

# National Green Hydrogen Mission

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## R&D Roadmap

5<sup>th</sup> July 2023

# National Green Hydrogen Mission: Deliverables by 2030

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At least  
**5 MMT GH<sub>2</sub>**  
annual  
Production

**60-100 GW**  
Electrolyser  
capacity

**125 GW** RE Capacity for  
GH<sub>2</sub> Generation & associated  
Transmission network

**50 MMT CO<sub>2</sub>**  
Annual  
Emissions  
Averted

**600,000**  
Jobs

**USD 100  
Billion**  
Investment

# Green Hydrogen: Technology Challenges

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Improve Cost Effectiveness

- Electrolysers, Storage, Transportation, Fuel Cells, Industrial Applications, Advanced Materials

Enhance Efficiency

- RE-Electrolysis, Biomass-based pathways

Achieve Scale

- Moving to GW scale installations

Ensure Safety

- Design for safety, Standards, Regulations

Integrate

- Infrastructure for storage, transport, grid

# R&D Framework under the Mission

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## **Public-private partnership framework**

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Innovation to **enhance affordability, efficiency, safety and reliability** of systems

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Strategic International Partnerships

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**Applied research + Long shot research in breakthrough areas**

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Innovative **MSMEs and Start-ups** to be encouraged

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**Identifying and supporting Centres of Excellence**

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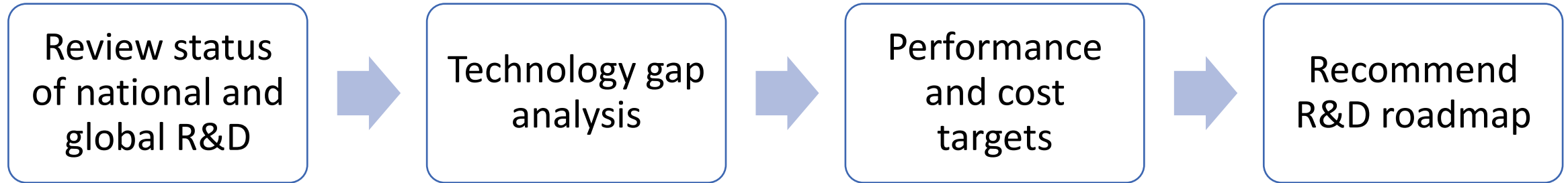
**Broad-based: Adequate provision for covering different research areas**

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**Research and Development Roadmap**

# Formulation of an R&D Roadmap

## Drafting committee of technical experts (Industry-Academia)



## Key Elements of Recommendations

Identification of High-Impact areas	Blue Sky, Mission Mode, Grand Challenge project themes	Strategies for implementation
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# Draft Roadmap: Hydrogen Production

- ❖ Steep reduction in electrolyser capital and operational expenditure.
- ❖ Improve the effectiveness and productivity of operations, with a focus on durability and reliability
- ❖ Design and develop large-scale (MW) Electrolyser systems, including Stack and BOP
- ❖ Build capacity and keep stock of material and critical components of Electrolyser stacks

## Grand Challenge Projects

AEM electrolyser development

Power to gas/co-electrolysis with SOEC

Demonstration of biomass gasification-based

Compact bio-methane reformers

## Mission Mode Projects

Low PGM catalyst/ electrode development

AEM electrocatalyst development

Development of SOEC electrolysers

Feedstock agnostic biomass gasification technology

## Blue Sky Projects

Sea water electrolysis

Photo electrochemical water splitting

Thermochemical water splitting

Bio-methane pyrolysis

# Draft Roadmap: Hydrogen Storage & Transportation

- ❖ Create efficient, safe, and affordable hydrogen storage techniques for high-density storage, minimized leakage, and convenient refueling; Indigenous development of Type III and Type IV compressed H<sub>2</sub> tanks.
- ❖ Developing test facilities for testing of compressed hydrogen tanks.
- ❖ Increase the efficiency and reduce the costs of hydrogen compression and liquefaction technologies.
- ❖ To strengthen the pressure and capacity for new builds of 100% hydrogen pipelines while reducing their cost.

## Grand Challenge Projects

Infrastructure development for upscaling technologies

Reduce boil-off losses in liquid stage storage

100% transportation of green hydrogen in pipelines

Market readiness of type IV and V cylinders developed in India

## Mission Mode Projects

Indigenous manufacturing of materials

Standards and regulations for H<sub>2</sub> storage

LOHCs, Reconversion of NH<sub>3</sub>

Leakage detection in hydrogen pipelines

## Blue Sky Projects

Novel materials with higher gravimetric capacity

National testing facility for Type IV cylinders

Movement of compressed and liquid hydrogen in trains

Research on Type V cylinders

# Draft Roadmap: End Use Applications

- ❖ Improving the reliability, endurance, and safety of hydrogen-fuelled jet engines.
- ❖ Improving overall system performance for fuel cell systems in terms of power density, reliability and durability.
- ❖ Improving technologies for the use of green hydrogen in blast furnaces/ DRI processes
- ❖ Designing safe boilers and heat exchangers for using hydrogen/ hydrogen-natural gas mixtures.

## Grand Challenge Projects

Mini hydrogen-powered power plants

hydrogen-powered locomotives

Fuel cell-based low Pt light vehicles with onboard H<sub>2</sub>

Pilot for green steel and green ammonia

## Mission Mode Projects

PAFC /PEMFC in the range of 100kW to 500kW range

High temp material/configuration of gas turbines for H<sub>2</sub>.

High efficiency, safe hydrogen high-pressure compressor

Pilot SOFC stacks for coupling with gasifiers

## Blue Sky Projects

H<sub>2</sub> high-efficiency gas turbine and fuel cell

Hydrogen-ICE and hydrogen Fuel cell-based light vehicles

Marine hydrogen-fuel cell-based ships

End-to-end networking of H<sub>2</sub> infrastructure with solar /wind



# Next Steps

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Draft Roadmap to be put up for public comments

Adoption of Final Roadmap by Government

Call For R&D project proposals

Award of projects

**Thank You**