



GRYOGEN

Most Efficient Green Hydrogen Technology



Why Hydrogen Economy?

01

To stabilize or **reduce concentrations of CO2** in the atmosphere, the world needs to reach a net-zero emissions as soon as possible.

02

Hydrogen is a **universal fuel**.
Virtually any primary energy source can be turned into hydrogen
Removes **Intermittency of renewable energy**

03

Renewable Hydrogen **contributes to National Energy Objectives:**
Energy Security
Environmental Stewardship
Economic Competitiveness

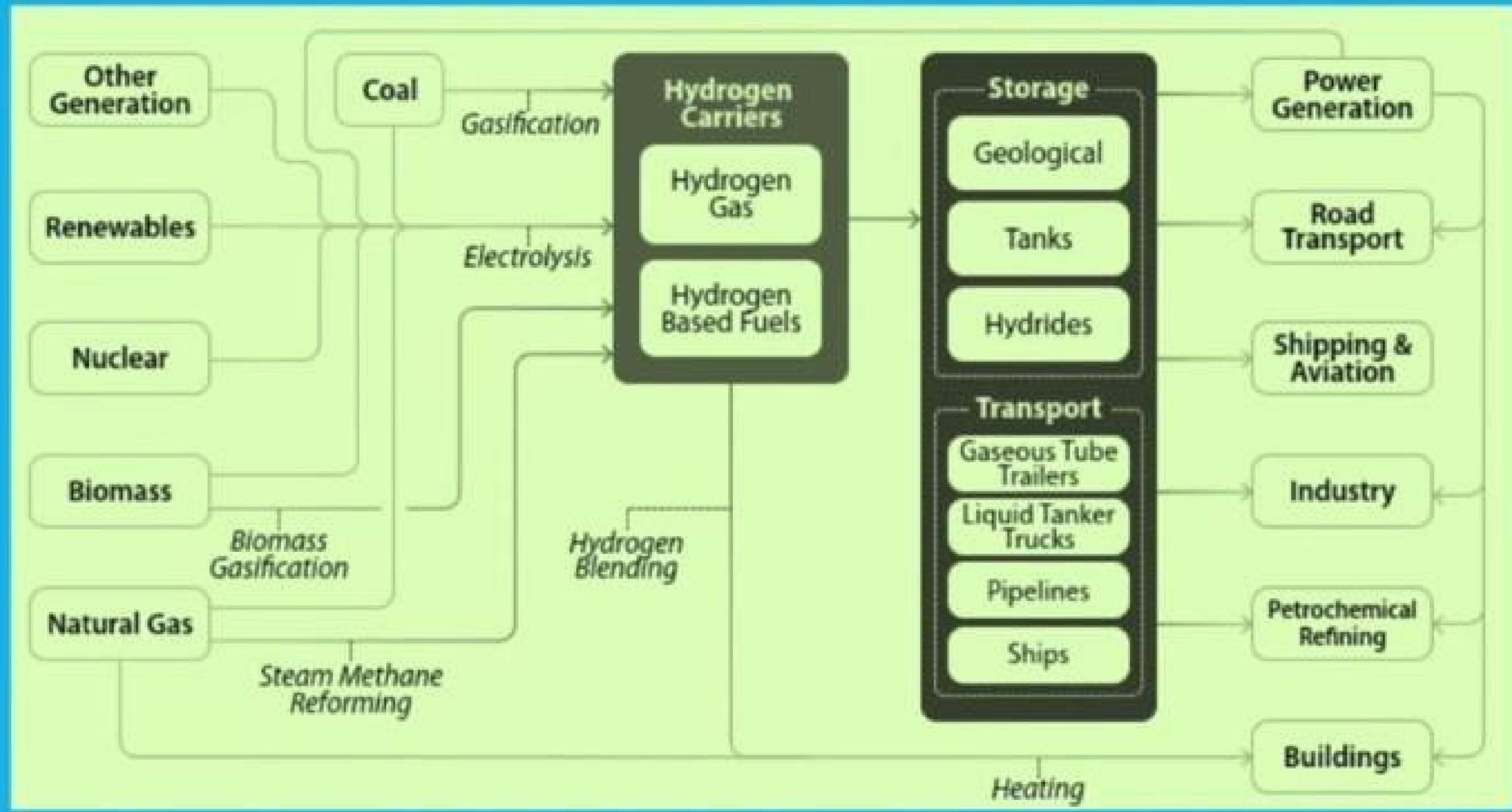
04

Hydrogen is a **well-established \$120 Billion annual global existing market**





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Energy Carrier

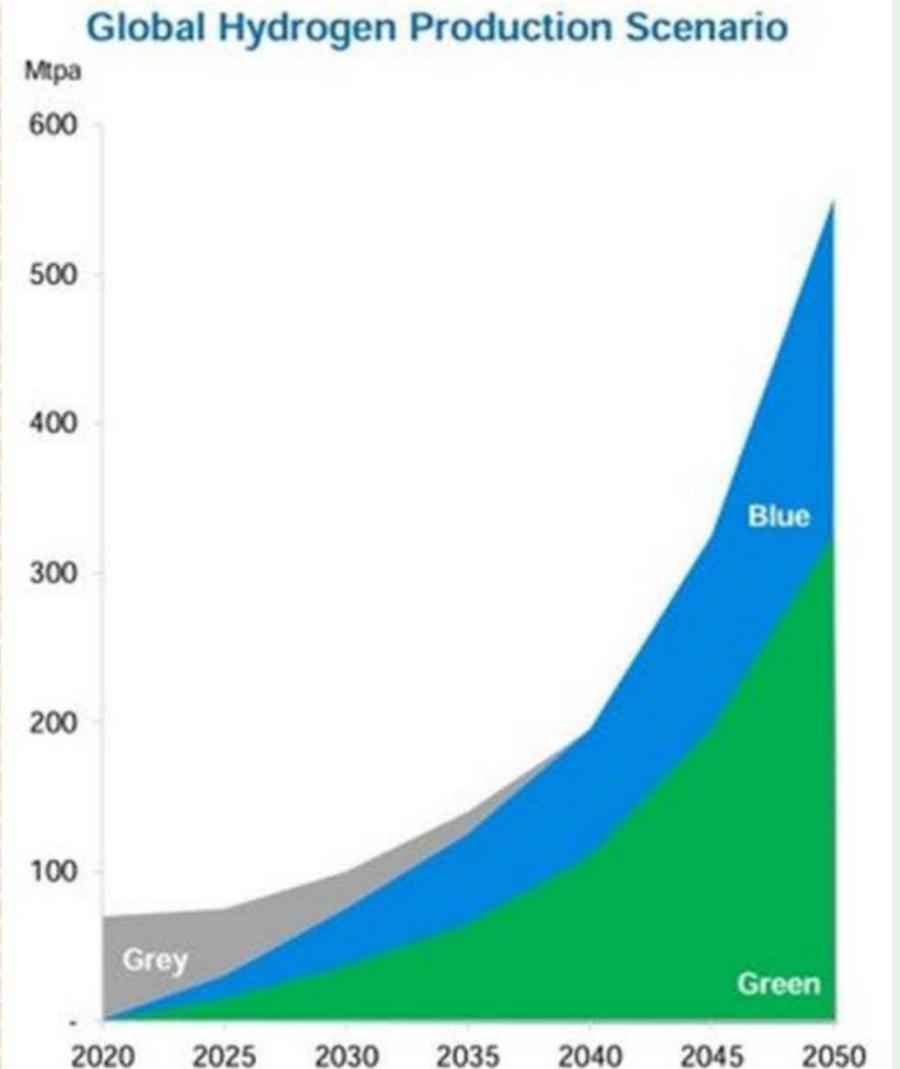
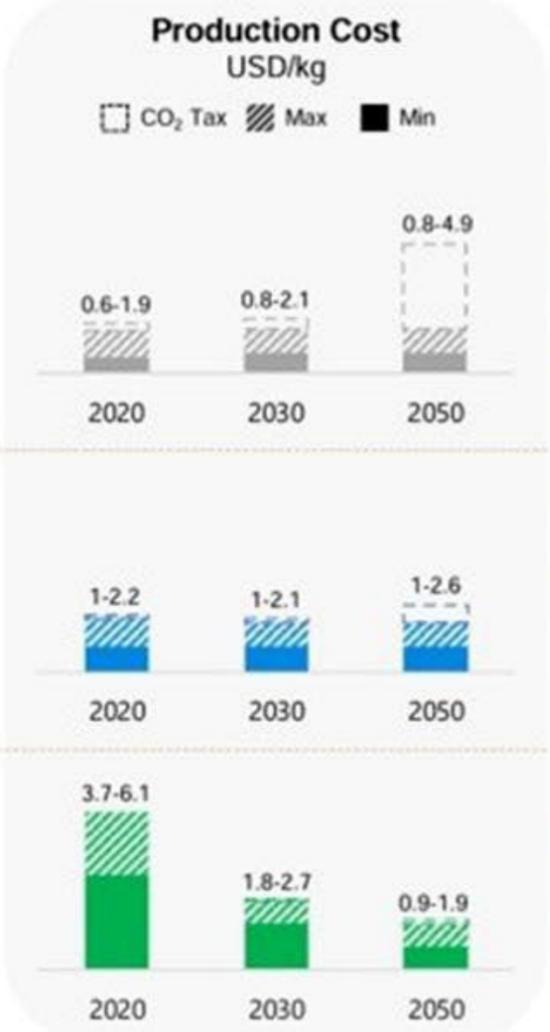
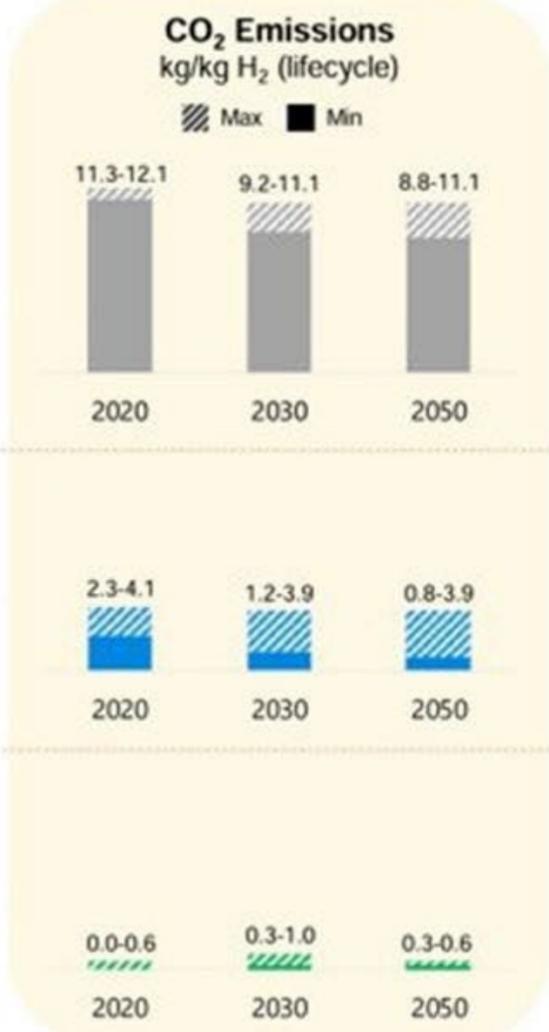
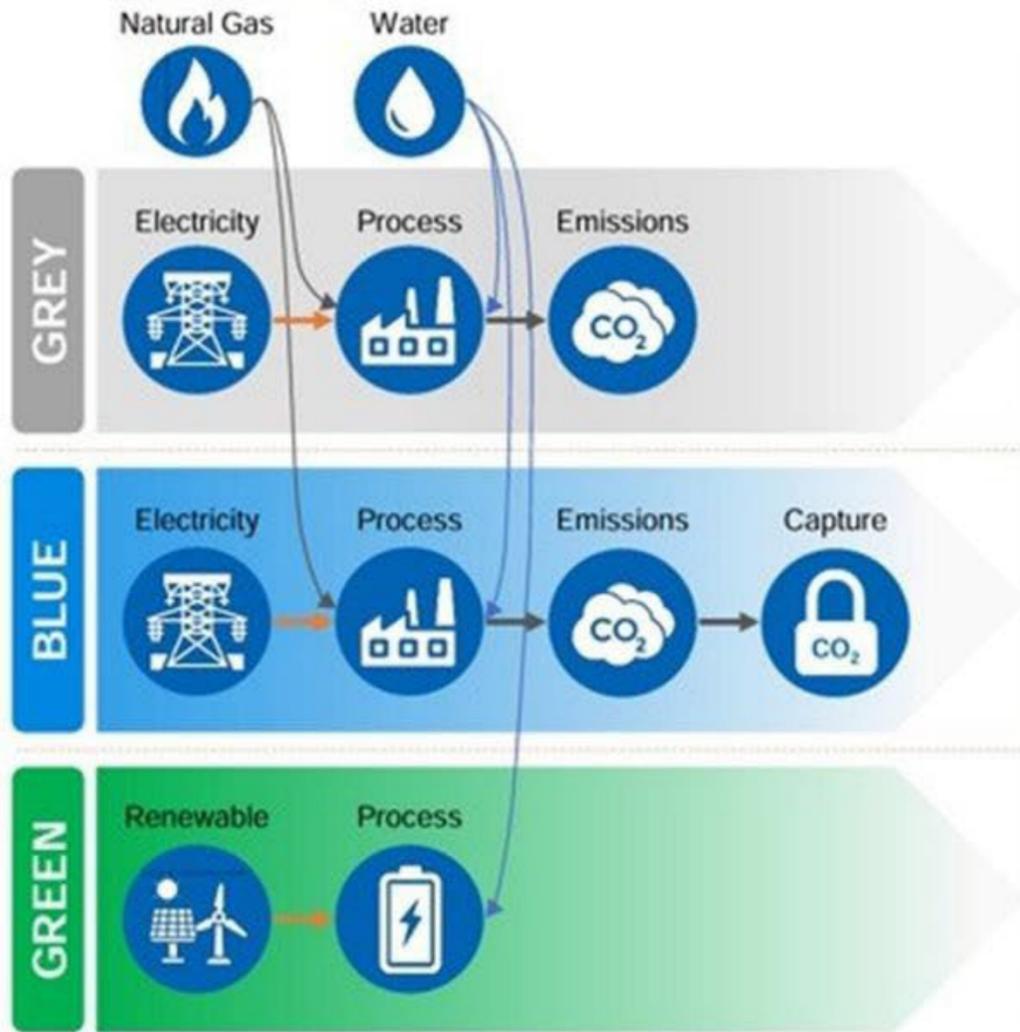
Table 1. Classification of Hydrogen Based on Energy Source and Carbon Intensity

Classification Based on Energy Source	Energy Source for Hydrogen Production	Classification Based on Carbon Intensity
Black Hydrogen	Bituminous coal	High Carbon Hydrogen
Gray Hydrogen	Natural Gas or Methane	
Brown Hydrogen	Lignite (brown coal)	
Blue Hydrogen	Natural Gas or Methane with CCUS	Lower Carbon Hydrogen
Green Hydrogen	Electrolysis powered by renewable energy	
Pink Hydrogen	Electrolysis powered by nuclear energy	

Decarbonization A Necessity & Cost Reduction Imperative



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Currently, green hydrogen makes up less than 0.1% of the world's hydrogen supply

To take a central role in the energy transition, existing and new uses of hydrogen need to be met with decarbonized or clean hydrogen production sources

Illustrative scenario that could achieve a completely decarbonized hydrogen supply from 2040 where the global production portfolio contains a mix of green and blue hydrogen

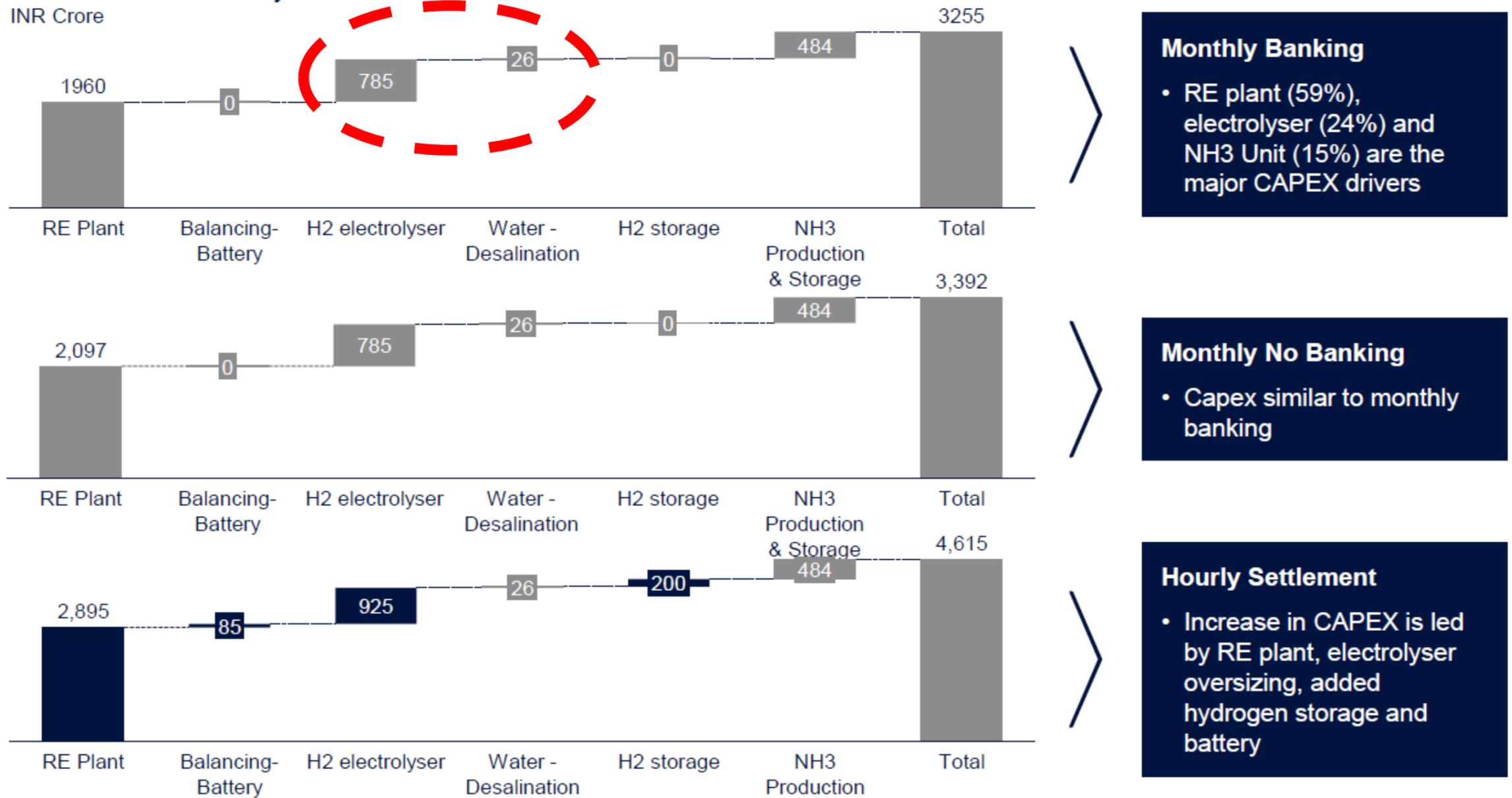
Problem Statement: **Bring cost of Green Hydrogen production down by 50%**

Cost of production is a huge challenge. No one has been able to successfully create cost efficient and commercially viable green hydrogen from sea water, which is abundantly available, without desalination.

Desalination: Increases CAPEX cost by 4-5%

CAPEX | RE Plant, Electrolyser and NH3 unit are the key cost drivers with Electrolyser oversizing, hydrogen storage and battery increasing CAPEX in hourly settlement

Waterfall of CAPEX and key cost drivers
INR Crore

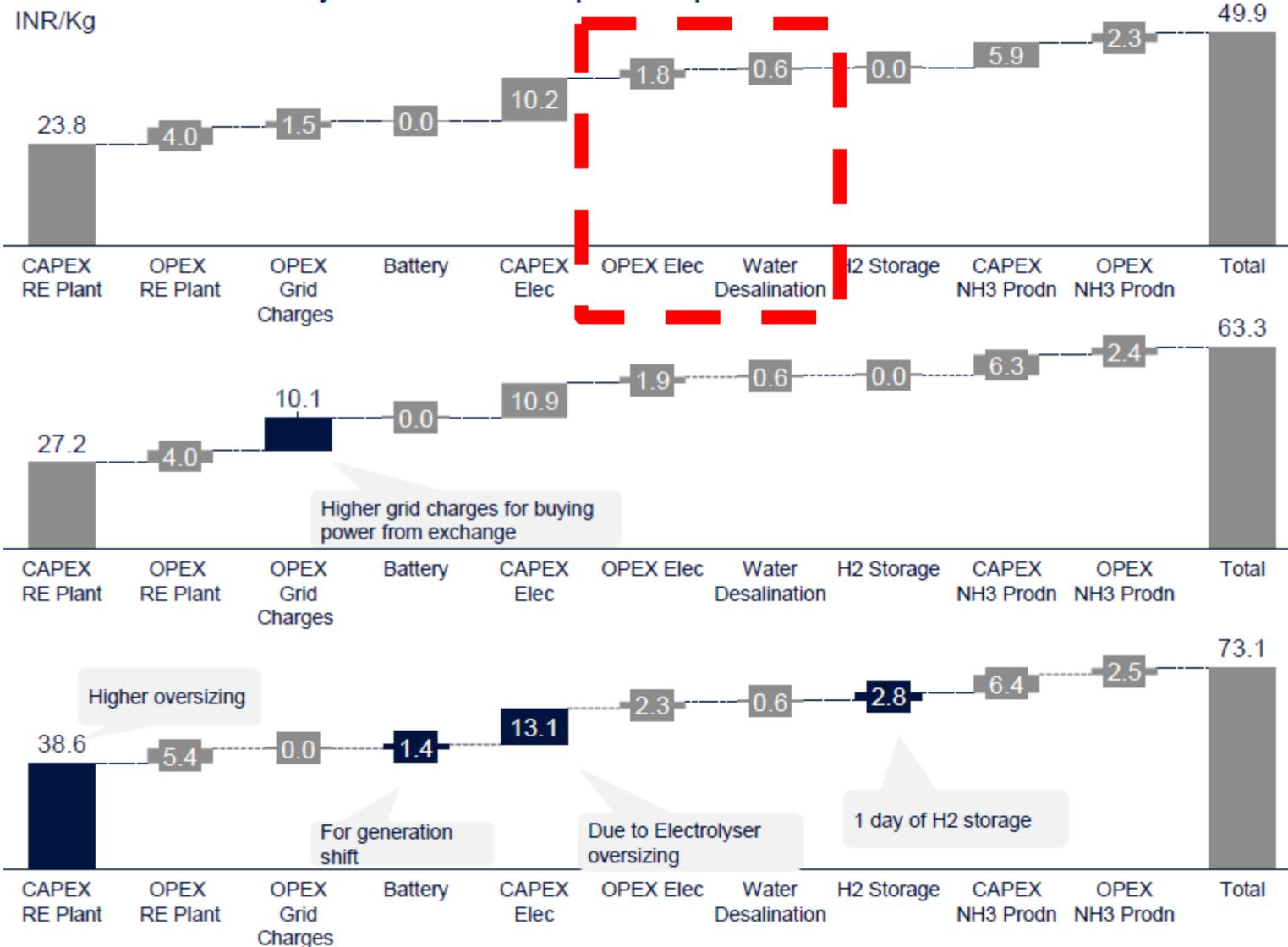


Note: Archetype plant specifications (considered in the above slides) used for monthly and hourly scenarios
40 | Source: MEC+ Analysis

Desalination: Increases OPEX cost by 25%

LCOA | RE Plant, Electrolyser and NH3 unit are the key cost drivers with Electrolyser oversizing, hydrogen storage and battery adding costs in hourly settlement

Waterfall of LCOA and key cost drivers incl. capex and opex



Monthly Banking

- RE plant (56%), electrolyser (23%) and NH3 Unit (17%) are the major LCOA drivers

Monthly No Banking

- Buying power from the exchange to meet monthly demand (when RE is unavailable) leads to increase in grid charges

Hourly Settlement

- Increased cost of RE, electrolyser oversizing, hydrogen storage and battery leads to increased LCOA

Note: Elec – Electrolyser; Prodn – Production; Archetype plant specifications (considered in the above slides) used for monthly and hourly scenarios; LCOA – Levelized cost of Ammonia

Our Innovation

In-house Catalyst

- Our catalyst can withstand saline. Conditions thereby solving major problem of catalyst corrosion
- It specifically splits the water, irrespective of other ions, which means chlorine free hydrogen and almost negligible corrosion
- The efficiency to generate hydrogen is higher than conventional catalysts used so far.

Inhouse Membrane innovation

- Membrane can withstand saline water and very cost effective and can be scaled up for commercial use

Nano Technology-Based Solar Innovation

- Nano Technology based coating on solar panels to increase energy generation

Solar + Battery Storage Grid

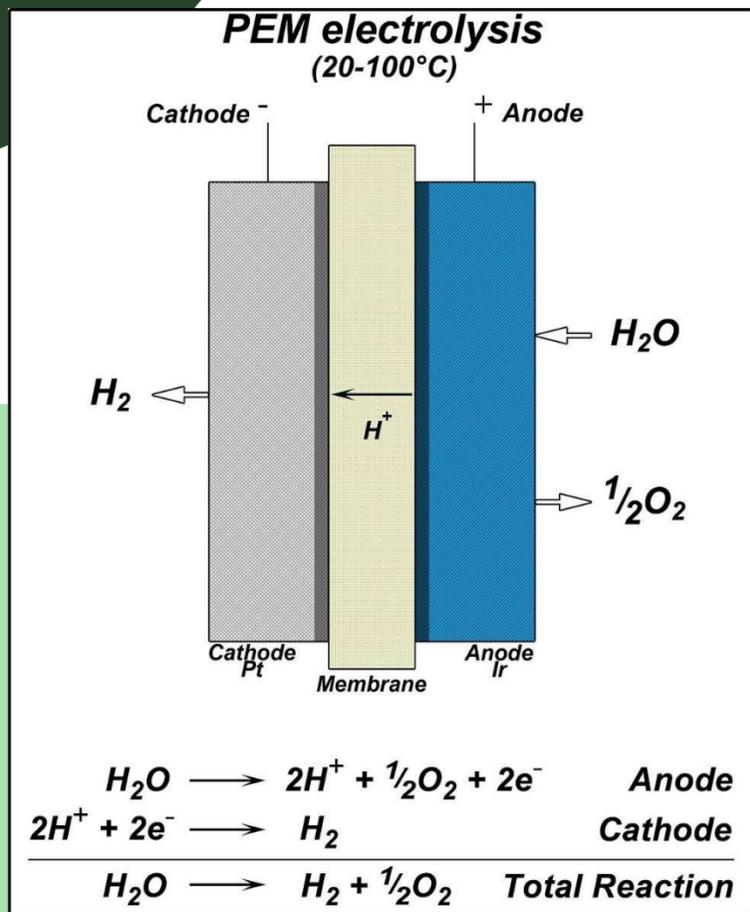
- Solar + Battery storage Grid to ensure 24X7 Green hydrogen production which takes care of limitation of Solar power availability



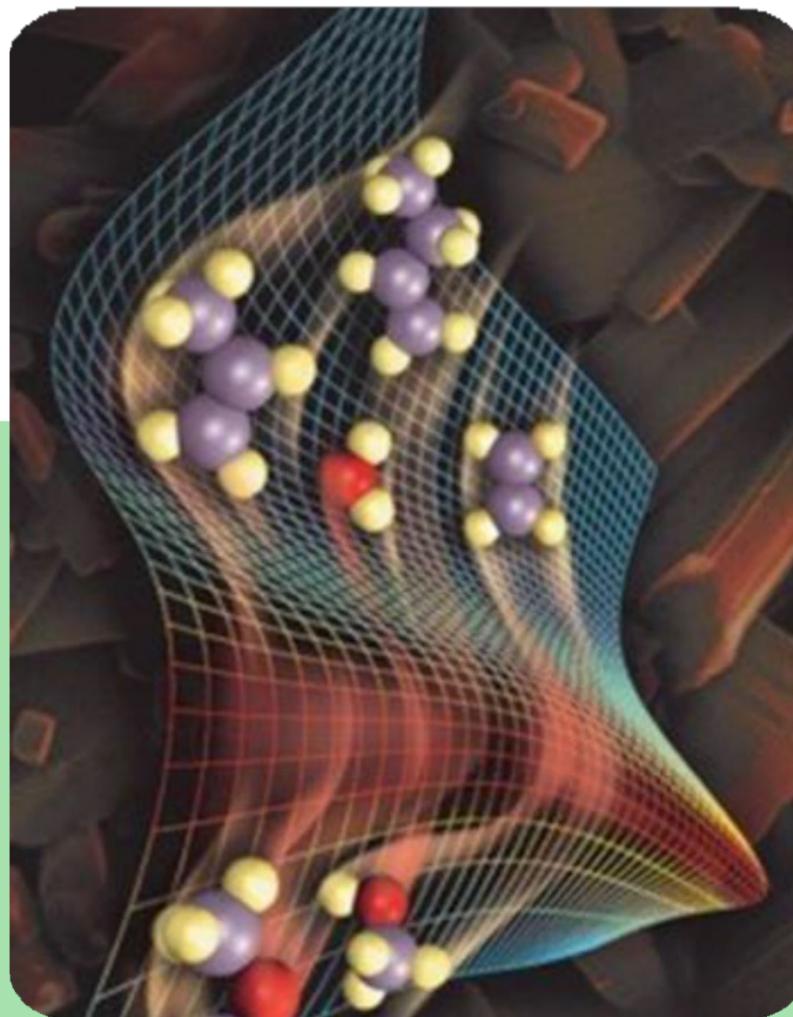
Our Innovation



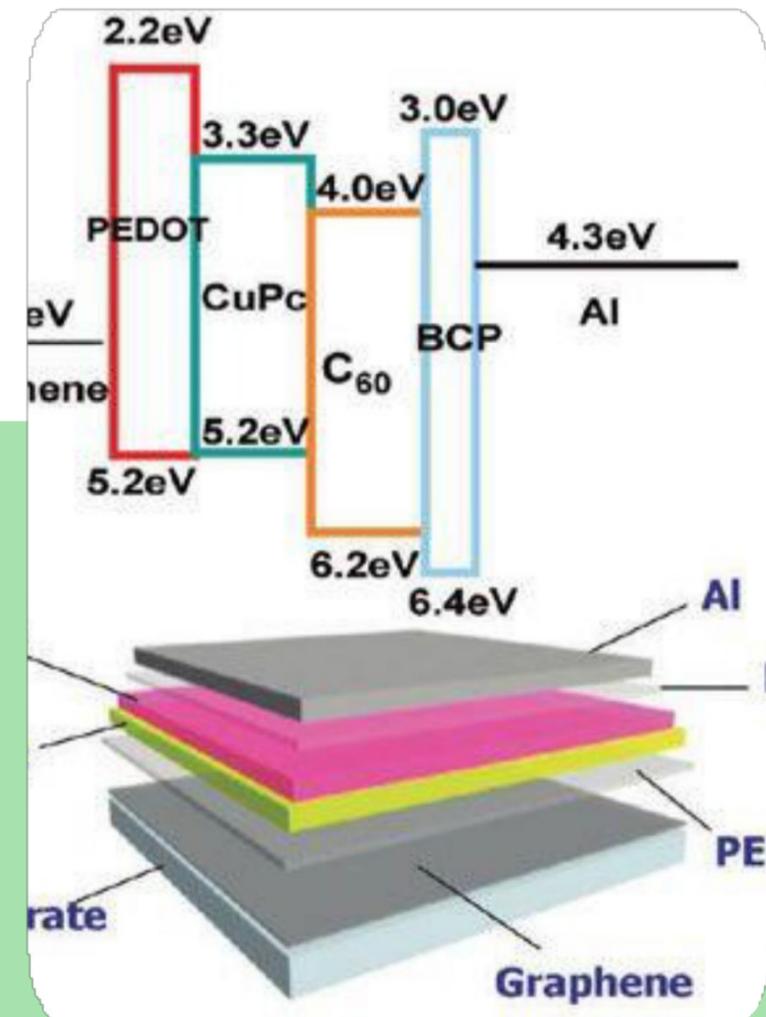
Gryogen: Hydrogen production cost reduction by 50%



In-house built Membrane innovation to withstand Saline Sea Water



In-house Catalyst Innovation to increase rate of chlorine free hydrogen production



Nano Technology in Solar

24X7 Production plan with power storage grid along with Solar

Hydrogen End Use



Fuel

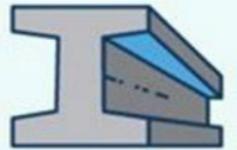
Transport - Maritime, Trains, Buses, Flights.

Power - Flexibility, Seasonal Storage, Peaking Plants, Power Backups



Power

Industries - Steel, Paper, Cement, Aluminium, Food



Feedstock

Chemicals - Fertilizers, Plastics, Fuel Refining

Products - Metallurgy, Food, Glass, Steel.

Target Market: South East, US, Europe, Australia

1	Transportation	Green hydrogen can be used as a fuel for various modes of transportation, including cars, buses, trucks, and trains. India has ambitious plans for transitioning to electric and hydrogen-powered vehicles to reduce emissions and dependence on fossil fuels. Under its National Hydrogen Mission, India aims to deploy 1 million hydrogen fuel cell vehicles (HFCVs) by 2030.
2	Industry	Industries such as steel, cement, chemicals, and refineries can utilize green hydrogen as a feedstock or fuel for their processes. Hydrogen can help reduce emissions in these energy-intensive sectors.
3	Power Generation	Green hydrogen can be used in power generation through fuel cells or in hybrid power plants, providing clean and reliable electricity. This can help integrate renewable energy sources like solar and wind by storing excess energy as hydrogen. Green Hydrogen to produce 25% of electricity requirement by 2050.
4	Energy Storage	Green hydrogen can serve as a means of energy storage, helping to overcome the intermittency of renewable energy sources. It can store surplus electricity generated from renewables during periods of low demand and release it when needed.
5	Residential and Commercial Heating	Hydrogen can be used for heating purposes in residential and commercial buildings, replacing natural gas or other fossil fuels for space heating and water heating. India HVAC Market has valued at USD9.1 billion in 2023 and is anticipated to project robust growth in the forecast period with a CAGR of 14.5% through 2029.
6	Off-grid Applications	In remote or off-grid areas where access to conventional energy sources is limited, green hydrogen can provide a clean and reliable source of energy for various applications like lighting, cooking, and powering appliances.
7	Export Market	India can also target the export market for green hydrogen and its derivatives, leveraging its abundant renewable resources to produce hydrogen for international markets, particularly in regions aiming to decarbonize their economies.

Business Model: Green H2 Market

Growing at 61% CAGR



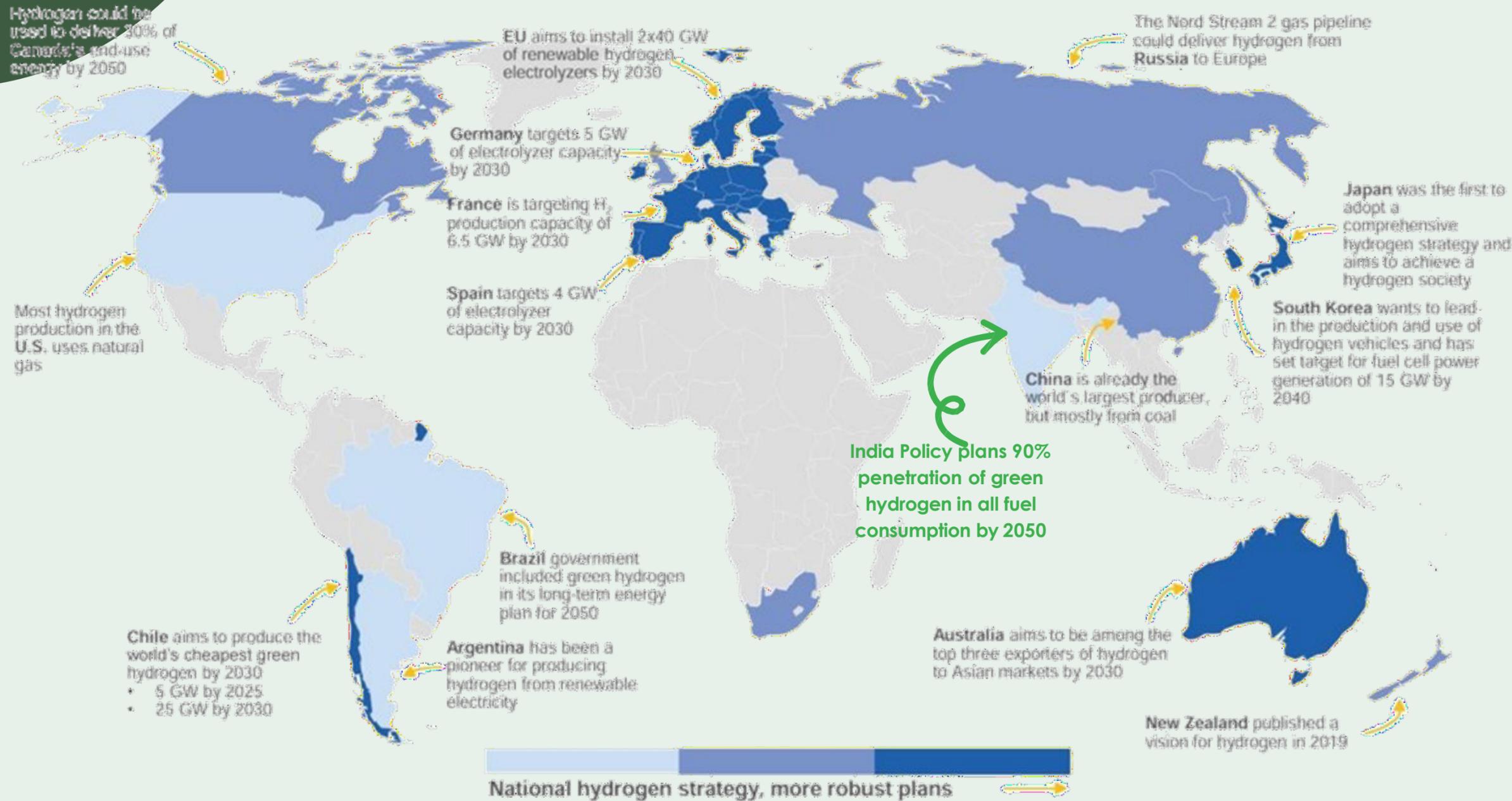
Enable 20% of Green Hydrogen Global Market a by 2030: USD 30.6 Bn

Three Routes to commercialization

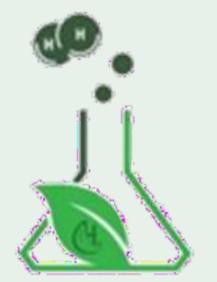
- Catalyst +Membrane Sales
- Technology Licensing
- JV for commercialization

High Scalability: Global Capacity Building at Policy Level

Hydrogen could be used to deliver 30% of Canada's end-use energy by 2050

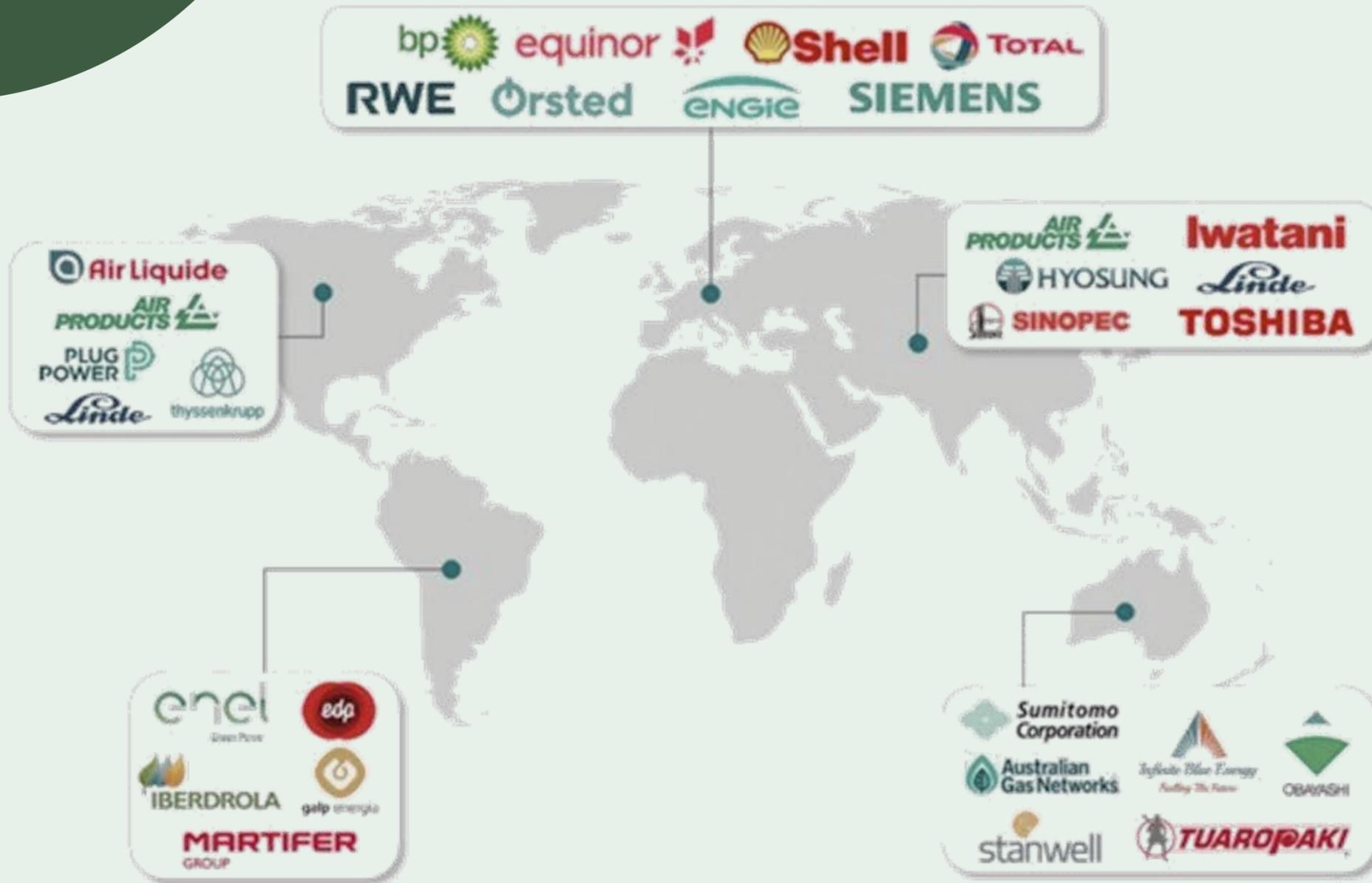


270 GW of electrolyzers will be needed by 2030 to **keep the global temperature increase under 2°C**

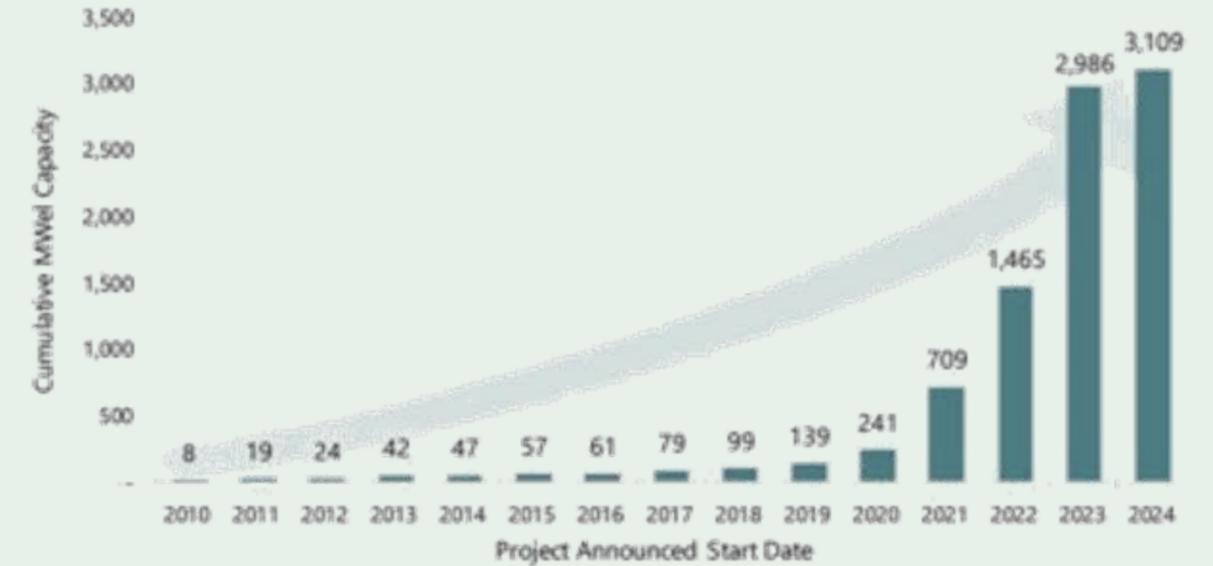


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Corporate Led Hydrogen Projects Increasing Globally & in India



Electrolysis Produced Hydrogen Capacity
Increasing Exponentially



Select Projects Expected to Come Online

Start Date	Project Name	Companies	Capacity
2020	Air Liquide Béancour	Air Liquide, HYDROGENICS	20 MW
2021	Port Lincoln, Eyre Peninsula	H2U, thyssenkrupp	30 MW
2022	ECB Paraguay	thyssenkrupp	310 MW
2022	H2V France Phase 1	Air Liquide	100 MW
2023	H2V France Phase 2	Air Liquide	100 MW
2023	Hybridge Germany	amprion, OGE	100 MW
2023	Shell - Port of Rotterdam	Shell, Eneco	200 MW
2023	Hydro-Québec	Hydro Québec, thyssenkrupp	88 MW
2024	GreenHydroChem Central	SIEMENS, Linde	120 MW

Many large corporations have announced plans to operate green hydrogen production plants globally



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Research and Development
Completed



Prototyping Stage
Ongoing



Commercial POC
Next Step



Full Scale POC
Final Step



Traction Achieved



Team: Collective experience of 50+ years in social & green entrepreneurship



Dhiraj Nauhbar

Founder & CEO

IIT Kanpur, London Business School, NIT Calicut

Social Entrepreneur
Successfully developed Graphene based battery startup Capattery and took exit in 2022. Keen interest in Chemistry of things

20+ years of experience Ex Tata Motors, Maruti Suzuki, Taj Hotecls & Resorts, Impact Guru, Lythouse, Capattery



Subramanian

CTO & Cofounder

IIM Bangalore, IIT Guwahati
B.Tech Chemical Engineering

20+ years of experience in Electrolyzers, Fuel Cells & Speciality Chemical Scaleup, ESG Consulting experieice with PWC



Ankit Tewari

Cofounder & Climate Financing

MSc, BITS Pilani

He has worked on researching climate financing Green energy while his stint at NSE

Social Entrepreneur with experience of 19+ years of experience. EX NSE, EXL, Lythouse



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THANK YOU!

Join Gryogen on the forefront of the green energy revolution. Together, let's build a sustainable future powered by innovation and commitment to environmental stewardship.

Dhiraj Naubhar

CEO & Founder

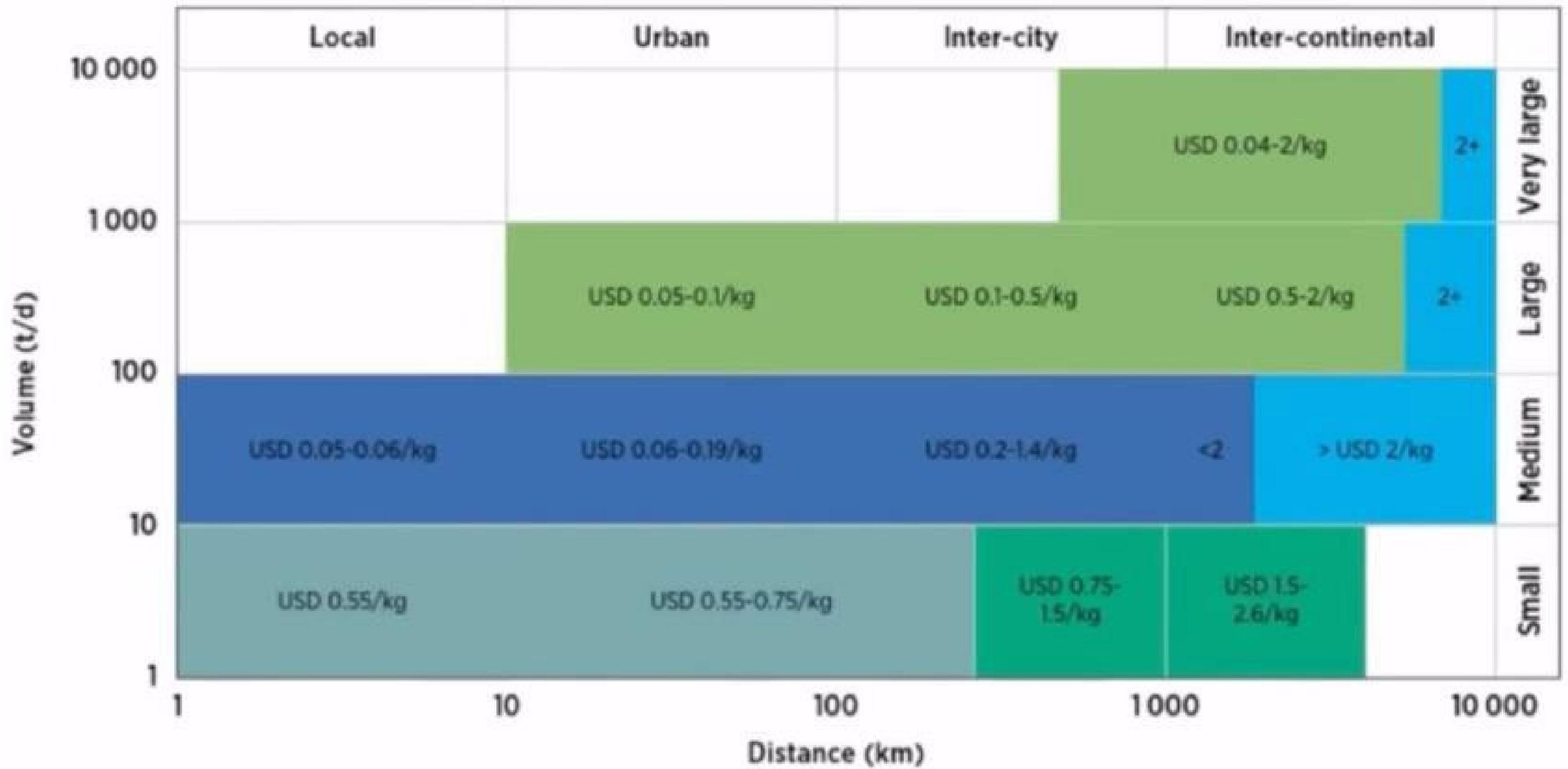
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GRYOGEN

HIGHLY EFFICIENT GREEN
HYDROGEN TECHNOLOGY



● Ships
 ● Transmission pipelines
 ● Distribution pipelines
 ● Compressed hydrogen trucks
 ● Liquid hydrogen trucks



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