

van hool | Fuel Cell

**Fuel cell Electric Bus :
It works and it's ready !**



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FUEL CELL ELECTRIC BUS : IT WORK'S AND IT IS READY



Key facts :

141 fuel cell buses sold

**10 million driven kilometers
in several projects**

**Follow-on orders of main
customers**

QBuzz Groningen 2 (2017)+ 30 (2020)

RVK Cologne 2 (2014)+ 35 (2019)



Why do customers choose fuel buses ? :

1. Autonomy

Battery Bus 400 kWh

versus

Fuel cell bus with 600 kWh usable energy

x 1,5

2. Time to charge

Battery Bus 1 hour@400kW or 5 hours@80kW

versus

Fuel cell bus in 8 to 10 minutes

x 6/ x 30

3. Operational flexibility

Depot & charging station centralised at one location.

100% flexibility on the road.



Picture : fuel cell bus in Versailles

FUEL CELL ELECTRIC BUS : HOW IT WORKS

Hydrogen

5 containers with 38 kg of hydrogen at 350 bar.

Fuel cell

Fuel cell stack 85 kW.
Electricity produced on board of the bus.

Traction battery

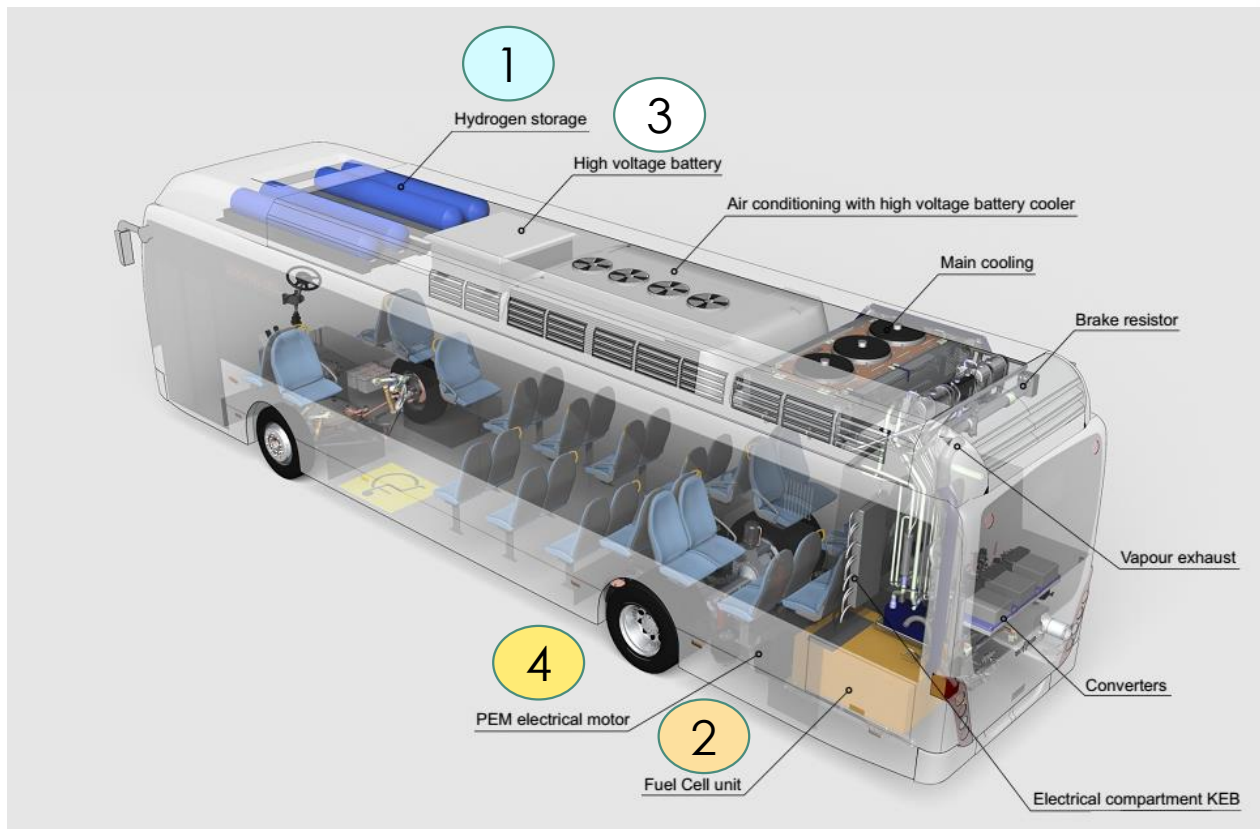
Hybrid buffer

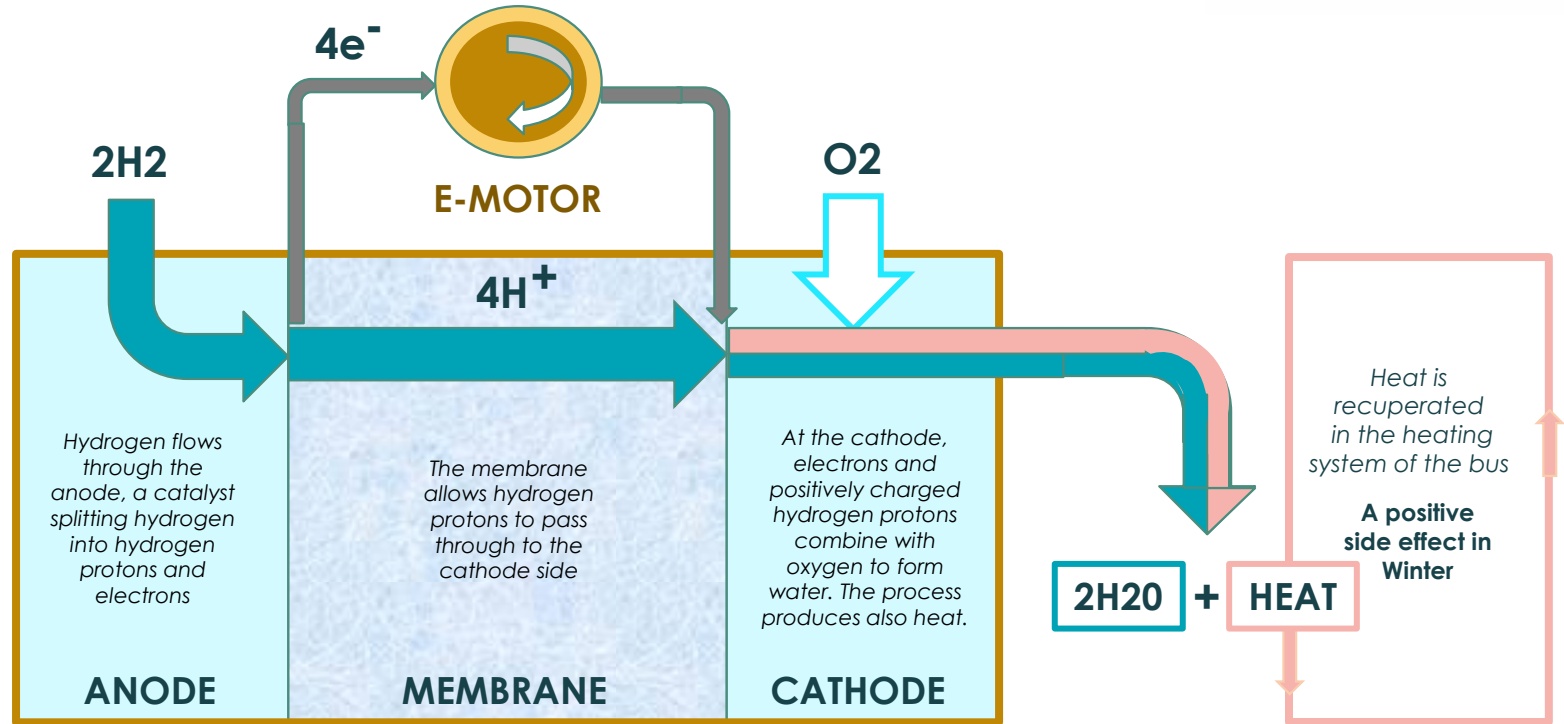
in the electrical system :

- Providing extra energy while accelerating, climbing,...
- Recuperating energy while braking, driving downhill,...

E-Motor

Electric engine powers the bus.





THE FUEL CELL (the chemical factory inside the bus)

Reason #4 why customers choose fuel cell buses :

Battery electric bus :

Assumptions :

400 kWh battery

90% of battery usable or 360 kWh

Traction + Aux : 1 kWh/km

Average speed : 20 km/h

Heating : 10 kW * 16 hours = 160 kWh
(assume no additional heating with biofuel)

RANGE : 200 km

(200km * 1 kWh/km + 10 kW * 16h)

Fuel Cell bus :

Assumptions :

38 kg hydrogen or 1200 kWh

50% usable for traction or 600 kWh

Traction + Aux : 1 kWh/km

Average speed : 20 km/h

Heating : 10 kW * 16 hours = 160 kWh
15% usable for heating or 180 kWh

RANGE : 600 km

(600km * 1 kWh/km + "heating for free")



FUELING OF A FUEL CELL BUS

Standardised H2 receptacle



Standardised charging protocol

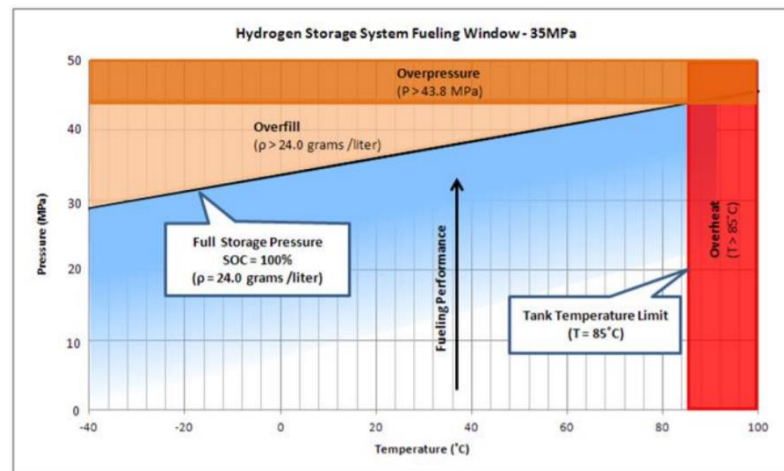


Figure 3 SAE J2601-2 temperature and pressure limitations

While charging the temperature and pressure are controlled simultaneously at the bus and at the tankstation. The flow rate of hydrogen is optimised in relation to these parameters (T,P)

FUEL CELL ELECTRIC BUS : LARGE SCALE PRODUCTION

Production rate : 2,5 FC buses/week
Ready to boost production rate



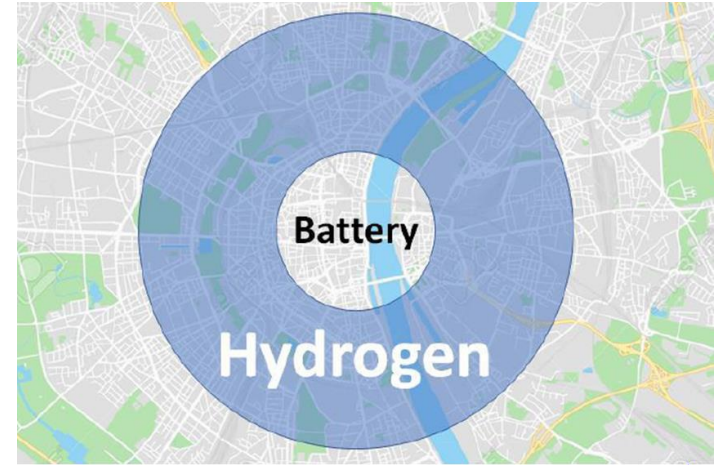
The future will be multi modal :

Deployment of multi-mode zero emission bus fleets :

- Battery if less than 200 km autonomy required
- Hydrogen if range or flexibility is needed

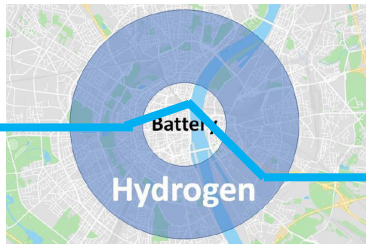
Trend for hydrogen buses :

- Low entry (sub-urban traffic)
- Articulated buses



Hydrogen will become a solution for flexible BRT systems:

- Project Pau, France
- In service since dec. 2019
- 8 articulated Tramlook buses
- No catenary wiring, no rails.
- + 300 km autonomy per day





Q&A



Thank you for your attention

*During this 10 minute presentation
one fuel cell bus has been refuelled !*