

Green Steel: Decarbonising a Hard-to-abate Sector

An underwriter's view on the "green" steel industry –
Massimo Ferrari & Jimmy Keime





Changes in the risk landscape

Production methods

- Regulatory pressure
- Refurbishment of existing plants
- Use of new and/or unproven technologies
- CCUS, waste-heat recovery systems
- Maintain the product standards even with new production technologies

Supply chain

- Increase complexity of the supply chain (upstream and downstream)
- Use of renewable energy as reliable energy source

Large use of Hydrogen

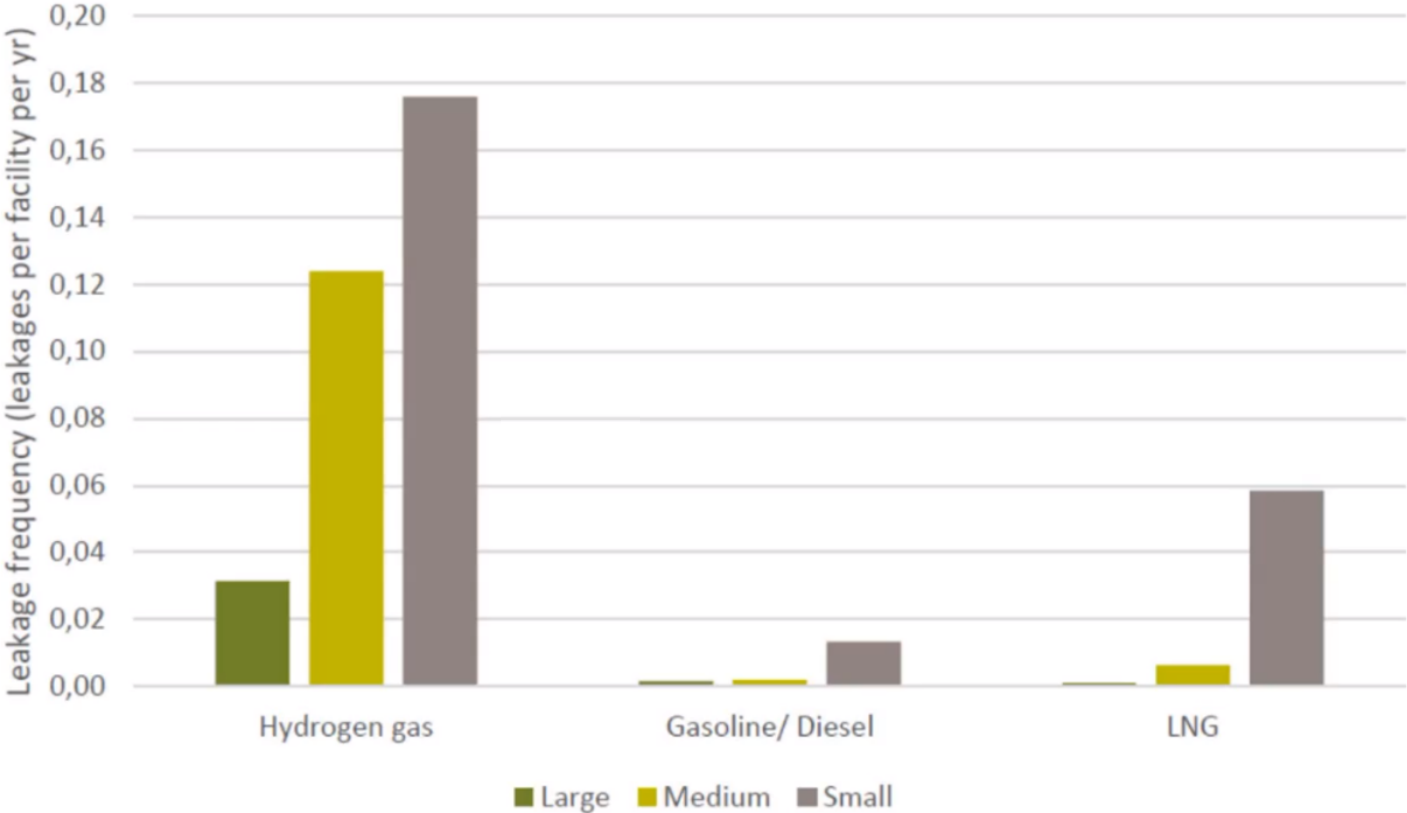
- Hydrogen supply chain
- Hydrogen handling and production
- Hydrogen related process safety management systems

Hydrogen has very different properties than current chemical elements used in steel production

| Properties | Hydrogen | Comparison |
|-------------------------------------|---|-----------------------|
| Density (gaseous) | 0.089 kg/m ³ (0°C, 1 bar) | 1/10 of natural gas |
| Density (liquid) | 70.79 kg/m ³ (-253°C, 1 bar) | 1/6 of natural gas |
| Boiling point | -252.76°C (1 bar) | 90°C below LNG |
| Energy per unit of mass (LHV) | 120.1 MJ/kg | 3x that of gasoline |
| Energy density (ambient cond., LHV) | 0.01 MJ/L | 1/3 of natural gas |
| Specific energy (liquefied, LHV) | 8.5 MJ/L | 1/3 of LNG |
| Flame velocity | 346 cm/s | 8x methane |
| Ignition range | 4-77% in air by volume | 6x wider than methane |
| Autoignition temperature | 585°C | 220°C for gasoline |
| Ignition energy | 0.02 MJ | 1/10 of methane |

Notes: cm/s = centimetre per second; kg/m³ = kilograms per cubic metre; LHV = lower heating value; MJ = megajoule; MJ/kg = megajoules per kilogram; MJ/L = megajoules per litre. Source: *The Future of Hydrogen: Seizing today's opportunities*, IEA, June 2019.

e.g. Leakage frequency - H2 compared to traditional fuels



Significantly higher leak rate expected for Hydrogen compared to traditional fuels

Source: RISE - Research Institutes of Sweden, Report 2021:26

These challenges create new risks across the green hydrogen (and steel) value chain

Stages of the value chain: Production, Storage and transmission, Usage

| Stages of the value chain | Production | Storage and transmission | Usage |
|---------------------------|--|--|--|
| Conventional | Steam methane reforming (SMR) or coal gasification | Pipelines | BF-BOF |
| New or low-emission | Greenfield renewables + electrolysis plants | New or retrofitted pipelines, trucks or shipping via high-pressure tanks | H ₂ -DRI-EAF, or BF-BOF with CCUS |



| Challenges | Production | Storage and transmission | Usage |
|-------------------------|--|--|--|
| Challenges | New technologies, some prototypical Availability of spare parts Leakage | Requires very low temperature and high-pressure during transportation and storage, higher risk of leakage Effect on long term structural integrity of metallic materials and polymers ("Embrittlement") | Effect on long term structural integrity of metallic materials and polymers ("Embrittlement") Higher risk of leakage New combustion process with Hydrogen-based direct reduced iron |
| Related Insurance Risks | Construction related risks Machinery breakdown Business Interruption Fire and explosion | Construction related risks Business Interruption (BI) Fire and explosion due to H ₂ leakage Transmission line breakdown | Damage from improper handling Fire and explosion due to H ₂ leakage Contingent Business Interruption (CBI) due to H ₂ or renewables supply Damage to property |

A few things to consider prior to start underwriting...



- ✓ Work with warranty surveyors / technical inspections services to define risk management approaches that reduce risks (e.g. combined UV/IR sensing system for invisible flames, purging systems to void H2 accumulation under ceilings, ...)
- ✓ Reflect on what is prototypical vs. proven technology
- ✓ Set your risk appetite in terms of scope of cover (e.g. Leg hydrogen clauses, time element covers)



Terms & Conditions

- ✓ Check the scope of cover (full green steel value chain vs. steel production only)
- ✓ Reflect on cover extensions (e.g. time element covers like BI, CBI, DSU) and how impacted they can be in case of a loss (e.g. supply chain of replacement parts)



Reinsurance alignment

- ✓ Review ambitions and plans with reinsurers for additional input
- ✓ Apply adequate line size management and think of accumulation potential (e.g. CBI loss due to green H2 supply difficulties)



Take-Away: Green Steel should be on every underwriter's radar



Global Steel demand up 40% by 2050...

... Global Steel emissions should decrease by 95%

Green Steel production risks are interlinked with those of Green Hydrogen



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