BULGARIAN ACADEMY OF SCIENCES | ENERGY RESOURCES AND ENERGY EFFICIENCY

HYDROGEN ENERGY AND FUEL CELLS.

A VISION FOR OUR FUTURE

INSTITUTE OF ELECTROCHEMISTRY AND ENERGY SYSTEMS
ACADEMICIAN EVGENI BUDEVSKI

WHY TO USE FUEL CELLS?

Scientists and politicians predict that

FUELL CELLS ARE A KEY SOLUTION FOR THE ENERGY OF THE 21ST CENTURY

"High Level Group for Hydrogen and Fuel Cells"
European Commission, JUNE 2003

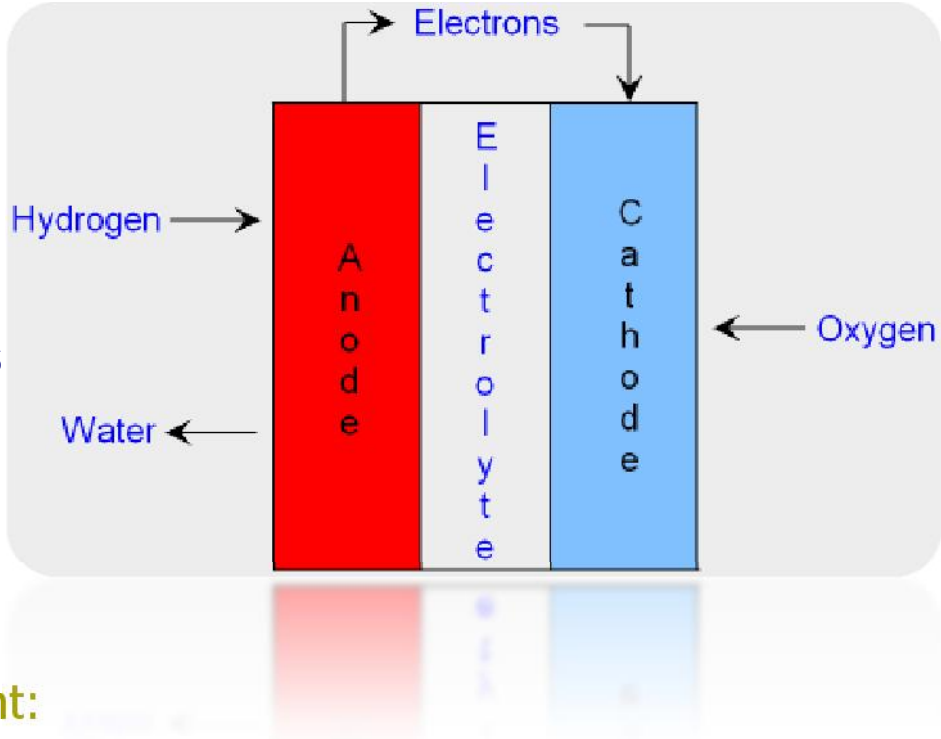
WHAT ARE FUEL CELLS?

Electrochemical energy devices that convert O_2 and H_2 into H_2O

By-products of the process are electricity and heat

Fuel cells have the elements of batteries

- two electrodes (cathode and anode)
- electrolyte between them



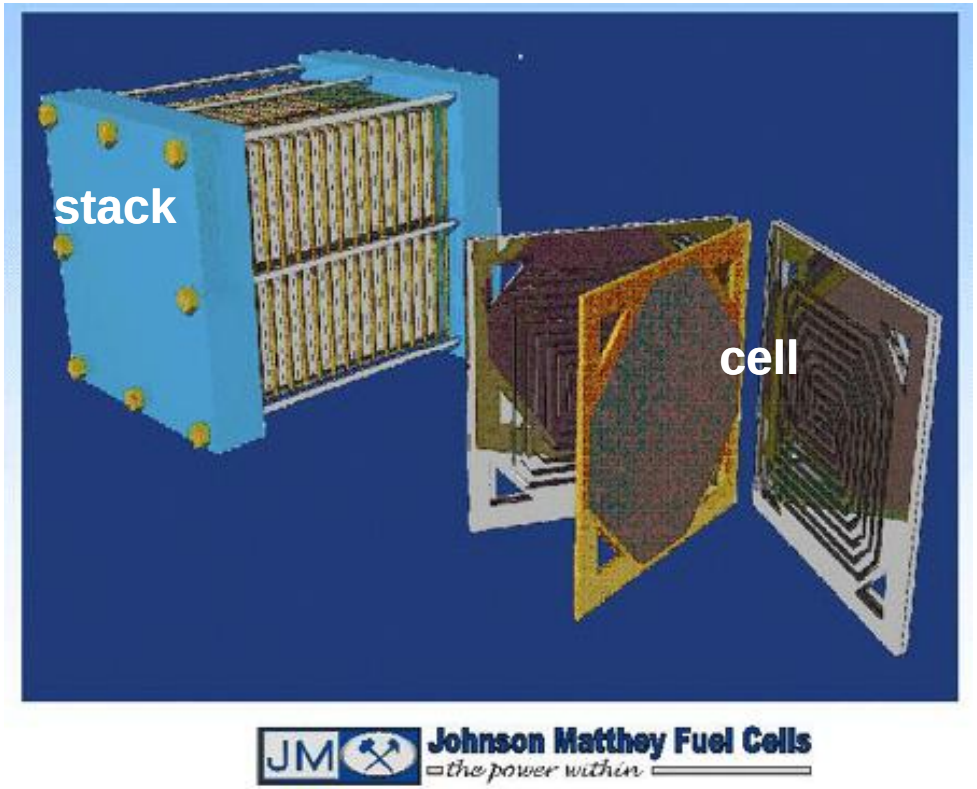
BUT the operating principles are different:

BATTERIES	FUEL CELLS
convert stored chemicals into electricity	chemicals constantly flow into the cells
eventually "go dead" and have to be recharged or thrown away	never go dead - as long as there is a flow of O_2 and H_2 into the cell

WHAT ARE FUEL CELLS?

Fuel cells consist of “stacks”

The stack is built up of a number of individual cells.



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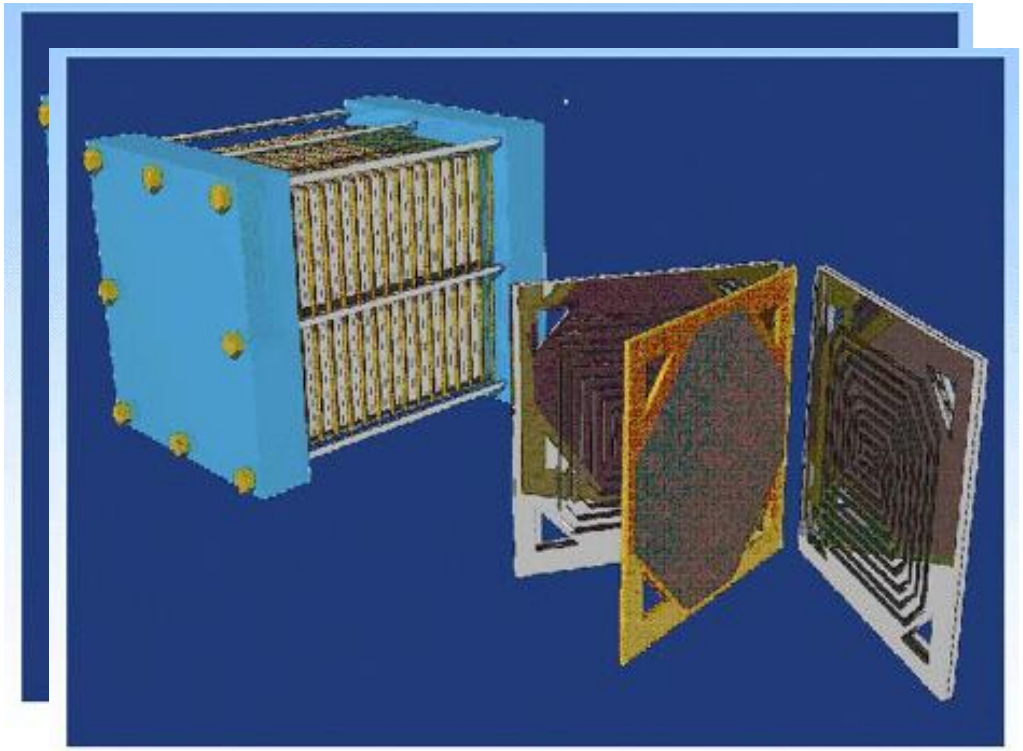

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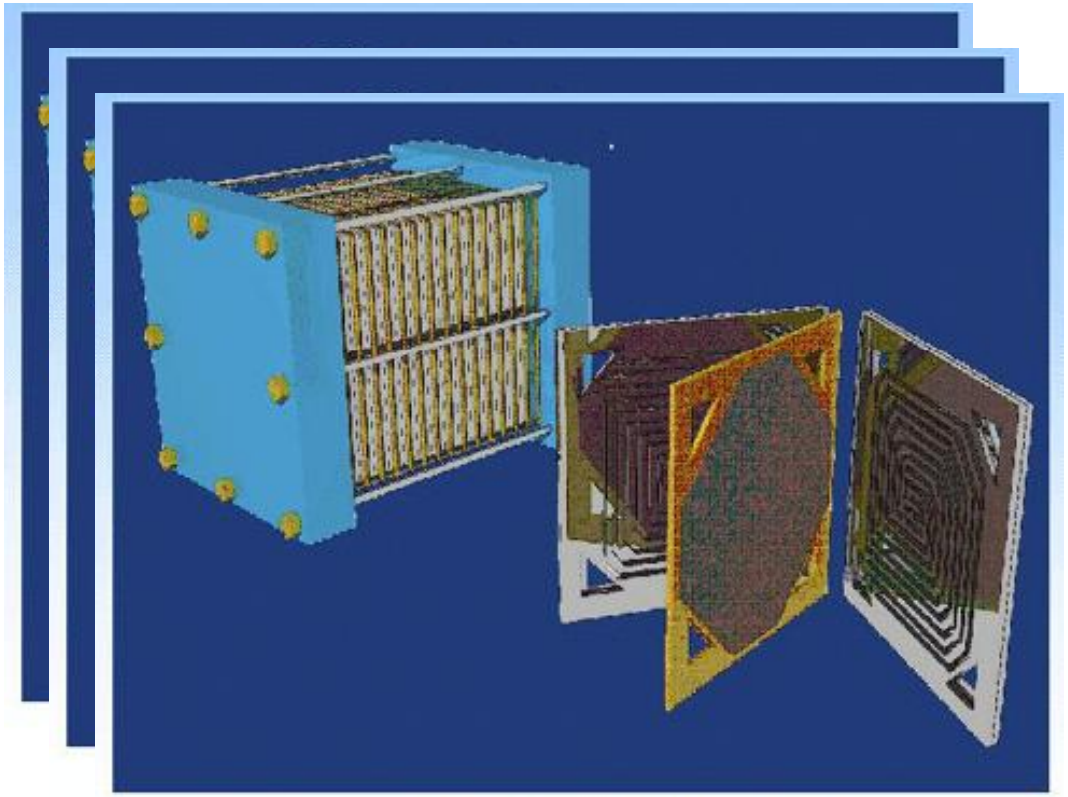

Johnson Matthey Fuel Cells
the power within

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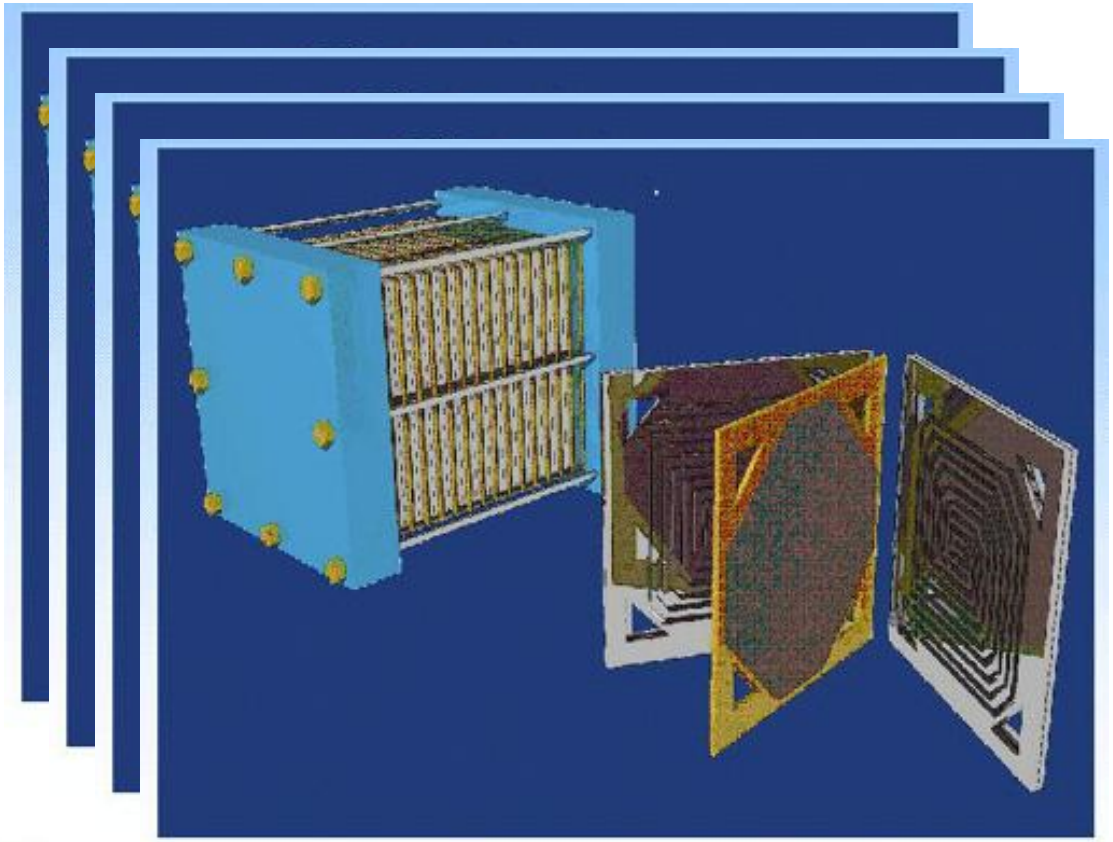

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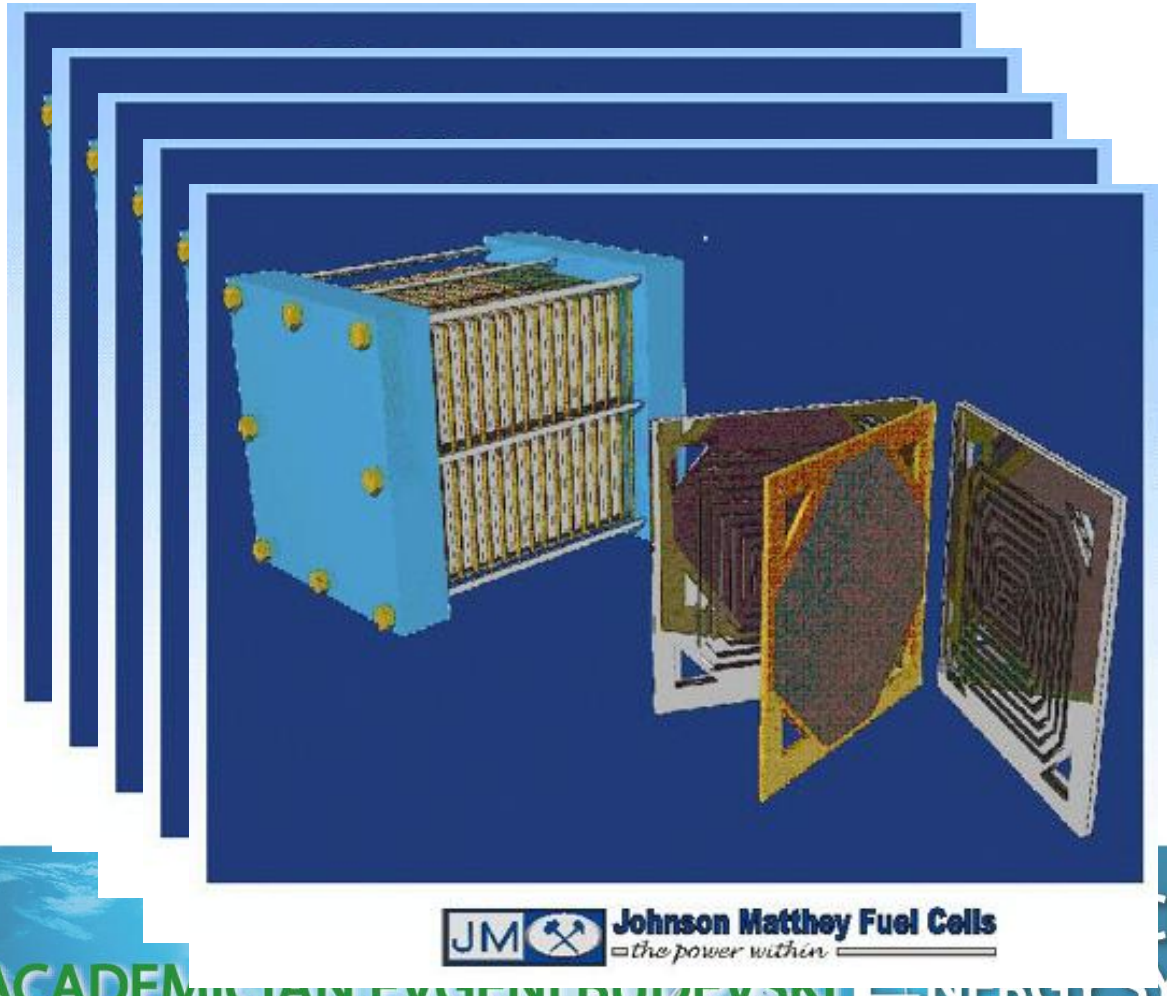

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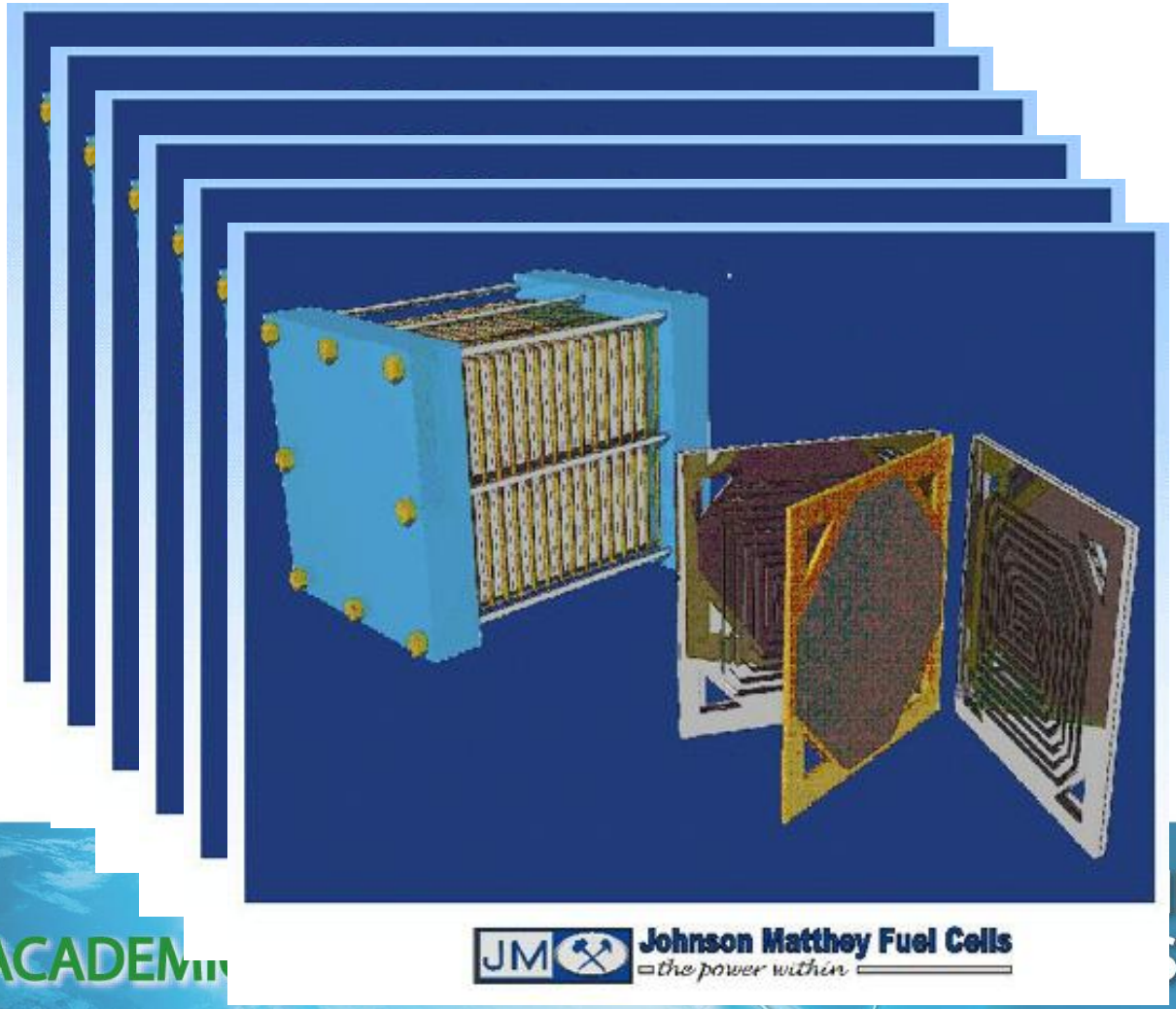

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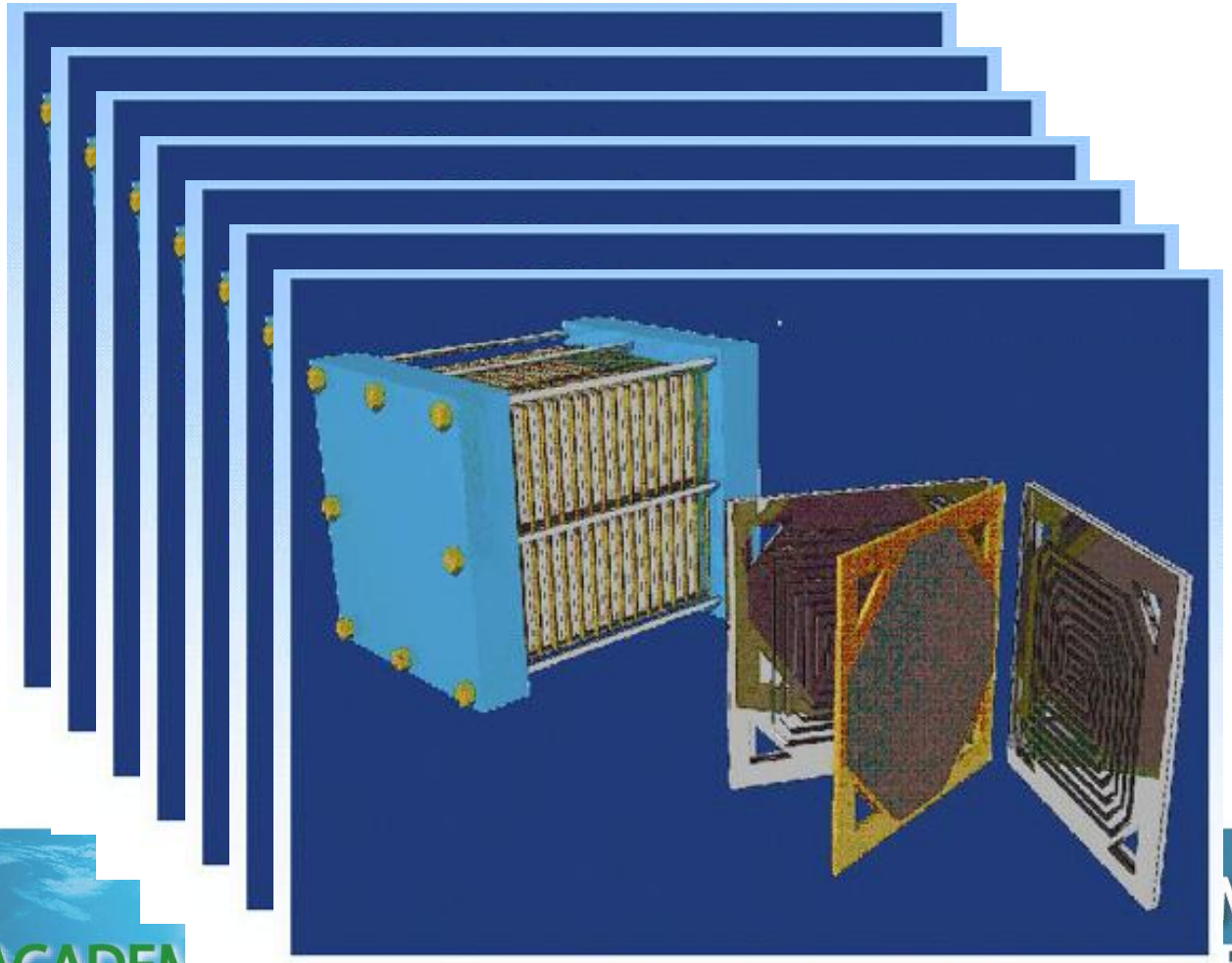
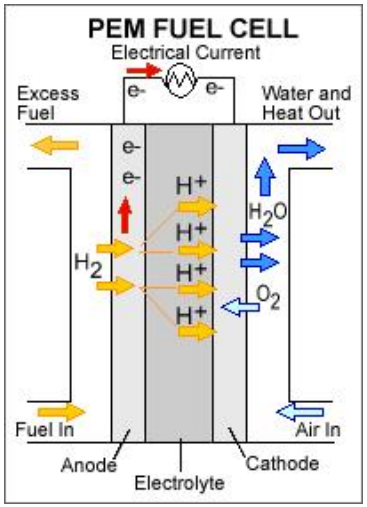


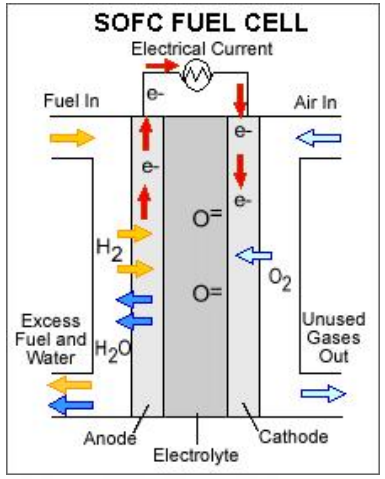
WHAT ARE FUEL CELLS?

Fuel cells are classified by the type of electrolyte they use.



Proton Exchange membrane Fuel Cells (PEM)

- use a polymeric membrane as proton conducting electrolyte
  - looks like ordinary kitchen plastic wrap
  - blocks electrons
  - lets protons through
  - use platinum electrodes
  - operate at low temperatures (under 100ºC)
  - are ideal for cars



Solid Oxide Fuel Cells (SOFC)

- use solid ceramic electrolyte, which conducts oxygen ions
  - use ceramic electrodes
  - operate at high temperatures (800-1000ºC)
  - are very efficient ⟹ ideal for industrial applications

FUEL CELL HISTORY

Fuel cells have been around for 177 years!

Discovered by Christian Friedrich Schönbein German-Swiss chemist

- 1839: Published in “Philosophical Magazine”

- 1843: First fuel cell developed by Welsh scientist Sir William Robert Grove

- 1959: First 5 kW stationary fuel cell developed by Francis Thomas Bacon

- 1960: Fuel cells used in US space program

- present: Fuel cells began to become commercial in a variety of applications

FUEL CELL BENEFITS

- Fuel cells have a higher efficiency than diesel or gas engines.
- Fuel cells operate silently, compared to internal combustion engines.
- Fuel cells can eliminate pollution caused by burning fossil fuels
- The only by-product at point of use is water.

FUEL CELL BENEFITS

•Fuel cells can reduce economic dependence on oil producing countries.

•Since hydrogen can be produced anywhere where there is water.

•Operating times are much longer than with batteries

•Unlike batteries, fuel cells have no "memory effect" when they are getting refueled.

•.....

FUEL CELL APPLICATIONS

Portable (and emergency) energy systems

Toshiba, Hitachi, Samsung, Sanyo support fuel cells

- Convenient alternative
- Very long energy life

With fuel cells, you can always carry around...

...your TV , laptop. mobile

FUEL CELL APPLICATIONS

Transport

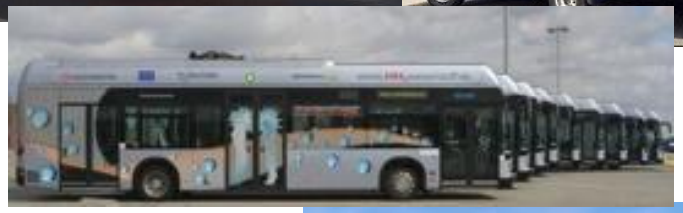
Bikes

Scooters

Forklifts

FUEL CELL APPLICATIONS

Transport



Cars

Busses

FUEL CELL APPLICATIONS

Transport

- first commercial

Fuel Cell Submarine:

Made in Italy

Boats

Submarines

FUEL CELL APPLICATIONS

CHEAP CLEAN POWER

Fuel cells offer an unlimited variety of power generators

World's largest fuel cell power plant,

south of Seoul

- Personal
- Portable
- Emergency

FUEL CELL APPLICATIONS

REFUELLING INFRASTRUCTURE

San Francisco Plans World's Largest Hydrogen Fueling Station

- Even Schwarzenegger uses hydrogen fuel cell car

FUEL CELL IN EUROPE

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Public private partnership

supporting research, technological development and demonstration activities in fuel cell and hydrogen energy technologies in Europe

European Commission + Hydrogen Europe + ON.ERGHY RESEARCH ON FUEL CELLS & HYDROGEN

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FUEL CELL IN EUROPE

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

The three members of the FCH JU are:

- the European Commission
  - the industries - NEW Industry Grouping
    - the research community - Research Grouping N.ERGHY.

European Commission + Hydrogen Europe + N.ERGHY RESEARCH ON FUEL CELLS & HYDROGEN

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FUEL CELL IN EUROPE

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Aim:

to accelerate the market introduction of the

FUEL CELL and HYDROGEN technologies in Europe

European Commission + Hydrogen Europe + ON.ERGHY RESEARCH ON FUEL CELLS & HYDROGEN

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FUEL CELL IN EUROPE

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

Support:

- 2008-2013 – 960 Million €
- 2014-2020 – 1.33 Billion €
- About 150 projects

European Commission + Hydrogen Europe + ON.ERGHY RESEARCH ON FUEL CELLS & HYDROGEN

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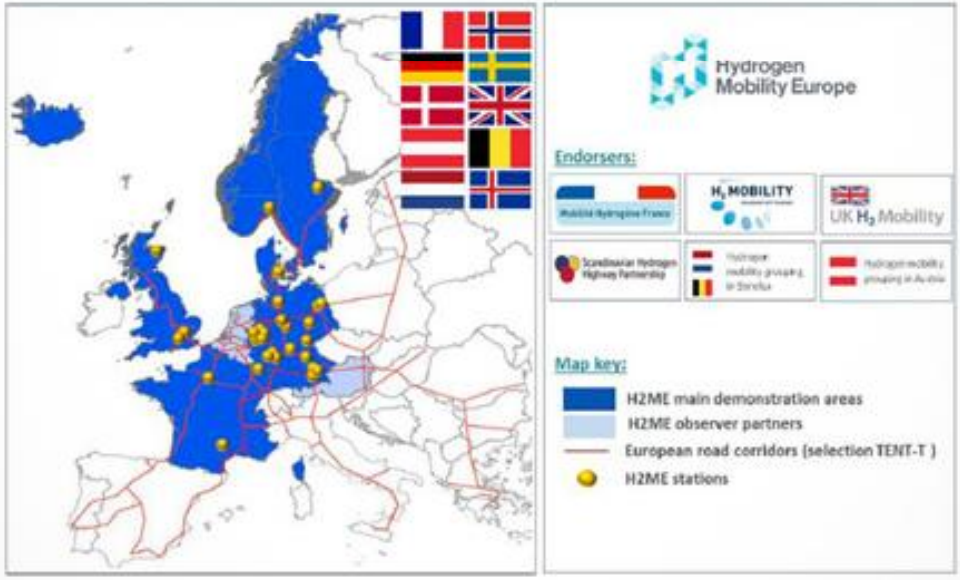
FUEL CELL IN EUROPE

FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

Hydrogen
Mobility Europe

The most ambitious hydrogen mobility initiatives in Europe have joined forces to support the introduction of hydrogen-fuelled transport



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FUEL CELL IN BULGARIA

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

First Bulgarian Hydrogen Car

- 2010 Technical University Sofia and BG H2 Society

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FUEL CELL IN BULGARIA

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

First Visit of Mr. Bert De Colnenaer Executive - director FCH JU

- 29-30 April 2013

Second Visit

- 13 December 2013

BAS became a member of FCH JU

- 19 May 2014

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FUEL CELL IN BULGARIA

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

First Bulgarian Participation in FCH JU Projects

- ENDURANCE / FCH-JU Grant Agreement 621207

7 FP/THEME: Improving understanding of cell & stack degradation mechanisms using advanced testing techniques, and developments to achieve cost reduction and lifetime enhancements for Stationary Fuel Cell power and CHP systems]

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d.vladikova@bas.bg

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FUEL CELL IN BULGARIA

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First Bulgarian Participation in FCH JU Projects

- IMOOD - an innovative project

ИМООД

"conductIvity and reversibility Mechanisms in an InnOvative design of sOlid oxiDe fuel cell"

• funded under Grant Agreement No E02/3/2014 of the National Science Foundation – Bulgaria.

•IMOOD aims to develop an intermediate temperature fuel cell based on proton conducting solid oxide electrolyte, which can work as electrolyzer in reverse mode.

• IMOOD proposes a highly efficient concept for reversible fuel cell.

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This material is prepared and disseminated in the frames of both projects:

ENDURANCE

- ENDURANCE (Grant Agreement No 621207 of the European Union's 7 FP (FP7/2007-2013) Fuel Cells and Hydrogen Joint Undertaking (FCH-JU-2013-1)

- IMOOD (Grant Agreement No E02/3/2014 of the National Science Foundation – Bulgaria).

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