LARGE SCALE HYDROGEN PRODUCTION

«Renewable Energy and Hydrogen Export»
Trondheim, Norway – March 24th 2015
Henning G. Langås, NEL Hydrogen
• Private Norwegian company, listed on Oslo Stock Exchange
• ~ 25 employees
• Business: water electrolysers
• Worldwide presence with customers in more than 50 countries
• Financials 2014;
  – Revenues 69,3 MNOK
  – EBIT 14,5 MNOK
COMPANY HISTORY

1927
Norsk Hydro started up electrolyser technology for **large scale H₂ production** at its ammonia fertilizer plants in Rjukan, Norway

1974
Commercial sales of water electrolyser commenced in the 1970’s

1993
Spin-off, Norsk Hydro Electrolysers (NHEL) established as a separate and limited company fully owned by Norsk Hydro

2007
Statoil becomes the owner of NHEL as a result of the Statoil-Hydro merger

2011
The company leaves Statoil and has a new ownership, name and logo

2014
NEL Hydrogen listed on Oslo Stock Exchange
ELECTROLYSER IN HISTORICAL CONTEXT

1800’s – 1920’s

COAL GASIFICATION

1920’s – 1960’s

WATER ELECTROLYSIS

1950’s – TODAY

GAS REFORMING

H₂ ECONOMY?

2010 –
REVITALISATION OF GREEN H₂ PRODUCTION
H₂ ECONOMY

H₂ MOBILITY / FUEL FOR TRANSPORT + ENERGY STORAGE / POWER-TO-GAS (PtG)

NEED FOR ELECTROLYSERS
2010: «A portfolio of power-trains for Europe» - fact based analysis

COMPANIES:
BMW, Daimler, Ford, GM, Honda, Hyundai, Kia, Nissan, Renault, Toyota, Volkswagen
ENI, Galp, OMV, Shell, Total
EnBW, Vattenfall
Air Liquide, Air Products, Linde
Intelligent Energy, Powertech
Nordex
ELT, Hydrogenics, NEL Hydrogen, Proton
European Climate Foundation, FCH JU, NOW

Future power trains a combination of ICE*, BEV*, FCEV* and partly PHEV*

Early stages of FCEV; government stimulus required for build-up of infrastructure

25% FCEV by 2050; 800 retail stations in 2020, 5,100 by 2030, 18,200 by 2050

30% on-site electrolyser in 2020, and 15% on-site + 15% central electrolyser by 2050

*ICE = Internal Combustion Engine
*BEV = Battery Electric Vehicles
*FCEV = Fuel Cell Electric Vehicles
*PHEV = Plug-In Hybrid Electrical Vehicle
2015:
«Commercialisation of Energy Storage in Europe» - *fact based analysis*

**COMPANIES:**

Future increase in RES* (2020: 36%, 2030: 45-60%, 2050: > 80%) will required flexibility

Flexibility not solved by traditional solutions, energy storage technologies required

Conversion to H₂ by electrolysis is the only technology enabling full utilization of all excess energy

Positive business case for PtG by 2030, but need to offset H₂ to local industrial consumer for short term solutions

*RES = Renewable Energy System*
POWER-TO-GAS
- UTILISING EXCESS RENEWABLE POWER

Renewable power → Energy → Electrolyser → H₂ → Hydrogen vehicle

Electrolyser also produces H₂ → Industry

H₂ in combination with CO₂ from the power grid undergoes methanisation to produce CH₄ → Natural gas grid

Power grid connects all processes.
KEY CRITERIA’S

• How to enable a business case for PtG and H₂ mobility with focus on water electrolyser technology?

• CHALLENGE?
  – Minimize Capex
  – Long term reliable technology
  – Minimize Opex
HISTORICAL LARGE SCALE PLANTS

Rjukan, Norway; 1927 – 1970’s
Glomfjord, Norway; 1953 – 1991

- Two largest electrolyser plants worldwide
- Capacity: 30 000 Nm³/h each
- Energy consumption: approximately 135 MW each
- Supplied by renewable hydro power
NEW LARGE SCALE PLANTS

Company: Nitol Solar
Industry: Polysilicon
Start-up: 2011
Capacity: 1 940 Nm³/h
Energy: 8,8 MW
Source: Hydro Power

Company: Tokuyama
Industry: Polysilicon
Start-up: 2012 & 2013
Capacity: 2 500 Nm³/h + 3 000 Nm³/h
Energy: Total 25 MW
Source: Hydro Power
250 kW PLANT (50 Nm³/hr)

- Typical size for demo-projects
- CAPEX: ~€ 500 000
- ~€ 2 000 / kW
2,2 MW PLANT (485 Nm³/hr)

- One large electrolyser unit
- CAPEX: ~€ 1 500 000
- ~€ 680 / kW
10 MW PLANT (2,250 Nm³/hr)

- 5 large electrolyser units
- CAPEX: ~€ 5,500,000
- ~€ 550 / kW
50 MW PLANT (10 800 Nm$^3$/hr)

- 24 large electrolyser units
- Set up as 6 separate production lines
- CAPEX: ~€ 25 000 000
- ~€ 500 / kW
CAPEX SUMMARY

• Today’s demo-projects not representative
• A need to go large scale to reduce CAPEX
• Reduction to about 1/4 of initial CAPEX
• Not much to gain on going from 10 to 50 MW (but somewhat untapped potential?)
COST; OPEX

1. Get right technology!
   - Stable operation
   - No shut-downs
   - Minimum maintenance
   - Long lifetime (cell stack & plant)

2. Focus on energy efficiency
   - If technology is right; energy cost is > 90% of OPEX
KEY FOR SUCCESS:
1. Go large
2. Reliability & efficiency
THANK YOU!