Batterier og hydrogen

Teknologi for nullutslipp i transport

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Innhold

- Batteri- og hydrogenteknologi (*key technology*)
  - Materialer
  - Nøkkelkomponenter
  - Systemer

- Teknologiytelser (*key performance*)
  - Energitetthet
  - Ladetider
  - Levetid

Institutt for energiteknikk

Energy & Environment

Man & Technology

Material Technology

Nuclear Power & Safety

Nuclear Technology & Health

Oil & Gas

IFE – Energi & Miljø

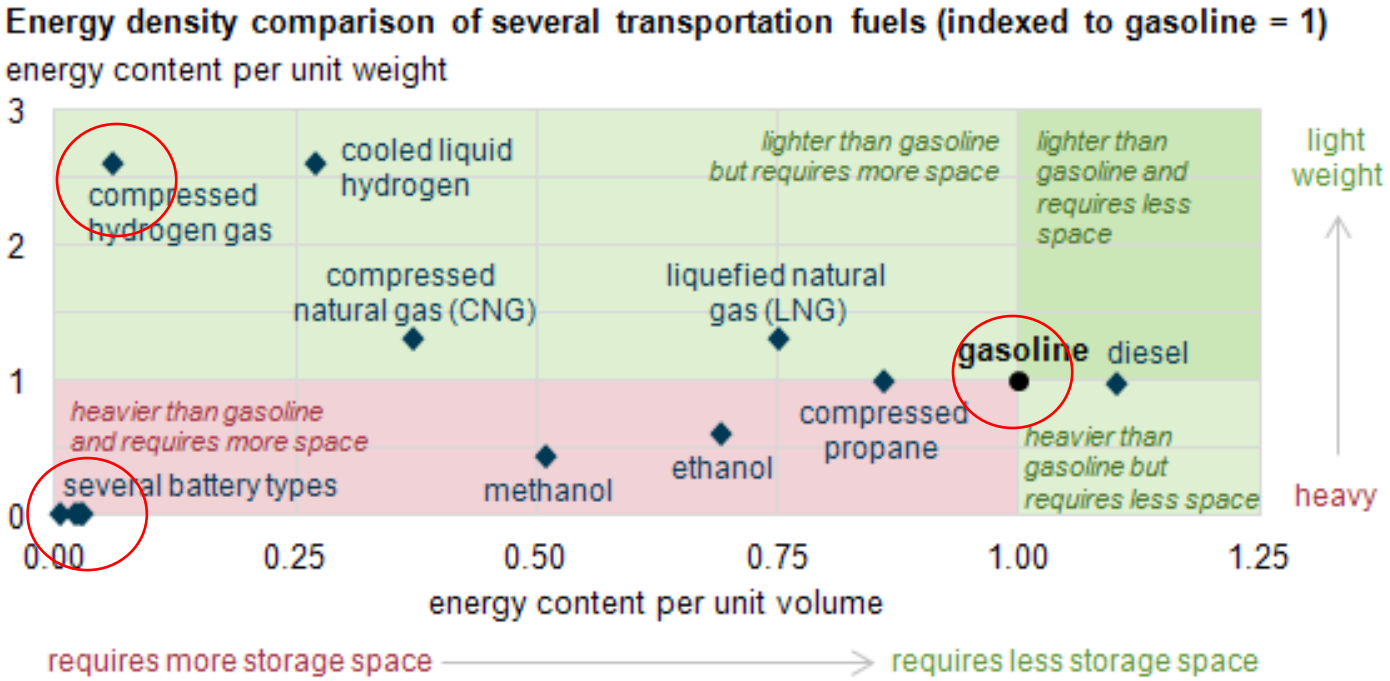
- Solcelleteknologi
- Vind
- Geotermi
- **Batterier**
- **Hydrogen**
- Miljøkjemi/ miljøovervåkning
- Silisiumteknologi
- Materialprosesser
- Industriprosesser
- Smarte energisystemer

- FME sentere
  - Solenergi
  - **Nullutslippstransport**

FME FORSKNINGS-SENTER FOR MILJØVENNLIG ENERGI

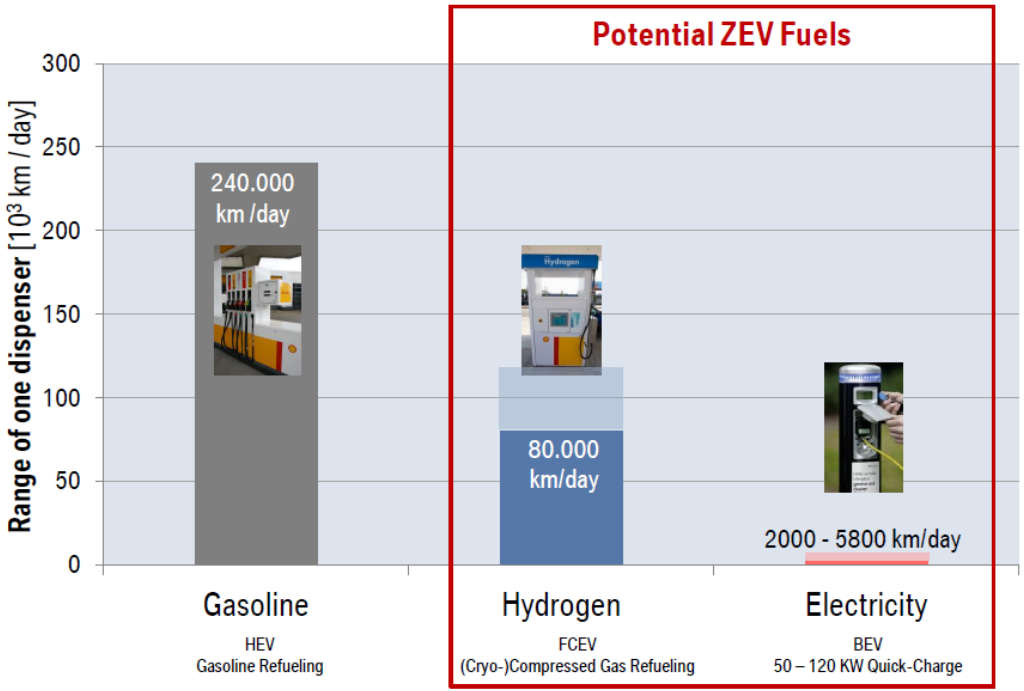
MOZEES Mobility Zero Emission Energy Systems

Energilagring – Volum og vekt



Kilde: U.S. Department of Energy

Energioverføring til kjøretøyer



Kilde: BMW (2013)

Energilagring & Energioverføring

Batteries (Li-ion)

3 MWh

60 000 kg
40’ container

460 battery modules

1-hour charging:
*1 C → **3 MW***

Hydrogen (250 bar)

20 MWh

6 000 kg
40’ container

4 × 12 m H_2-tanks

Fuel Cell (PEM)

1 MW

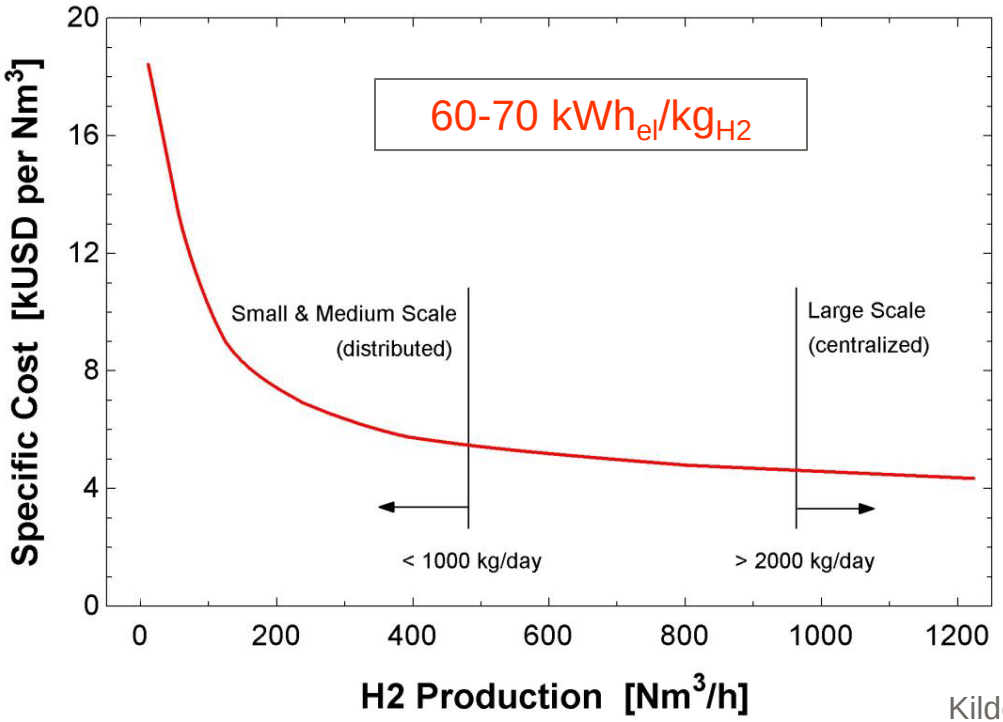
3 600 kg
10’

1-hour charging:
150 kg/h per H_2-tank
*→ **20 MW***

Hydrogenproduksjon – Vannelektrolyse

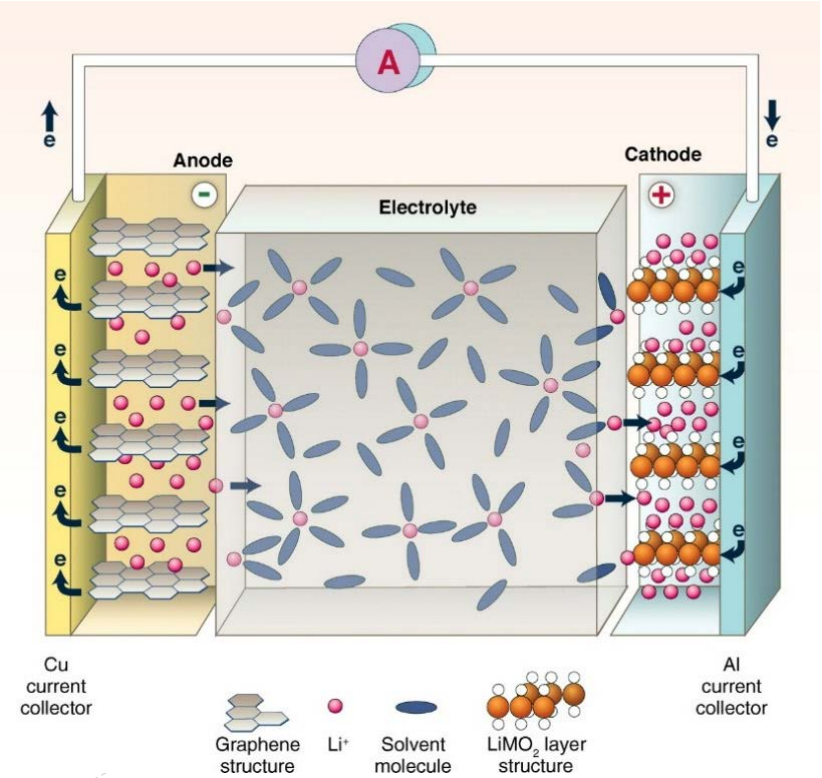
Hydrogenics

NEL Hydrogen



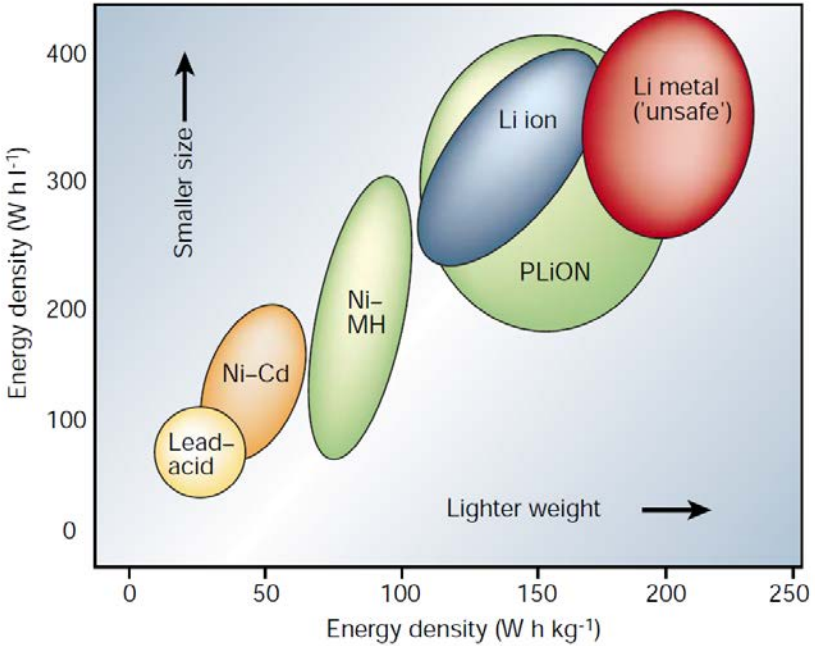
Kilde: IFE

Li-ion batterier – Energitetthet



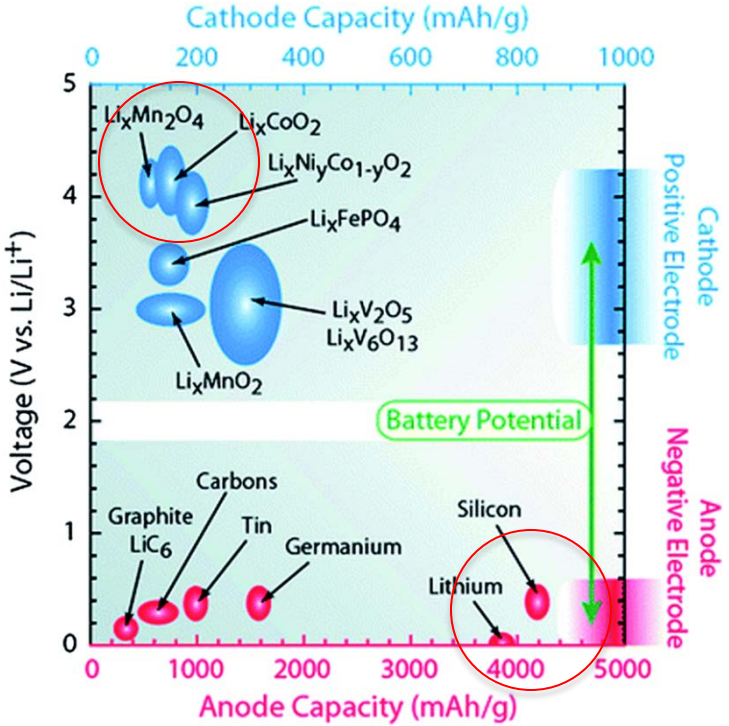
Kilde: Dunn *etal* (2011), *Science*

$$Li^+ + e^- \rightleftharpoons Li \quad (E^0 = -3.045\ V)$$



Kilde: Tarascon and Armand (2001), *Nature*

Li-ion batterier – Nye materialer



- LMO-baserte katoder
  → høy spenning

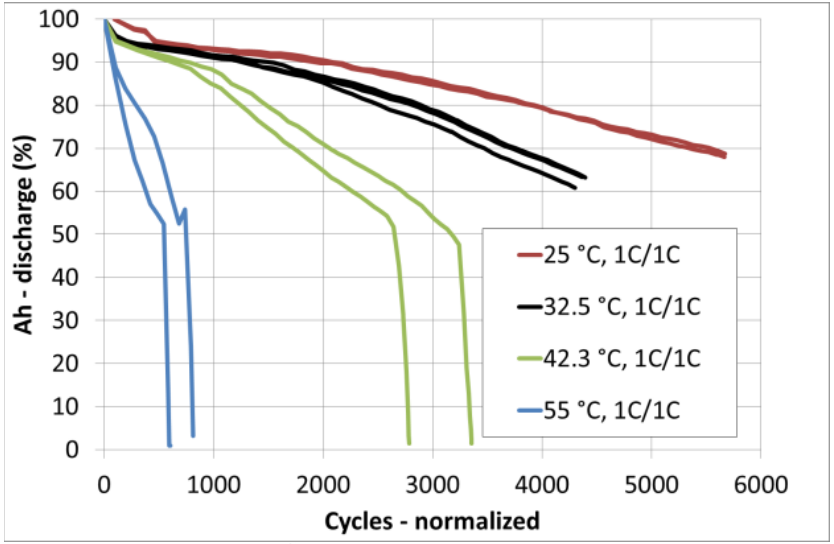
- Si-baserte anoder
  → høy energitettthet

Kilde: *J. Mater. Chem. A* (2014)

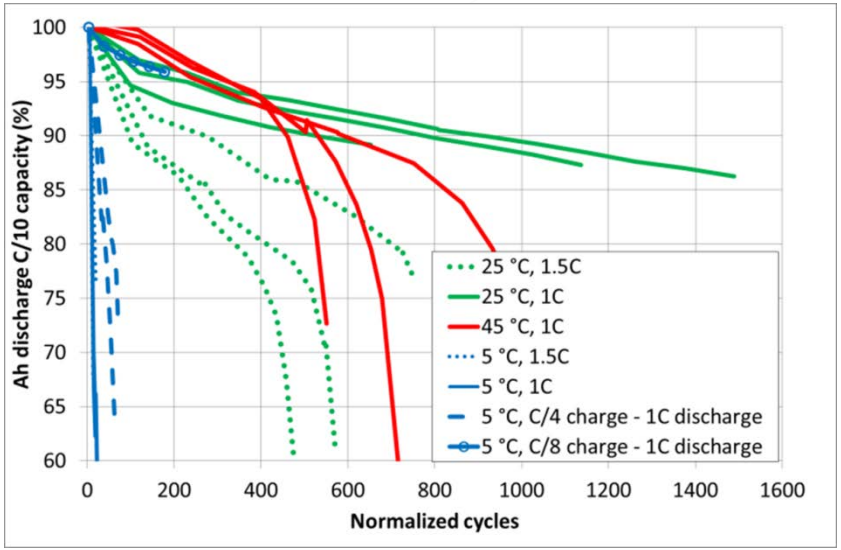
IFE – Laboratorier for batteritesting

- Battery life testing & characterization
- Li-ion battery ageing
- Li-ion accelerated battery life testing
- Post-mortem of cells
- *In-situ* techniques (thermal characterization)

Li-ion batterier – Ytelse & driftstemperatur



NMC pouch cell – type 1



NMC pouch cell – type 2

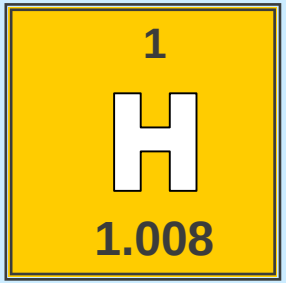
Hydrogen

- Hydrogen er en gass ved standard atmosfære
- 1 elektron + 1 proton

- Ikke-giftig (fargeløs, ingen lukt eller smak)
- Brennbar (usynlig flamme)

- Lav volumetrisk tetthet (lettere enn luft)
- Høy gravimetrisk tetthet (3 × bensin)
- Kokepunkt: -253˚C

- Reaksjon: $H_2 + ½\ O_2 = H_2O$



1 m³ = 90 gram

@STP

PEM-brenselceller

- Proton Exchange Membrane
- Temperature: 60-70°C
- Hydrogen quality: 99.995% H_2
- Electrical efficiency: 45-55%

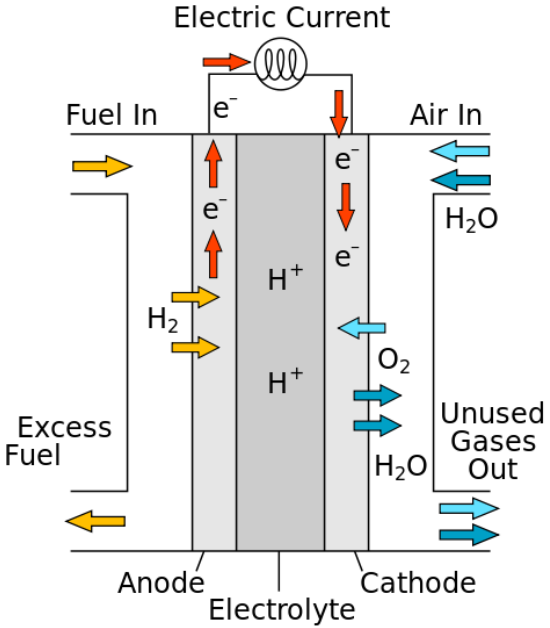
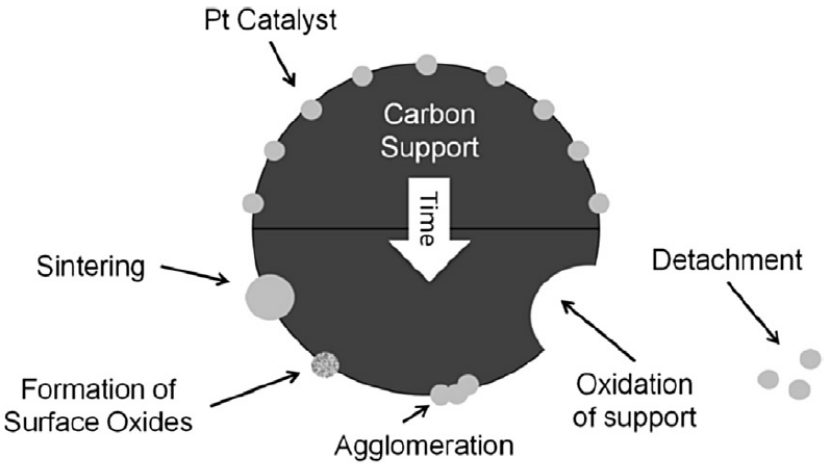


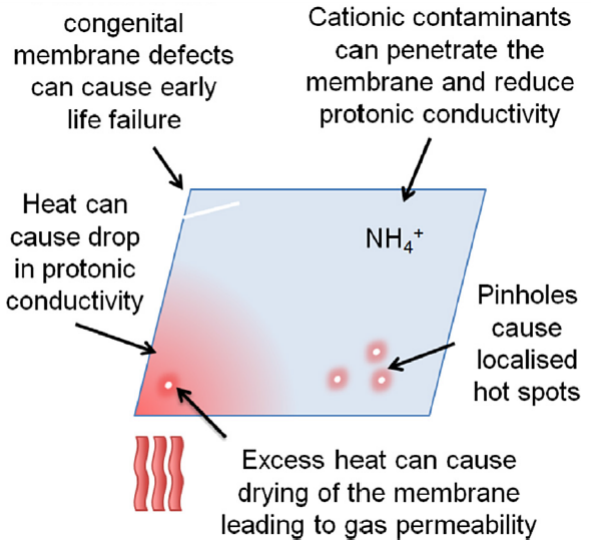
Illustration:Wikipedia

PEM-brenselceller – Levetid

- Catalyst degradation

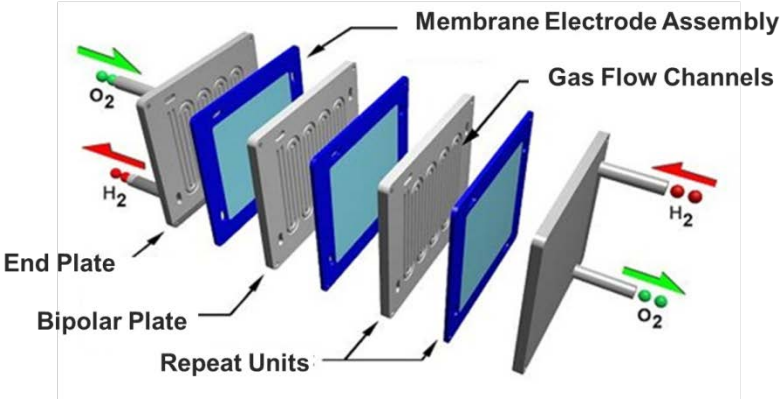


- Membrane degradation

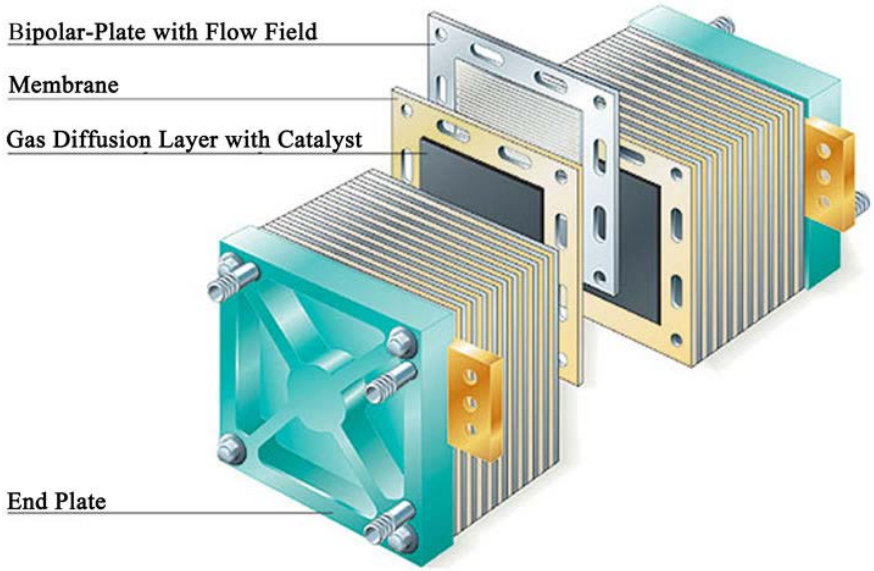


Kilde: Tom Fletcher *etal* (2016), *Int'l. J. of Hydrogen Energy*

PEM-brenselcellestacks



Kilde: FCR Group



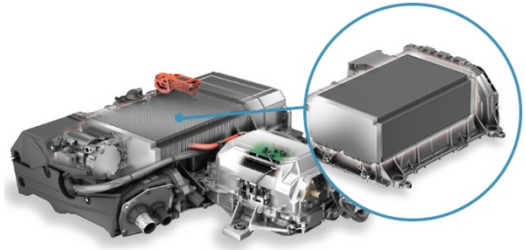
Kilde: Scientific Research

PEM-brenselcellemoduler

Supplier	FC Stack (Model)	Power Capacity (kW)	Power Density (kW/kg)	Power Density (kW/L)	Comment
Ballard	HD7	150	0.37	0.23	FC module for HD transport
Hydrogenics	HyPM HD180	198	0.42	0.24	FC module for HD transport
Toyota	Mirai	114	2.0	3.1	FC stack for FCEVs

Hydrogenics

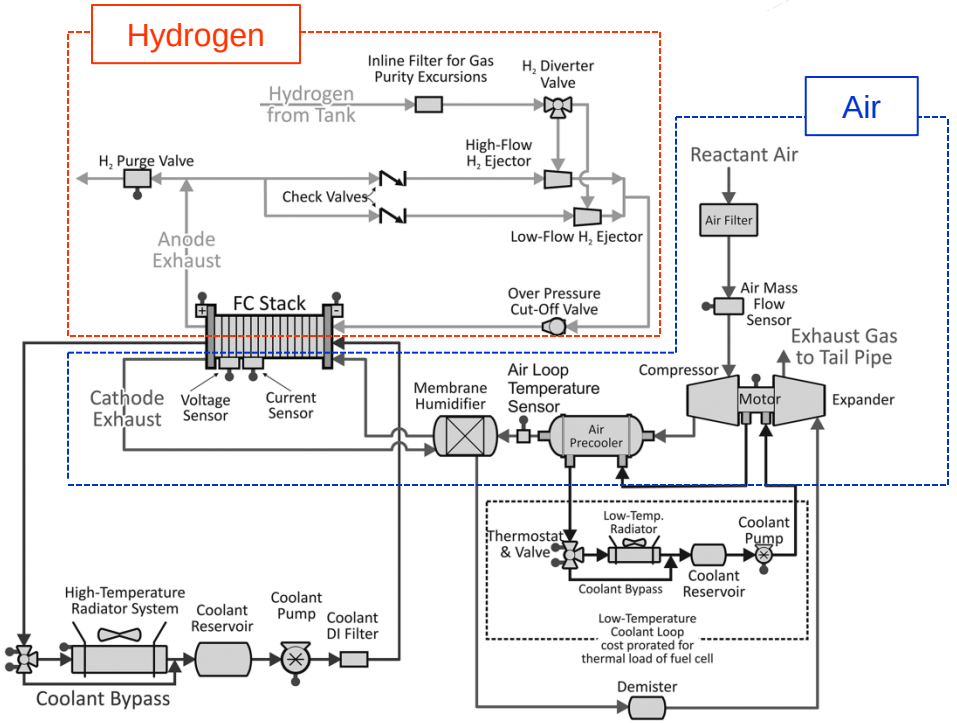
Ballard



Toyota

PEM-brenselcellesystemer

- Fuel cell stack
- Hydrogen recirculation pump
- Air Compressor
- Air Humidifier
- Cooling systems
- Boost converter
- Batteries
- Power controls system



Kilde: James B.D. *etal* (2014) *Journal of Manufacturing Science and Engineering*

Hynor Hydrogen Technology Center

NORWEGIAN FUEL CELL AND HYDROGEN CENTRE
FUEL CELL & ELECTROLYSER SYSTEMS

New Research Infrastructure (2016 –)

- Hybrid Fuel Cell / Battery testing system
- Water electrolyzer testing system
- Gas supply and monitoring system




New Key Projects (2017 –)

MOZEES
Mobility Zero Emission Energy Systems

METROLOGY for HYDROGEN VEHICLES
EMPIR MetroHyVe-project

MoZEES
Applied Research on Battery & Hydrogen Systems

1. Advanced fuel cell control systems
2. Battery cell lifetime, durability, and safety
3. Battery and hydrogen system safety
4. Novel efficient low temperature water electrolysis processes
5. Design specifications for selected applications (case studies)

MoZEES
Mobility Zero Emission Energy Systems

www.mozees.no

MOZEES

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