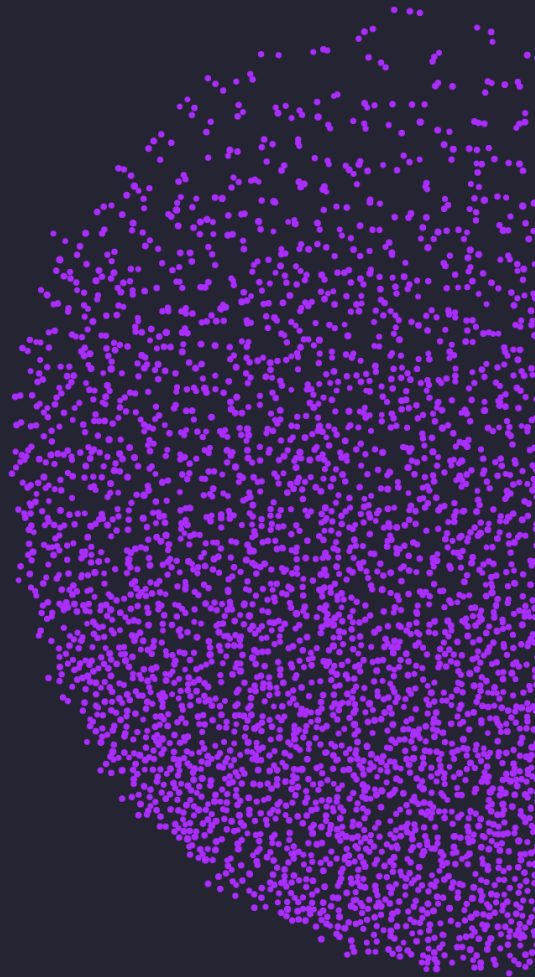


HYDROGEN

Electrolysis empowering green hydrogen

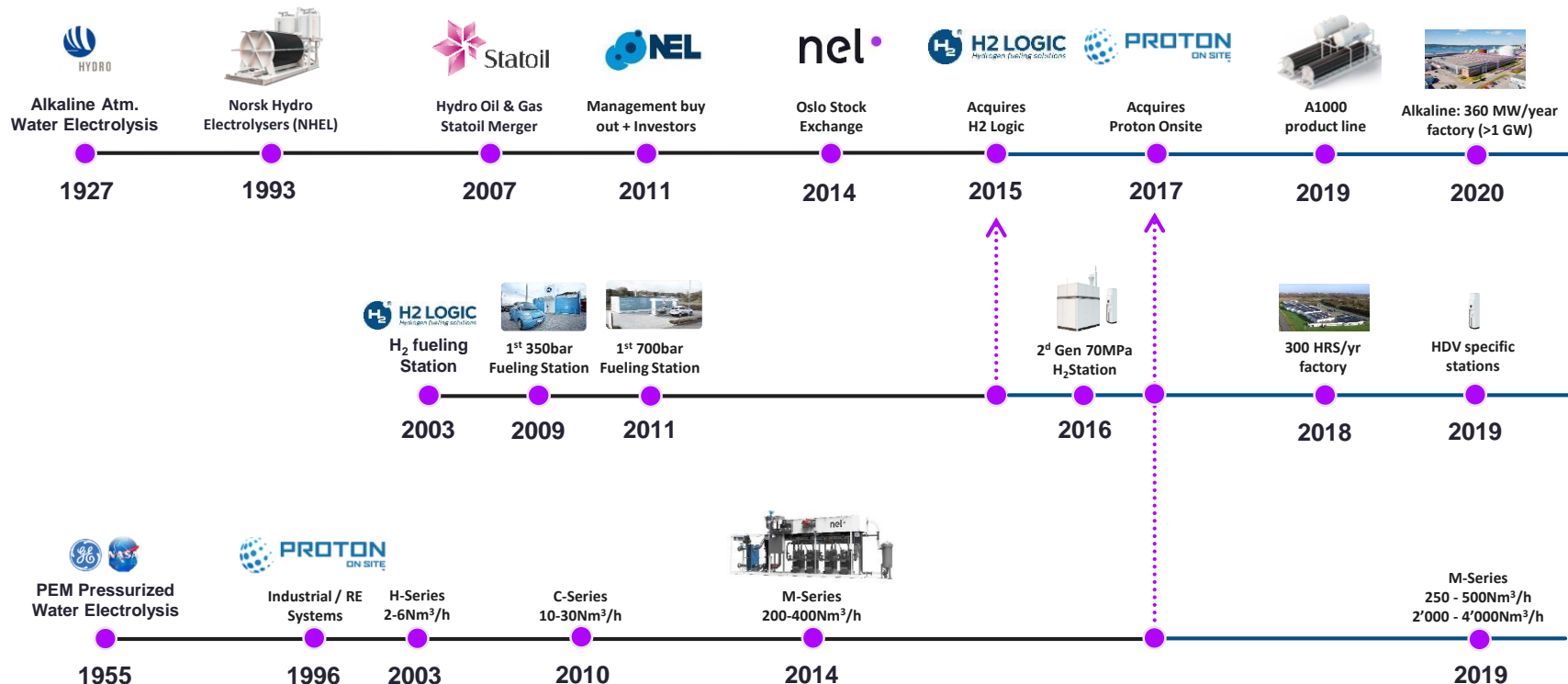
Luc Graré

VICE PRESIDENT SALES AND MARKETING



90+ year's experience

PEM, alkaline electrolysis & fueling stations extended field know-how



Nel Hydrogen today

- Pure play hydrogen technology company listed on the Oslo Stock Exchange (NEL.OSE)
- Manufacturing facilities in Norway, Denmark and U.S. & global sales network
- World's largest electrolyzer manufacturer, with >3500 units delivered in 80+ countries since 1927
- World leading manufacturer of hydrogen fueling stations, with ~50 H2Station® solutions delivered to 9 countries



ALKALINE AND PEM ELECTROLYZERS

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



HYDROGEN FUELING STATIONS

Hydrogen fueling stations capable of fueling any kind of vehicle. World's most compact – simple to integrate with other fuels & standardized

Strong field know-how & manufacturing capacity



Wallingford, USA

PEM electrolyzers

2,700+ systems delivered

Production capacity:

>40 MW/year



Notodden/Herøya, Norway

Alkaline electrolyzers

800+ systems delivered

Production capacity:

40 MW/year

→ 360 MW/year (> 1 GW/year)



Herning, Denmark

Hydrogen refuelling stations

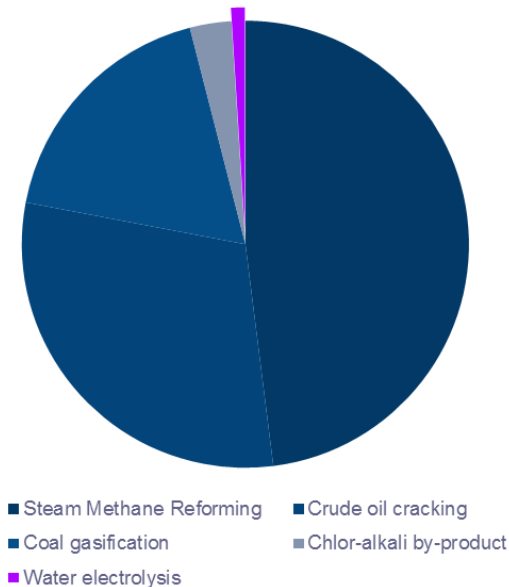
50+ stations delivered

Production capacity:

300 HRS/year

Electrolysis accounting for ~1% of global hydrogen production today

Hydrogen from water electrolysis currently represents 1% of hydrogen produced globally



~15% merchant market, rest captive

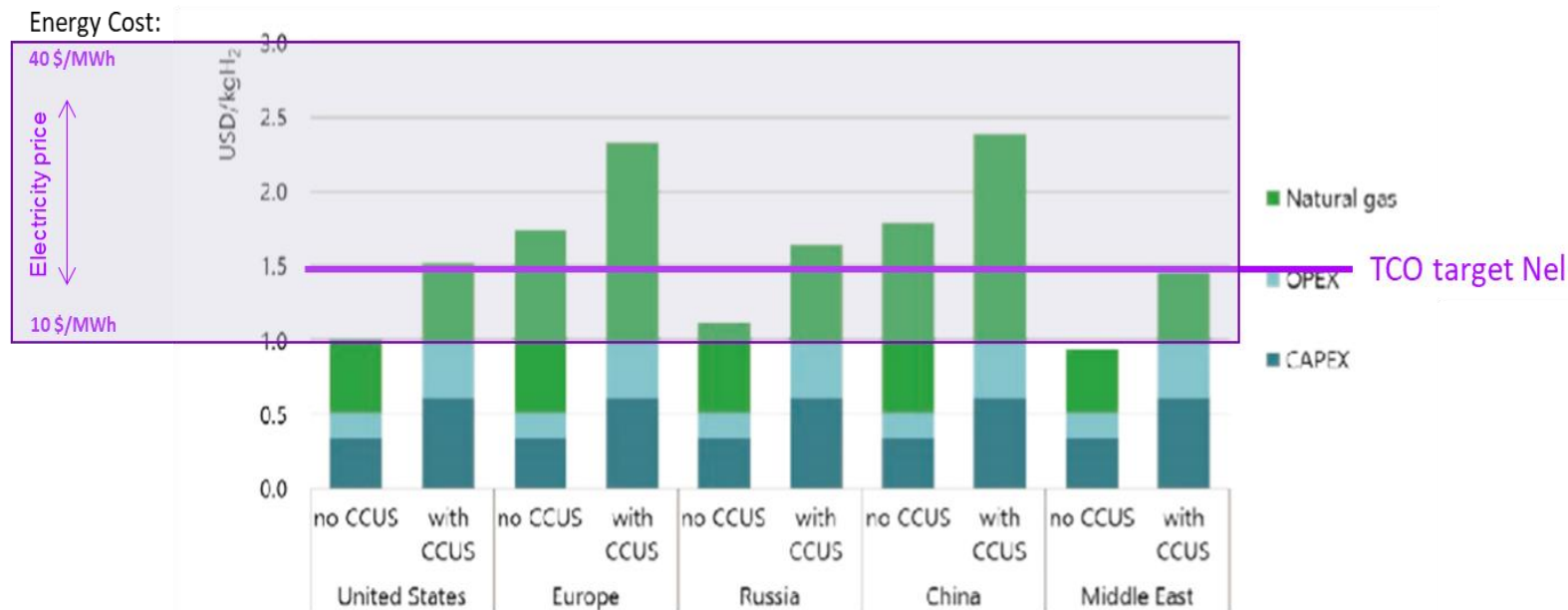
Only 1% from water electrolysis

Emissions from various sources of fossil hydrogen

- Coal: 18 tons of CO₂/ton of hydrogen
- Petroleum coke: 18 tons of CO₂/ton of hydrogen
- Natural gas: 12 tons of CO₂/ton of hydrogen

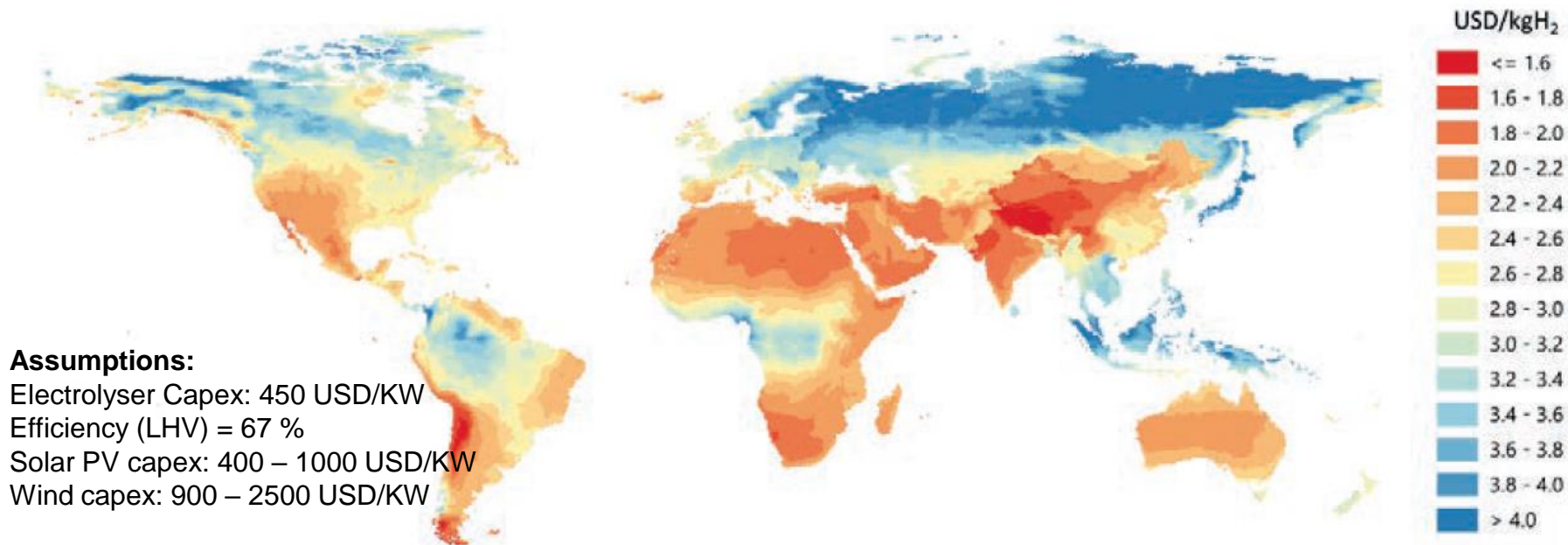
Renewable hydrogen can be
competitive with fossil hydrogen

Growth in renewable hydrogen will accelerate with reduced capex for electrolyzers



Notes: kgH₂ = kilogram of hydrogen; OPEX = operational expenditure. CAPEX in 2018: SMR without CCUS = USD 500–900 per kilowatt hydrogen (kW_{H₂}), SMR with CCUS = USD 900–1 600/kW_{H₂}, with ranges due to regional differences. Gas price = USD 3–11 per million British thermal units (MBtu) depending on the region. More information on the underlying assumptions is available at www.iea.org/hydrogen2019.

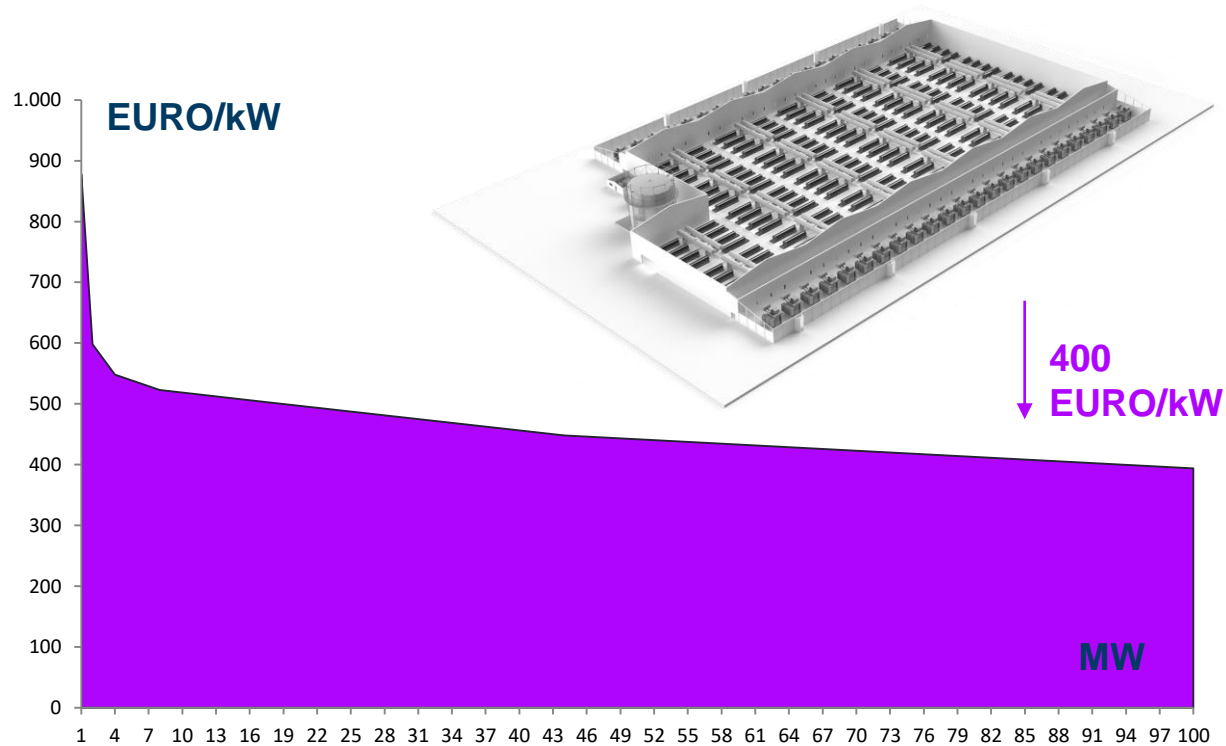
Source: IEA 2019. All rights reserved.



Source: IEA analysis

Nel Electrolysers

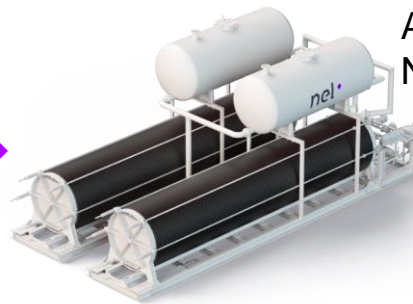
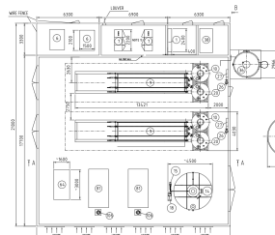
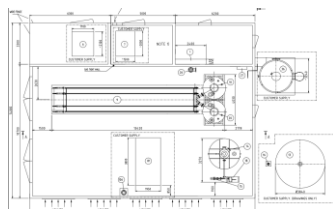
CAPEX - Significant economy of scale



Nel Electrolysers

Configuration and process optimization through upscaling

Base product: A485 (2,2 MW)

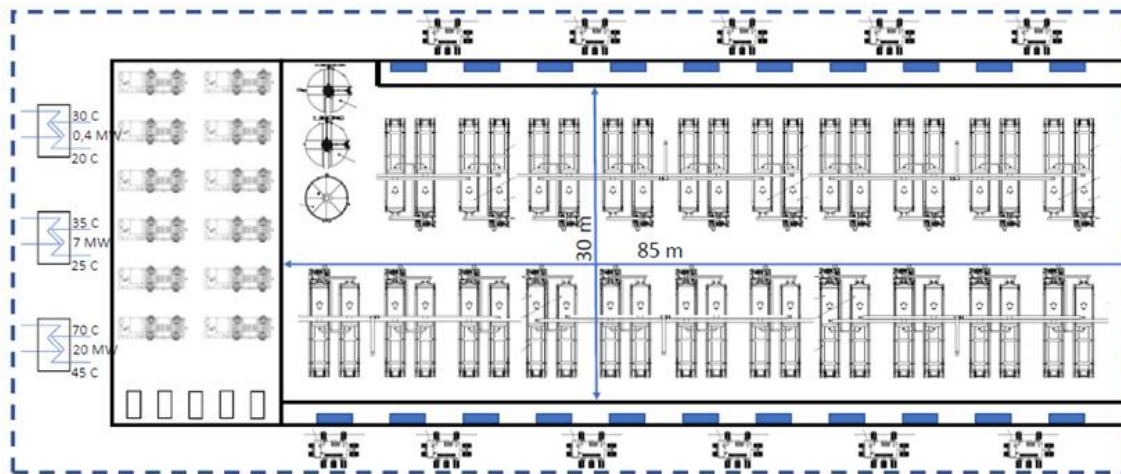


A1000: pair of 2 times
A485 producing 970
 $\text{Nm}^3/\text{h H}_2$ (4,4 MW)



A 100 MW plant
based on 21 times
A1000

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Large scale electrolysis has been
done before

Nel electrolyzers

Pioneering large scale renewable hydrogen production since 1927

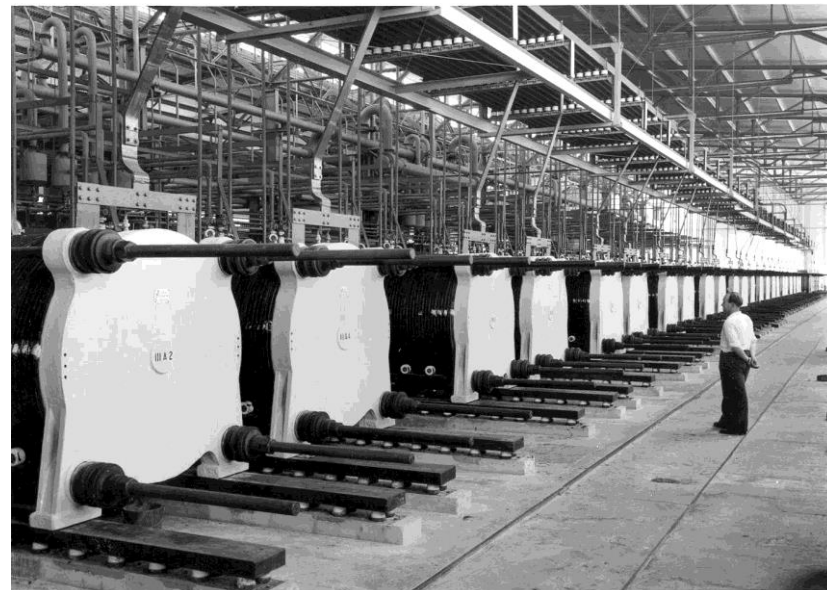


Rjukan, Norway; 1927 – 1988

Approx. 60 000 Nm³/h or 300

MW

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Glomfjord, Norway; 1953 – 1991

Approx. 30 000 Nm³/h or 150

MW

THE biggest green H₂ plant in operation

Industrial site (polysilicon): 25MW/5'500Nm³/h with hydro power



Largest water electrolyser installation in operation in Europe

Chemicals (1'940Nm³/h, 9.2MW) – Norway. From hydro power



Project examples

Power-to-gas using wind energy

Utsira (2004 – 2010)

World's first power-to-gas project, powering 10 households with wind and hydrogen

2 x 600 kW wind turbines

- 10 Nm³/h alkaline electrolyzer
- 2400 Nm³/h storage @ 200 bar
- 55 kW Hydrogen engine
- 10 kw fuel cell
- 10 households were completely disconnected from electrical grid, and relied 100% on electricity from power-to-gas system



Wind-to-Ammonia

Morris, MN, USA (2010)

First ever wind-to-green-ammonia project

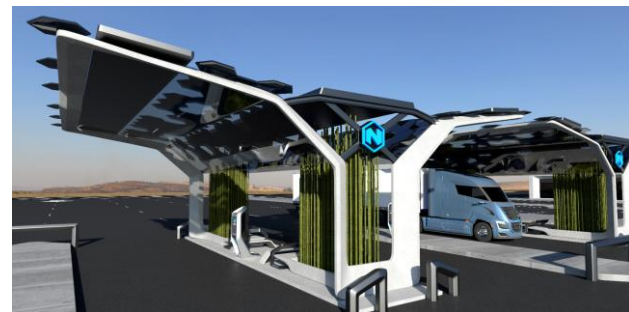
- $6\text{Nm}^3/\text{h}$ PEM electrolyser - $14\text{kg}/\text{day}$ $\sim 41\text{kW}$
- Direct connection to wind farm
- N_2 and H_2 to produce NH_3 (Haber-Bosch reactor)
- H_2 used for Toro FC utility vehicle
- H_2 used in combustion genset



First gigawatt contract for heavy duty mobility

Nel and Nikola = Hydrogen @Scale

- Nel awarded contract as part of Nikola's development of a hydrogen station infrastructure owned and operated by Nikola in the U.S.
 - Multi-billion NOK 1 000 MW electrolyzer and fueling station contract, to be deployed from 2021 – largest electrolyzer contract ever awarded
- Nikola and Nel
 - Nikola producing Fuel Cell Class 8 Trucks at the end of 2022
 - Nikola using Nel technology for 8 tons H₂ / day @ Scale Stations
- Nikola currently has 14,000+ trucks in pre-orders
- Currently developing fueling standard & hardware



Next generation green fertilizer manufacturing plants

Landmark project on green fertilizer initiated

- Project for developing next generation green (renewable) ammonia and fertilizer production supported by the PILOT-E program
- Nel role in project: developing next generation alkaline electrolyzer
 - Tailored for large scale hydrogen production for industrial applications w/direct connection to renewables
 - Development targets: lower unit cost, higher level of flexibility, higher pressure, lower footprint, equal efficiency to current Nel electrolyzers
- Ammonia represents >50% of hydrogen market, currently based on fossil sources – significant market opportunity for electrolysis

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Jon André Løkke, CEO in Nel and Tove Andersen, EVP Production in Yara signing the collaboration agreement. Photo: Yara

Developing fossil free steel production in Sweden using green hydrogen

HYBRIT aims to develop fossil free steel production for the future

- Nel has received a purchase order for a 4.5 megawatt alkaline electrolyzer which will be used in a pilot plant for fossil free steel production
- Hybrit Development AB (HYBRIT) is a joint venture owned equally by SSAB, LKAB and Vattenfall
- The steel industry accounts for 7% of global and 10% of Swedish CO₂-emissions
- Pilot plant will operate in Luleå, Sweden from 2021 – 2024, with target of full-scale implementation by 2035
- Steel market opportunity is potentially 3x the size of ammonia



Source: Hybrit Development AB (HYBRIT) is a joint venture owned equally by SSAB, LKAB and Vattenfall

*Thanks for the ride, dinosaurs!
We'll take it from here.*

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