Indian R&D sector within an array of subjects like

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development of 3rd generation electrocatalysts, reversible Solid Oxide Electrolysers (SOECs) and Solid Oxide Fuel Cells (SOFCs), seawater electrolysis, thermo-catalytic pyrolysis, plasma pyrolysis, salt cavern surveys, high entropy alloys for reversible hydrogen storage etc.

- e. A public-private partnership framework for R&D (Strategic Hydrogen Innovation Partnership – SHIP) will be facilitated under the Mission. The framework will entail creation of a dedicated R&D fund, with contributions from Industry and Government institutions. Funding contribution from Venture Capitals will also be explored to encourage innovation for immediate needs and in the long run. The R&D programme under the Mission will seek to develop globally competitive technologies in various segments. A consortium-based approach, leveraging strengths of each institution/industry, will be encouraged.
- f. The R&D programme will also focus on identifying and supporting Centres of Excellence to foster innovation and technology development, by building subject expertise and research infrastructure. A network approach will be undertaken involving the academia-industry-government to ensure seamless transfer and commercialisation of new technologies.
- g. The Mission will seek to leverage the inherent strengths and technological experience of institutions such as ISRO, IITs, IISc etc and the Indian industry. Development work undertaken thus far will be consolidated for optimum utilization of knowledge and other resources. Industry-academia-government networks would be important to ensure that the technological developments are commercialised and appropriate policy and regulation support is provided. MNRE will facilitate effective industry-academia collaboration.
- h. In addition to industrial and institutional research, innovative MSMEs and startups working on indigenous technology development and adaptation will be encouraged under existing Government programmes and through specific support mechanisms under the Mission.

The R&D themes mentioned in sub-para b, c, and d above, is indicative; a phased R&D roadmap identifying specific areas and projects will be prepared by the Advisory Group.

## **7.12 SKILL DEVELOPMENT**

- a. Development and utilization of Hydrogen technologies will necessitate specific expertise and skill sets. Knowledge of power electronics, advanced materials, electrolysers, fuel cells, Hydrogen storage, compression and distribution, covering design, manufacturing, installation, operational and maintenance aspects of these technologies will be necessary. Hydrogen Safety, standards, certification and integrated project management will also require special focus.
- b. A coordinated skilling programme, that considers skill requirements in various segments, will be undertaken in coordination with the Ministry of Skill Development and Entrepreneurship. The programme will effectively associate institutions, skill development centres, universities, industry, and businesses. Green Hydrogen and associated aspects will also be suitably covered

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under the various efforts of the National Skill Development Mission. Global best practices and developments will be incorporated in the skilling programmes, including through access to international training content. Hydrogen technologies will also be suitably incorporated in various course curricula to develop a broad knowledge base, in partnership with the Ministry of Education.

- c. A significant part of Skill Development programme will focus on reskilling the workforce in polluting, sunset sectors to be absorbed into the Green Hydrogen and its auxiliary ecosystem. This will enable greater productive capacities of human capital and enable a just transition.

### **7.13 PUBLIC AWARENESS AND STAKEHOLDER OUTREACH**

- a. Expansion of Green Hydrogen, especially in public centric sectors such as transport and city gas distribution, will require concerted public awareness and stakeholder outreach activities. It is also important to project the development of this sector across various strata of academia, industry and society to build an organic momentum for the sector.
- b. Towards this end, the Mission will focus on disseminating knowledge regarding Hydrogen and Fuel Cell technologies and its prospects among students, researchers, businesses, policymakers, investors and public at large. It is important that the Mission becomes widely accepted across the country. Dedicated workshops, seminars and exhibitions will be encouraged for building stakeholder partnerships. Steps would be undertaken to co-own the Mission objectives among the relevant stakeholders to make the Mission a success.
- c. MNRE will involve experts, think-tanks, and civil society organisations from various regions of the country to disseminate the usages and benefits of Green Hydrogen and its forward and backward linkages to the economy. A national online portal on Hydrogen will be developed which will compile and update information on all Hydrogen related activities being undertaken by various agencies in the country.

### **7.14 INTERNATIONAL COOPERATION**

- a. Given the global momentum for Green Hydrogen and the implementation of respective national strategies for Hydrogen by various countries, it is imperative that India forges strategic partnerships in all areas of Green Hydrogen development – technology, financing, regulations, trade, and policy. Joint investments, collaborative projects and long-term trade agreements will also be explored under these partnerships.
- b. A key axis of the Mission will be to promote multilateral engagement and collaboration with various international efforts in Hydrogen and fuel cells such as the International Partnership on Hydrogen and Fuel Cells in the Economy, Mission Innovation, Clean Energy Ministerial etc. Cooperation among Academia, universities, technical institutions, industry and research laboratories will be facilitated under bilateral and multilateral collaboration programmes for result-oriented technology development, knowledge creation and dissemination.

- c. Active engagement in various international collaborative efforts for Hydrogen and fuel cell development will be encouraged within the existing cooperation framework, and new cooperation programmes will also be developed wherever necessary. As the market matures, India will endeavour to build partnerships for international trade of Green Hydrogen and its derivatives.

## 8. RISK MANAGEMENT

- 8.1** Success in achieving the outcomes of this mission is dependent on several factors. It will require constant monitoring, indexing, and sufficient flexibility for mid-course corrections. The underlying Governance Framework will be tasked with Risk Identification, classification and timely action through necessary policy changes.
- 8.2** The Mission seeks to minimise various risks through an appropriate mix of financial and non-financial levers, and review mechanisms. These will be monitored regularly by the Mission Secretariat through regular consultations with stakeholders. An indicative categorization and associated management/mitigation measures for the likely risks are detailed in the following table.

Type of Risk	Risk categorisation	Risk Management/Mitigation Measures
Strategic Risks	Supply Chain Disruptions in Critical Inputs	Diversification in Supply Chains
Technological Risk	Technology Disruptions and Unforeseen Developments	Diversification of technology options, Technology agnostic approach in funding support. Funding of multiple R&D and pilot threads, Collaborative platforms for industry, academia and startups
Operational/Project Level Risks	Water Availability	Optimizing location of Renewable Energy and Green Hydrogen production plants
	Land Availability	States to be requested to create land banks for Renewable Energy and Green Hydrogen deployment
	Safety Concerns	Rigorous safety standards and regulatory mechanisms
Financial and Market Risks	Sustainable Demand	Demand creation efforts in identified sectors
	Availability of Affordable Renewable Energy (RE)	Integrated planning of RE capacity addition
	Availability of Electrolysers and other key components	Incentives to create domestic manufacturing ecosystem
	Additional infrastructure costs and capital expenditure	Ramp up of capacities to achieve economies of scale
	Availability of accessible Credit	Risk sharing framework in procurement, Facilitating projects to access FDI, bond markets, MFAs

## 9. MISSION GOVERNANCE FRAMEWORK

9.1 Effective implementation of the Mission activities requires strong coordination among various Ministries and Departments of Central and State Governments, Industry, Institutions, and other Stakeholders. A flexible and result-oriented governance structure will be created for steering and guiding the implementation of the Mission. An Empowered Group (EG) chaired by the Cabinet Secretary and comprising Principal Scientific Adviser to the Government of India, CEO, NITI Aayog, and Secretaries of Ministries of New and Renewable Energy, Petroleum and Natural Gas, Power, Road Transport and Highways, Steel, Heavy Industries, Ports, Shipping and Waterways, Skill Development and Entrepreneurship; and Departments of Fertilizers, Science and Technology, Scientific and Industrial Research, Promotion of Industry and Internal Trade; and experts from the industry will be set up. The EG will oversee the Mission activities, provide guidance, continuously monitor progress, recommend policy interventions to be made in furtherance of mission objectives and approve mid-course corrections if required. Secretaries of other Ministries/ Departments, Chief Secretaries from the States, and other experts may be invited as required by the Empowered Group.

### Mission Governance Framework

#### Empowered Group

- ✧ Chaired by Cabinet Secretary
- ✧ Members: Principal Scientific Adviser to the Government of India, CEO, NITI Aayog, and Secretaries of Ministries of New and Renewable Energy, Petroleum and Natural Gas, Power, Road Transport and Highways, Steel, Heavy Industries, Ports, Shipping and Waterways, Skill Development and Entrepreneurship; and Departments of Fertilizers, Science and Technology, Scientific and Industrial Research, Promotion of Industry and Internal Trade; and experts from the industry.

#### Advisory Group

- ✧ Chaired by the Principal Scientific Advisor to the Government of India
- ✧ Members: Experts from academic and research institutions, industry, and civil society.

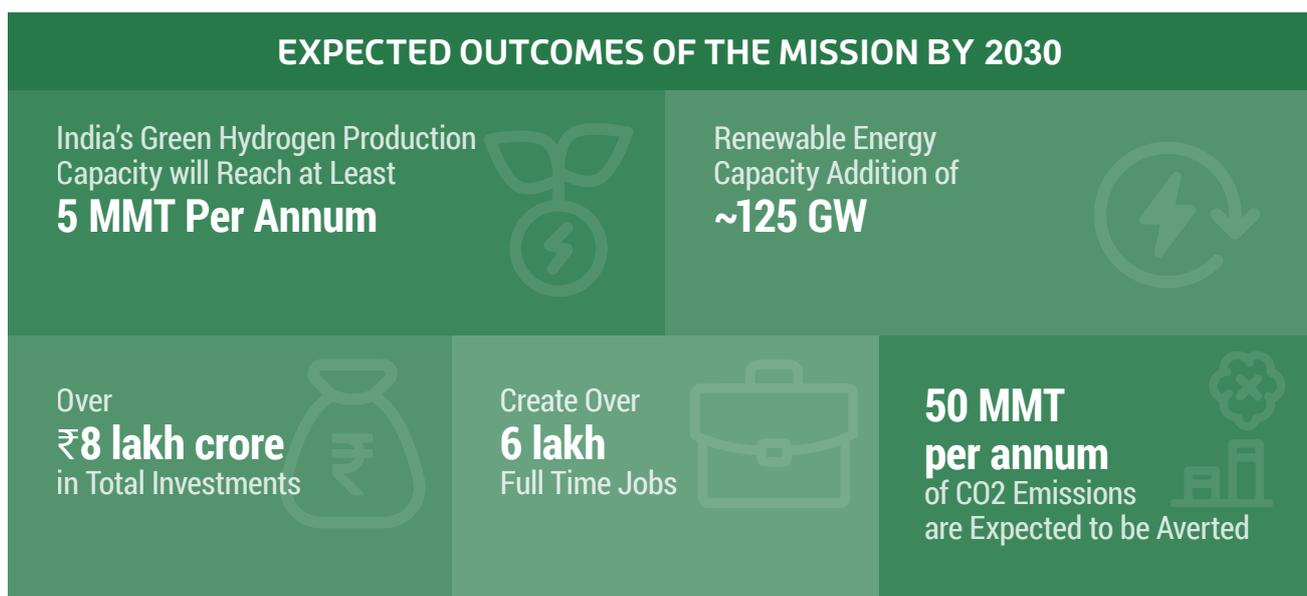
#### Mission Secretariat

- ✧ Headquartered in MNRE
- ✧ Headed by Mission Director
- ✧ Comprise subject matter experts and professionals

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- 9.2** The Empowered Group will be responsible for the overall implementation of Mission objectives, addition or deletion of any activities/projects, recommending fiscal, monetary or regulatory interventions to appropriate authorities, removal of difficulties in interpretation or giving effect to any provision of this Mission document.
- 9.3** The EG will ensure complementarity of the Mission with other Government of India programmes and activities related to Hydrogen and facilitate cohesive action among the various Ministries/ Departments participating in the Mission. Activities will be taken up in close coordination with all stakeholders, avoiding duplication of efforts and ensuring optimum utilisation of resources and expertise. The EG will be fully empowered to constitute thematic Sub-Committees comprising domain experts to support its functions as deemed necessary. The EG will also monitor performance and impact of projects to identify potential for further investment and scaling up.
- 9.4** A National Green Hydrogen Advisory Group comprising experts from academic and research institutions, industry, and civil society will also be constituted. It will be chaired by the Principal Scientific Advisor to the Government of India. The Advisory Group will advise the EG on all science and technology related matters pertaining to the Mission. It will carry out technology gap analysis for various aspects of the value chain and accordingly define broad performance and cost targets based on global benchmarking. The Advisory Group will recommend R&D roadmap based on industry requirements, impact potential of various pathways, alignment with core competencies of institutions, and current state of maturity of technology and research. It will also assist the Empowered Group in formulating targeted calls for proposals for pilot and R&D projects and evaluation of proposals for financial support.
- 9.5** MNRE will be the nodal coordinating Ministry for the Mission and will undertake the overarching policy formulation and programme implementation with an aim to scale up production of green hydrogen, green ammonia and other derivatives and enable cost reduction. Line Ministries/ Departments will support the uptake of green hydrogen in respective sectors in accordance with the overall guidance of the EG. A Mission Secretariat, headquartered in MNRE, will coordinate the programme and facilitate the day-to-day activities of the Mission.
- 9.6** Mission Secretariat will be headed by the Mission Director, who will be a professional with domain knowledge and experience. The Mission Director will serve as the Secretary of the EG. The Secretariat will comprise subject matter experts and professionals. The Secretariat will formulate or facilitate formulation of policies including guidelines for procurement of Green Hydrogen and its derivatives; schemes for incentives and projects; and undertake appraisal, funding and management of pilot and R&D projects. It will also assist the EG and the Advisory Group, as required. The Mission Secretariat will continuously monitor the sector's exposure to various risks, categorize and address them in a timely manner, with the guidance of the EG from time to time. A specific portion of the Mission budget will be earmarked for programme management activities to support the Secretariat.

- 9.7 A National Portal for the submission of application, sanctioning of projects, their approval, disbursement of funds, monitoring of projects, dissemination of knowledge and awareness about the Mission and connecting stakeholders will be established during the early stages of the programme and populated as the Mission progresses.
- 9.8 Other Ministries/Departments will implement green hydrogen projects in respective sectors (including fertilizers, refining, natural gas, transport, shipping, steel etc), under the overall guidance of the EG. In order to ensure coordinated approach, line Ministries responsible for Green Hydrogen projects will also create dedicated Green Hydrogen cells to coordinate the respective activities under the Mission.
- 9.9 Efforts will be made to leverage existing institutions under administrative control of/funded by various Ministries/Departments like MoPNG, DST, DSIR, ISRO, MoRTH etc. for implementation, testing, standardization, R&D activities etc. to ensure optimum utilization of resources.

## 10. EXPECTED OUTCOMES



- 10.1 The Mission will lead to economy-wide benefits through decarbonisation of industrial, mobility and energy sectors; reduction in dependence on imported fossil fuels; development of indigenous manufacturing capabilities; creation of employment opportunities across the value chain; and development of cutting-edge technologies and innovation ecosystem in the country.
- 10.2 Implementation of the Mission is expected to create a large-scale ecosystem for Green Hydrogen production and use in the country. India's Green Hydrogen production capacity is likely to reach at least 5 MMT per annum, with an associated renewable energy capacity addition of about 125 GW. With growth of export markets and international partnerships, the production capacity could be scaled to 10 MMT per annum.

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**10.3** The ecosystem for Green Hydrogen will also create substantial investment and employment opportunities and save a significant amount of outgo towards energy imports. The production capacity targeted by 2030 is likely to leverage over ₹8 lakh crore in total investments and create over 6 lakh jobs.

**10.4** The Mission will significantly decarbonise the identified industrial sectors and prepare a foundation for similar transition in other emerging sectors like steel, shipping, energy storage and long haul mobility. Nearly 50 MMT per annum of CO<sub>2</sub> emissions are expected to be averted as a result of the various Green Hydrogen initiatives under the Mission. Ultimately, use of Green Hydrogen will play a crucial role in ensuring India's energy independence and Net Zero goals.

## 11. FINANCIAL OUTLAY

**11.1** Financing the Mission would require both public and private investments. In principle, Government of India support will de-risk private investment from various sources. These investments would primarily be in developing new projects and assets for Hydrogen production, supporting retrofits required for enabling greater use of Green Hydrogen and Green Ammonia, and support activities including software, testing, maintenance etc. The aim is to create multiplier effect in investment using the government support and creating an enabling environment for accelerated growth of Green Hydrogen production, uptake and exports.

**11.2** The initial outlay for the Mission will be ₹19,744 crore, including an outlay of ₹17,490 crore for the SIGHT programme, ₹1,466 crore for pilot projects, ₹400 crore for R&D, and ₹388 crore towards other Mission components. MNRE will formulate schemes guidelines for implementation of the respective components.

## 12. IMPLEMENTATION ROADMAP

The strategies identified under the Mission will be implemented in a planned and coordinated manner. The phased approach of the Mission will enable taking up foundational activities like the regulatory framework and pilot projects while also creating demand and early deployment. Later phases will build on these activities and undertake green initiatives in new sectors of the economy. Activities will be taken up in close coordination with respective stakeholders to achieve the Mission objectives.

The key actions and implementation timelines are summarised in the table below:

## MISSION IMPLEMENTATION TIMELINE

YEAR	Facilitate	Green Fertilizers	SIGHT	Pilots & Hubs	Regulations & Standards	R&D		
2022-23			Consultation and Market Review	Roadmap for key sectors	Procedure for regulatory approval of pilot projects	Formulation of R&D Roadmap		
2023-24	Notification of targets as may be decided by EG	Notification of Bids Award of Capacity	Notification of Incentive Schemes	Call for Proposals Phase I Implementation	Adoption of relevant international standards	Call for Proposals Phase I Implementation		
2024-25	Preparatory steps for implementation	Construction						
2025-26	Implementation	Green Fertilizer production	Implementation of incentives	Call for proposals	Continuous Review and Monitoring	Call for proposals		
2026-27								
2027-28							Phase II Implementation	
2028-29								
2029-30								

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## 13. CONCLUSION

Green Hydrogen is likely to play a critical role in India's energy transition, particularly in decarbonization of hard to abate sectors. The National Green Hydrogen Mission is a step in this direction. The Mission is expected to facilitate deployment of Green Hydrogen ecosystem and create opportunities for innovation and investments across the Green Hydrogen value chain, translating into investments, jobs and economic growth. The Government of India interventions will ignite the process and provide required impetus for unlocking the market potential in various sectors through cost reduction and economies of scale.

