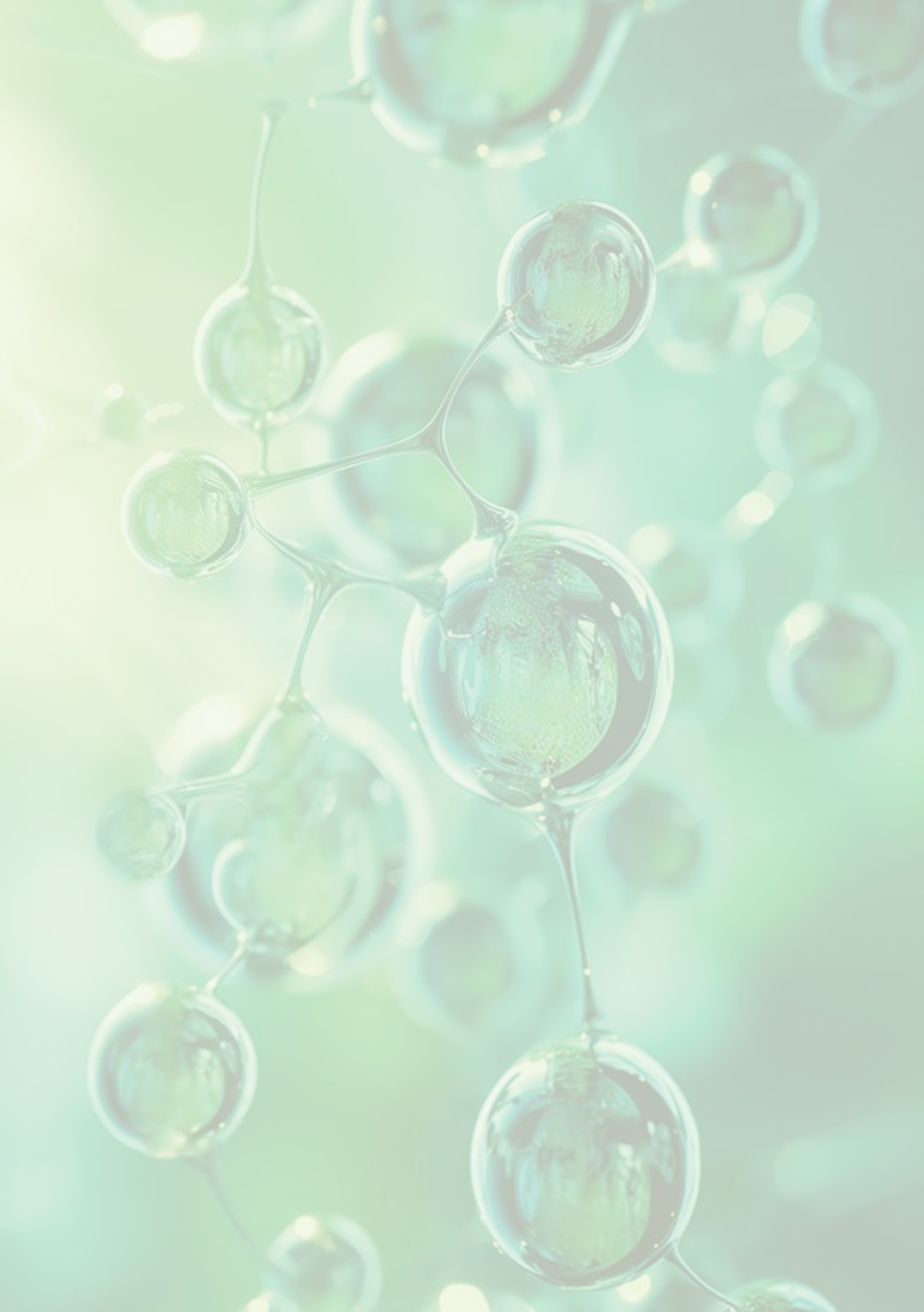


INDIA'S **GREEN HYDROGEN REVOLUTION** – An Ambitious Approach

May 2024





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ACKNOWLEDGEMENT

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We express our sincere gratitude to all the industry leaders, who have expressed their views on the subject matter.

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Disclaimer

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PREFACE

The world faces a pressing challenge: **DECARBONISATION**. To combat climate change, nations around the globe are striving to reduce greenhouse gas emissions and transition towards cleaner energy sources. International conferences like COP 26 (2021) and COP 28 (2023) have played a crucial role in fostering global collaboration on this front.

The booklet includes overview of decarbonisation scenario in India and the policy measures of the Government for supporting the need of the hour, with right mix of decarbonisation pathways and technology levers.

In this context, Green Hydrogen emerges as a game-changer. Produced using renewable energy sources like solar, wind, hydro and biomass, Green Hydrogen offers a clean and sustainable alternative to fossil fuels. However, large-scale production necessitates significant renewable energy capacity.

Recognizing this potential, India launched the National Green Hydrogen Mission in 2023. This ambitious mission aims to establish India as a global hub for Green Hydrogen production, usage, and export. The mission seeks to:

- Drive down production costs through financial incentives for electrolyser manufacturing and Green Hydrogen production.
- Boost domestic demand by mandating minimum Green Hydrogen consumption in specific sectors.
- Facilitate exports by establishing supportive policies and strategic partnerships.

The Government of India already has a strong focus on renewable energy with ambitious targets for capacity expansion. This focus on renewables is crucial for powering Green Hydrogen production and achieving the mission's goals. The economic potential of Green Hydrogen in India is significant and the mission projects creation of millions of jobs, attracting substantial investments, and reducing dependence on fossil fuel imports. This economic development will contribute to India's overall energy security and Aatmanirbhar Bharat (self-reliant India) goals.

Several major Green Hydrogen projects (Pilot and Commercial) are already underway across India, showcasing the country's commitment to its clean energy targets. Few success stories of the projects have been showcased in the booklet. These projects pave the way for a greener future powered by innovation and sustainability.

Financing Green Hydrogen and Renewable Energy projects requires a multi-pronged approach. Traditional methods remain important, but innovative solutions and supportive policies are crucial to unlock the full potential of clean energy investments. Along with the financing options of debt and equity, green financing facilities like Green Bonds & Sovereign Loans can be explored. Collaboration between public and private sectors is key to bridging the financing gaps and accelerating the transition to a sustainable future.

FOREWORD



Ajay Yadav
Joint Secretary
Ministry of New &
Renewable Energy

As we stand at the cusp of a transformative era in energy evolution, the significance of Green Hydrogen cannot be overstated. With great enthusiasm that I introduce this booklet, depicting the brief development of Green Hydrogen in India.

In recent years, the discourse around sustainable energy solutions has shifted towards the imperative of decarbonisation, and Green Hydrogen has emerged as a beacon of hope in this journey. Unlike its grey counterpart, Green Hydrogen production offers a pathway free from harmful emissions, harnessing the power of renewable energy sources such as solar and wind. Through the process of electrolysis or biomass gasification, water is transformed into a clean fuel that holds immense potential across various sectors, from industry to transportation.

India's commitment to this cause is underscored by the National Green Hydrogen Mission, a visionary initiative aiming to produce 5 million tonnes of Green Hydrogen by 2030. This mission not only aligns with our national goals for sustainability but also positions India as a frontrunner in the global green energy landscape.

As we embark on this journey, it is imperative to prioritize quality and safety at every step. The development of robust standards and regulations will ensure that Green Hydrogen maintains its promise as a safe and reliable energy source.

The booklet you hold in your hands is not just a compilation of articles; it is a testament to our collective vision for a greener, more sustainable future. Through insightful analysis and informed perspectives, we aim to provide you with a comprehensive understanding of the development of Green Hydrogen eco system in India.

Moreover, this booklet serves as a platform to highlight the pioneering Green Hydrogen projects already underway in India. These projects stand as testament to our nation's capacity for innovation and our unwavering commitment to a cleaner, brighter tomorrow.

I am confident that this booklet will prove to be a valuable resource for understanding the Indian initiatives for the development of Green Hydrogen in India. By fostering dialogue, sharing knowledge, and promoting collaboration, we can accelerate the adoption of Green Hydrogen and usher in a new era of sustainable development.

In closing, I extend my gratitude to the contributors, who have made this booklet possible. Together, let us strive towards a future powered by clean, renewable energy, where Green Hydrogen takes its rightful place at the forefront of our energy transition.

Warm regards,

FOREWORD



Somesh Kumar

Partner

Ernst & Young-LLP

The world stands at the crossroads of an energy revolution, where sustainability and innovation converge to create a future that is not only green but also economically vibrant. India, with its rich history of leadership in renewable energy, is at the forefront of this transformative journey. It is with great pleasure that I welcome you to this special issue of our booklet, where we explore the National Green Hydrogen Mission of India and the various initiatives that are propelling this mission toward success.

The National Green Hydrogen Mission of India represents a landmark effort to position India as a global leader in the production, use and export of Green Hydrogen (GH₂) and its derivatives such as Green Ammonia and Green Methanol. By harnessing the power of renewable energy sources like solar and wind, green hydrogen has the potential to decarbonize industries, reduce reliance on fossil fuels, decrease import and contribute significantly to India's climate goals. This mission embodies the spirit of innovation and sustainable development, with a vision to create a robust green hydrogen economy that benefits industries, communities, and the environment.

The Ministry of New and Renewable Energy (MNRE), under Government of India plays a pivotal role in this endeavour, with various schemes designed to encourage the adoption of green hydrogen technologies. Through strategic incentives, infrastructure development, and policy frameworks, the ministry is laying the groundwork for a vibrant green hydrogen ecosystem. The schemes by MNRE are not just about promoting green hydrogen but also about fostering a culture of sustainability and clean energy that resonates across the nation.

We also delve into the initiatives undertaken by various government bodies and public-private partnerships, highlighting their collaborative efforts to make the green hydrogen mission a reality. From pilot projects that demonstrate the viability of green hydrogen in diverse applications to financing options that support its large-scale deployment, these initiatives showcase the commitment and creativity that drive India's green hydrogen vision forward.

Finally, we feature a selection of pilot projects that are leading the way in green hydrogen innovation. These projects, ranging from industrial applications to transportation and energy storage, demonstrate the versatility and potential of green hydrogen in transforming various sectors. They serve as beacons of progress, showcasing the tangible impact of India's green hydrogen mission.

We hope this booklet inspires you to learn more about the National Green Hydrogen Mission of India and the collective efforts driving its success. As we embark on this journey toward a greener, more sustainable future, let us remember that innovation and collaboration are the keys to unlocking the full potential of green hydrogen. Thank you for joining us, and enjoy the read.

Warm regards,

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ACRONYM

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| ADB | Asian Development Bank |
| AEM | Anion Exchange Membrane |
| BEE | Bureau of Energy Efficiency |
| BIS | Bureau of Indian Standards |
| BESS | Battery Energy Storage System |
| BoP | Balance of Plant |
| BOS | Balance Of Systems |
| CCUS | Carbon, Capture, Utilisation and Storage |
| CEA | Central Electricity Authority |
| CERC | Central Electricity Regulatory Commission |
| COP | Conference of Parties |
| CSP | Concentrated Solar Photovoltaic |
| DC | Direct Current |
| DISCOM | Distribution Companies |
| ECIU | Energy & Climate Intelligence Unit |
| EG | Empowered Group |
| EPC | Engineering, Procurement and Construction |
| ESG | Environmental, Social and Governance |
| ETS | Emission trading system |
| EU | European Union |
| EV | Electric Vehicle |
| EOUs | Export Oriented Units |
| FCEV | Fuel Cell Electric Vehicle |
| GA/GNH3 | Green Ammonia |
| GB | Green Bonds |
| GCF | Green Climate Fund |
| GDP | Gross Domestic Product |
| GHG | Greenhouse Gas emissions |
| GH2 | Green Hydrogen |
| GoI | Government of India |
| GW | Gigawatt |
| IPCC | Intergovernmental Panel on Climate Change |
| IREDA | Indian Renewable Energy Development Agency |
| IRENA | International Renewable Energy Agency |
| ISTS | Inter State Transmission Systems |
| LCoH | Levelised Cost of Hydrogen |