Industrial strategies on the Hydrogen value chain

Krish R. Krishnamurthy
Clean Hydrogen Technologies R&D
Linde

Making our world more productive
### Hydrogen Value Chain

Linde’s capabilities ready to be leveraged, today

#### Production

- 500 plants built worldwide, more than 150 plants operated by Linde
- Steam methane reforming, autothermal reforming and partial oxidation of natural gas through heavy oil to coal
- Solvent and adsorption based carbon capture technologies ready for commercial application
- Large scale SMR H2 plants in Linde’s portfolio in the US gulf coast and mid-west

#### Liquefaction

- Global capacity leader with 170 TPD
- A range of liquefier capacities
- A network of five large scale liquefiers serving the current US market

#### Storage & Distribution

- 1000+ km of hydrogen pipeline, globally
- Major pipeline network in gulf coast (TX, LA)
- Large scale cavern storage in gulf coast
- Fleet of 1600+ trucks worldwide
  - GH₂: total load of 530 kg/trailer
  - LH₂: total load of 3,370 kg/trailer
Clean energy opportunity

**Carbon Solutions**

- **Carbon capture, utilization & storage**
  - CO₂ removal from industrial processes with CO₂ storage or re-use

**Clean Hydrogen**

- **Blue Hydrogen**
  - H₂ production from natural gas with CO₂ removal, storage or re-use

- **Green Hydrogen**
  - Electrolysis powered by renewable energy, no CO₂ emissions

**Hydrocarbon market - Today**

- $6T Hydrocarbon sales

**Clean Hydrogen Opportunity – 2030**

- $100B Clean H₂ sales
  - 1.5% of today’s hydrocarbon market

**Significant opportunity despite uncertain timing**

(1) Source: IHS
(2) Based on Hydrogen Council forecast of 24MMt H₂ demand by 2030 and Linde price assumptions
Building momentum for Hydrogen
Favorable Trends for Clean Hydrogen, but Uncertainties Remaining

Favorable trends for Clean H₂ ...

- Strong push to limit carbon emissions
- Strategic intent of national Clean H₂ roadmaps
- Industry momentum growing

... but more needs to happen

1. H₂ technologies delivering on expected cost reductions
2. End-user adoption and ecosystem build-up
3. Regulatory framework creating supportive policies, while ensuring funding and access to renewable energy
Clean energy strategy

**Strategy**

- **Leverage +$2B existing business & integrated supply network**

- **Execute local market driven strategies** in core geographies

- **Develop partnerships** to accelerate opportunities

- **Advance technology leadership** across the value chain

**Recent projects under construction**

**Q1 2021**
- $290MM investment to develop **hydrogen infrastructure in South Korea**

**Q1 2021**
- $35MM investment to build, own and operate **World’s Largest PEM Electrolyzer** in Germany

**Q4 2020**
- $35MM investment to **produce clean H2 for mobility market in California**