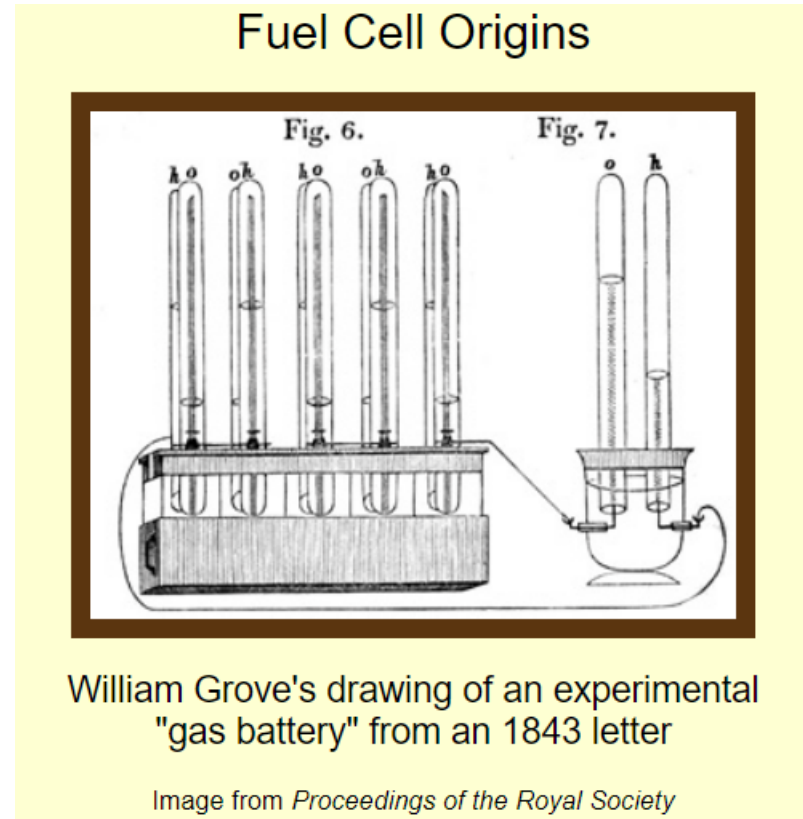
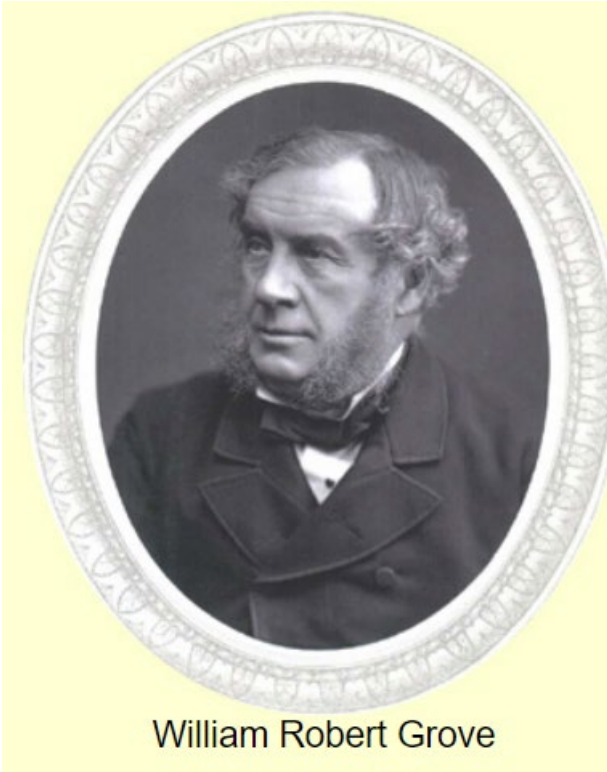




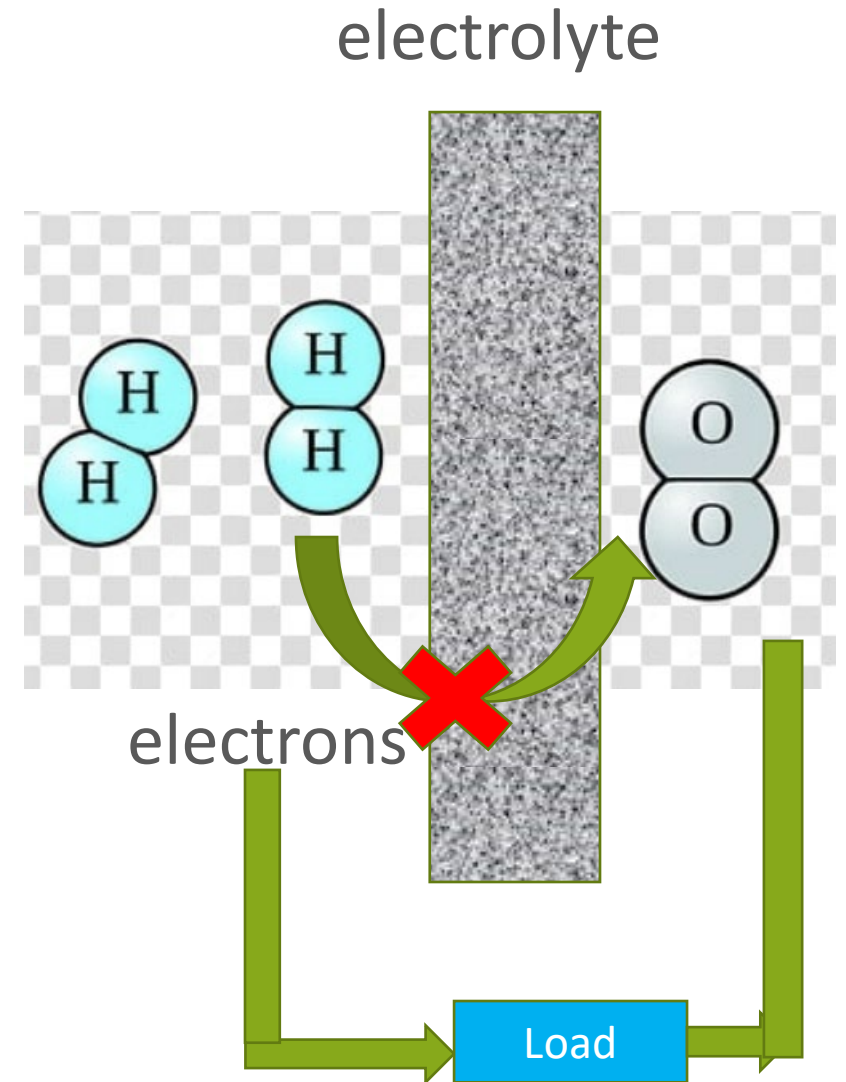
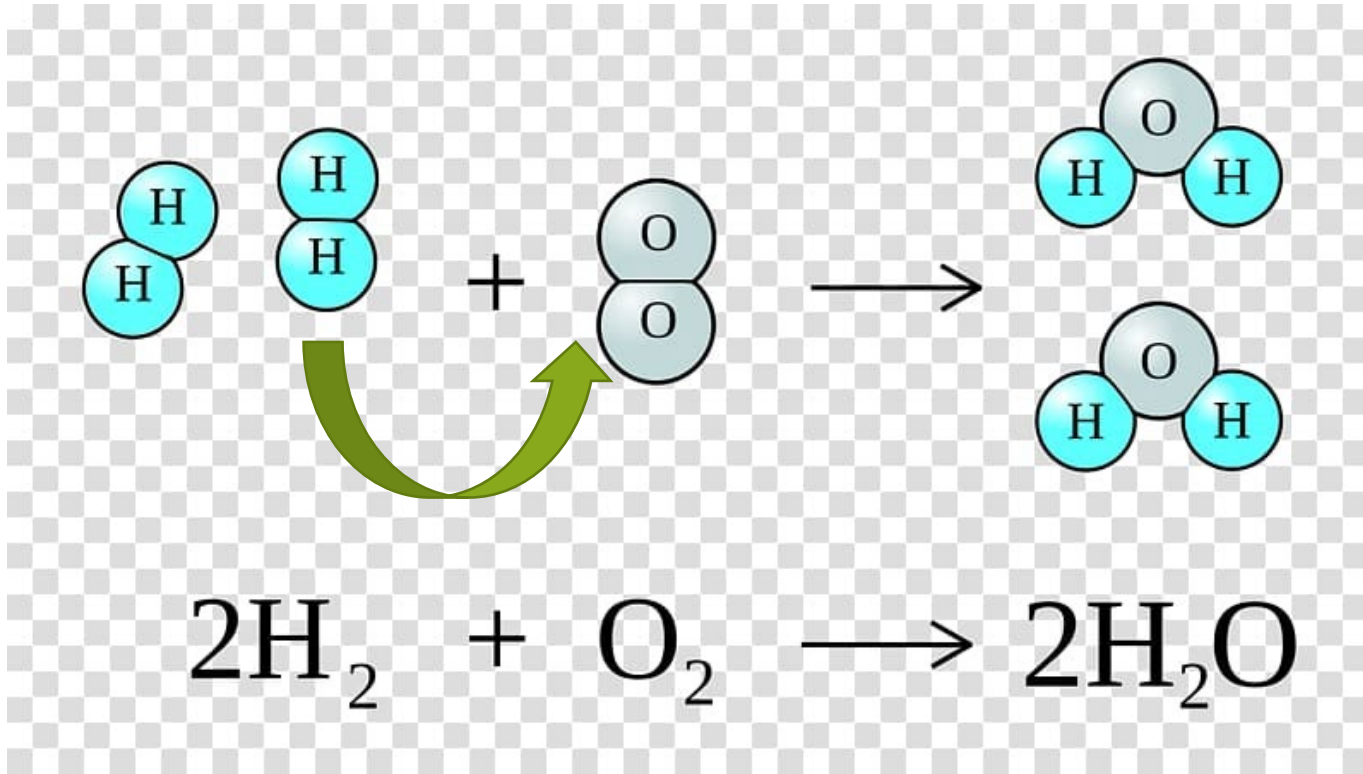
FROM GEMINI SPACECRAFT TO TOYOTA MIRAI
- PROGRESS AND FUTURE OF PEM FUEL CELLS

May 24, 2022

THE BEGINNING : ~ 1850S



<https://americanhistory.si.edu/fuelcells/origins/orig1.htm>

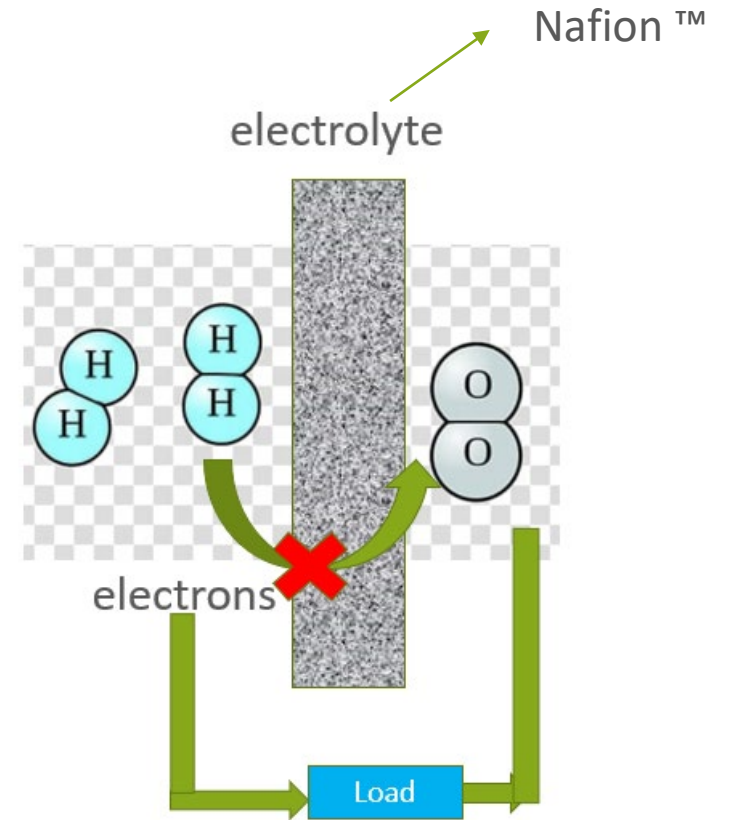


GEMINI SPACECRAFT : ~ 1960S

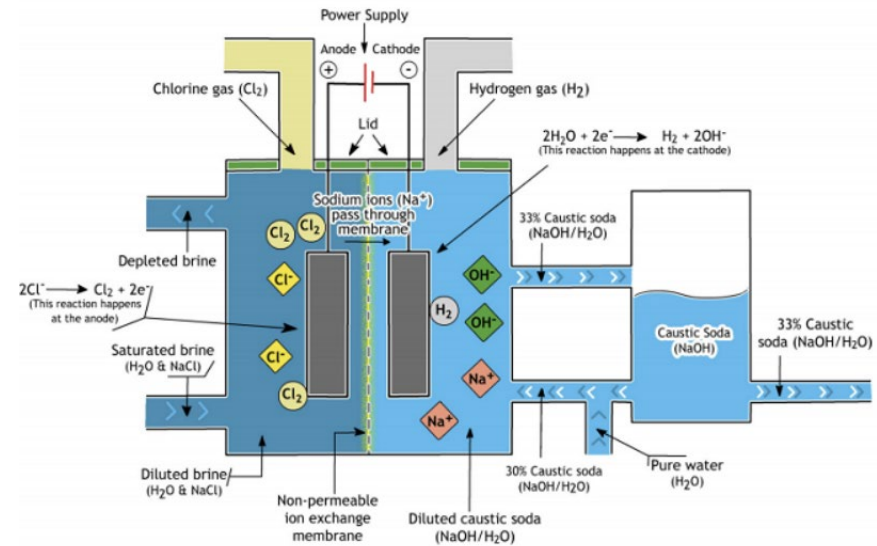
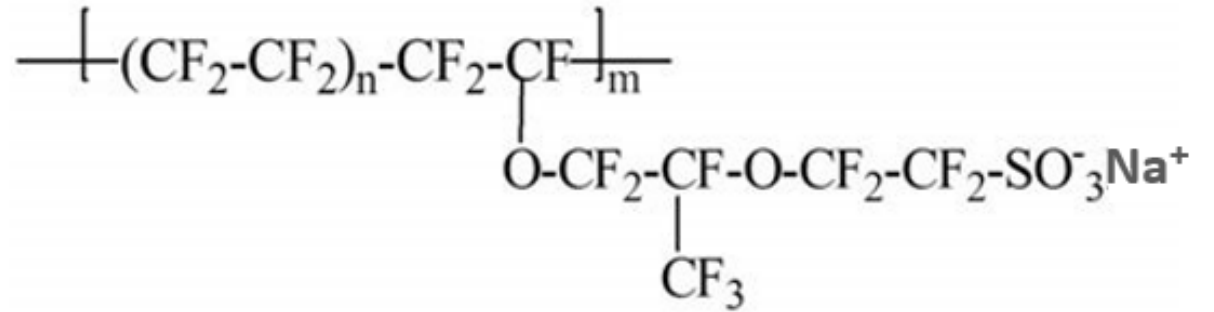
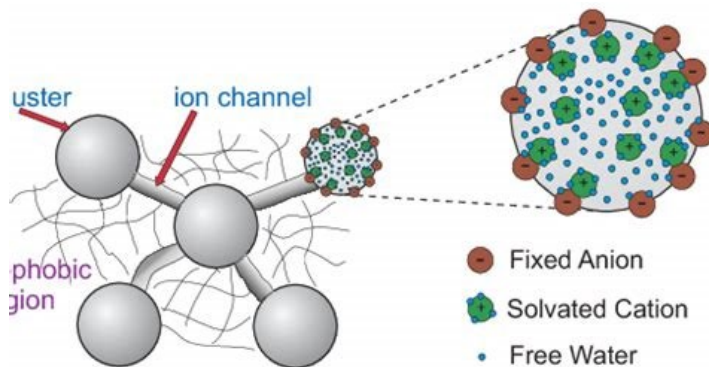
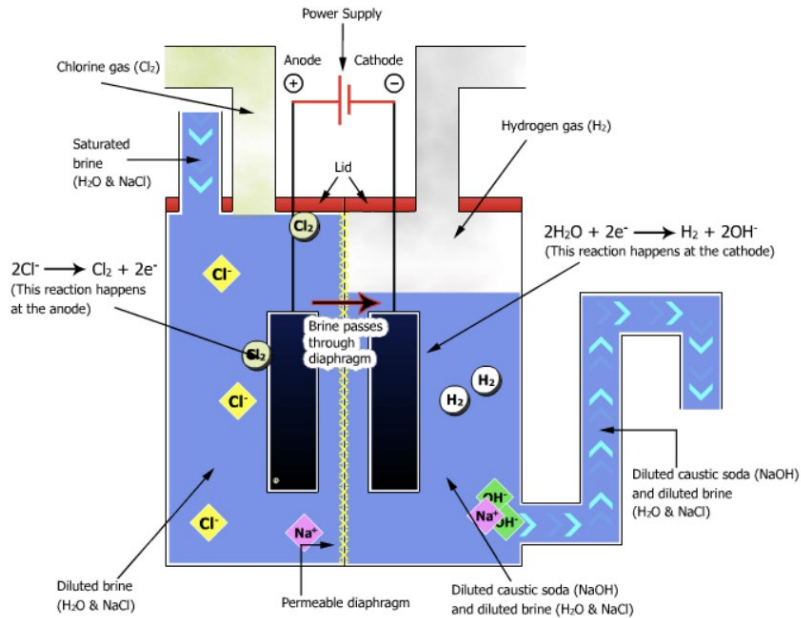
1962 January 23 - .

- **Power sources for the Gemini spacecraft.** - . *Nation: USA. Spacecraft: Gemini, Gemini Fuel Cell.*

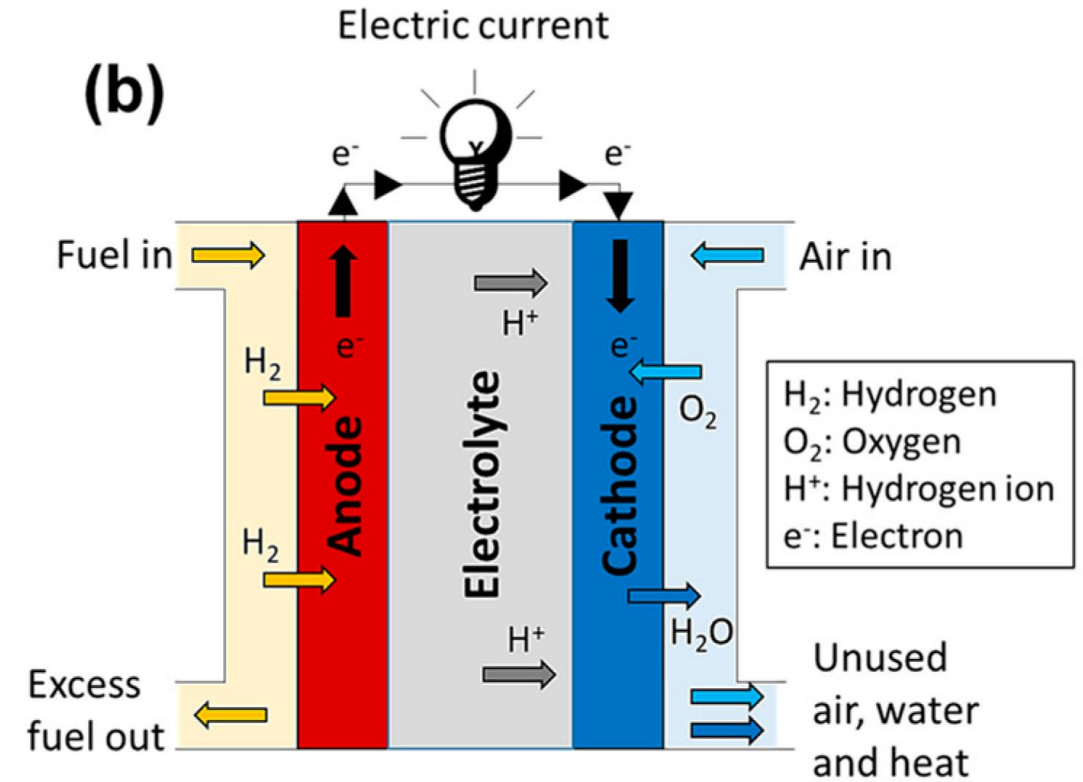
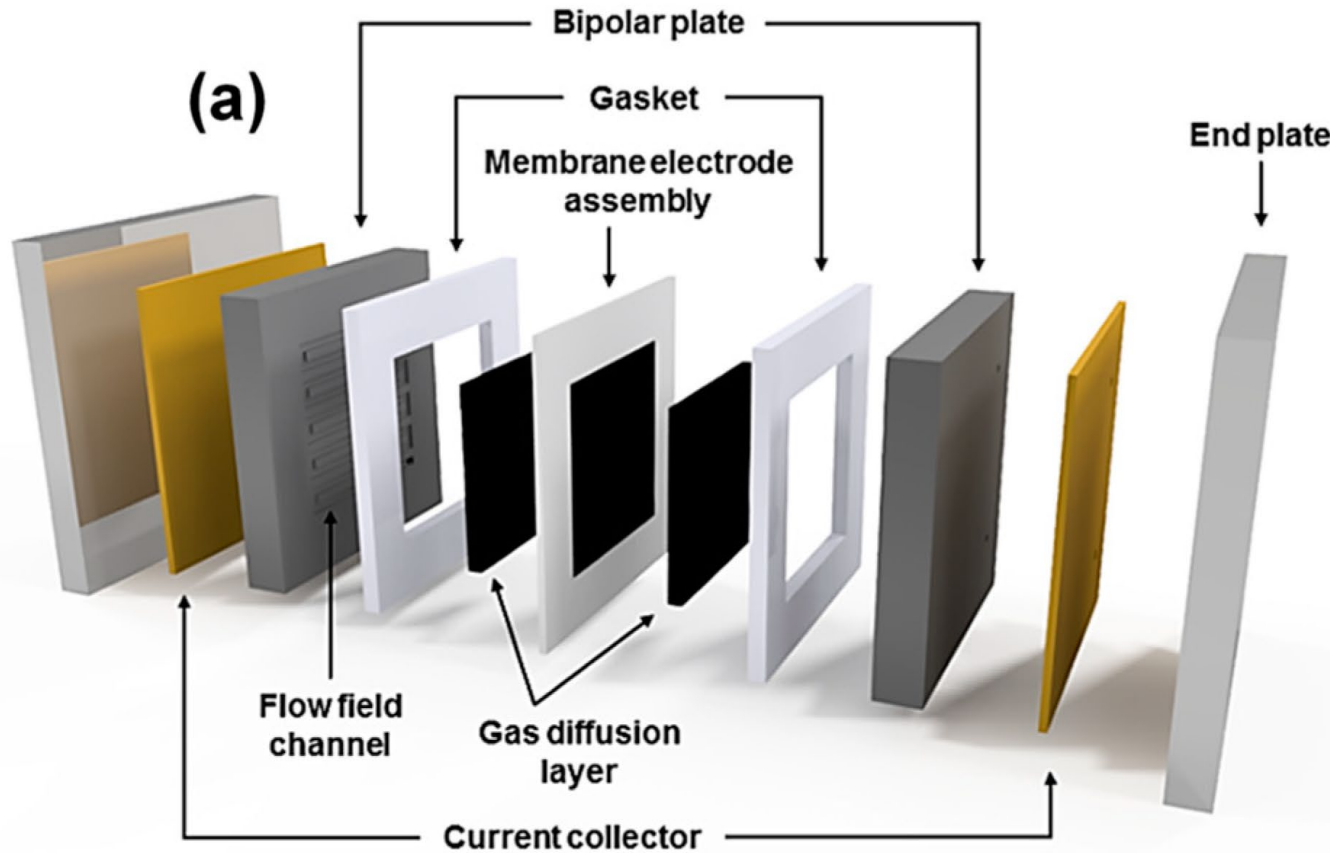
Manned Spacecraft Center completed an analysis of possible power sources for the Gemini spacecraft. Major competitors were fuel cells and solar cells. Although any system selected would require much design, development, and testing effort, the fuel cell designed by General Electric Company, West Lynn, Massachusetts, appeared to offer decided advantages in simplicity, weight, and compatibility with Gemini requirements over solar cells or other fuel cells. A basic feature of the General Electric design, and the source of its advantages over its competitors, was the use of ion-exchange membranes rather than gas-diffusion electrodes. On March 20, 1962, McDonnell let a \$9 million subcontract to General Electric to design and develop fuel cells for the Gemini spacecraft.



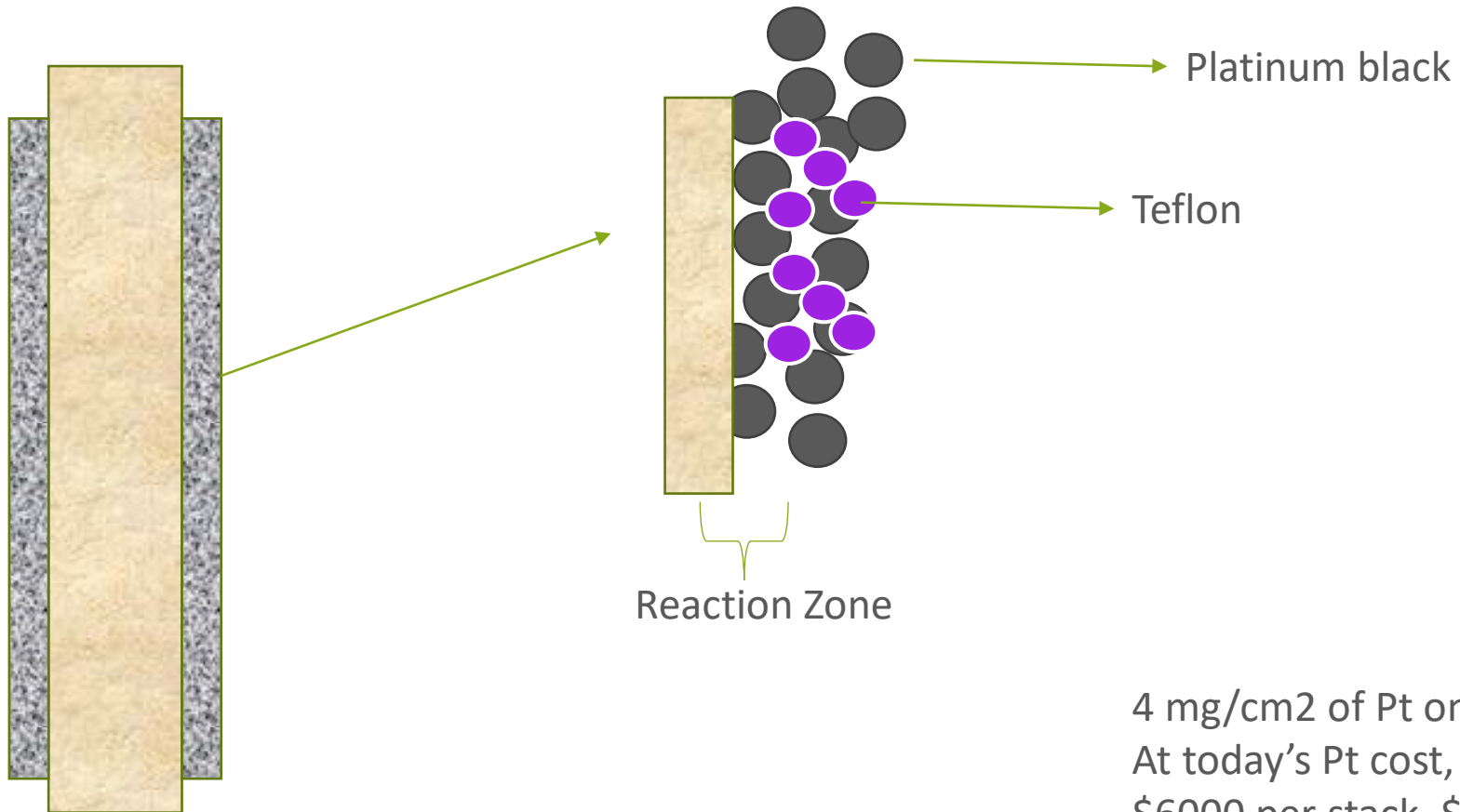
<http://www.astronautix.com/g/geminifuelcell.html>



GEMINI FUEL CELL : BASICS

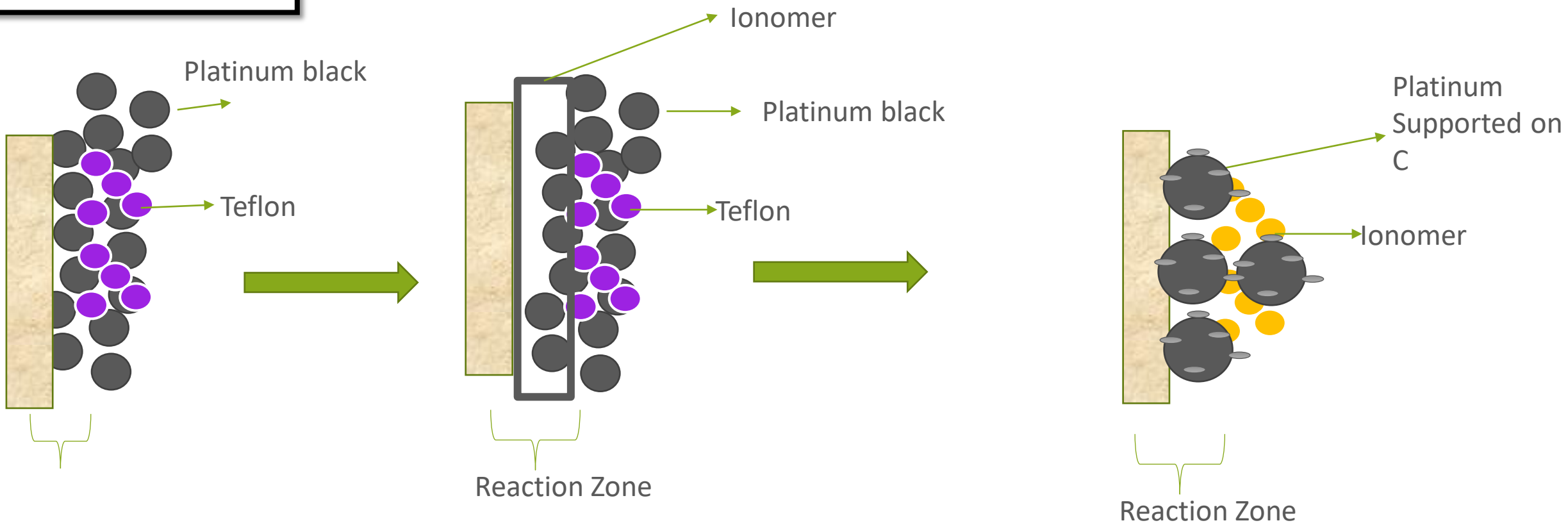


GEMINI FUEL CELL : BASICS



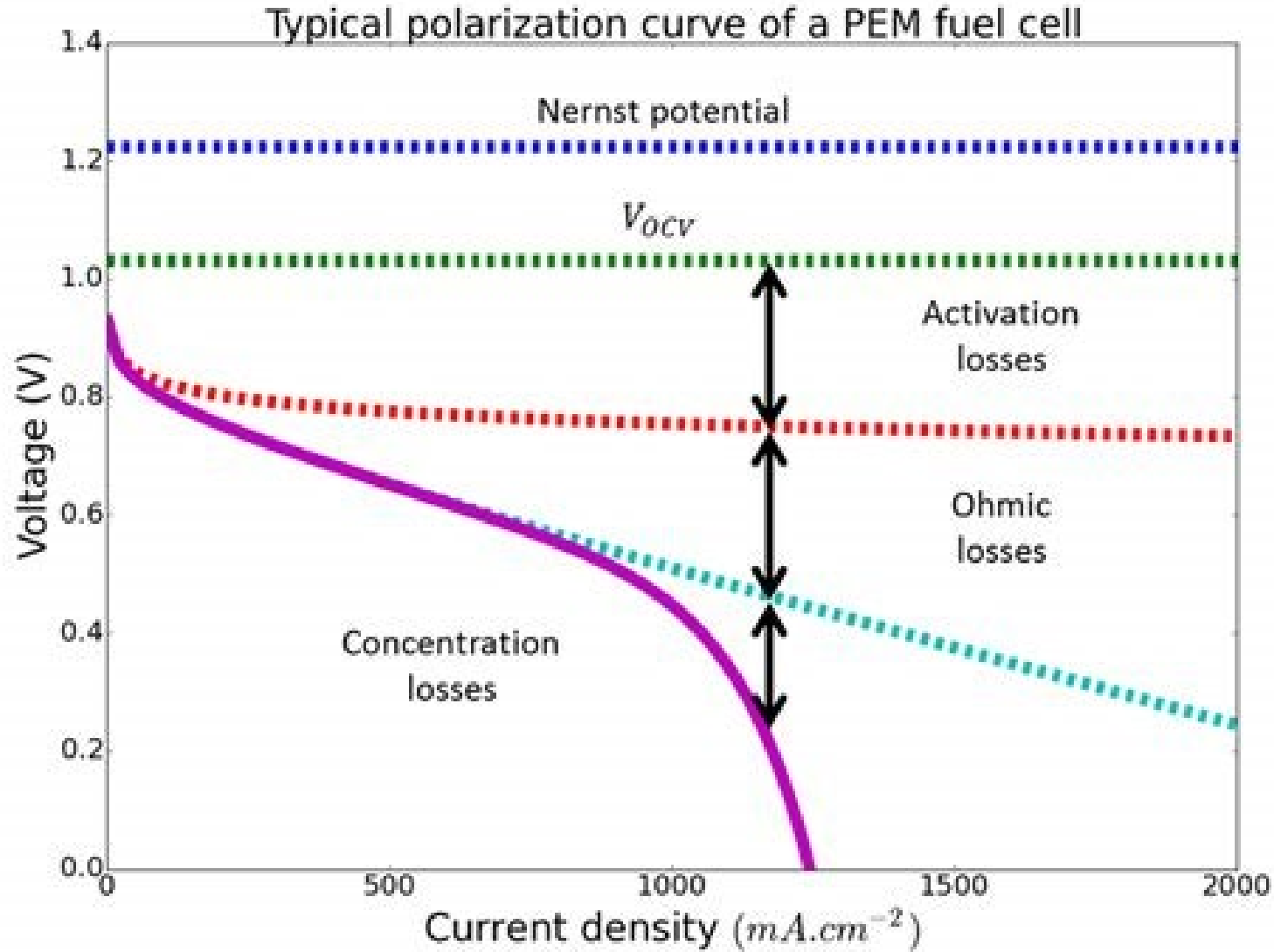
4 mg/cm² of Pt on each side
At today's Pt cost, ~ \$60/cell,
\$6000 per stack, \$100/kW

LANL FUEL CELL EVOLUTION : ~ 1990

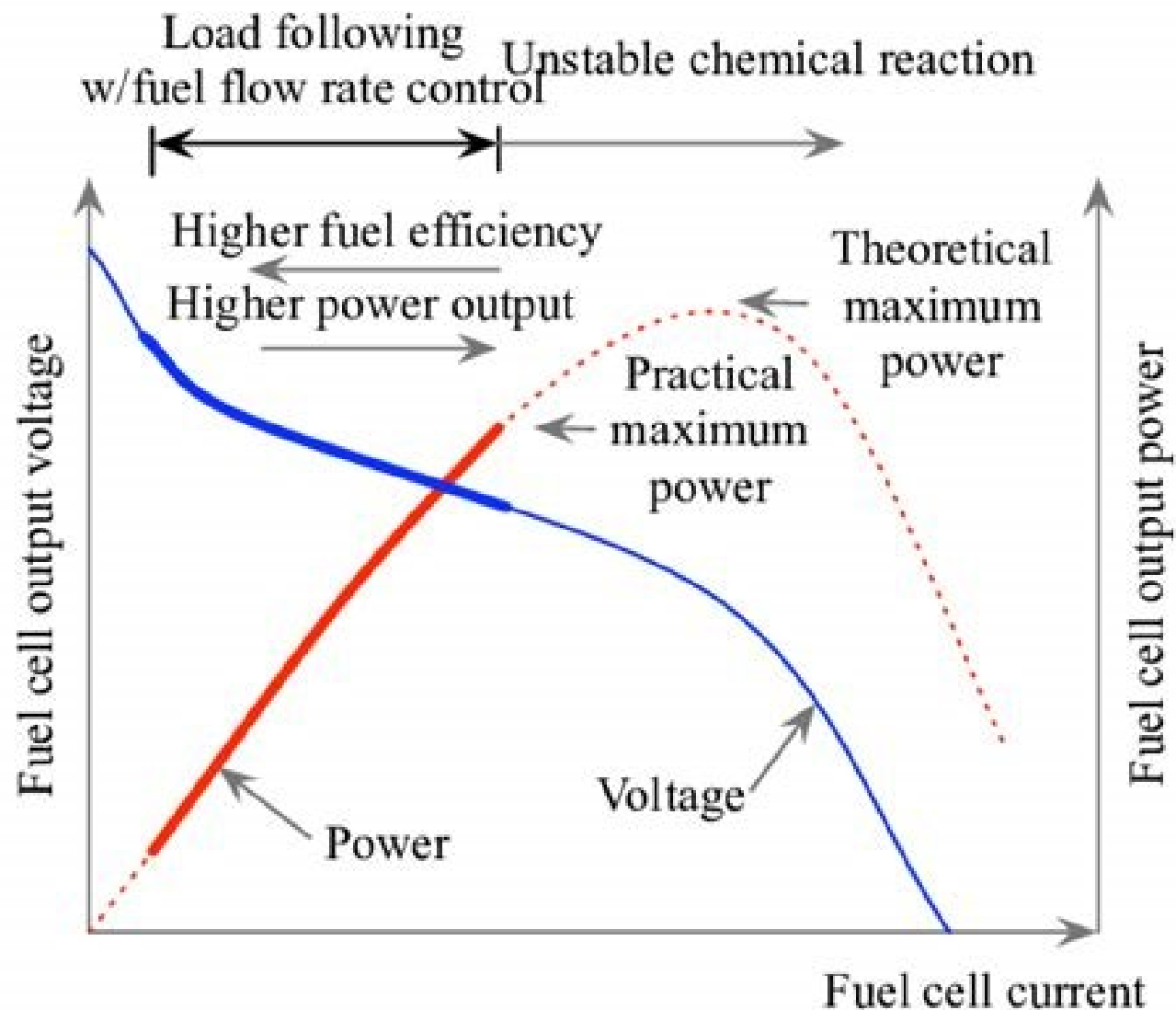


40 X reduction in Platinum Loading

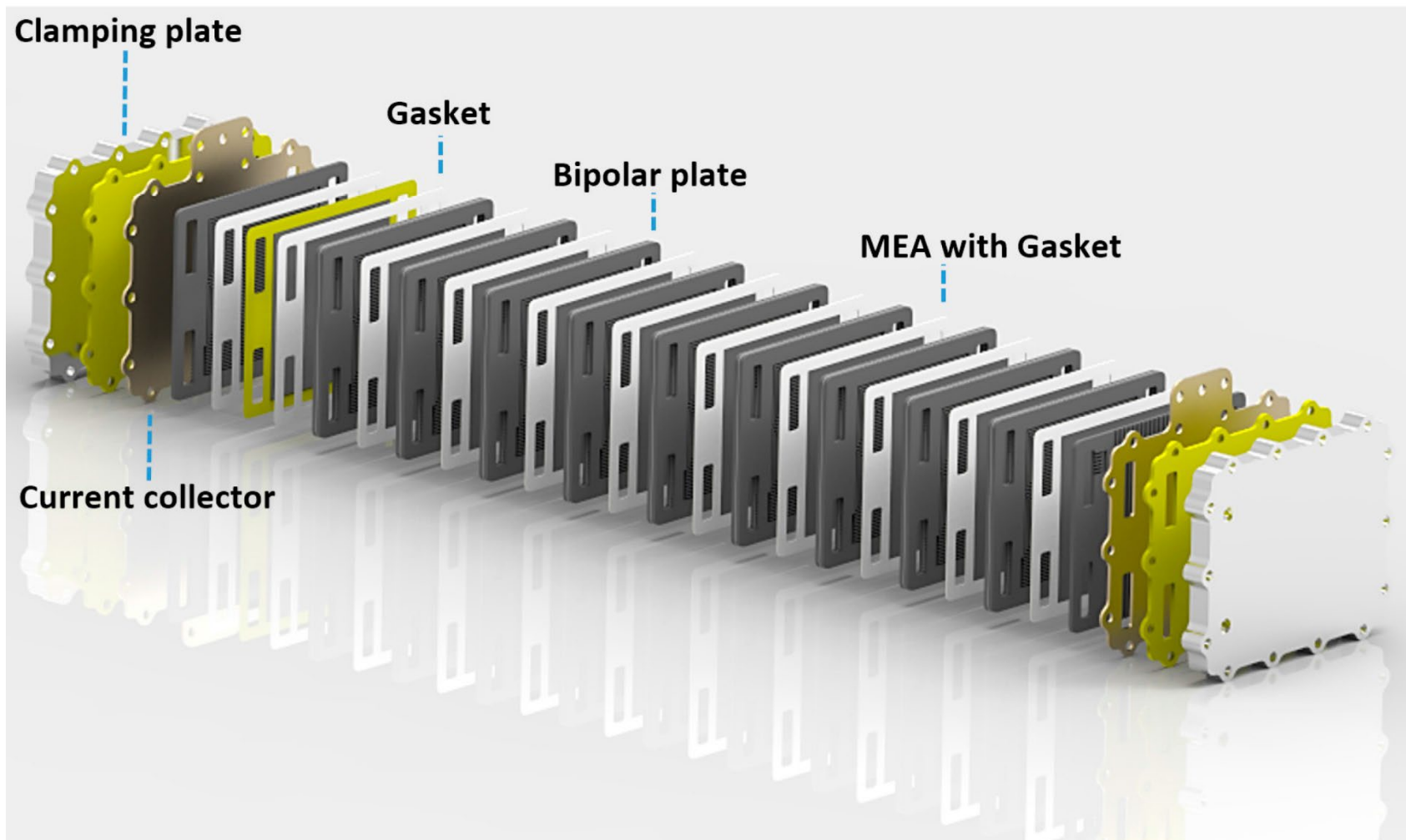
FUEL CELL PERFORMANCE CURVE



FUEL CELL PERFORMANCE CURVE

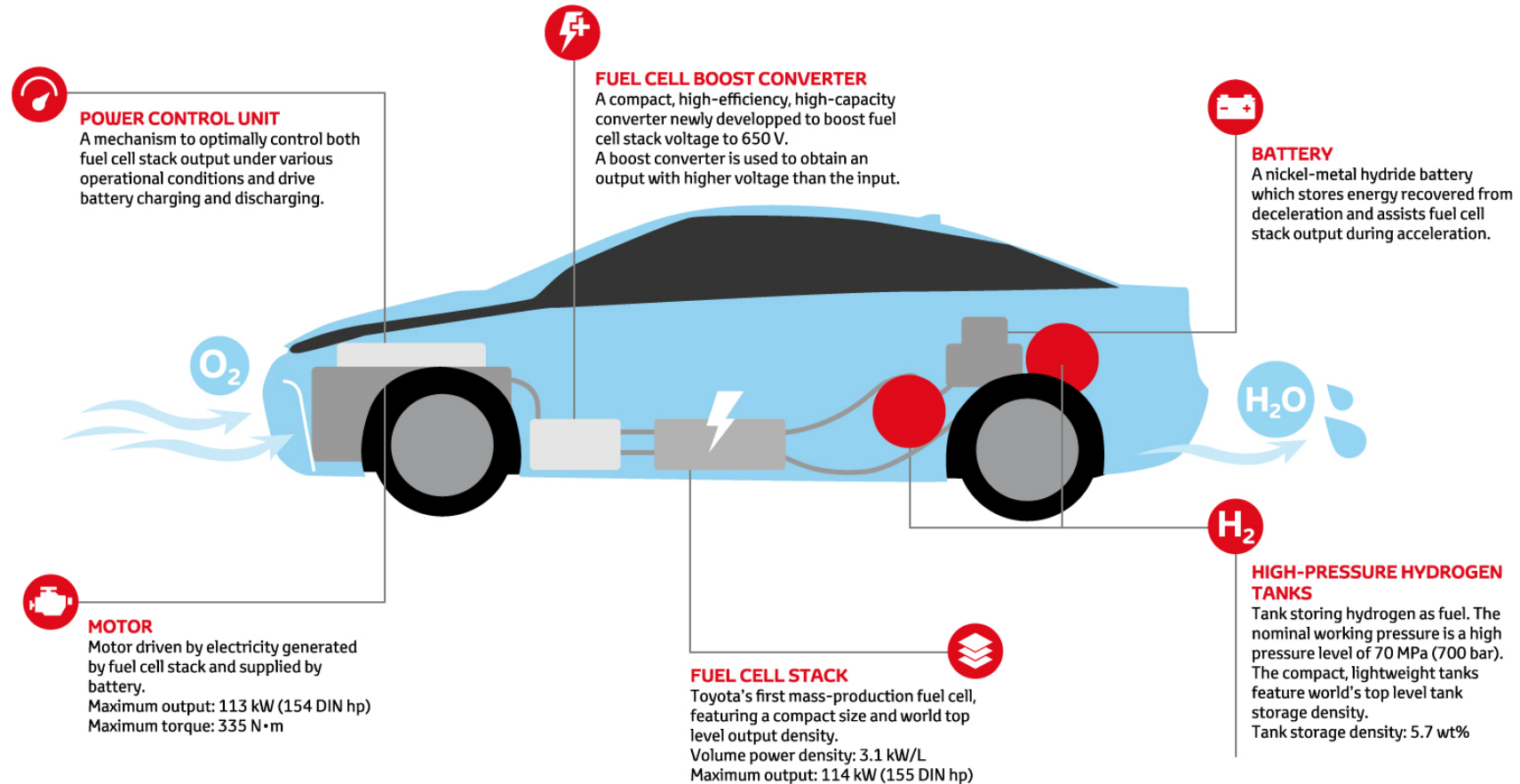


SINGLE CELL TO A STACK



FUEL CELL ENGINE : EXAMPLE: MIRAI

Fuel cell technology explained

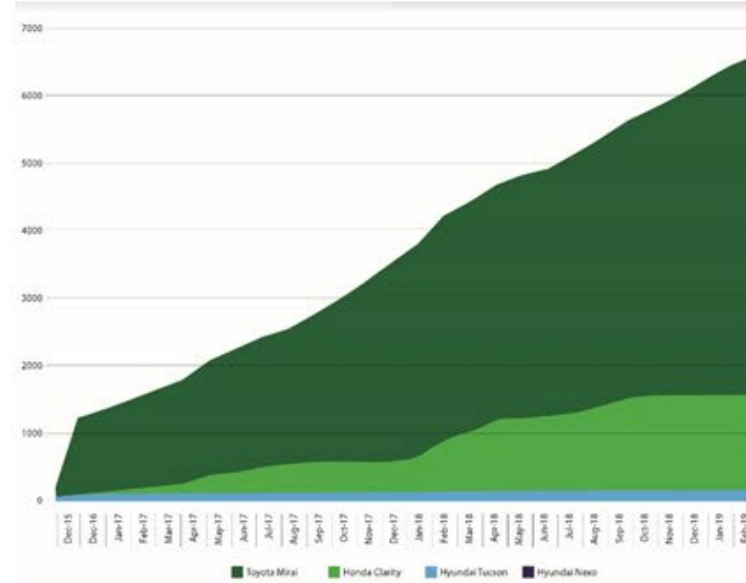


https://t1-cms-4.images.toyota-europe.com/toyotaone/gben/5_OperatingPrinciples_Detailed_OK_tcm-3060-554848.jpg

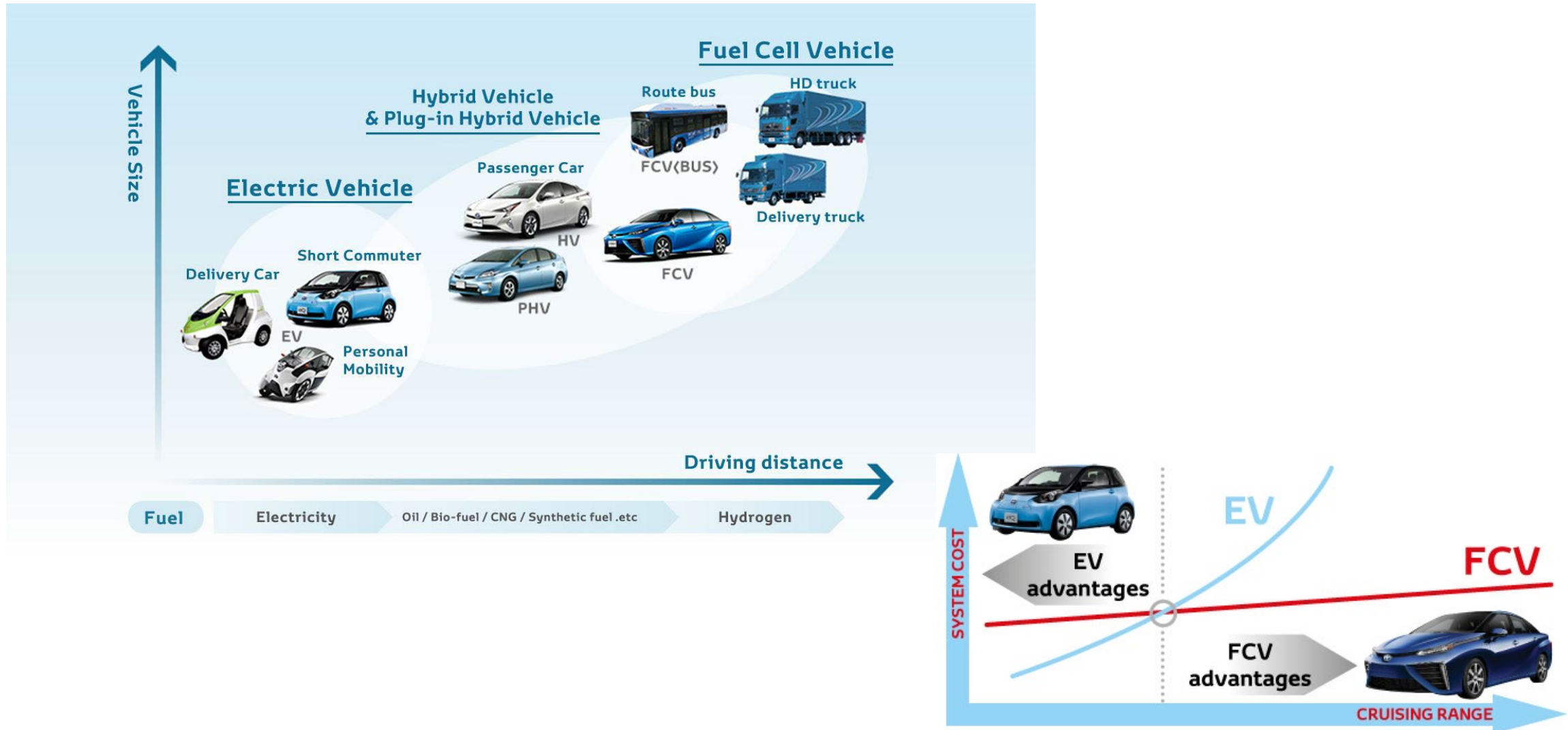


U.S. DEPARTMENT OF
ENERGY
Energy Efficiency &
Renewable Energy

GET *the* **FACTS**
ABOUT
FuelCells



BEV VS FCEV : ARE FUEL CELLS FOOL CELLS?





QUESTIONS?



THANK YOU