



# ELEMENT 2

## Hydrogen For Transport

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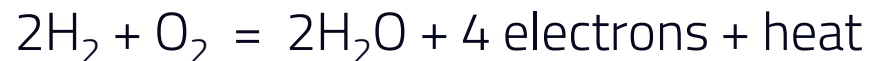
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Building the first national network of hydrogen refuelling stations across UK and Ireland

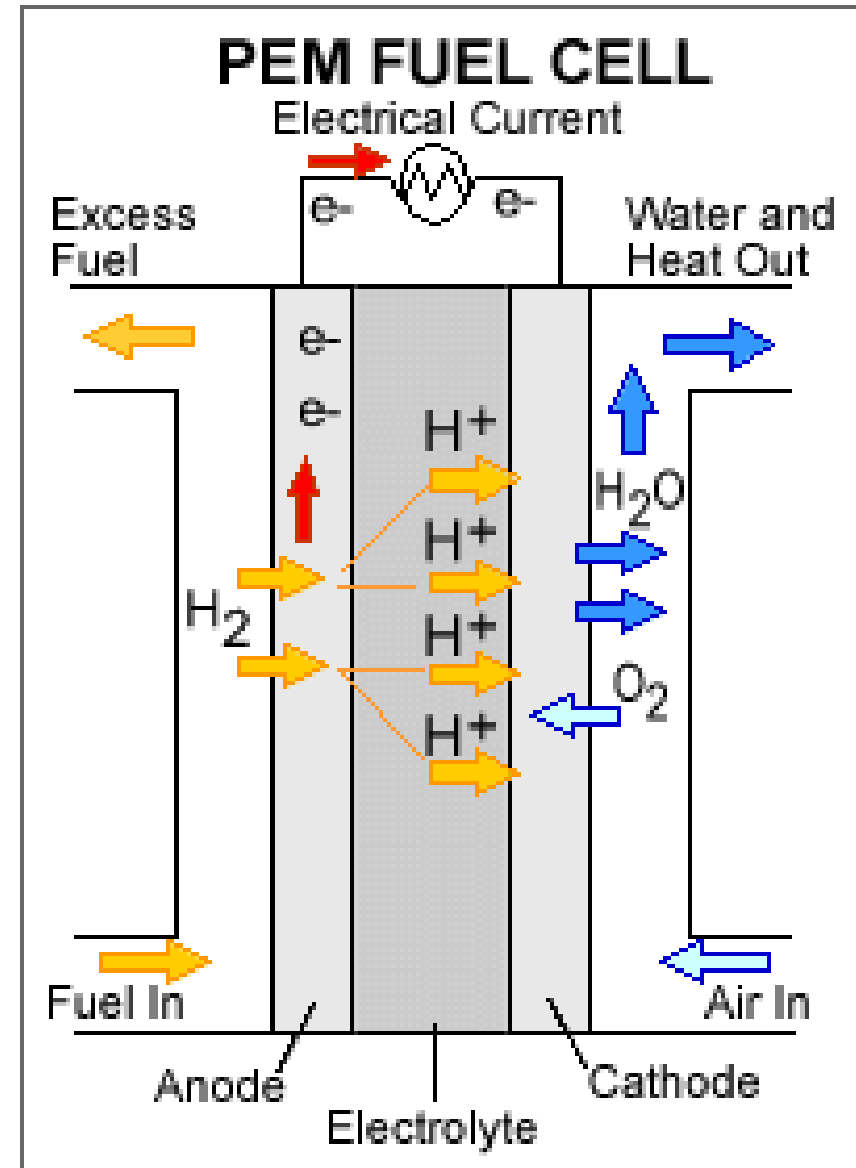
# What is a Fuel Cell?

"A fuel cell is an electrochemical cell that converts the chemical energy of a fuel and an oxidizing agent into electricity through a pair of redox reaction"

For hydrogen fuel cells the reaction is



*A Fuel Cell is a Hydrogen Battery*



# History of Fuel Cells

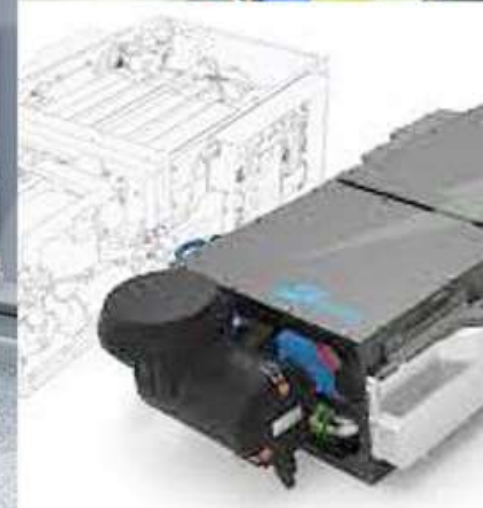
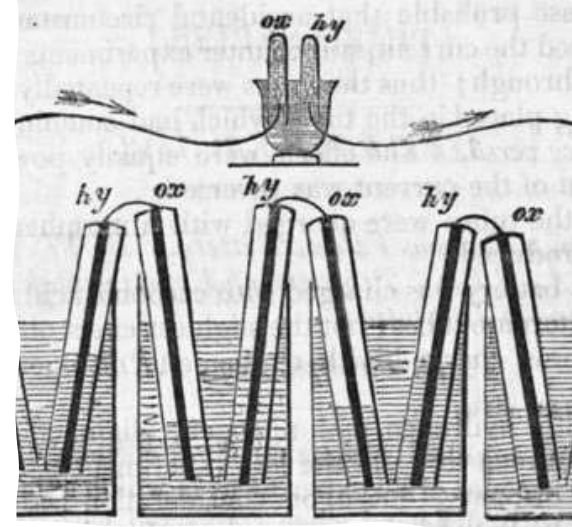
First hypothesised by Sir Humphrey Davy in 1800

Discovered by Sir William Gove in 1839

First functional device Prof Francis Bacon 1953

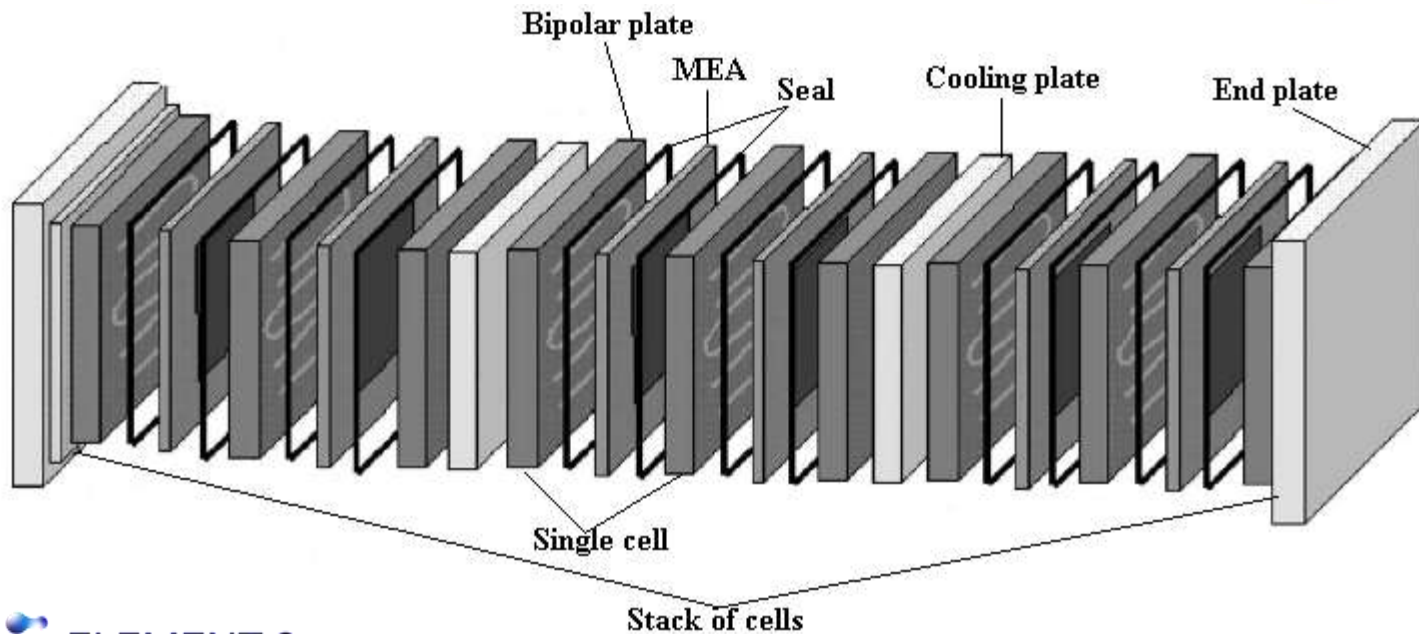
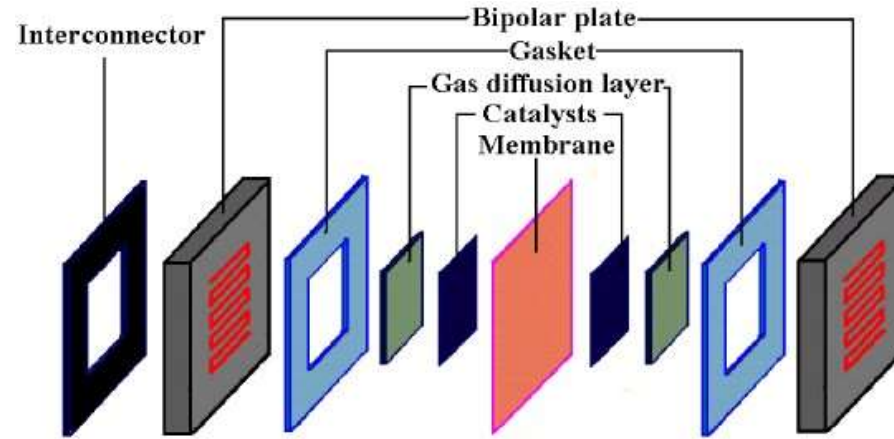
First use – Gemini and Apollo manned space flights

First use of PEM fuel cells in vehicles by Ballard 1992



# How To Make a Fuel Cell

Single Cell



Fuel Cell Stack

# Current State of The Art & Developments

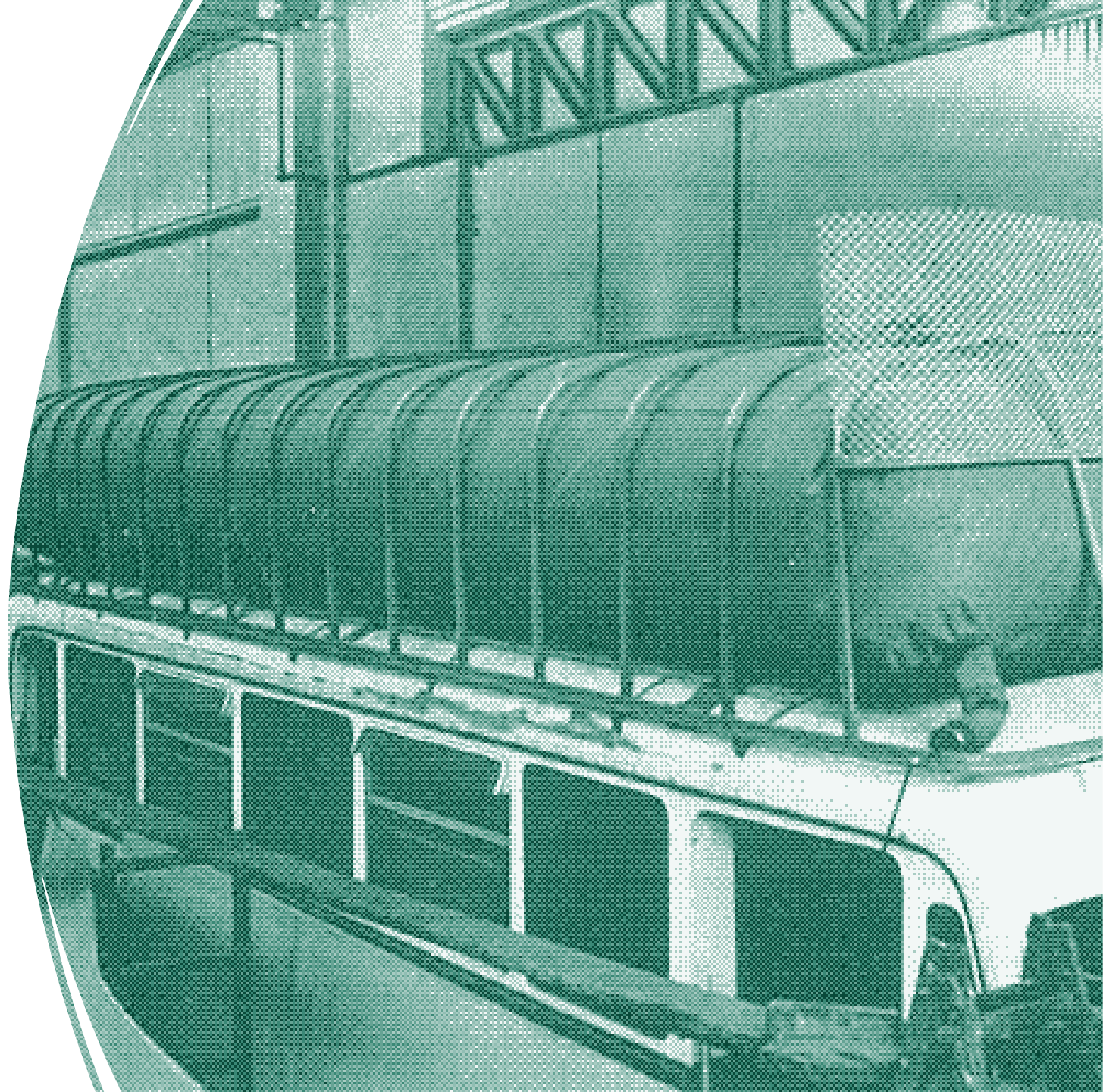
	Current	Planned
PEM System Cost (\$/KW*)	\$75-100	\$50-75
Power Density (Gravimetric) (Volumetric)	4.0 KW/Kg 1.2 KW/Litre	5.0kW/Kg 2.0 KW/Litre
Durability ('000 hrs)	>10,000	>30,000
Thermal Efficiency	50-55%	55-60%

\*Assumes 50,000 vehicles p.a.

# Hydrogen As A Combustible Fuel

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- First self-sustaining combustion engine developed by Etienne Lenoir in 1860 (16 years before Otto Benz), using hydrogen.
- First hydrogen powered buses – WW2 conversions
- Hydrogen fuelled engines are the most efficient ICE's developed to date
- Every current combustion process can be modified to use hydrogen.



# Current Developers of Hydrogen Combustion Vehicles

- Ulemco, UK – conversion of vehicles to dual fuel hydrogen and diesel.
- First Hydrogen – conversion of vehicles to dual fuel hydrogen and diesel.
- Cummins – engines now available for supply to OEM's with warranties (15 litre V8 engine blocks).
- JCB – started to make construction diggers with hydrogen fuel based on a modified diesel engine block.
- Isuzu (Toyota), Mercedes, Volvo, Iveco, DAF and MAN all planning to launch hydrogen combustion trucks over the next 24 months.
- UK Government has now changed the definition for zero emission vehicles, which will allow H2 combustion vehicles to be the same as BEV.

