Engineers India Limited

Net Zero by 2035

HYDROGEN INFRASTRUCTURE & COMPATIBILITY

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6TH JULY 2023

Delivering Excellence Through People

COMPANY BACKGROUND

- India's leading Engineering Consultancy & EPC - **NAVRATNA** company
- 1965 - Established as a JV between GoI and Bechtel.
- 1967 – Became wholly owned GoI company
- Over 7000 assignments of Project worth over $ 200 bn executed
- Significant track record across entire oil & gas value chain with experience of landmark projects
- In-house and collaborative R&D (34 active patents)
- **International presence** : *Middle East, Africa, South Asia & Central Asia*
- Around 2700 employees
- **Focused diversification:** *Infrastructure, Strategic crude oil storage, Fertilizer, Ports, LNG, Non-ferrous Metallurgy, Water & Waste Water Management, Clean Energy (H2)*

Dangote Refinery & Petrochemical

DANGOTE

[~ $ 12 Bn]

[~ $ 4 Bn + ~ 3.5 Bn]

GGSR Refinery & Cracker

HMEL

HRRL Integrated Refinery Complex

HRRL

[~ $ 10 Bn]

[~ $ 1 Bn]

Indian Strategic Petroleum Reserve Ltd

ISPRL

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LINE OF BUSINESS

Net Zero by 2035

SERVICE OFFERING - CONCEPT TO COMMISSIONING

Net Zero by 2035

Technology Licensing

- Conceptualization of Process
- Process Modelling & simulation
- Bench / Pilot Studies
- Technology Development & Licensing

Process Design

- Pre-feasibility studies
- Technology and licensor selection
- Conceptual design & feasibility
- Process design package

Project Management

- Integrated Project Management services
- Project Control - Planning & Scheduling, Monitoring, Costing

Engineering

- Residual engineering and FEED
- Detailed engineering
  - Engineering for procurement
  - Engineering for construction

Construction Management

- Materials /warehouse management
- Quality assurance and health, safety & environment
- Progress monitoring/ Scheduling
- Mechanical completion
- Site closure

Supply Chain Management

- Supplier and contractor management
- Expediting and inspection
- Vendor development

Commissioning

- Pre-commissioning and commissioning assistance
- Safety audit
- HAZOP and SIL studies
- Risk analysis

Specialized Services

- Environment engineering
- Heat and mass transfer
- Plant operations and safety management
- Specialist materials and maintenance services

Certification (through CEIL)

- EIL subsidiary – Certification Engineers International Limited (CEIL)
- Certification and re-certification services
- Third party inspection

THE HYDROGEN VALUE CHAIN

Net Zero by 2035

INPUT	H2 PRODUCTION	H2 DISTRIBUTION	H2 APPLICATION
Natural Gas	SMR	Liquefaction	Industrial
Naphtha	With CCS	Trailers	Transportation
Renewable Power, Water	Electrolysis	Pipelines	Building & industrial heat
		Underground storage	Power

EIL is committed to support its customers in the transition to clean energy

★ With the support of Technology Supplier/OEMs

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GREEN HYDROGEN

The Govt. of India launched the National Green Hydrogen Mission on 4th January 2023 with an aim to establish a green hydrogen ecosystem in India.

India has set its sight on becoming energy independent by 2047 and achieving Net Zero by 2070.

Hydrogen Policy – Phase 2 (Jan '23)

National Hydrogen Mission approved by Cabinet Ministry on 4th Jan'23 for a outlay of Rs. 19744 Cr

- Strategic Interventions for Green Hydrogen Transition (SIGHT) – Rs.17490 Cr
  - PLI for Electrolyser Manufacturers
  - PLI Incentives on H2 Production
- Pilot Projects – Rs. 1466 Cr
- R&D – Rs. 400 Cr

GREEN HYDROGEN

The MNRE recently announced the following guidelines under the National Green Hydrogen Mission:

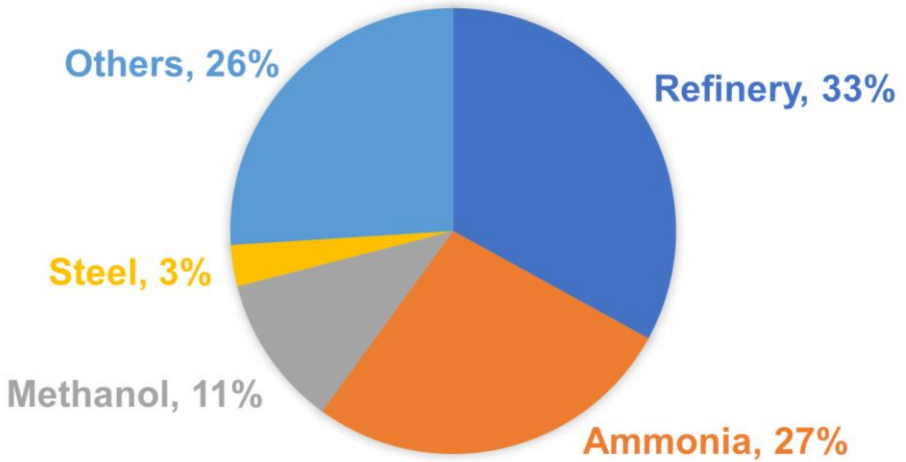
- ❑ SIGHT Programme - Component 1: Incentive Scheme for Electrolyser Manufacturing
- ❑ SIGHT Programme - Component 2: Incentive Scheme for Green Hydrogen production

The World Bank has approved $1.5 bn in financing for the Indian government to scale up green hydrogen and renewable energy, and support other climate-related policies.

GREEN HYDROGEN

- Sectors like transport, chemicals and Iron & Steel are also recognized as major consumers of energy and green hydrogen offers ways to decarbonize these sectors.

- The top four single uses of hydrogen are*:
  - Oil Refining
  - Ammonia production
  - Methanol production
  - Steel production



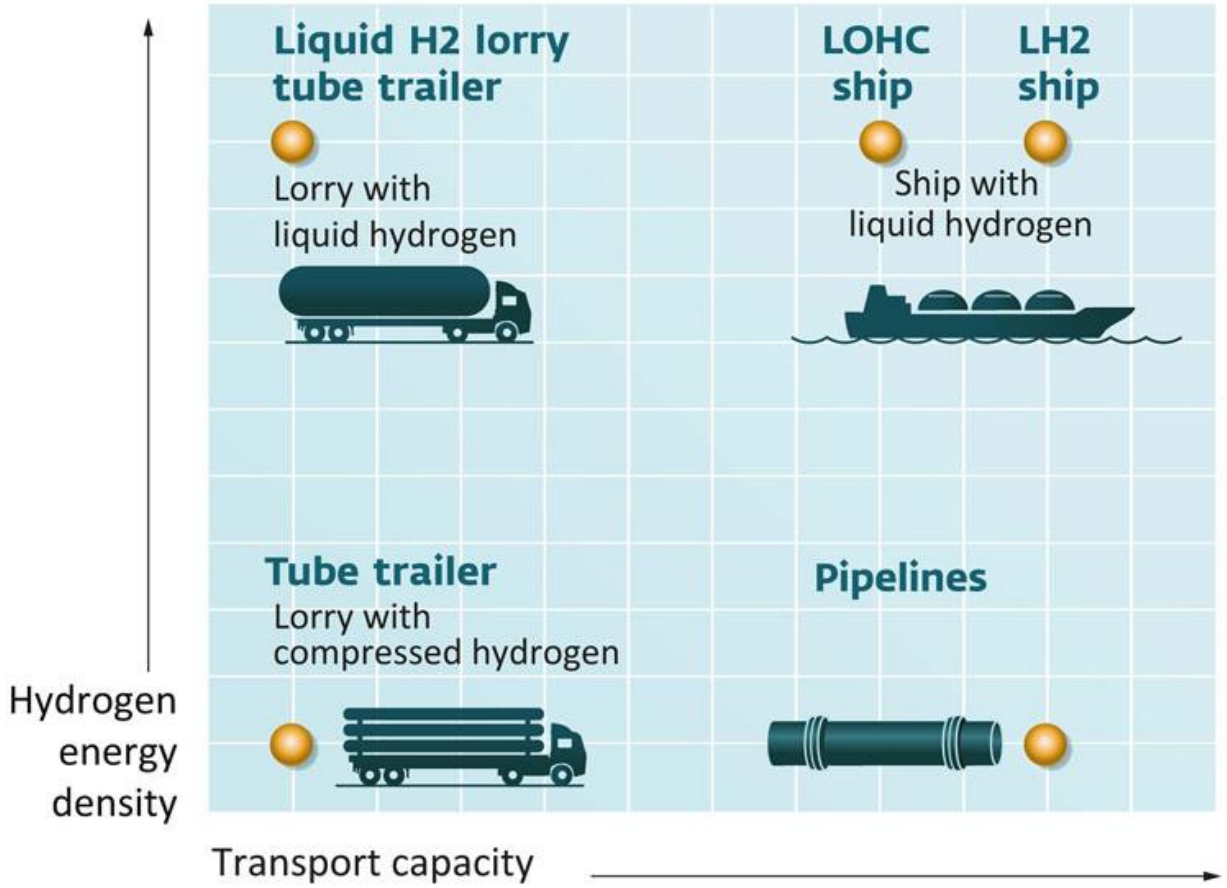
- Hydrogen use is responsible for around 20% of total refinery CO2 emissions*.
- Hydrogen demand is set to grow as regulations for Sulphur content of oil products tighten*.

* Source: The Future of Hydrogen, Report prepared by the IEA for the G20, Japan, June 2019

GREEN HYDROGEN

- Green hydrogen, produced through electrolysis powered by renewable energy sources, has a potential solution for decarbonizing various sectors, including the refinery industry.
- Refineries worldwide have initiated pilot projects and feasibility studies to assess the viability of integrating green hydrogen into their operations.
- Indian Oil and Gas Sector PSUs have also taken initiative for green hydrogen plant with a capacity of 218.6 MW (30.07 KTA) by Dec 2025.
- EIL is providing services in some of the above initiated projects for green hydrogen plant.

HYDROGEN – TRANSPORTATION



- Cryogenic liquid tanker truck or gaseous tube trailer can be transported over the road to meet the demand at small scale.
- Hydrogen pipelines are the most cost - efficient option for long-distance, high volume transport at €0.11-0.21/kg (€3.3-6.3/MWh) per 1,000 km.*
- All shipping methods – LOHC, and LH_2 – have high upfront costs, related to conversion and reconversion installations and in the case of LOHC the carrier chemical costs.
- Ship-transport is typically three to five times more expensive compared to pipeline transport.*

Liquid organic hydrogen carriers (LOHC): Organic compounds that can absorb and release hydrogen through chemical reactions say Toluene / methylcyclohexane

* Source: Analysing future demand, supply, and transport, European Hydrogen Backbone, June 2021

HYDROGEN – TRANSPORTATION THROUGH PIPELINE

- Hydrogen can be transported through pipelines much the same way natural gas is today.
- Currently about 2600 km of hydrogen pipelines are operating in the United States and in Europe the estimate is around 2000 km.
- The existing natural gas network can be utilized for transportation of pure hydrogen after proper assessment and adaptation. However, depending on the type of pipeline and its operational characteristics, the technical challenges will differ.
- EIL has undertaken projects involving the transportation of green hydrogen through new pipelines and currently involved in assessment of natural gas pipeline for transporting hydrogen blended natural gas.

HYDROGEN – TRANSPORTATION THROUGH PIPELINE

CHALLENGES

NEW PIPELINES FOR PURE HYDGROGEN

- Finalisation of Material for Pipeline
- Gas Turbine for pure Hydrogen (as driver at remote intermediate compressor station).
- Leak Detection System (Vendor identification)
- Pigging System
- Standard Code and Regulations say OISD & PNGRB guidelines
- Right of Use (ROU) H2 pipeline

HYDROGEN – TRANSPORTATION THROUGH PIPELINE

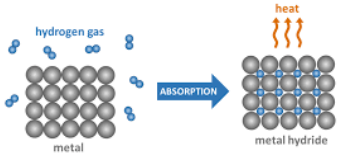
CHALLENGES

EXISTING NATURAL GAS PIPELINES FOR PURE HYDGROGEN / HYDROGEN BELENDED NATURAL GAS

- Suitability of the existing pipeline material
- Suitability of existing equipment for new service
- Suitability of existing fittings
- Suitability of existing instrument items

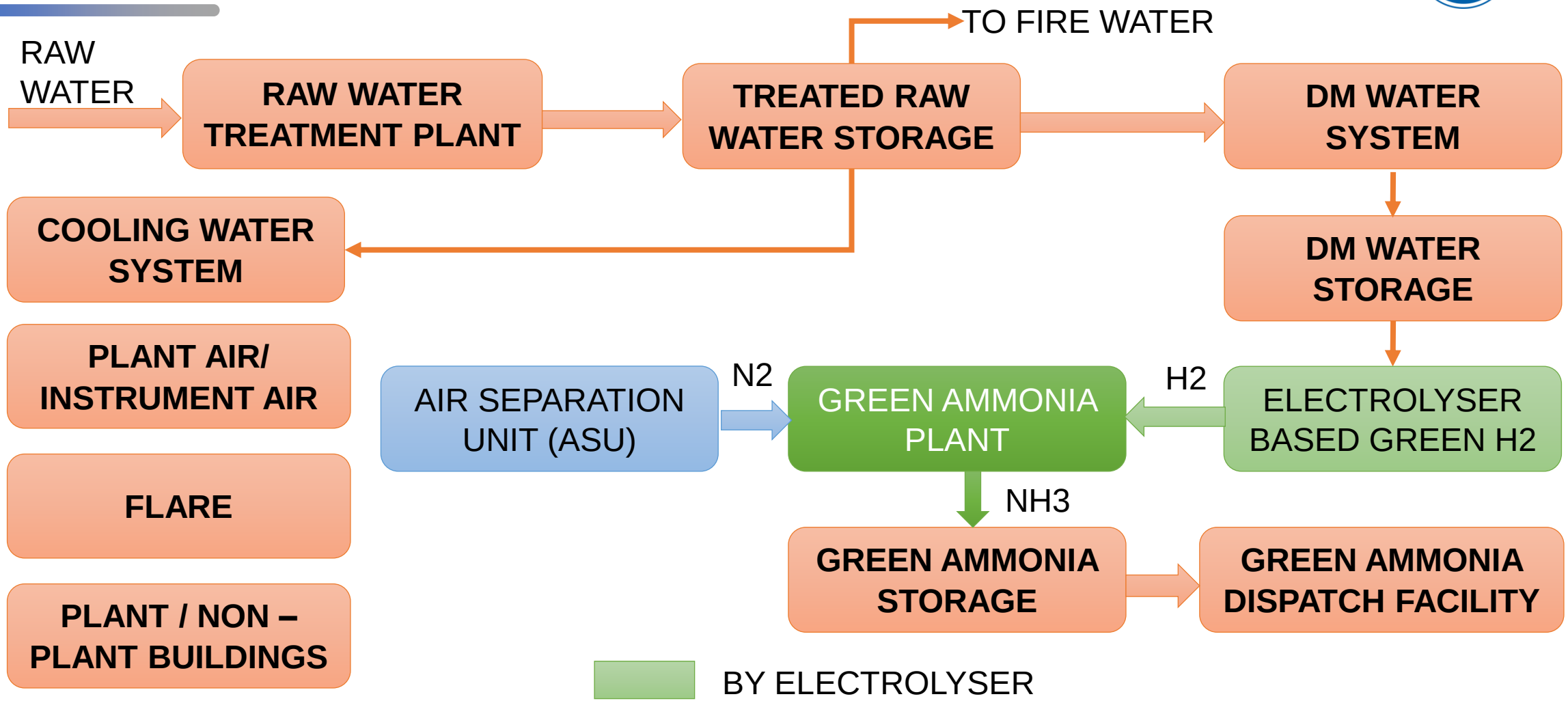
GREEN HYDROGEN – STORAGE

Net Zero by 2035

COMPRESSED GASEOUS STORAGE	LIQUID STORAGE	MATERIALS BASED STORAGE	GEOLOGICAL STORAGE
H2 Bullet 	Liquid H2 Storage tank 	Metal hydrides from elements Say Palladium 	
Under-ground Pipe 	Cooled to ~ (-) 253°C and stored in insulated tanks	Material - NH3, Toluene	H2 in Salt Cavern
Basic Design and Detailed Engineering	Detailed Engineering based on Basic design of others	Detailed Engineering based on Basic design of others	Basic Design and Detailed Engineering (under development)

EIL'S STRENGTH AND CAPABILITY

GREEN AMMONIA

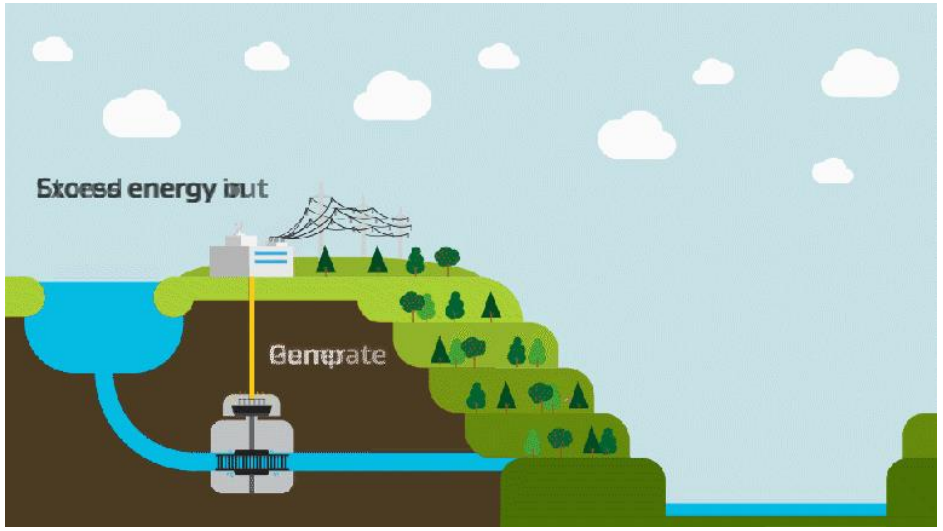


PUMPED STORAGE PROJECTS – WATER BATTERY

- Can store a large amount of energy during off-peak hours and discharge stored energy over longer period.
- Helpful in Renewal Energy (RE) curtailment and in improvement of the plant load factor of Variable RE.
- Estimated PSPs, worldwide, can store up to 9,000 gigawatt hours (GWh) of electricity.

DRIVERS:

- Ecologically friendly
- Atmanirbhar Bharat
- Tested Technology
- Longer and reliable duration of discharge



BARRIERS:

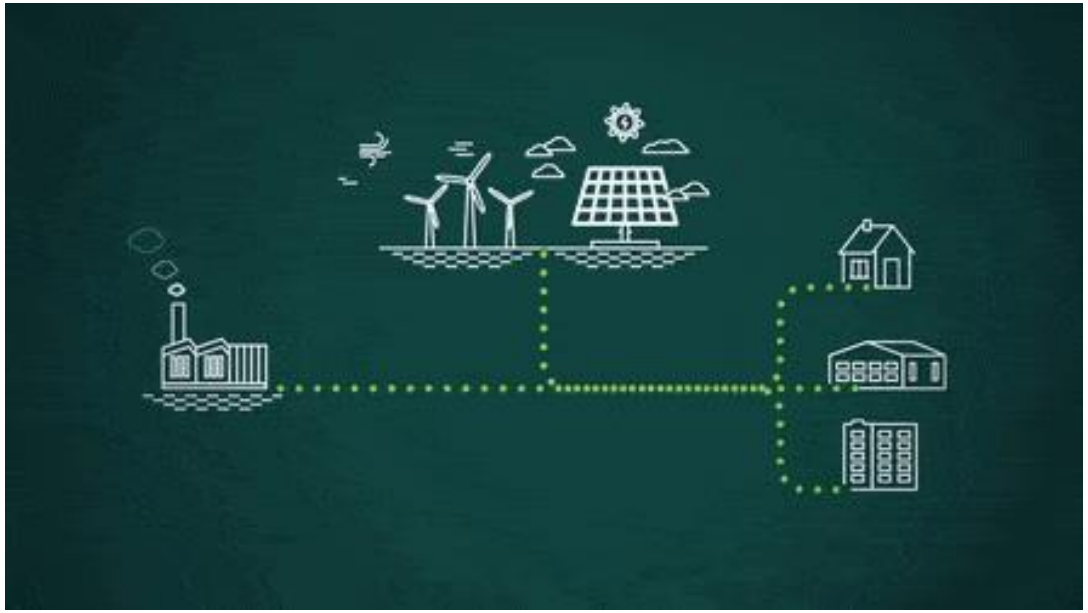
Environmental clearance, Cost of pumping, value of peak power

BATTERY ENERGY STORAGE SYSTEMS

- The draft National Electricity Plan(NEP) published by Central Electricity Authority indicates that 18.8 GW of Pumped Storage Projects and 51.5 GW of BESS (5 hour) are required to integrate the planned RE capacity addition till 2032.

DRIVERS:

- Greater flexibility
- Greater scalability
- Lower cost
- Higher efficiency



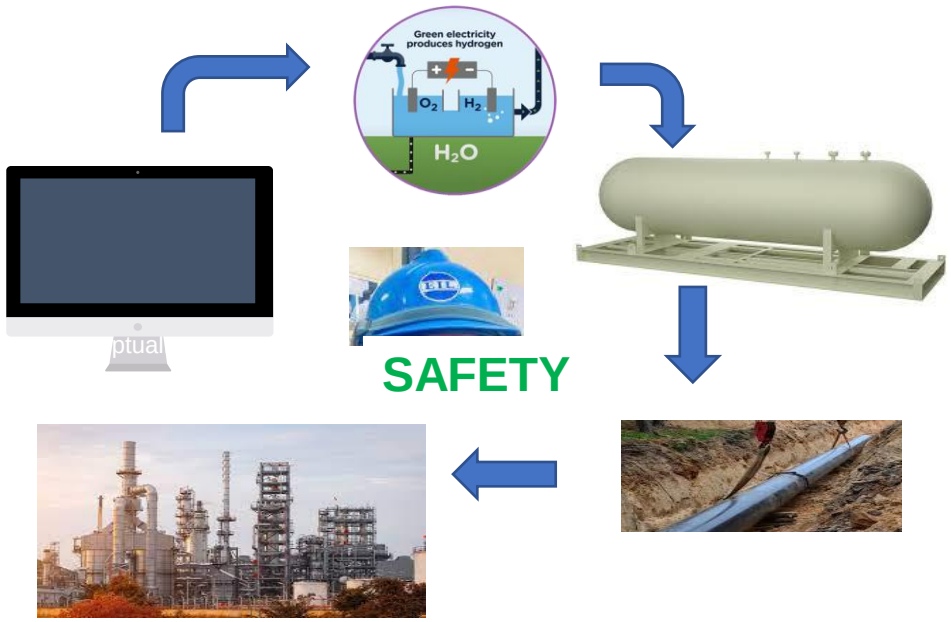
BARRIERS:

Batteries are heavily import-dependent especially given the current holding of lithium reserves at the global level.

GREEN HYDROGEN – EIL PRESENCE

GREEN HYDROGEN (GH2) VALUE CHAIN

- Conceptualisation of GH2 Plant Configuration
- Design of Balance of GH2 Plant
- Design of GH2 Storage
- Transportation of GH2 through Pipeline
- Utilization – Green Ammonia/Green Methanol Plant with support from Unit Licensor



SERVICE OFFERING:

- Conceptual Study
- Pre-feasibility Study/Detailed Feasibility with support with Electrolyser OEM
- Detailed Engineering
- Commissioning Assistance

EXPERIENCE LIST - GREEN HYDROGEN

- LEPC selection for water electrolyser based on Green H2 plant of capacity ~ 8.5 TPD (~ 20 MW) (Alkaline)
- PMC Services for water electrolyser based Green Hydrogen plant of 4.3 TPD (10 MW) (PEM)
- DFR of setting up of 4000 TPD Green Ammonia plant
- Hydrogen Blending in NG pipeline/ CGD Network & impact on end user (5 CGDs)
- Feasibility & Basic Engineering of Hydrogen Pipeline (more than 200 KM)
- Conceptual Study for Setting up Green Hydrogen Facility in one of the Smart City


EIL
THANK YOU