
# h2e Power Systems Private Limited

**March 17, 2023**

Green Hydrogen | Power To X

**An opportunity to decarbonize our world**

Presentation by:
***Siddharth R Mayur,*** Founder & CEO
**h2e Power Systems Private Limited**
E: sid@h2epower.net

**Unless India stands up to the world, no one will respect us. In this world, fear has no place. Only strength respects Strength.**

**— A P J Abdul Kalam**

# Urja Udhyami Program

. An integrated skill development program for developing energy entrepreneurs.

. A 9-month end-to-end program on the functional training for on ground implementation of NetZero Solutions.

. We target creating 100,000 Urja Udhyami, thus creating > 1 Million Green Jobs & a billion NetZero Indians.

# Why Hydrogen in Maritime transport?

Because hydrogen could be an option for maritime transport, which is a major contributor to:

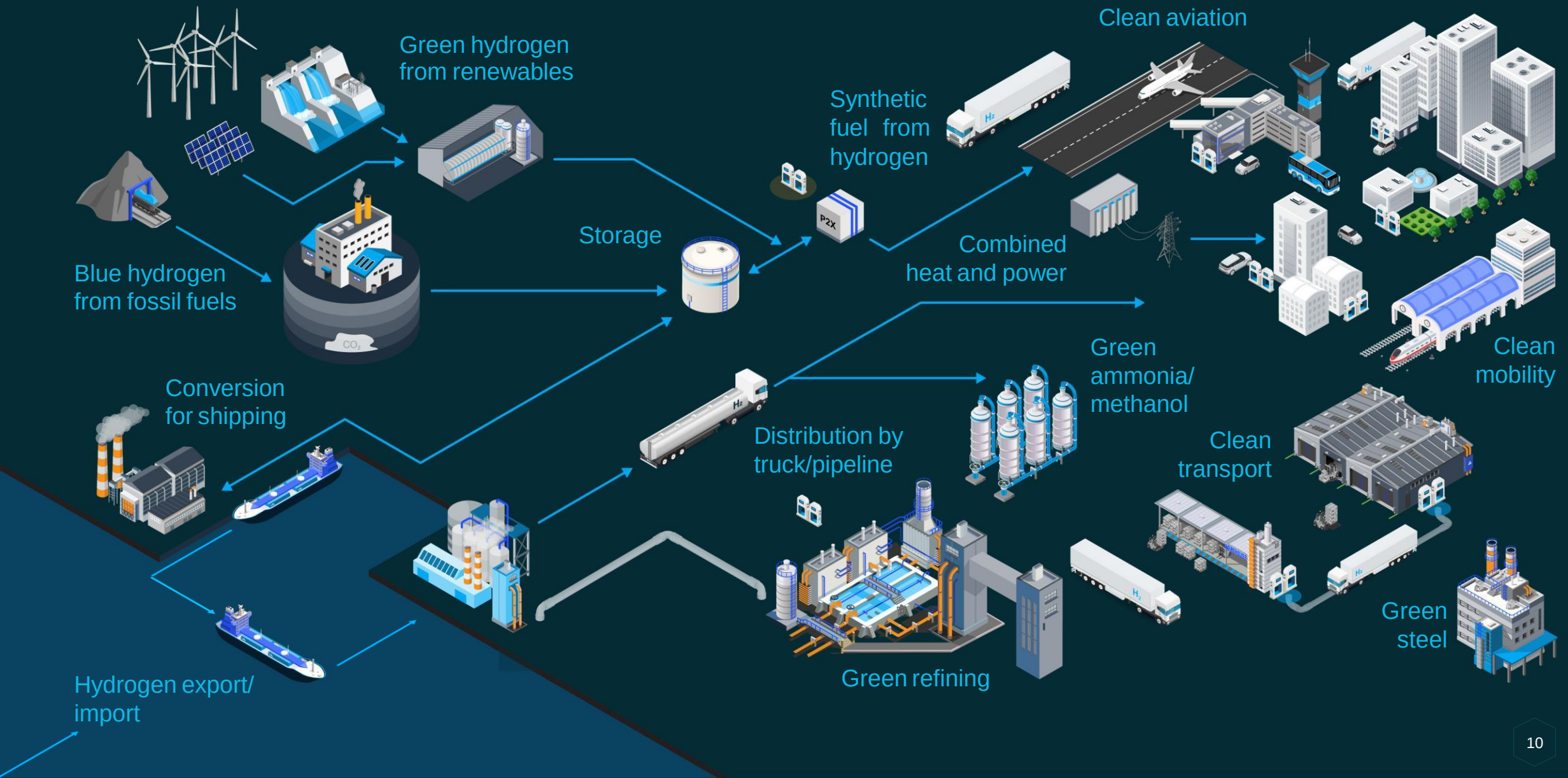
- GHG emissions
  - 2.8 % of annual global emissions

- Pollutant emissions
  - SOx
  - NOx
  - VOCs
  - Particles
  - ODS, ROGs…



Regulated by IMO (Emission Controlled Area, …) + Kyoto protocol

# The hydrogen economy spans across sectors



# Maritime Sector Overview

Approximately 80 percent of global trade by volume and over 70 percent of global trade by value are carried by sea and are handled by ports worldwide

The maritime sector is responsible for only 2.9 percent of global greenhouse gas emissions and moves freight with some of the lowest carbon emissions per tone. kilometer (t.km) of any transport sector. However, maritime emissions are expected to increase as global trade continues to grow;

In addition, maritime shipping is needed to support low-carbon transitions of other industries—for example, by moving wind turbine blades and lithium-ion batteries for electric vehicles.

# COMPETING DISTRIBUTED GENERATION TECHNOLOGIES

| | Fuel Cell & Hybrid systems | Recip Engine | Steam Turbine | Gas turbine | Microturbine |
|---|---|---|---|---|---|
| Electric Efficiency (HHV) | **58% - 65%** | 27-41% | 5-40% | 24-36% | 22-28% |
| Net CHP Efficiency (HHV) | **89% 93%** | 77-80% | Approx. 80% | 66-71% | 63-70% |
| Typical Capacity (MW) | **0.2-2.8++** | 0.005-10 | 0.5- Hundreds | 0.5-300 | 0.08-1 |
| Power Density (kW/m2) | **5-20** | 35-50 | >100 | 20-500 | 5-70 |
| Part-Load Potential | **Good** | OK | OK | Poor | OK |
| Availability | **>97%** | 96-98% | 72- 99% | 93-96% | 98-99% |
| Startup-Period | **15min- 6hrs (by type)** | 10 sec- 15mins | 1 hour-1day | 2mins-1hr | 60 sec |
| Fuels | **NG, NH3, H2, biogas, LPG, methanol, diesel** | NG,biogas,LPG, sour gas, industrial waste gas | All | NG, biogas, synthetic gas | NG, biogas, sour gas, liquid fuels |

# H2E REFORMER TECHNOLOGY

## REFORMING SOLUTIONS

### Natural Gas/LPG

- 100% external to 100% Internal reformation of on stack.
- High tolerance for impurities in the fuel.
- Efficiency of the reformation over stack > 90%.

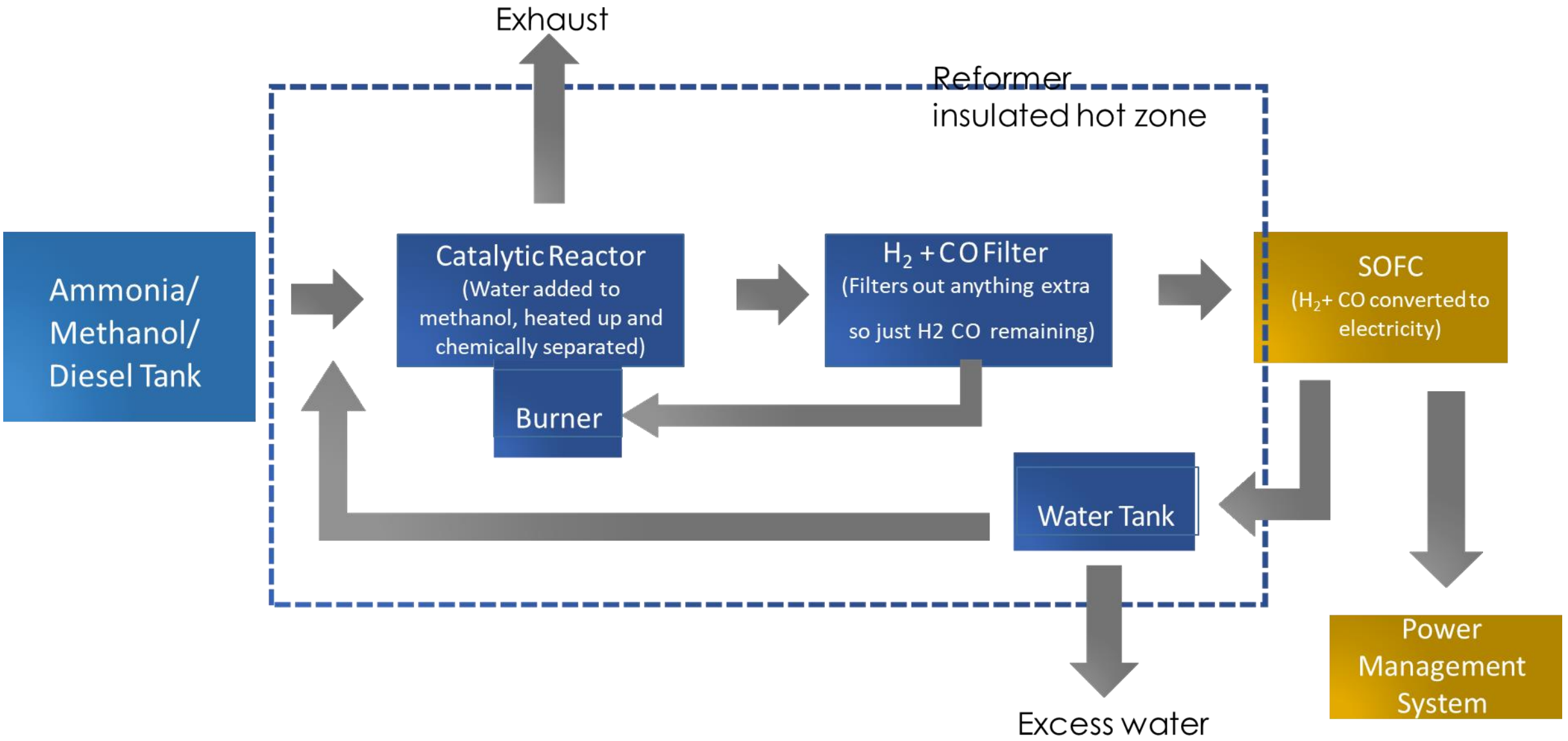
### Ammonia/Methanol/ Gasoline

- High Reforming Efficiency : > 80%
- Quick Start-up within 30 min
- Stable CO Content Lower than 0.5%
- Sulphur trap/ CO remover and heat recuperator inside

### Diesel


- **Sulphur removal** in gaseous phase in Hydro Desulfurizer (HDS) bed.
- **Fast Startup** (< 15 min) and higher turndown ratio (30% to 100%).
- **Efficiency** of the reformer over 80%
- **Sulphur** concentration of the reformer out gas: < 0.5 ppm
- **Expected Durability** >25000h (catalyst durability)
- **Integrated reformer** with burner & heat exchangers as per application requirements.

# FUEL REFORMING PROCESS



# KOCHI WATER METRO

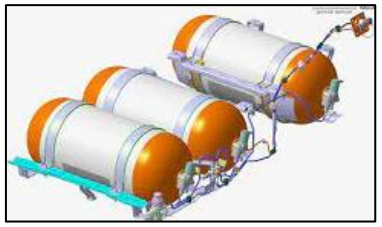
SOFC 1.5KW x 4 nos

Water

Electrical energy

AIR

$CH_4$



$CH_4$ cylinder

200 bar

Energy Management and Power electronics

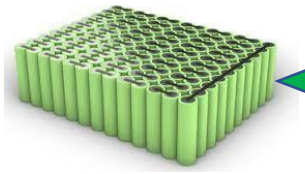
Propulsion motor

M

Bow thruster

M

Other loads



Electrical energy

Battery bank 120kW

# KOCHI WATER METRO – ARCHITECTURE

**SHIP**

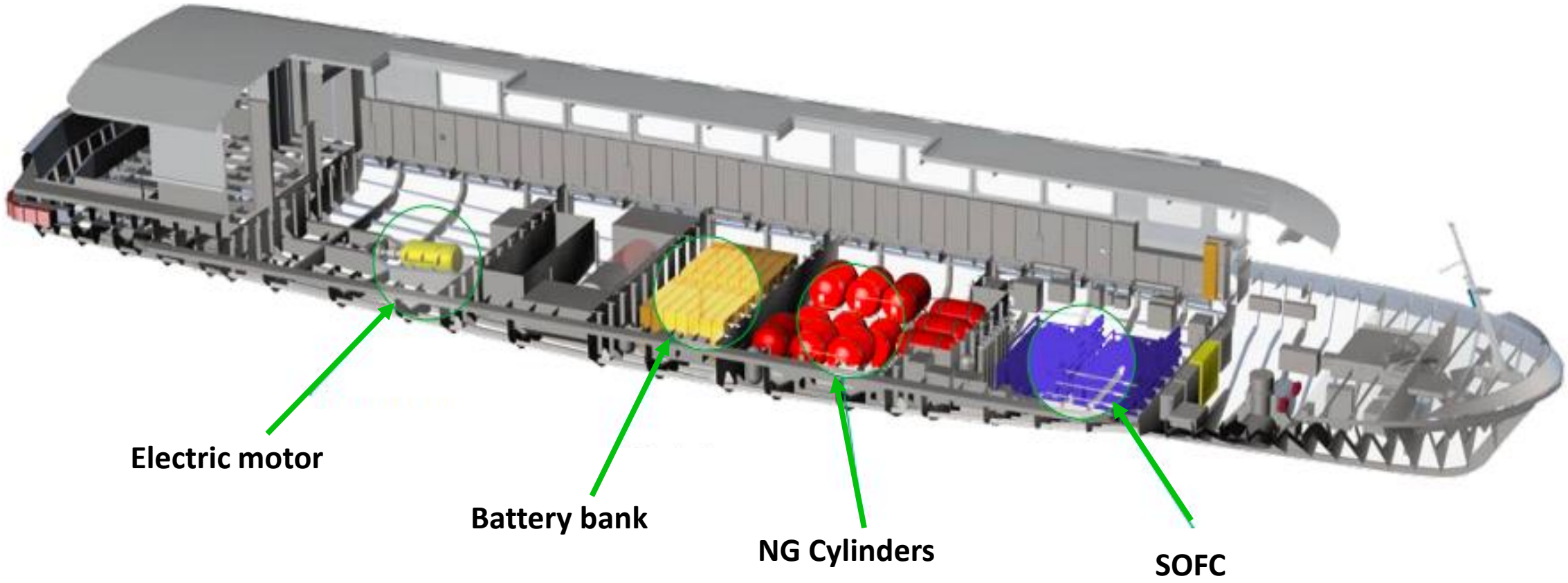

| | | |
|---|---|---|
| Power Consumption of Ship/day | 120 | KW |

**SOFC**

| | | |
|---|---|---|
| SOFC | 6 (1.5 x 4) | kW |
| Power Produced by SOFC per day | 144 | kW |
| Fuel Cell Efficiency ( Avg.) | 55% | |
| $CH_4$ Required/ day | 24 | kg |
| Cylinders required (2days operation) | 4 | nos |
| Cylinder specification | - 200 bar<br>- 12kg $CH_4$ capacity<br>- Weight ~42kg with Gas | |
| Space required<br>-SOFC<br>-Cylinder | - $2m^2$<br>- 1m2 | |

# BOAT ARCHITECTURE

- Possibility to use multi-fuel like ammonia, methanol, Diesel with external reformer.
- Storage of fuel is simple and existing storage can be adapted.
- Non-Dangerous and non-hazardous area as H2 is not stored/used.




Source : Zemships EU project

# PROSPECTS & BARRIERS

- Reduction of CO2 emissions during marine transportation
- Available, renewable energy is available
- Hydrogen electrolysis processes are mature and available
- Hydrogen Liquefaction processes are available with sufficient unit capacity output for shipping demands
- Onshore bunker fuel storage systems are
- mature and available
- Liquid Hydrogen has been used as a fuel for over 50 years
- Onboard power generation via Fuel Cells are available, mature, and rising in power output (presently +3MW)

- Lack of:
  - proper infrastructures to supply hydrogen to ships
  - safety regulations for hydrogen bunkering
- Cost (see next slide)
- Revision of the International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels
- A more vast scale of projects to validate and risk mitigate LH2 propulsion system design is required to
  - allow definition of safety standard, technical standards and regulation
  - incite makers to invest and develop
  - equipment and systems for Hydrogen
- Investment in LH2 (port and floating bunker facilities + production and regional availability)

# Company background and motivation:

## h2e at a glance

### EV Charging & Micro-Grids

Distributed Micro-Grids for EV charging, telecom towers & remote applications

### Green Hydrogen / Ammonia / SAF

Commercial grade Electrolyser for production of Green Hydrogen & e-Fuels

### End-to-End NetZero Solutions

Solutions for different industry segments to achieve NetZero

### Power Solutions

Electricity solutions for residential, industrial, commercial and defense applications

**62**
employees worldwide

**200+ Years Experience**

**500+**
carbon neutral installations worldwide

# We are investing in technology of the future

Investing into research for next generation of electolysers driving cost reduction & efficiency

- Cell chemistry
- Component level R&D

Investing into allied activities in the H2 value chain

- Collaboration with IIT-B to develop and commercialize Solid State Cylinders that can store Hydrogen at 50 bar pressure in Solid State
- Developing effective LOHC technology for short distance transport (50 - 400 km)


*The **next generation cell developed by mPower** that will have current density of 2 A/cm² and have **significant impact on the cost** of Solid Oxide electrolyser. The Cell was successfully printed in the presence of **Dr. Cyrus Poonawalla, Chairman Serum Institute of India***

*Collaboration with **IIT-B** to commercialize **Solid State Cylinders***

# Group's Engagement towards building the Hydrogen Value Chain in India

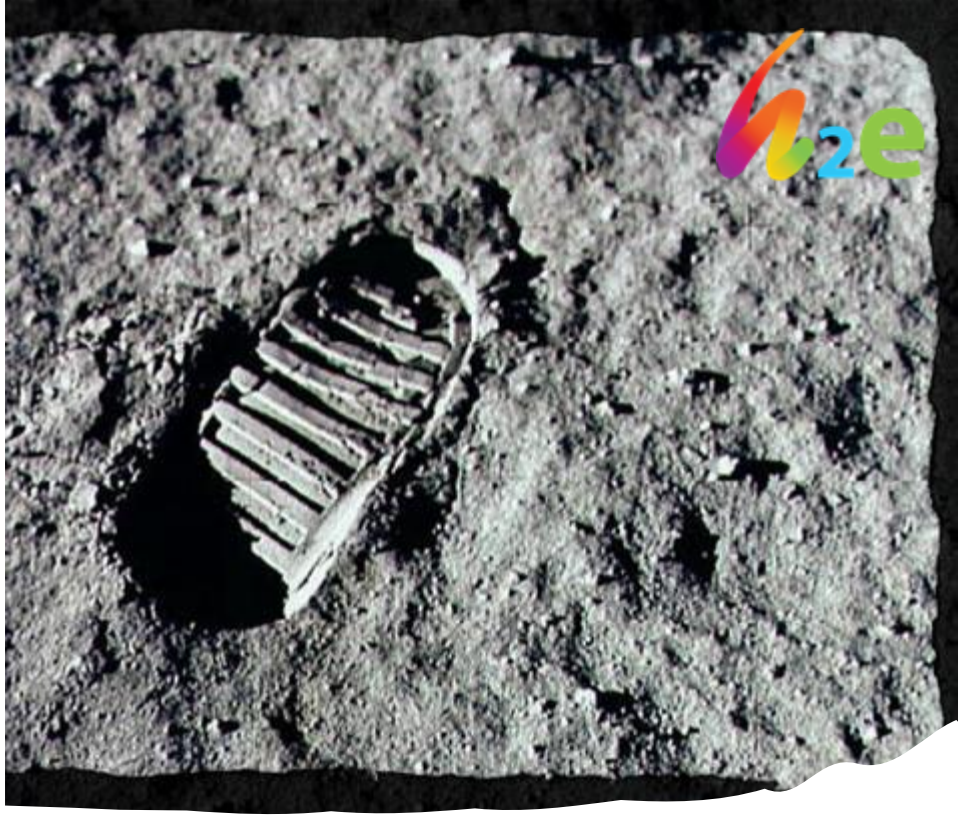
- India's first SOFC for electricity/heat installed at IOCL R&D
- India's first Hydrogen based forklift: PEM fuel cell zero emission forklift, a challenge undertaken and delivered by team h2e.
- Fuel Cell Hybrid for off-grid EV charging infrastructure as part of startup program. Charge2GO will provide independent power infrastructure for EV charging using Biogas. City's waste to Power City's Vehicles
- h2e has filed 6 Joint Patents with Indian Oil
- h2e is currently building a Solid Oxide electrolyser for Indian Oil, to be commissioned in April 2023

# Group's Engagement towards building the Hydrogen Value Chain in India

ऑयल इंडिया लिमिटेड
Oil India Limited

- Successfully commissioned India's first Green Hydrogen and Blending plant at PS3, Jorhat
- 100KWh of renewable energy to produce 10Kg of Green Hydrogen per day with capacity to scale up to 30Kg per day with a Blending Skid for Blending GH2 with NG
- Hydrogen FuelCell Bus flagged off by the Honorable Prime Minister
- Development of LOHC as part of SNEH, Startup Initiative of OIL

April 20, 2022



Commissioning of India's First Green Hydrogen Plant at Jorhat for OIL India

# A Small Step for Mankind, A Giant LEAP for Climate Change

#HarGharUrja #HarGharUnnati

॥ स्वदेशी ऊर्जा स्वावलंबी भारत ॥

PROUDLY MADE IN INDIA

H2E Electrolysers - Fuel Cell

## NetZero Solutions

. Mini / Micro Grid
- Residential, Industry

. PTX

. Green Agriculture

. Green Steel

. Storage - LOHC, Metal hydrite cylinders

## Green Hydrogen

. Electrolysers
- AWE, PEM, AEM, SOE

. e- fuels
- Ammonia
- SAF
- Methanol

homiHydrogen

## E-Mobility

. EV Charging Infrastructure

. ZEV
- Fuel Cell 3-wheeler
- Fuel cell bus

ohm CleanTech

## Fuel Cell

. SOFC
(Input- NG, Methanol, $H_2$, $NH_3$)

. PEMFC (Input- $H_2$)

KALAM FC

# H2E's पंचामृत

Electrolysers - Fuel Cell

## Race to Zero

. NetZero Advisory Service

. EPC / BOO

**Our Brands**

"Local, Yet Global"

**Global Partners**

mPower GmbH | ohm CleanTech | KALAM FC | HEXIS | homiHydrogen

POWER HYDROGEN | Oil India Limited | Enapter | H2 Energy | NUVERA | Fraunhofer IKTS | GREENSTAT | EH GROUP | ador | HnPower | IndianOil