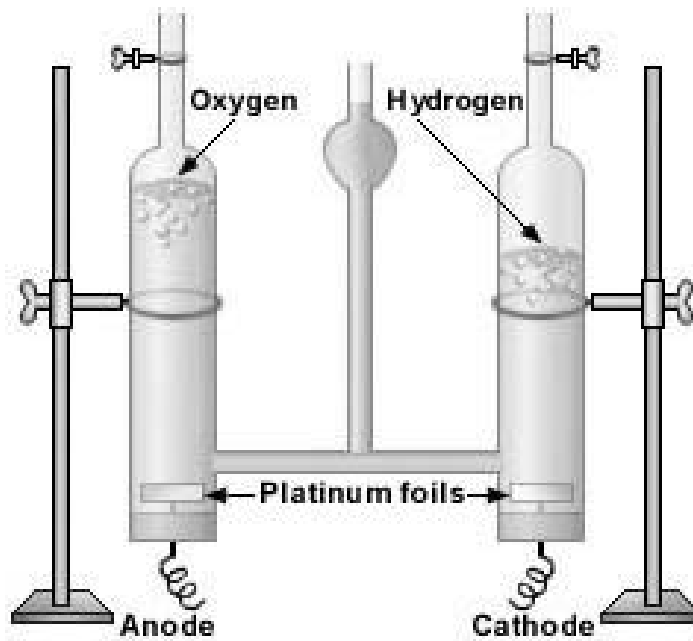


Fuel Cell Vehicles: A Viable Alternative?

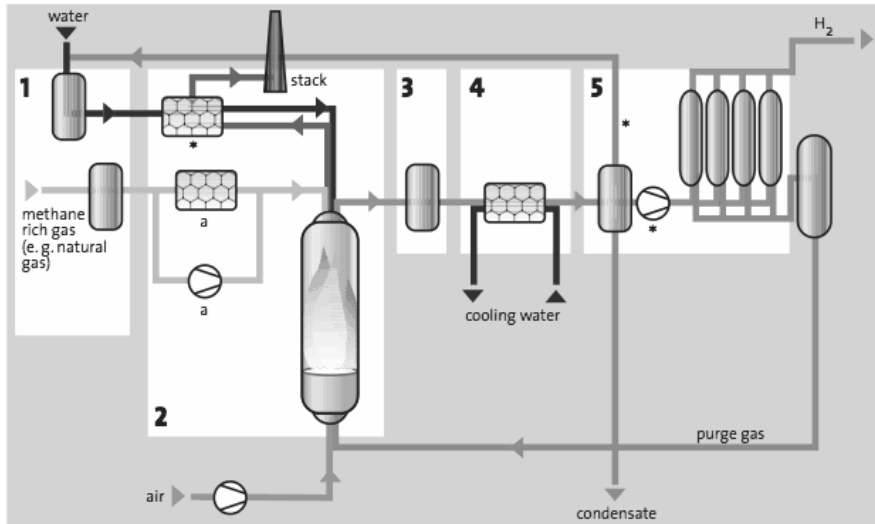


Battery Hydrogen Tanks Power Distribution Unit (PDU) Fuel Cell Module System Module Electric Motor

Electrolysis of H_2O



Steam Reforming of Natural Gas

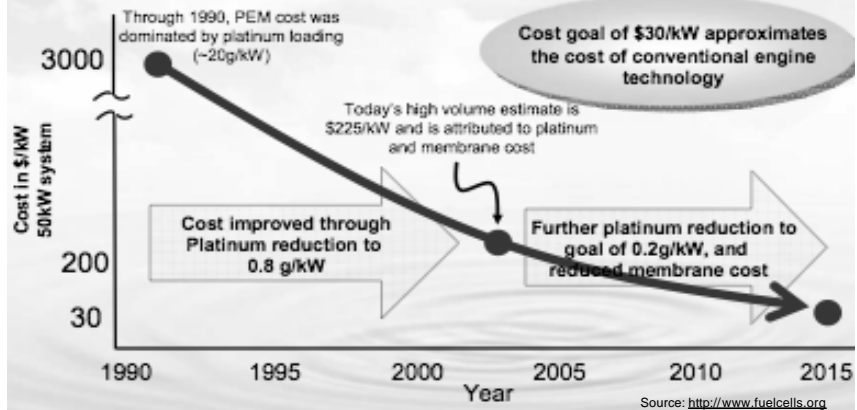


Proposed Hydrogen Fueling Stations Along Major Interstates



Cost: Can FCVs become affordable technology?

Cost of a fuel cell prototype remains high (~\$3,000/kW), but the high volume¹ production cost of today's technology has been reduced to \$225/kW



Technological Challenges

Onboard Storage

Limits of Hydrogen Volumetric Densities

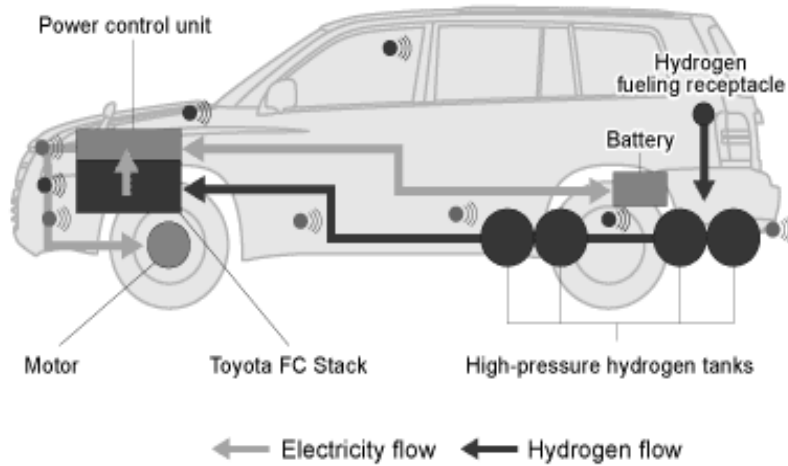
Fuel System	H2 Density, g/L
Gaseous H2	25
Liquid H2	70
Methanol	99
Liquid Ammonia	110
Reversible Metal Hydride	125

Practical Hydrogen Volumetric Densities

Fuel System	Practical H2 Density, g/L	Storage Efficiency, %
Compressed H2	10	40
Reversible Metal Hydride	20	16
Methanol Reformer	23	23
Liquid H2	26	37
Ammonia Dissociator	44	40

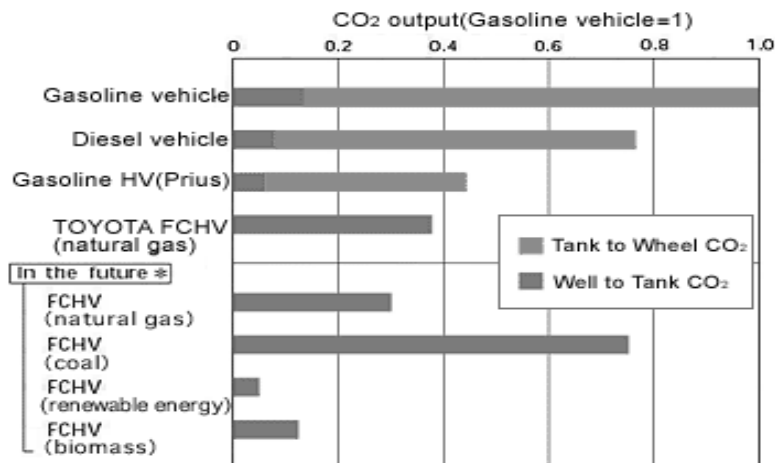
Safety Issues

- Components related to hydrogen
- Components related to high-voltage electricity
- Collision sensor
- Hydrogen sensor



Prospects for Implementation

Well-to-wheel CO₂ output



In the Japanese 10-15 test cycle, Toyota in-house testing
FCHV: Hydrogen fuel

* FCHV refers to direct hydrogen method;
items in parentheses are sources of hydrogen.