# GREEN HYDROGEN INNOVATION AND STARTUPS OPPORTUNITIES AND WAY FORWARD

Technology and Innovation Conclave 1.0 Date: 24–26 September 2024 Venue: New Delhi, India Jointly Organized by: DSIR & APCTT



Dr. MD ABDUS SALAM, AMIChemE, MyIEM Senior Principle Engineer Bangladesh Council of Scientific & Industrial Research (BCSIR) & Scientist (In-Charge), Hydrogen Energy Laboratory E-mail: <u>salam.bcsir@gmail.com</u>, <u>salam.ctg@bcsir.gov.bd</u> Mobile: +8801881609053

### Contents

- Green Hydrogen and its Global Potential
- Hydrogen Energy Activities (Ecosystem) of Bangladesh
- Global Hydrogen Market
- Innovations Impact to the Hydrogen Economy
- Challenges and way forward
- Generation

#### Sankey-Diagram-based insights into the hydrogen economy



Fig.1: Sankey-Diagram-based insights into the hydrogen economy (2023)

Ref: DOI: 10.1039/D3RA05158G (Review Article) <u>RSC Adv.</u>, 2023, 13, 28262-28287



Fig. 2. Recent green hydrogen production technologies.

Table 1: Breakdown of the potential of global green hydrogen production by region

No.	Region	Estimated energy capacity, Exajoule (EJ)	Percentage value
1	Sub-Saharan Africa	2715	28.6
2	Middle East and North Africa	2023	21.3
3	North America	1314	13.8
4	Oceania (Australia)	1272	13.4
5	South America	1114	11.7
6	Rest of Asia	684	7.2
7	Northeast Asia	212	2.23
9	Europe	88	0.92
10	Southeast Asia	64	0.67

Ref; Ali O.M. Maka1, Mubbashar Mehmood, Green hydrogen energy production: current status and Potential, Clean Energy, 2024, Vol. 8, No. 2, 1–7, https://doi.org/10.1093/ce/zkae012



Fig. 3. Global green hydrogen production (in EJ) potential by region.

Frontrunners	Progressives	Prospectives	Potentials	
<section-header><list-item><list-item><list-item><list-item></list-item></list-item></list-item></list-item></section-header>	<ul> <li>Italy</li> <li>India</li> <li>Egypt</li> <li>Netherlands</li> <li>Sat</li> <li>Sat</li> <li>Rep</li> <li>Om</li> <li>Arg</li> <li>Arg</li> <li>Arg</li> <li>Alg</li> <li>Sot</li> <li>taken - stration intent, relevent infrastructure experience, doing busine existing RE</li> </ul>	<text></text>	<section-header><list-item><list-item><list-item><list-item></list-item></list-item></list-item></list-item></section-header>	
<b>Categorization</b> Source:	of Coun ISA Blueprin demand and	and And And Andrews Andrews Androgen And Andrews Andre	<b>rk</b> n Hydrogen 2022	
Ref: A roadmap for developing a	nd scaling th project outle	ovember 2023, ISA (Ir	ovember 2023, ISA (Int. solar alliance)	

## Hydrogen Energy Laboratory, BCSIR (2019-2022)







Hydrogen Fuel Cell Power Generation prototype Location: Hydrogen Energy Lab, BCSIR







Hydrogen Fuel Cell Vehicle Location: Hydrogen Energy Lab, BCSIR OF THE PEO

BANGLA



Fig. 3. Hydrogen storage technologies with respect to its storage scale

Ref: Recent challenges and development of technical and technoeconomic aspects for hydrogen storage, insights at different scales; A state of art review, https://doi.org/10.1016/j.ijhydene.2024.05.182



## Hydrogen Storage Cylinder at 6000 psi



Location: Hydrogen Energy Lab, BCSIR





## Hydrogen Storage Cylinder at 12000 psi



## Location: Hydrogen Energy Lab, BCSIR

### Hydrogen Storage Tank





Fig. 4: Hydrogen Sorption techniques

Ref: An overview of hydrogen storage technologies – Key challenges and opportunities, Materials Chemistry and Physics https://doi.org/10.1016/j.matchemphys.2024.129710







Fig 5: FESEM image of MNAM 211 (a) before (b) after hydrogen adsorption.

Key innovations for green hydrogen storage



### Green Hydrogen Market





#### Fig.6:Green Hydrogen Market Size



Fig.5:Green Hydrogen Market Size (ASIA Pacific)



Fig. 6. Current potentials and challenges of hydrogen production technologies.

**Ref:** Recent advancement and assessment of green hydrogen production technologies, Renewable and Sustainable Energy Reviews, Volume 189, Part A, January 2024, 113941

#### **Innovations Impacting the Hydrogen Economy in 2024**



Ref : Top 10 Hydrogen Trends and Startups)

## **Technologies Accelerating the Green Hydrogen Revolution**

## **1. Advanced Electrolyzers:**

Modern Electrolyzer are more efficient and can operate at high pressures, reducing the cost of subsequent compression for storage or pipeline transport .

## 2. Renewable Energy Sources:

The declining costs of renewable electricity, which accounts for about 70% of the cost of producing hydrogen, are making green hydrogen a viable investment.

## 3. Digital Technology:

Digital technology can help optimize plant designs and end-to-end green hydrogen systems, reducing costs and complexity.

## 4. Storage and Transport Infrastructure:

New technologies are being developed for the efficient storage and transport of hydrogen, including advanced materials for high-pressure composite fuel tanks.



#### Global Demand Driver.....



Fig. 7. Demand for global hydrogen by sector under the Net Zero Scenario, 2020–2030. NZE = Net Zero Emissions

"Industry is expected to be the biggest driver of the clean hydrogen demand until 2030, mobility could overtake industry by 2025"

Fig.10: Biggest driver of Green Hydrogen Production

Ref: Global Energy Perspective 2023: Hydrogen outlook/https://www.mckinsey.com/industries/oil-and-gas/our-insights/globalenergy-perspective-2023-hydrogen-outlook

Share of clean

#### **Upside Potential in Power Power**





Fig.8. The roles of government, hydrogen producers, and researchers in mapping the future of green hydrogen development.



- 1. Regulators and governments must establish clear and supportive regulatory frameworks
- 2. Producers need to improve cost competitiveness and narrow the gap with fossil fuels through technological advancements, economies of scale, and optimized production processes.
- **3. Off-takers** (especially in hard-to-abate sectors) must commit to incorporating hydrogen into their energy mix and set clear timelines for its adoption.
- **4. Distributors, traders and intermediaries** should expand the infrastructure needed—including pipelines, storage facilities and refueling stations—for hydrogen to reach its end users.
- **5.** Aggregators can manage the consistent demand for hydrogen—enabling larger projects to be built and transforming long-term contracts required for producers into short-term contracts required for off-takers.

# Plants make fuel from water and sun, and so can we

Green hydrogen is the strategic fuel for our generation