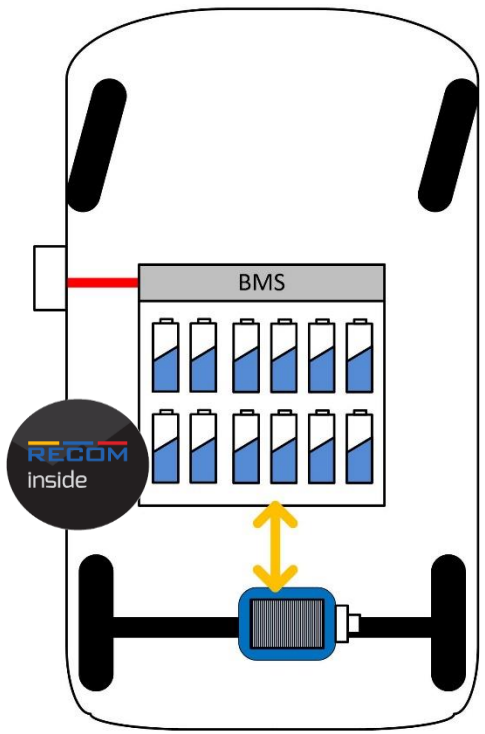
Rutronik TechTalk Future Mobility

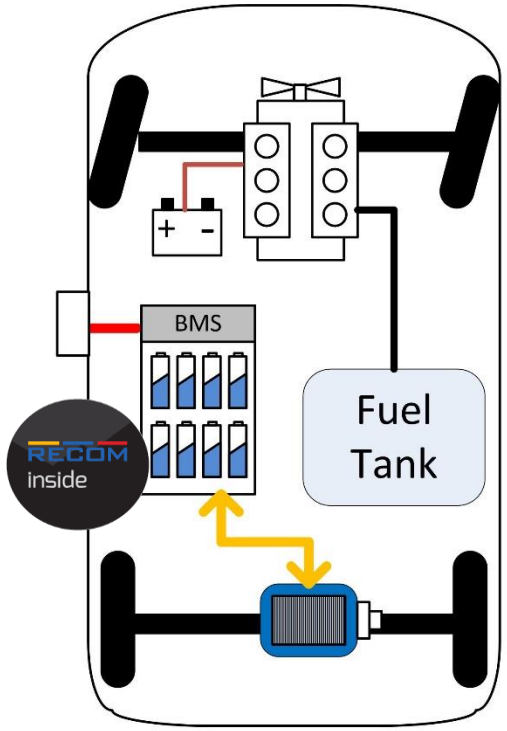
Not all EV‘s Need a Plug!

Many think that electric vehicles need a plug – but this is not always the case!

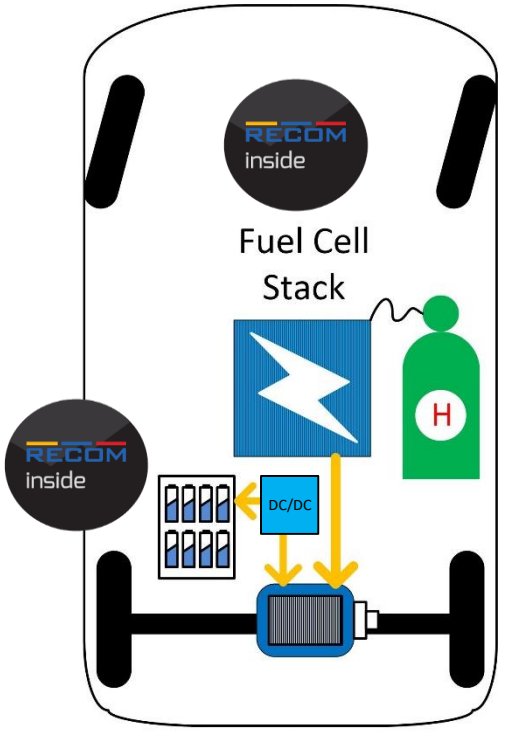
Types of Electric Vehicle



BEV



PHEV



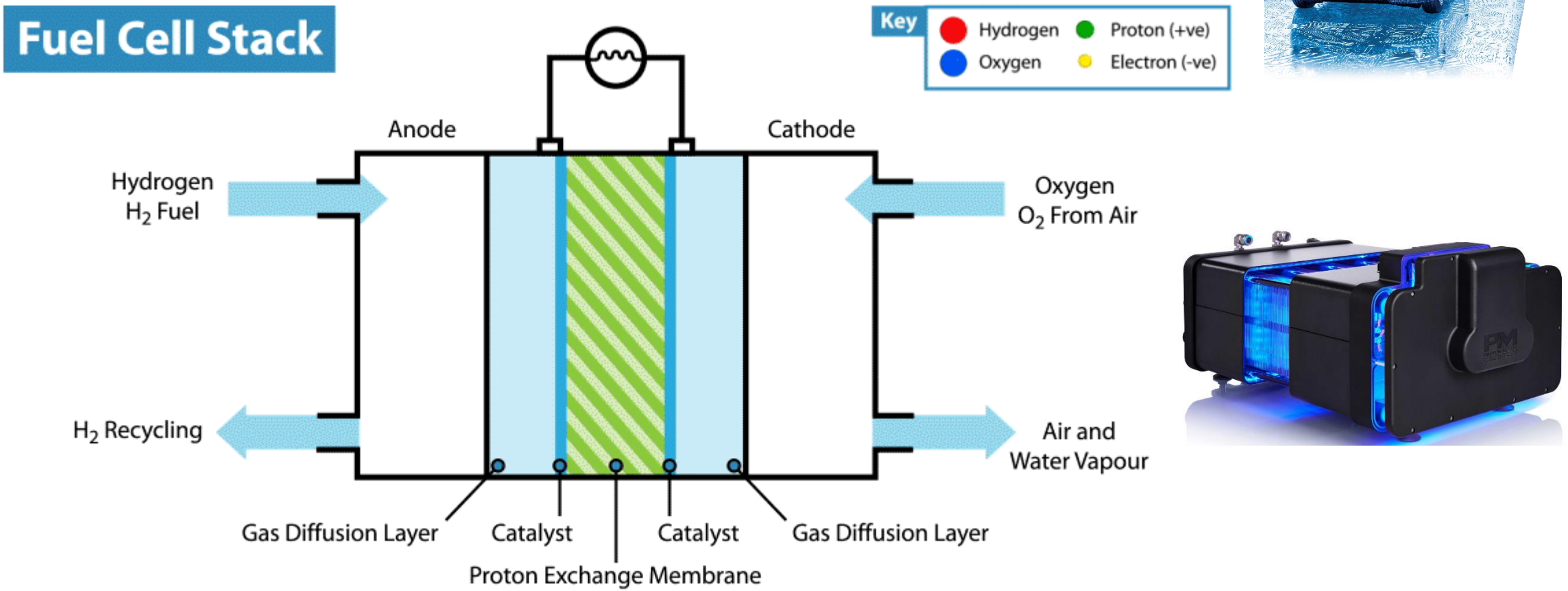
FCEV

Battery Electric Vehicle (**BEV**)

Plug-in Hybrid Electric Vehicle (**PHEV**)

Fuel Cell Electric Vehicle (**FCEV**)

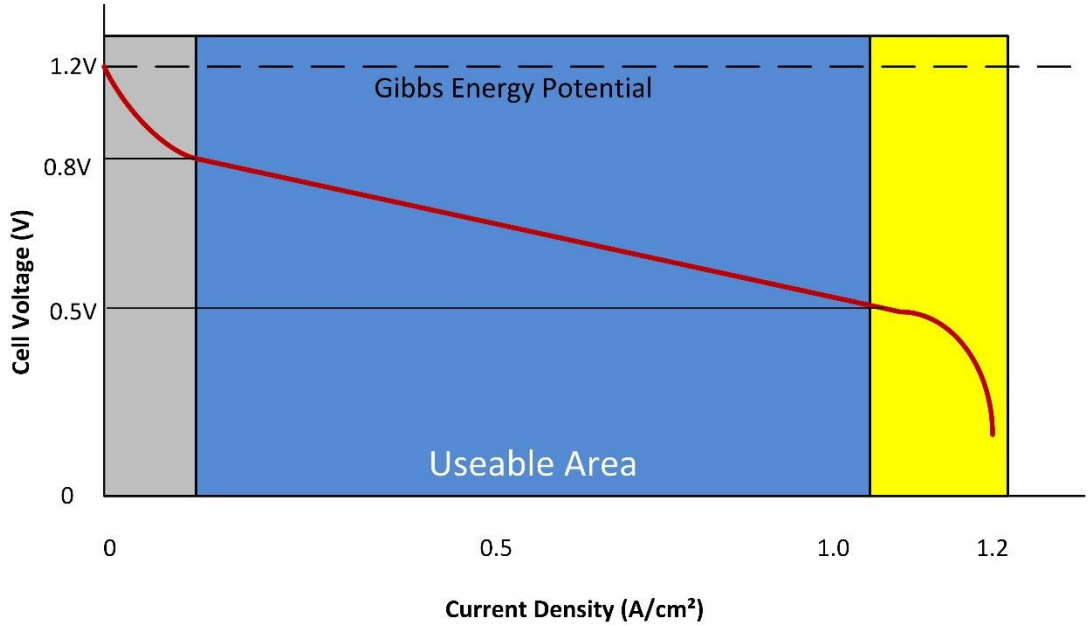
How a Fuel Cell Works



Source: https://www.intelligent-energy.com/static/img/animations/fuel_cell_stack.gif

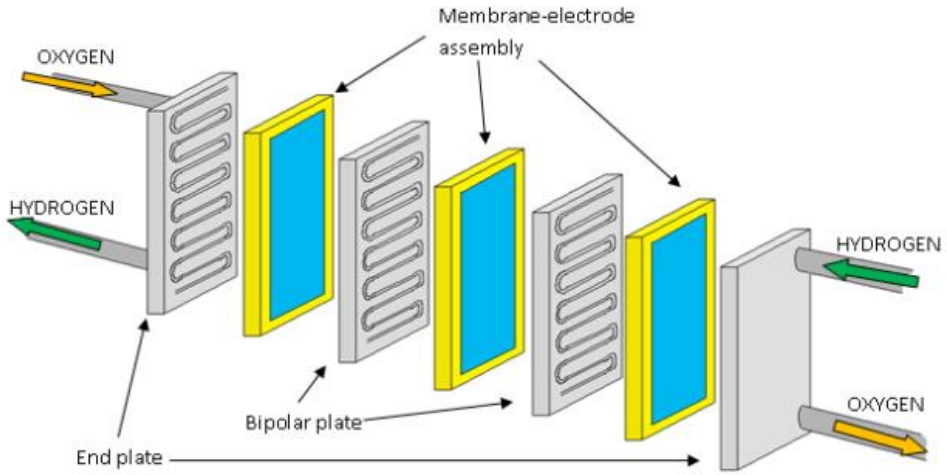
How a Fuel Cell Works

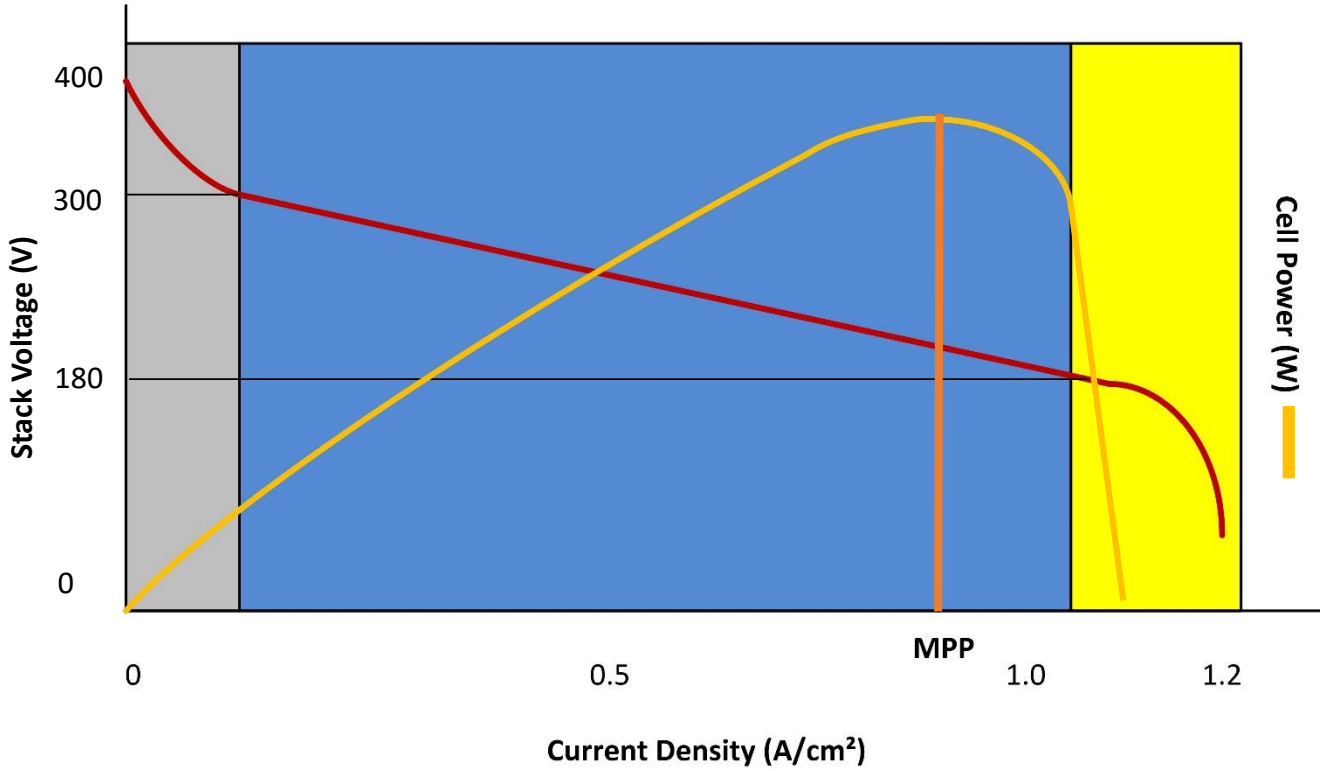
Each cell generates a loaded voltage of 0.8 - 0.5V at a current that is proportional to the area of the cell.
The maximum open circuit voltage is 1.22V (the Gibbs Energy Potential), but this voltage is reduced if air is used instead of pure oxygen and also by the Cathode Activation Potential:



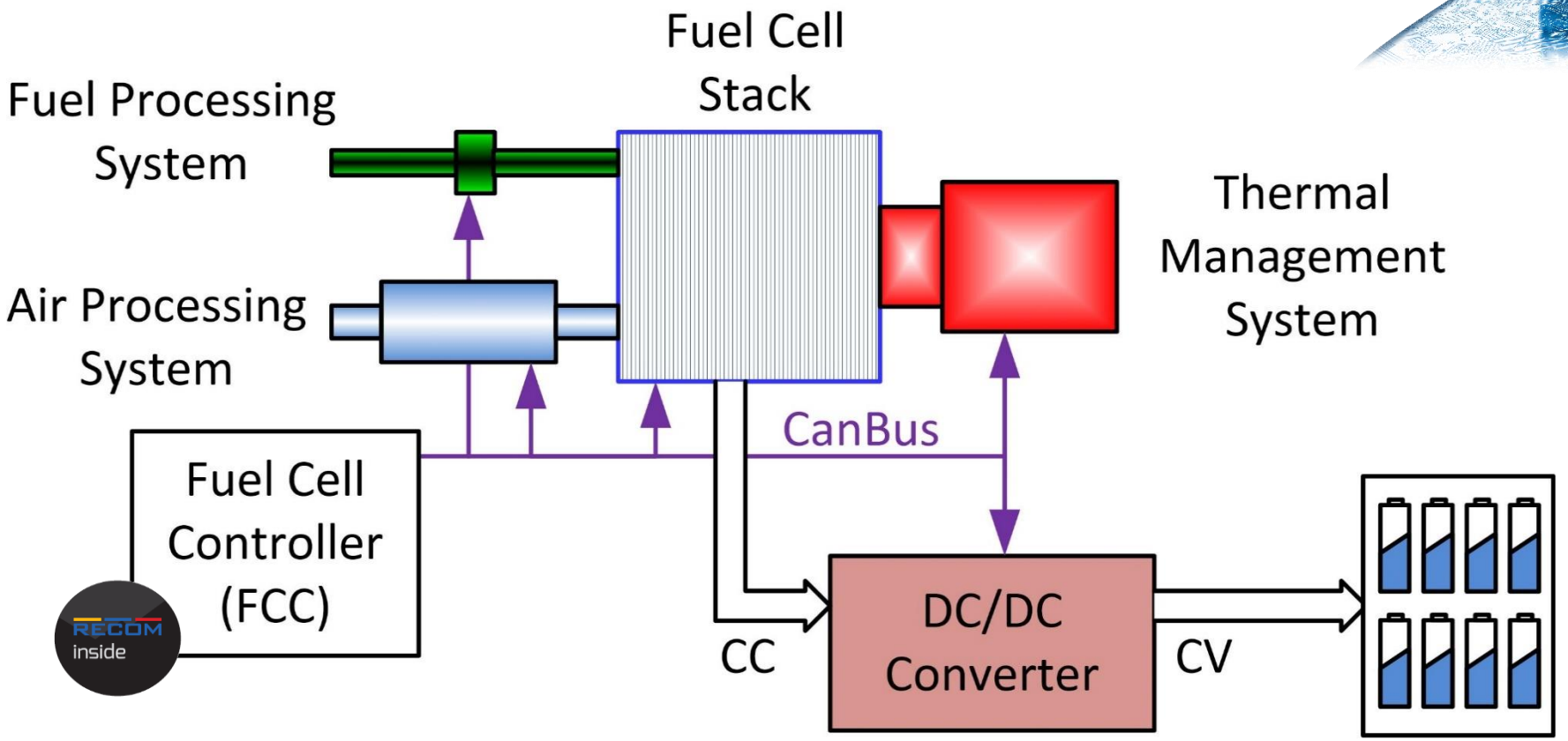
How a Fuel Cell Works

To get a useful amount of power, the individual cells are placed in series to make a stack. The thicker the stack, the higher the output voltage.
The larger the stack area, the higher the output current.
Each stack has a maximum power point (MPP) dependent on load, gas throughput and temperature.



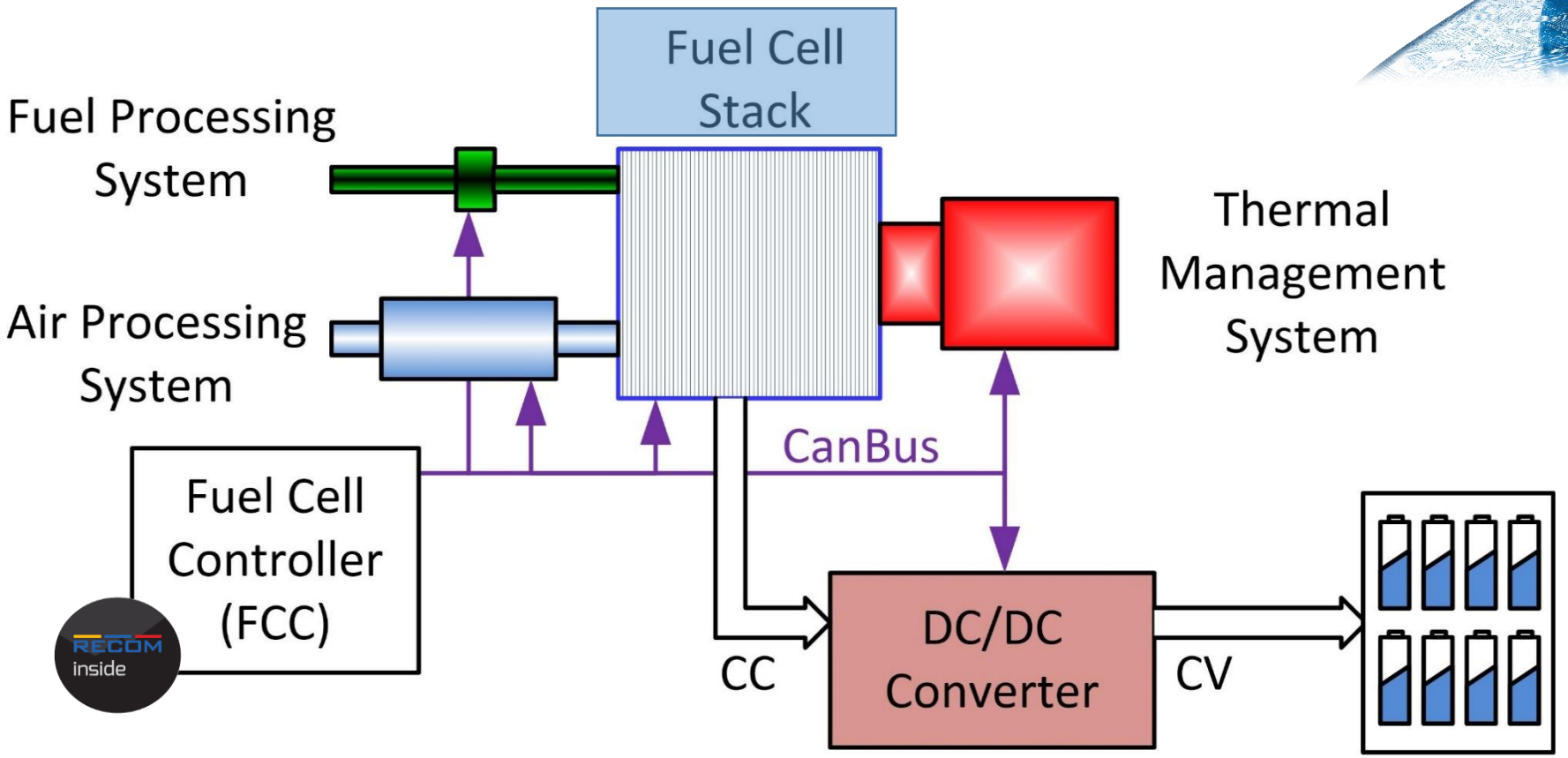


Fuel Cell System



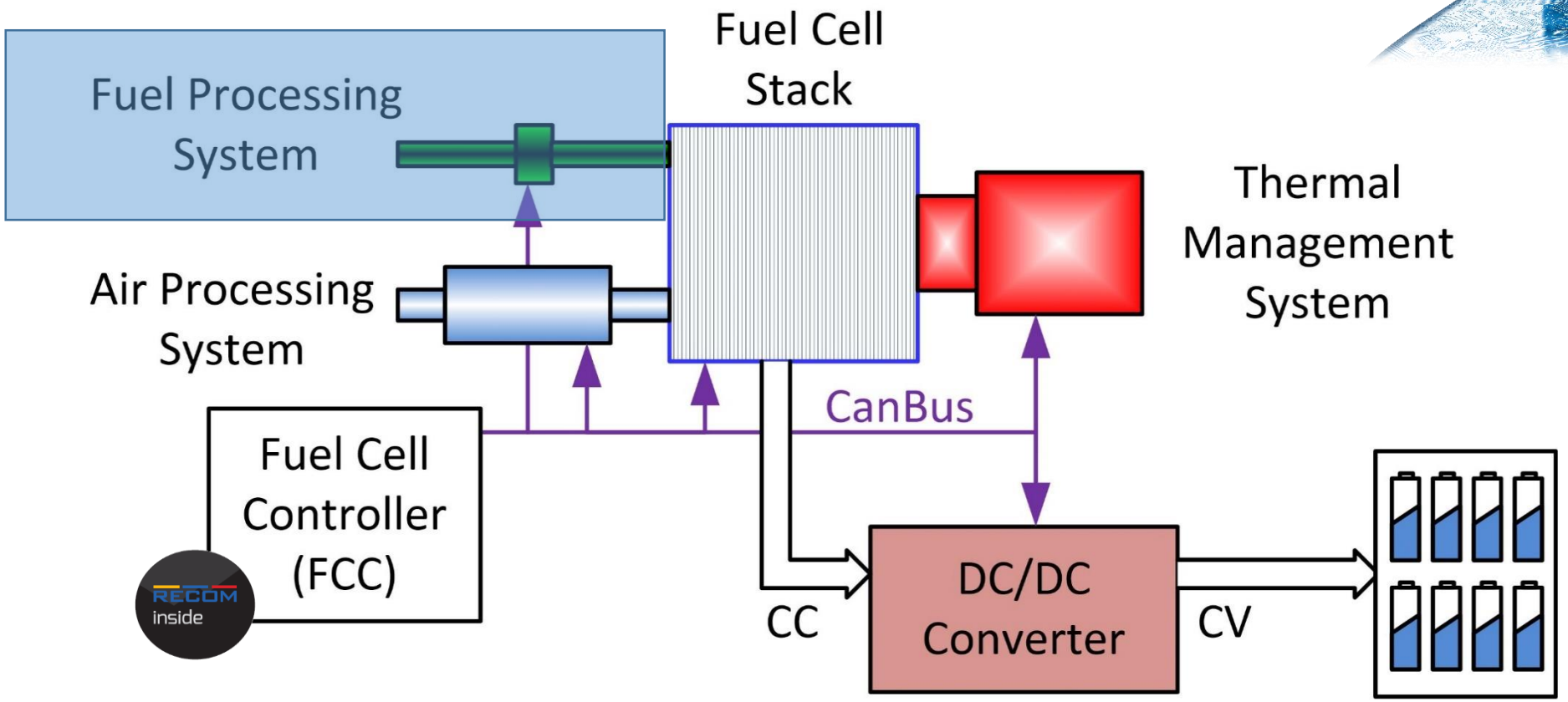
Fuel Cell System

Core device that combines hydrogen and oxygen to create electricity

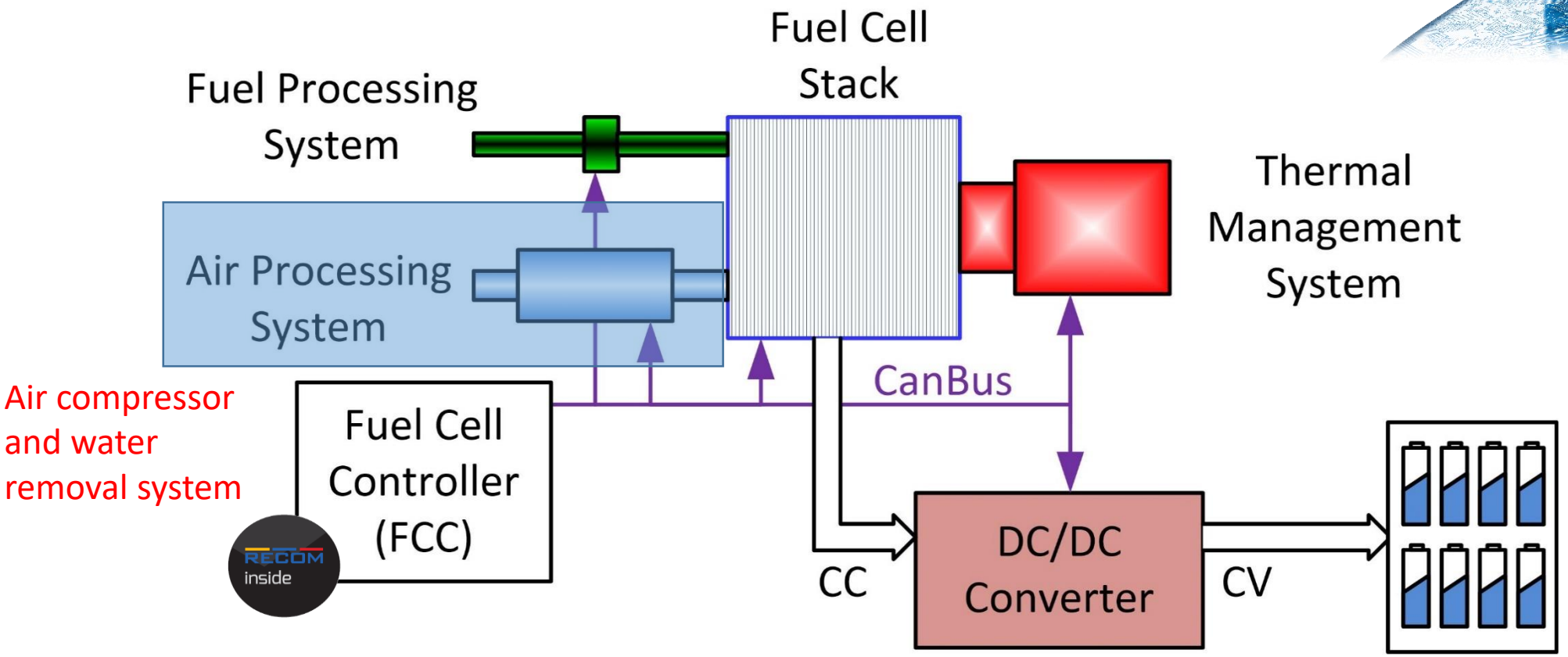


Fuel Cell System

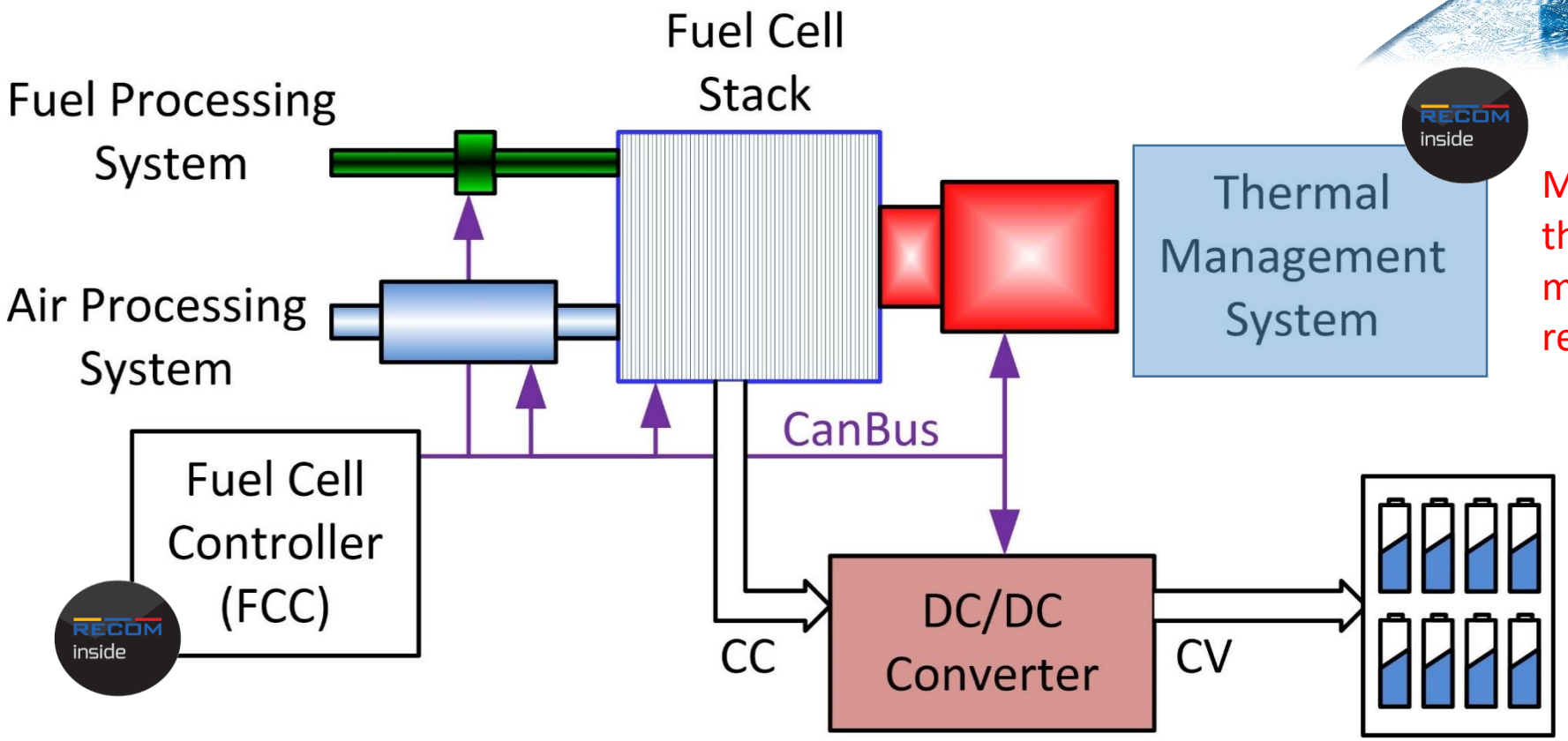
Regulates gas pressure and recirculates unused fuel



Fuel Cell System

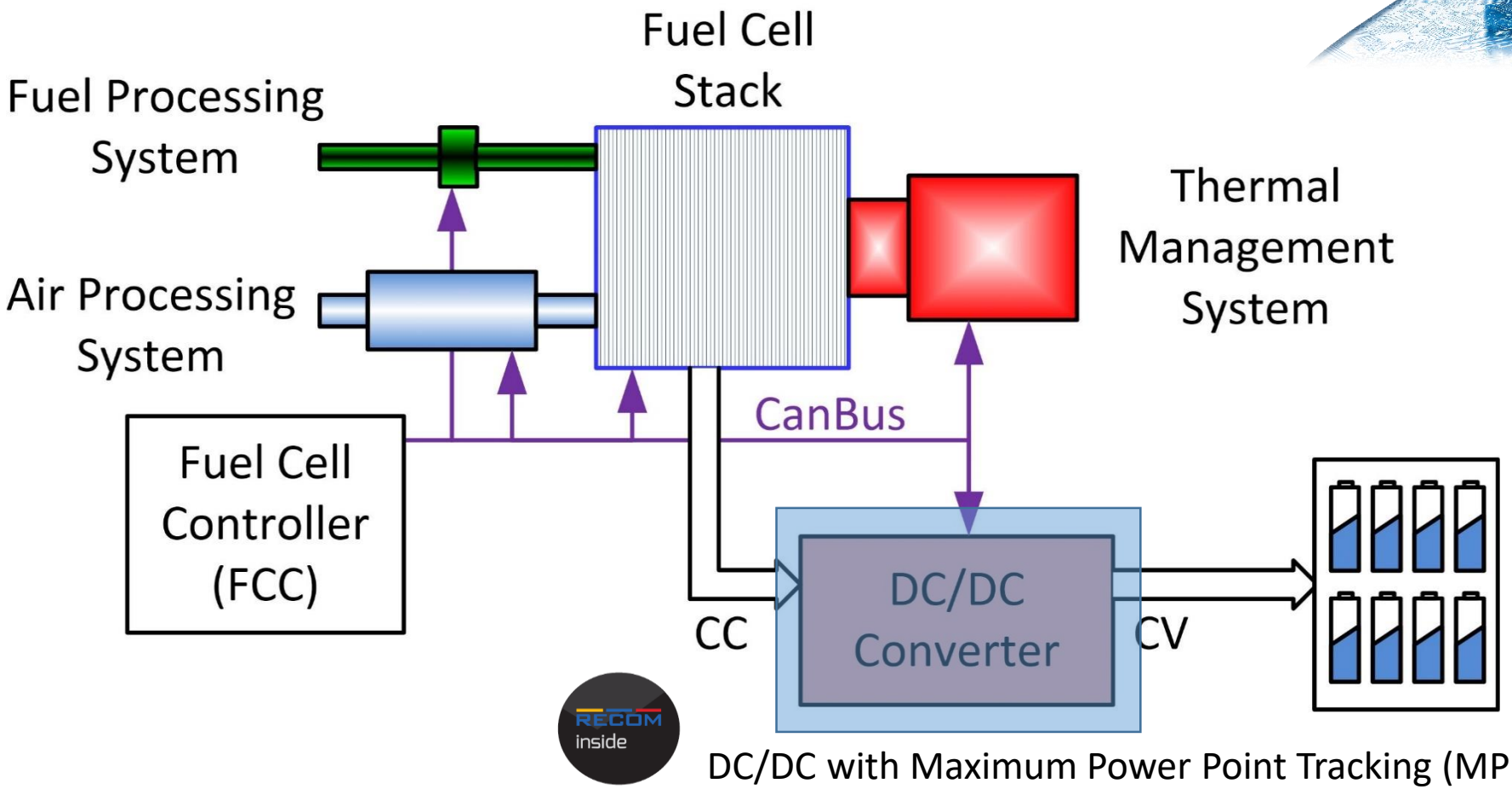


Fuel Cell System



Monitors and cools the stack to maintain optimum reaction conditions

Fuel Cell System

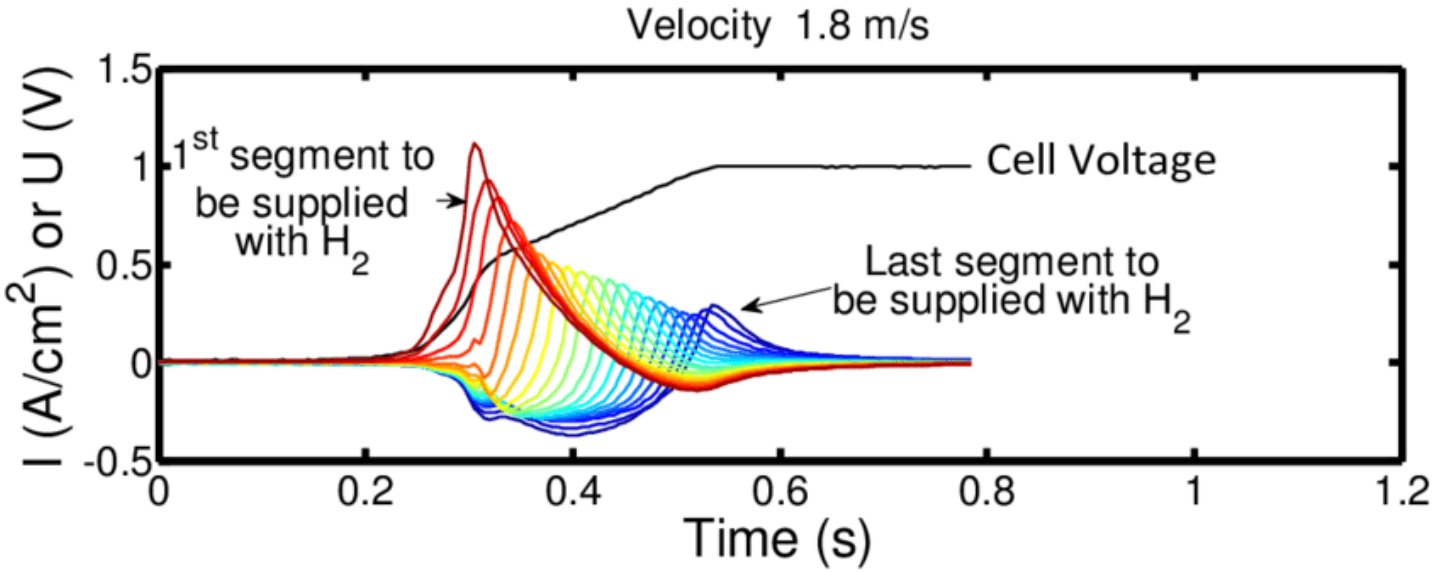


DC/DC with Maximum Power Point Tracking (MPPT)

Fuel Cell DC/DC Requirements

Normal Start-up Sequence:

Start gas flow, contactors close, DC/DC input ramps up the output power as it tracks the cell voltage (non-linear start-up):



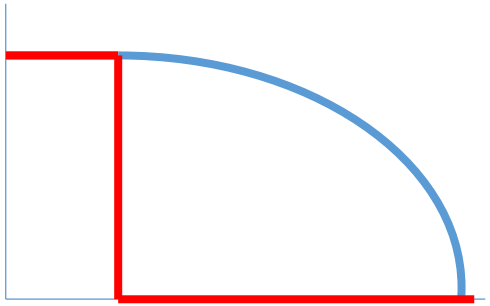
Source: LEMTA - University of Lorraine

Fuel Cell DC/DC Requirements

Normal Shut-down Sequence:

Stop gas flow, DC/DC tracks the cell power down to zero,

DC contactors open (gradual shut-down)



Emergency Stop:

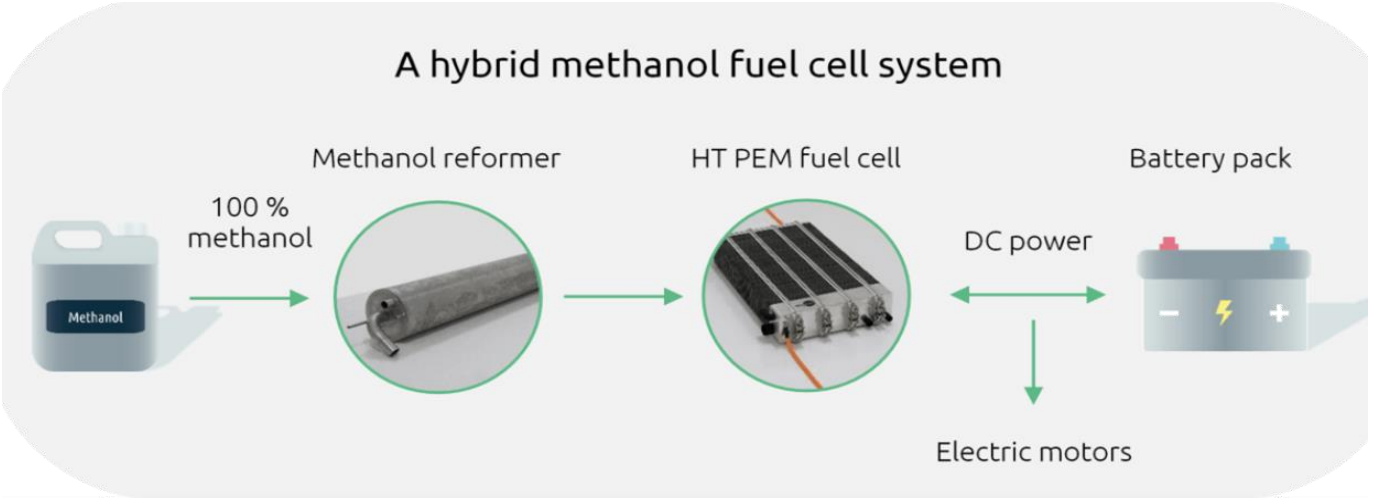
Shutdown of the stack by venting gas is too slow, so DC contactors open under full load.

The DC/DC must handle massive surges and transients and self-discharge safely.

Light Duty Fuel Cell DC/DC

5kW DC/DC for Hybrid Methanol Fuel Cell Systems:

- Range extenders
- Stand-alone refrigeration units for trailers
- Zero Emission off-grid power generation
  - Military, mining, construction
  - Emergency supply (telecoms)
  - PV/Battery/FC combi-systems



Fuel Cell DC/DC Requirements

4.8 kW **SD4008-X-24**

Vin = 18-54VDC @ 200A max

Vout = 20-56VDC adj.

(24V @ 185A max / 48V @ 110A max)

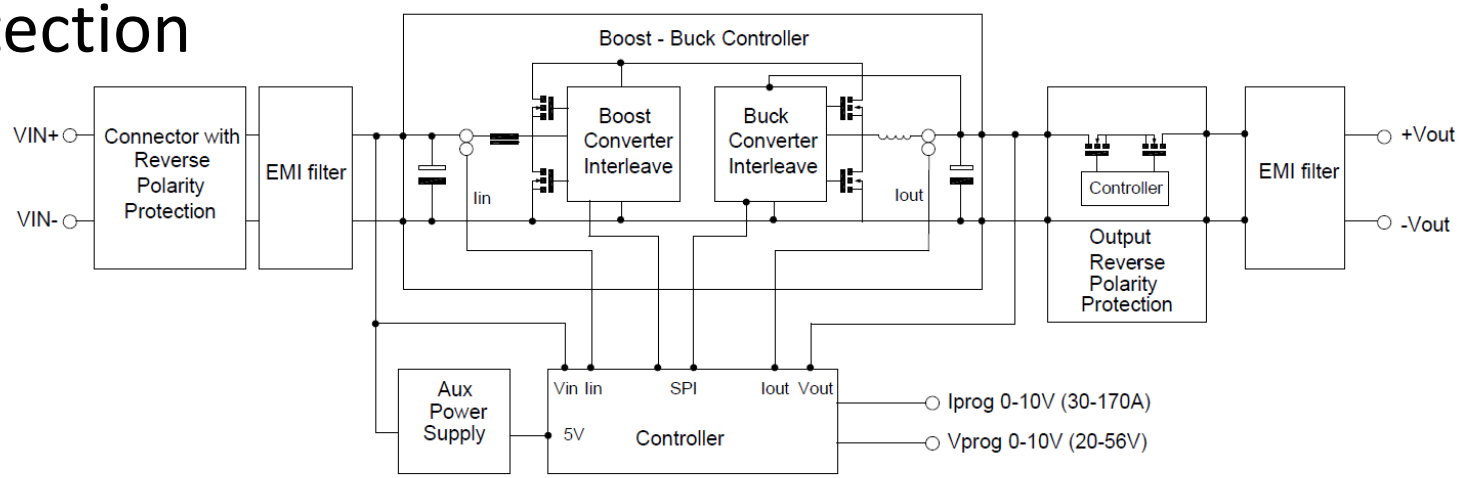
95% efficiency

Reverse polarity + surge protection

MPP tracking

Baseplate cooled (fanless)

Analogue or digital control



Fuel Cell DC/DC Requirements

7 kW **SD7008-X-48-2**

Vin = 48V (30-70VDC) @ 220A max

Vout = 48V (36-60VDC adj.) @ 190A max

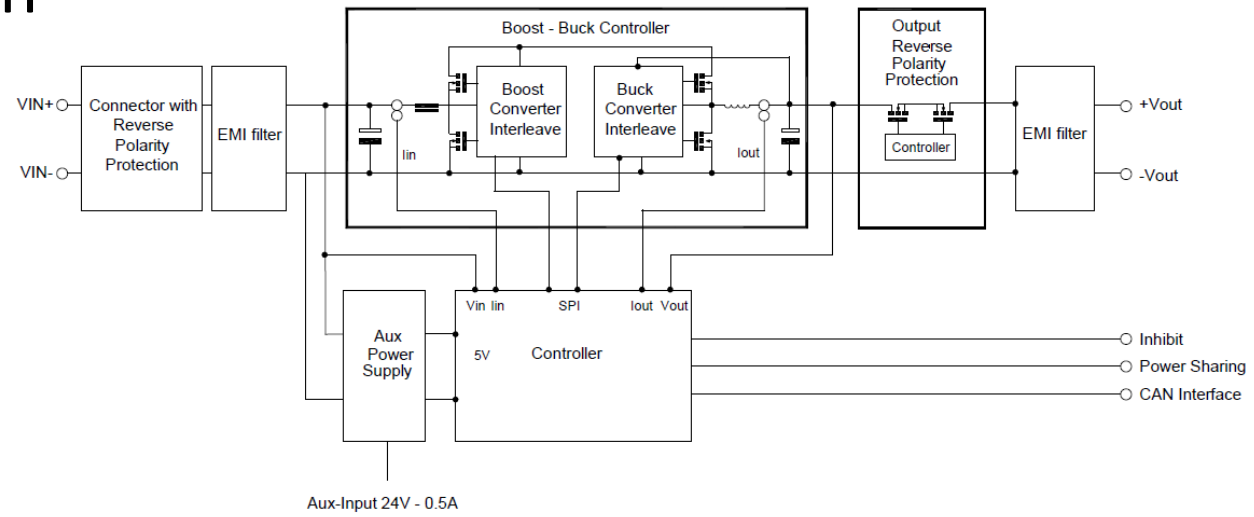
Buck/Boost with >97% efficiency

Reverse polarity + surge protection

MPP tracking

Liquid cooled baseplate

CAN J1939 bus interface



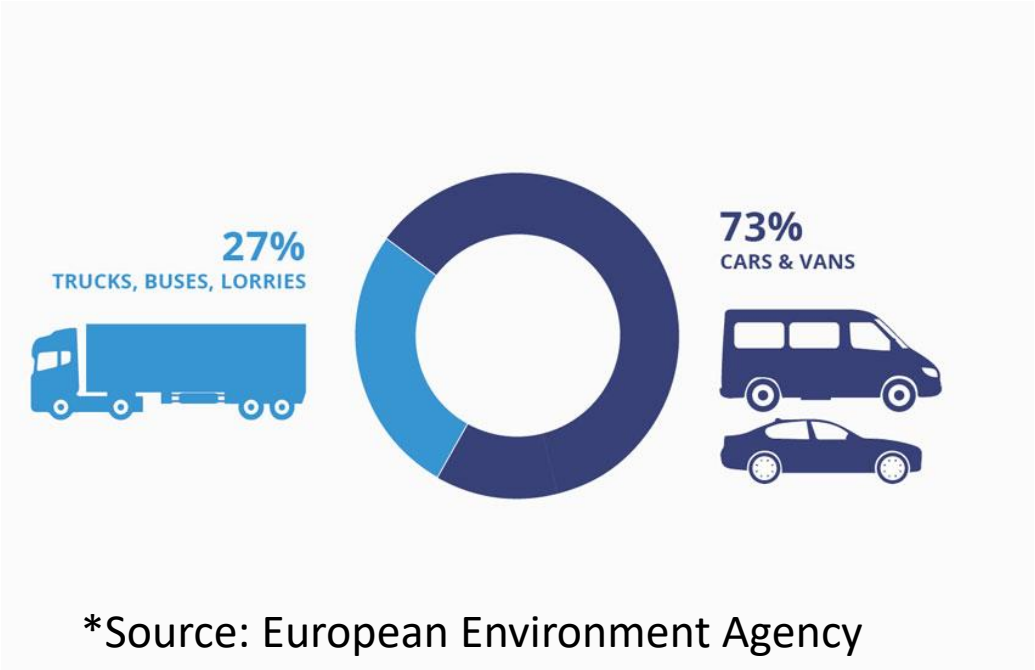
Heavy Duty Fuel Cells

Transport is Europe‘s biggest source of CO^2 emissions. Vehicles over 3.5t are responsible for 27% of these emissions*.

Therefore, zero-emission commercial trucks, buses and municipal refuse vehicles are of special focus for the EU:

„From 2025 onwards, new trucks and buses will emit on average 15% less CO^2. And from 2030, they will emit 30% less CO^2.“

Elisabeth Köstinger, Bundesministerin



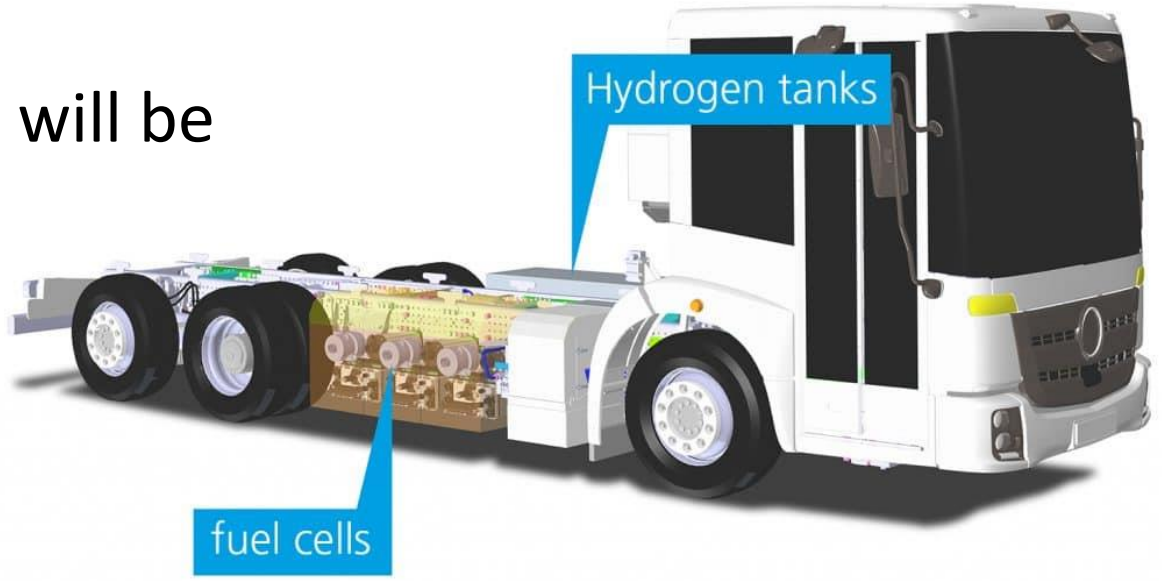
*Source: European Environment Agency

Heavy Duty Fuel Cell DC/DC

Applications:

- H_2 Range extenders for BEV trucks
  (e.g. 1 recharging stop Berlin – Munich)
- „Last Mile“ ZE operation.

From 2025, diesel-powered vehicles will be banned from many urban areas.



Heavy Duty Fuel Cell DC/DC

Applications:

- On-board electrical power for H_2 powered ICE ships, trucks and busses (e.g. China 2022 Winter Olympics will use a fleet of 655 ICE hydrogen vehicles suitable for operation at -20°C)

Source: China Daily.com.cn

Heavy Duty Fuel Cell DC/DC

Applications:

- Stationary fuel cell power systems provide decentralised or emergency power, or can be used as ZE grid-independent generators.
- Typical stationary generator capacity is 25-70kW

Source: Wikipedia

HD Fuel Cell DC/DC Requirements

10-75 kW

Vin = 25-280VDC @ 500A max

Vout = 200-800 VDC

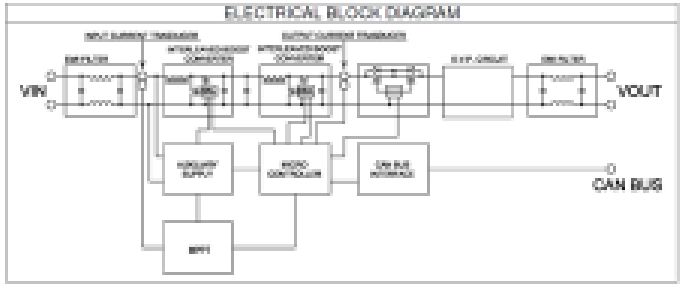
>97% efficiency

Reverse polarity + surge protection built-in

MPP tracking

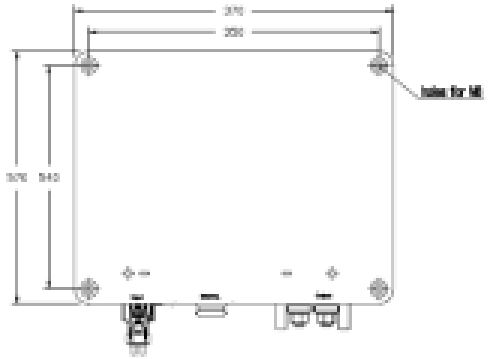
Liquid cooled baseplate

	Fuel Cell
	Transportation

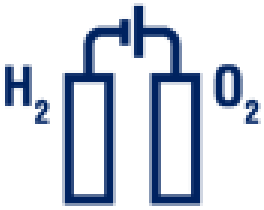


Functions:

- MPPT – 500A input current
- Input range 25 – 280VDC
- High efficiency >97%
- Compact design
- Active load sharing
- Can_bus interface
- IP6k9k
- Liquid cooling
- ECE R10 - E-Certified



Input:	500A@25 - 280V
Output:	200-800Vnom
	Battery charging or system supply
Power:	10-75kW



Summary

DC/DC converters for Fuel Cell Applications
need unique features:

1: High voltage/high current capability (100‘s Amps and Volts)
2: Reverse polarity protection on both input AND output
3: Maximum power point tracking
4: Emergency stop / high surge capability
5: Datalink for system integration