A Hydrogen Future? Exploring Pathways to Decarbonization

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Empowering generations with clean energy forever
Nel Hydrogen: A well capitalized pure play hydrogen technology company with a global footprint...

- Pure play hydrogen technology company listed on Oslo Stock Exchange (NEL.OSE)
- Manufacturing facilities in Norway, Denmark, and U.S., and a global sales network
- World’s largest electrolyser manufacturer, with >3,500 units delivered in 80+ countries since 1927
- Leading manufacturer of hydrogen fueling stations, with 110+ H2Station™ solutions delivered/in progress to 13 countries
Hydrogen technology solutions, commercialized and market ready...

Alkaline and PEM electrolysers

Converts water and electricity to hydrogen and oxygen – for industry, mobility and energy purposes

Compact hydrogen fueling stations

World’s most compact fueling stations, capable of fueling any kind of vehicle and simple to integrate with other fuels
Strong field know-how and manufacturing capacity “at scale”...

**PEM electrolysers**
Wallingford, USA

- Systems delivered: **2,700+**
- Production capacity: **>50 MW/year**
- History: **23 years**

**Alkaline electrolysers**
Notodden/Herøya, Norway

- Systems delivered: **800+**
- Production capacity: **40 MW/year → 500 MW/year (~2 GW/year)**
- History: **90 years**

**Hydrogen refueling stations**
Herning, Denmark

- Stations delivered: **110+**
- Production capacity: **300 HRS/year**
- History: **16 years**
The hydrogen opportunity
THE HYDROGEN OPPORTUNITY

Large opportunities for electrolysis within existing hydrogen market

Global hydrogen market by end use

- Ammonia
- Refineries
- Methanol
- Other

~70 Mton/year
~150 BUSD

- Currently only 1% from water electrolysis
- Large growth potential driven by increasing focus on climate and renewable energy, decreasing both electricity prices and electrolyser capex
- Focus on renewable hydrogen for refineries and ammonia, accounting for ~80% of market
- Electrolysis set to take larger share of overall hydrogen market. Annual electrolyser market potential of >$20 billion/year within existing hydrogen market alone

Source: 2020 estimates by Hydrogen Council (2017)
THE HYDROGEN OPPORTUNITY

Hydrogen is expanding its areas of application

**Industrial applications**
- Food Industry
- Glass Industry
- Polysilicon Industry
- Laboratories
- Chemical Industry
- Thermal processing
- Chemical vapor deposition
- Steel Industry
- Power Industry
- Life support

- Niche industrial applications represents “traditional” hydrogen markets
- Steady demand for hydrogen

**Power-to-X**
- Renewable hydrogen

- Decreasing cost of renewables and electrolysers is accelerating market
- Vast opportunities within existing & new sectors

**Mobility**
- Transportation

- Key market going forward – both within hydrogen production and fueling
- Heavy duty sector developing faster than anticipated – hydrogen now relevant fuel for all forms of mobility

**Steady growing market**

**Markets expected to see fast growth going forward**
Hydrogen demand grows eightfold by 2050

MARKET DEVELOPMENTS

Hydrogen use by 2050

Energy transition opens attainable market for electrolytic hydrogen to full spectrum of use cases

New use cases to develop into major markets: Transportation fuel, industrial heat and power, building heat and power, and power generation and storage

Hydrogen consumption could reach 540Mt per year by 2050, driven by industrial processes and transportation

Sources: Hydrogen Council, Kearney Energy Transition Institute analysis
Cost of wind and solar dropping significantly – green hydrogen to follow

**Global average cost USD**
Unsubsidised levelized cost of energy ($/MWh)

- With falling LCOE\(^1\) of wind and solar prices, renewable hydrogen follows the same path, as electrical power constitutes 70-80% of hydrogen’s total cost.
- Record low auction prices for solar PV and wind – prices as low as $13.5/MWh and $17.86/MWh respectively\(^3,4\).
- Prices expected to drop further, LCOE of solar PV and onshore wind expected to fall by 71% and 58% respectively\(^5\).
- Renewable hydrogen competitive with fossil fuels at $50/MWh – competitive in most markets at $30/MWh.

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Sources:
1. LCOE = Levelised cost of energy (total production cost of building and operating electricity-generating plant).
2. Lazard; Renewables Now,
3. PV magazine,
4. IRENA (International Renewable Energy Agency),
1.5 $/kg

Nel green hydrogen cost target by 2025

Assumptions: Nel analysis based on electricity of 20 $/MWh, >8% cost of capital, cost of land, civil works, installation, commissioning, building water etc., lifetime 20 years incl. O&M cost, at 30 bar
ELECTRODE PRODUCTION AT HERØYA

Capacity expansion at Herøya

- Fully automated and designed according to lean manufacturing and industry 4.0 principles
- Industrial scale production of most efficient electrolysers in the market, at a game-changing cost
- Large scale production line improvements identified, name plate capacity up from ~360 to ~500 MW
- Room to expand to ~2 GW annually
- CO₂ reduction potential in line 1 (pilot) of 1,000,000 ton – with 2 GW, 4-5 million ton
- Test production in new line Q2’21, start of ramp-up Q3’21
Further product development – improving efficiency and capacity of cell stack

Current vs. future 20 MW cell stacks

Enablers:
- Electrode size and form improvement
- Increase active electrode area
- Increase current density

Balance of plant on existing platform compatible with future
SCALING TECHNOLOGY FOR A 10X MARKET

Standardization reducing system cost to enable $1.5/kg

Electrolyser system cost today
Excludes Civil/Building

Herøya expansion
Increased capacity with Herøya expansion

Engineering
Standardizing large-scale offerings: 20 MW, 50 MW, 100 MW, 250 MW

Procurement
Continuous improvement of supply chains and framework agreements

Construction
Standardised design and pre-fabricated skids reduce time and cost for commissioning and installation

Reduced cost
~25%
Large-scale alkaline: Today’s technology and design approach

2.25 MW Cell Stack

100 MW plant layout
125 m x 60 m
New PEM electrolyser plant design: 10 to 25 MW

Awarded Iberdrola contract for 20 MW green fertilizer project in Spain

(Oslo, 14 January 2021) Nel Hydrogen Electrolyser, a division of Nel ASA (Nel, OSE:NEL), has been awarded a EUR 13.5 million contract by Iberdrola for a 20 MW PEM solution for a green fertilizer project.
Renewable/green hydrogen is on a trajectory to outcompete grey and blue hydrogen.

**Forecast global range of levelized cost of hydrogen/TCO production from large projects**

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<tr>
<th>Year</th>
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<th>Fossil fuel derived H₂ with CO₂-capture</th>
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- Green hydrogen cost expected to decline and close gap with fossil sources by 2030
- IEA expects cost parity by 2030 – Nel expects to reach this target by 2025
- Focus on reduction of capex, increase lifetime, improve efficiency, increasing current density, lowering catalyst, and scaling up system components

Source: BloombergNEF & IEA / conversations with oil & gas majors
number one by nature