Hydrogen Powered Vehicles Pathways and Challenges

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Light-Duty Fuel Cell Power Train

DaimlerChrysler Necar 5

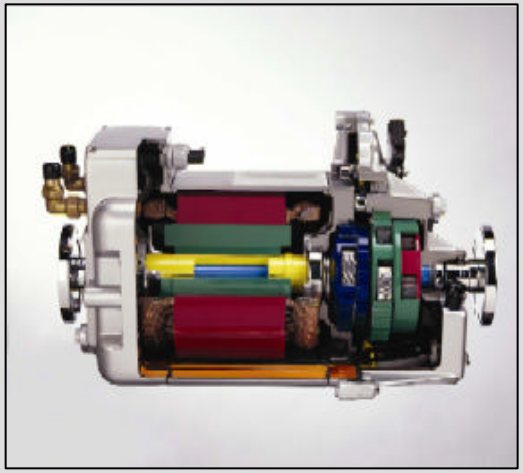
Pathways

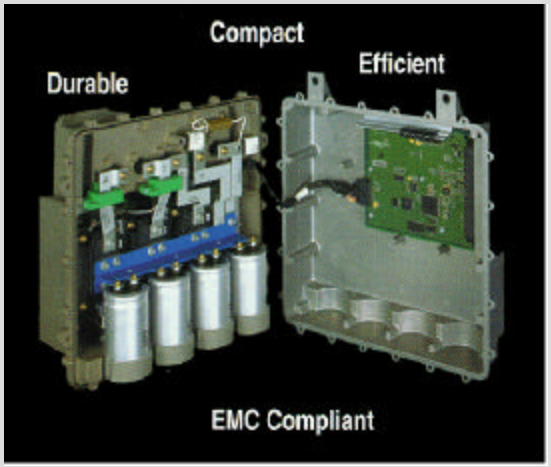
The Four Elements of Success

- Auto Companies work with Fuel Cell Developers for cost effective solutions
- Fuel Industry provide a viable fuel infrastructure
- Government develop financial incentives and set standards
- Coordinate for complimentary activities

Electric Drive Train

Co-axial design for battery
electric vehicles (Ford Ranger)





Transportation Field Trials

- Passenger cars
- There are 18 fuel cell vehicles powered by Ballard® fuel cells
- Buses
- Previous trials in Chicago, Vancouver and Palm Springs
- 30 buses in 10 European cities starting in 2002
- Other trials planned for Australia and California

Fuel Infrastructure

Multiple Sources

- Hydrogen can be produced from natural gas, electricity, and methanol

History On Our Side

- 1921 12,000 Gasoline Stations
- 1929 143,000 Gasoline Stations

Demand Drives Infrastructure

- All major hydrogen suppliers waiting for boom
- Infrastructure will grow from Centers-Of-Use

California Fuel Cell Partnership - Preparing The Future

- **Co-founded in 1999 by:**
  - Ballard, State of California, major auto-manufacturers and energy companies.
- **Currently has 19 partners and 9 associate partners**
- **Mission:**
  - Demonstrate / test Fuel Cell vehicles
  - Investigate fuel infrastructure issues
  - Promote public awareness of PEM Fuel Cell vehicles
  - Identify potential solutions to barriers to commercialization
- **Demonstrations**
  - The Partnership will place more than 70 fuel cell vehicles (cars and buses) on the road between 2000 and 2003

[1]Source: California Fuel Cell Partnership

Government's Challenges

- Funding
  - Advanced materials development
  - Demonstration programs
- Tax Incentives
  - Tax credits for rapid market penetration
- Standard Setting
  - Global Standards for engine and vehicle
  - Develop codes for refueling stations and service centers

What we need to do

- Continue to reduce costs
- Accelerate fuel infrastructure development
- Continue to validate reliability, durability, codes and safety standards
- Combine efforts for better overall solutions
- Promote partnerships to develop technology, products and market opportunities.