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New Hydrogen Facilities

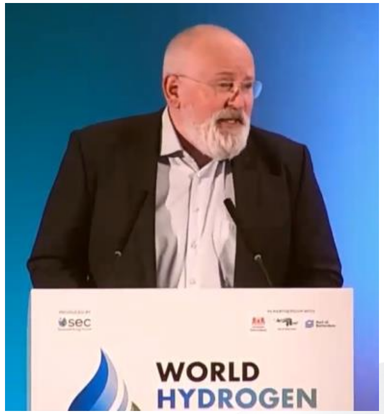
Building Hydrogen Infrastructure Symposium 2022

Introduction and Overview

- Why new hydrogen facilities?
- Hydrogen production technology
- Hydrogen production balance of system
- New facilities – market applications

Why new hydrogen facilities

"As a key technology to ***wean ourselves off Russian gas and oil***, ***hydrogen has become part of the answer*** to help Europe and the world to gain freedom in the true sense of the word. Hydrogen is an ***essential part of Europe's future energy sovereignty***."



Frans Timmermans
Executive Vice-President
European Commission

"Europe ***will continue banking on hydrogen***, and especially green hydrogen, as a ***clear part of our clean future***."

✓Decarbonisation

- Hard to abate sectors – i.e. not able to be readily electrified
- Provides opportunity to export/import green energy – chemical vector, compared to electrons

✓Energy security

- Europe agenda - REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition (18 May 2022)

✓Solve the "trilemma"

- Dilemma of climate change has become a trilemma

"Combination of the impact on the ***environment***, but also the ***security of supply*** of energy, and the ***affordability*** of that energy are never far away… thinking about how to solve that is going to be really critical."

Paul Bogers
Vice President – Hydrogen
Shell

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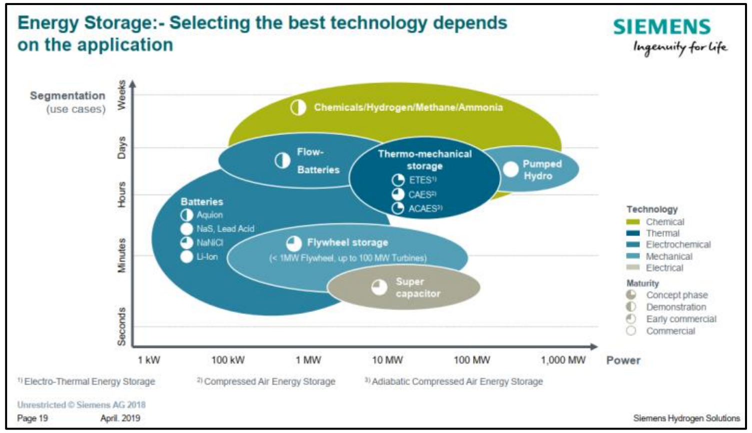
Why hydrogen



- Electrons can't "do it all"
- Hydrogen is the Swiss army knife.... Can fill the gaps where electrons can't
  - Shell examples: Steelmakers (DRI), data centres (24/7 renewable, replace diesel gen), aviation
- Generation + distribution + storage = reliable and affordable supply
  - Each country, each region, each town, each application is unique
  - The best (reliable and affordable) solution for a "decarbonised" energy system will be different from one location to the next

"It is truly a very ***versatile way of decarbonisation***; it can reach all of those parts of ***the energy system*** that are very ***hard to electrify***. Where that line is remains an open question."

Paul Bogers
Vice President – Hydrogen
Shell

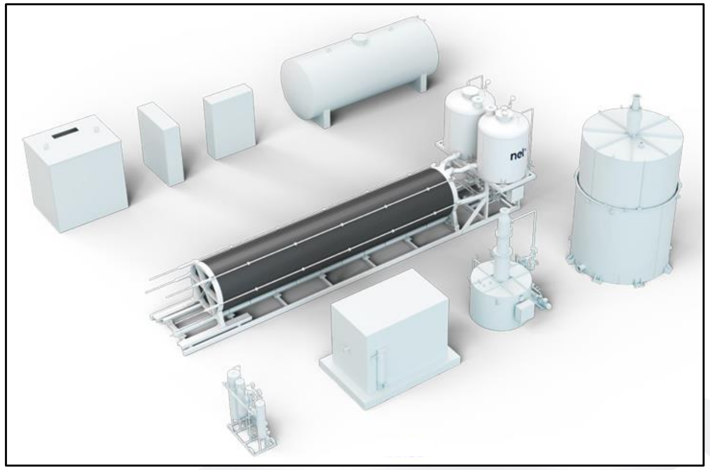
Hydrogen production technology

- Hydrogen from hydrocarbons (>95% current H_2 production)
  - Steam methane reforming (~68%)
  - Coal gasification (~29%)
- Pro:
  - Most cost-effective approach available today
- Con:
  - Associated GHG emissions
- Future:
  - Will require CCUS

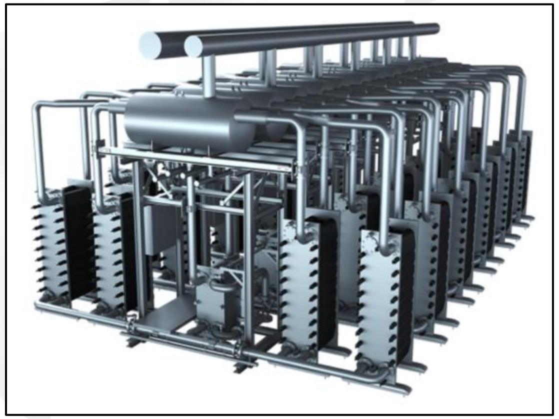
Hydrogen production technology

- Water electrolysis
  - Alkaline (established technology, lowest cost)
  - PEM (proton exchange, small scale has been established, technology scale up, higher cost)
  - SOE (solid oxide, developing technology)

	Alkaline	PEM	SOE
Maturity			
Cost (CAPEX)			
Cost (lifecycle)			
Operational range			
Responsiveness			
Overall efficiency (variable demand)			
Overall efficiency (steady demand)			



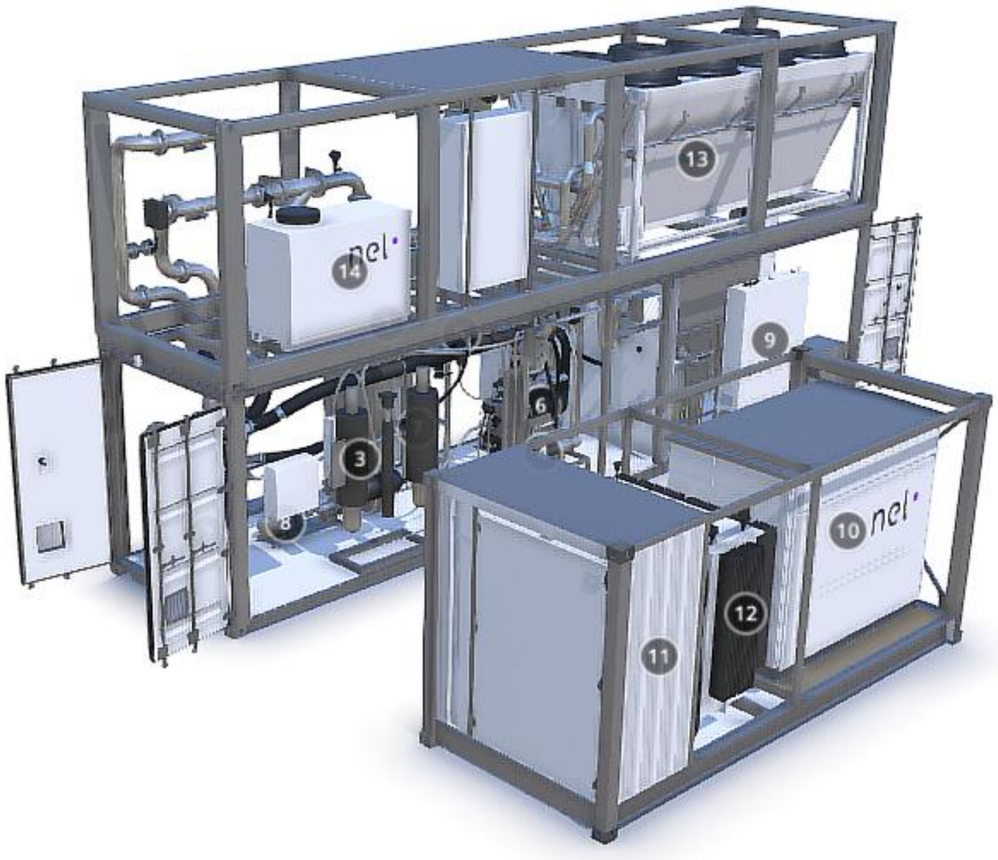
NEL A485.
(https://nelhydrogen.com/wp-content/uploads/2020/03/Electrolysers-Brochure-Rev-D.pdf)



Siemens Energy Silyzer 300.
(https://assets.siemens-energy.com/siemens/assets/api/uuid:a193b68f-7ab4-4536-abe2-c23e01d0b526/datasheet-silyzer300.pdf)

Hydrogen production balance of system

- Containerised (up to ~5 MW / 2 tpd)
  - Includes core systems (e.g. water treatment, cooling, purification)
  - Minimal balance of system (e.g. power supply, potable water supply, compressed air, nitrogen)
  - Purified H2 output



NEL MC250. 1.25 MW / 531 kg/d. (https://nelhydrogen.com/resources/m-series-containerized-pem-electrolysers/)

Hydrogen production balance of system

- Integrated production facility (20 MW+ / 8 tpd+)
    - Electrolyser, housed in an enclosure building
    - LP compression**
    - Cooling water system
    - H2 purification (deoxo/dryer)
    - HP compression and storage**
    - HV power supply
    - BESS**
    - Water treatment**
    - Utilities (instrument air, nitrogen)
    - LV electrical, controls and communication

**To suit project / OEM requirements

New facilities – market applications

- Gas blending
- Hard to abate industrial sectors
  - steel making
  - fertiliser production (ammonia)
  - cement
  - chemical processes with H2 feedstock
- Mobility
  - Heavy transport (displace diesel)
  - Logistics (high utilisation requirement, minimise payload)
  - Marine transport (ammonia)

"***1.5 GW*** of electrolysis would be required for Port Kembla ***steelworks***"

Chris Page
Head of Future Technologies
BlueScope

thyssenkrupp Steel Europe AG
H2 demand for ***steel DRI*** conversion
0.24 MT H2 in 2030 (***1.6 GW*** PEM)
0.7 MT H2 in 2045 (***4.7 GW*** PEM)

90 MT **grey H2 currently produced** globally each year
(***600 GW*** PEM)

200 MT ***NH3 currently produced*** globally each year
(35 MT H2, ***230 GW*** PEM)

"To convert Trafigura's existing marine diesel bunkering requirements to ***green ammonia*** would require 25 MT/annum ammonia"

Tim Rogers
General Manager Australia
Trafigura

"***Heavy transport*** (including marine) and ***ammonia*** for power generation are key markets for Woodside"

Arnout van Lent
Head of New Energy, Asia-Pacific
Woodside

50% of ***trucks in Europe*** running on H2 would require 10 MT each year
(***67 GW*** PEM)

1 Mtpa H2 = 2,700 tpd = 6,700 MW (H2 PEM electrolysis) = 380 TJ/d
0.176 t(H2) per 1 t(NH3)

Thanks for listening