Jean Botti
Chief Technologist
Delphi - Dynamics & Propulsion

Delphi Overview

- World leader in mobile electronics, transportation components & systems
  - Fortune 40 company
  - Global Presence
  - Expertise in gasoline & diesel engine systems
- Leader in technology and electronics integration
  - Customer differentiating products
  - Diverse product line now seeking a diversified customer base
- Growth opportunities:
  - Automotive:
    - » Progression of IC Engine driven transportation to lower levels of harmful emissions and higher levels of performance.
    - » Hybrid powertrains with IC Engines and alternate power sources
  - Non-Automotive:
    - » Stationary Power & Mobile Power
    - » Medical Accessories - Use of automotive technologies applicable to the non-automotive market

Extensive Global Presence

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Total Delphi	
Manufacturing sites:	190
Employment:	211,400
Joint ventures:	44
Technical centers:	31

U.S. & Canada	
Manufacturing sites:	51
Employment:	73,100
Joint ventures:	8
Technical centers:	14

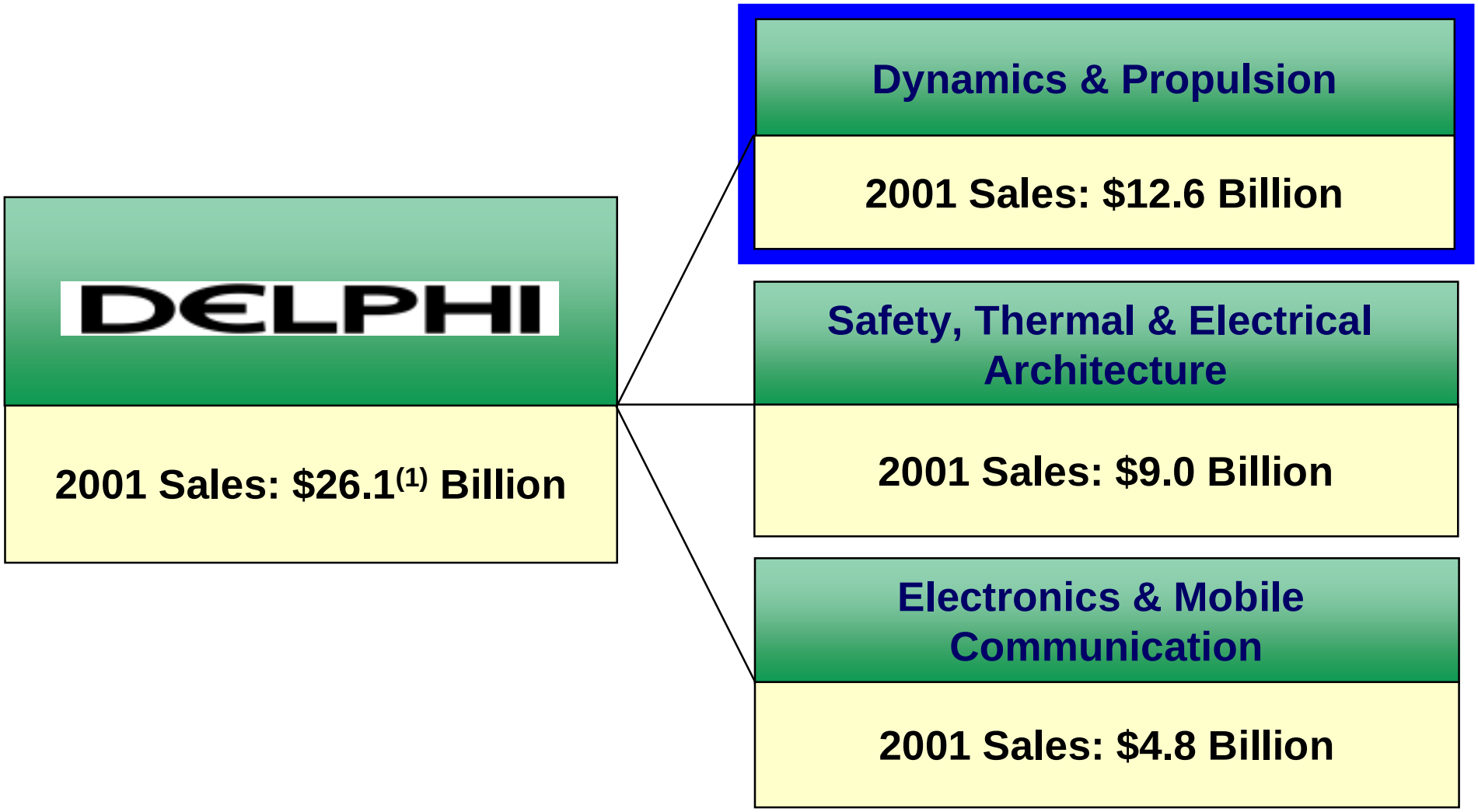
Europe & Middle East	
Manufacturing sites:	75
Employment:	48,000
Joint ventures:	8
Technical centers:	10

Mexico & South America	
Manufacturing sites:	46
Employment:	83,300
Joint ventures:	8
Technical centers:	4

Asia Pacific	
Manufacturing sites:	18
Employment:	7,000
Joint ventures:	20
Technical centers:	3

As of December 2000

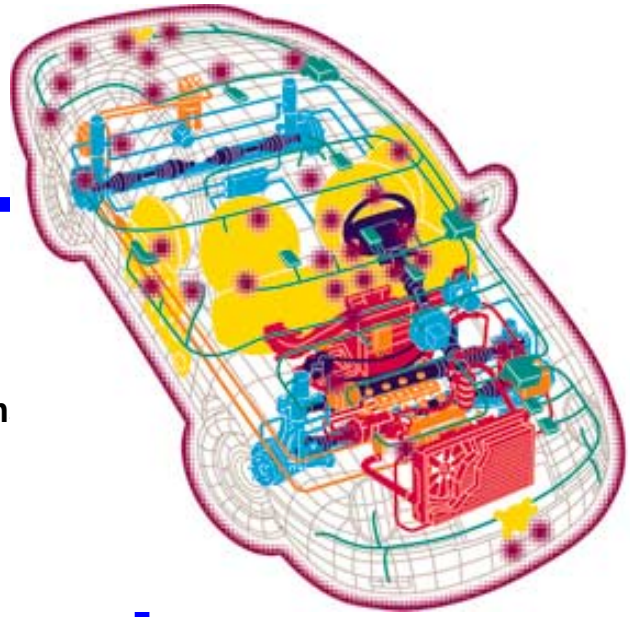
Delphi Sectors



(1) Includes inter-sector eliminations.

Current Product Portfolio

Fuel Cell related Systems & Components



Dynamics & Propulsion

Air/Fuel Systems
Ignition Systems
Exhaust Aftertreatment Systems
Fuel Handling & Evaporative System
Energy Storage & Conversion
Valve Train Products
Sensors & Solenoids
Chassis Systems & Modules
Intelligent Chassis Control Systems
Complete Brake Systems
Wheel Brake Components
Brake Apply Components
Gen III Wheel Bearing Modules
Suspension Dampers & Damper Modules
Vehicle Control Systems

- Electric Power Steering, Steering Columns, Power Steering Pumps & Hoses, Steering Gears, Driveline Systems, QUADRASTEER
- Half Shafts, CV Joints

Electronics & Mobile Communication

Sensors & Power Modules
Powertrain Controllers
Body & Chassis Electronics
Electronic Control Units
Supplemental Inflatable Restraint Electronics
FOREWARN Collision Warning Systems
Audio Systems
Communications Systems
Navigation Systems
Driver Information & Controls

Safety, Thermal & Electrical Architecture

Instrument Panels
Airbag Systems
Steering Wheels
Power Products
Door Hardware & Trim Modules
Latching Systems
Modular Doors
Climate Control Systems

- HVAC Modules, Condensers, Compressors, Accumulator Dehydrators, **Thermal Management Systems**

Powertrain Cooling Systems

- Radiators, Oil Coolers, **Engine Cooling Modules**

Power & Signal Distribution Systems
Connection Systems
Switch Products
Sensors
Electronic Products
Fiber Optic Lighting/Data
Electrical/Electronic Centers
Ignition Wiring Systems
Modular Cockpits

Fuel Cells
Delphi's Core Competencies

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- Application of skills to the commercialization of Fuel Cells for Automotive and other markets
  - Automotive Market access and experience
  - Systems integration expertise
    - » Engine Management Systems
    - » Fuel Systems Integration and Air-Fuel Management
    - » Emission System Control and Diagnostics
    - » Regulatory Compliance
  - Complementary technology expertise
  - Electronic Controls and Power Electronics in relatively harsh environments

- High Volume Low Cost Manufacturing
  - Decades of automotive experience in this very competitive market have honed skills of high reliability, low cost manufacturing

Fuel Cells
A Means to Realize Delphi's Vision

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- Following our customers' needs
  - Help reduce fuel consumption
  - Reduce harmful emissions
  - Use combination of fossil and renewable energy sources

- Duty as a Corporate Citizen
  - Use our expertise and established manufacturing base to support national imperatives
  - Support SECA by providing Auxiliary Power Units and 21st Century Truck Initiative with Essential Power Units
  - Help establish alternate energy sources for transportation and stationary power
  - Look after our stakeholders' interests by ensuring future growth

Fuel Cells
Fuels To Applications

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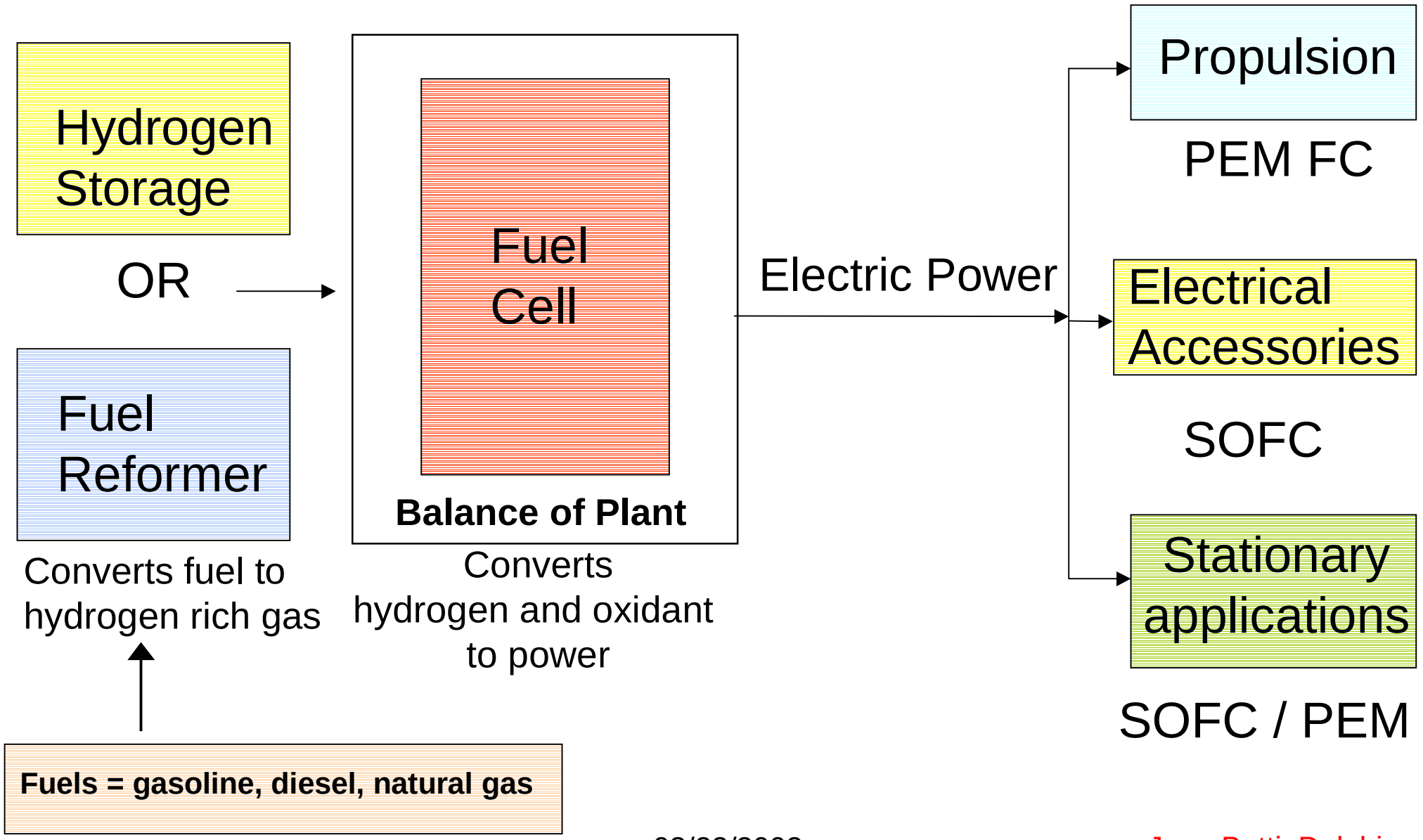

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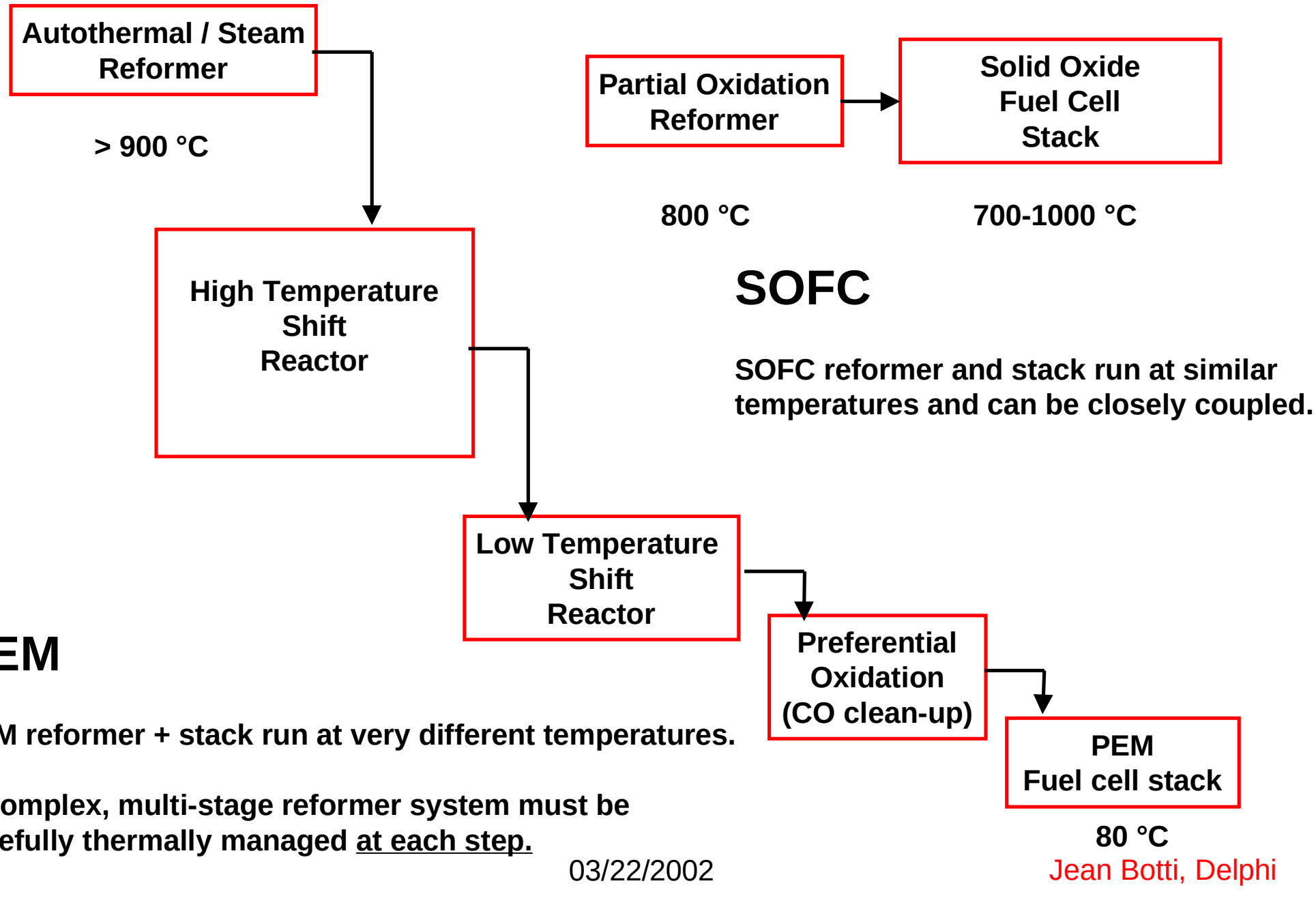
Reformer Complexity - SOFC vs PEM



SOFC

SOFC reformer and stack run at similar temperatures and can be closely coupled.

PEM

PEM reformer + stack run at very different temperatures.

A complex, multi-stage reformer system must be carefully thermally managed at each step.

SOFC APU Applications

- SOFC SYSTEM as an AUXILIARY POWER UNIT (APU).
  - Markets: trucks, passenger automobiles, recreational vehicles, stationary applications, military.

Gasoline APU
for passenger automobiles

Diesel Truck APU

Stationary applications -
Natural gas or diesel

Transportation Market Automotive - Need for APU

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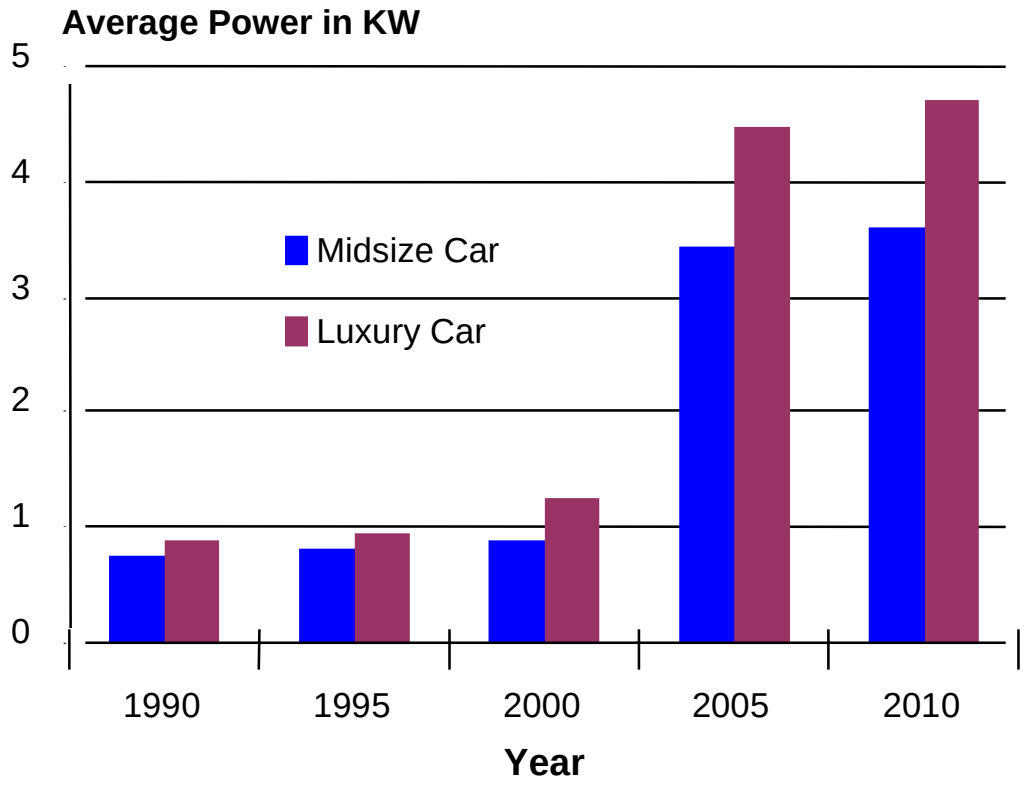
- Increased Electrical Power needs are being driven by advanced IC Engines for enhanced performance, emission controls, and creature comforts
  - Electrical Power Steering
  - Direct Injection
  - Electrically Heated Catalyst
  - Electrical Water Pump
  - Electro-magnetic Valvetrain
  - Engine Cooling Fan
  - Electric AC Compressor
  - Heated Windshield, Seats



- These requirements are beyond the capabilities of the Lundell type generator and require supplemental Electrical generation, such as from an SOFC APU.

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Transportation Market
Heavy Duty Truck

- Hotel Loads
  - Supply electrical power for cabin needs with vehicle engine off: air conditioning/heating, mobile office, microwave, etc.
- Reduce emissions by reduction of load or total run time of the engine
  - Allow the shutdown of engine during extended idle or overnight operation
  - Reduce parasitic loads on the engine through electrification of accessory drives, i.e. water and oil pumps, hydraulic drives, cooling fans
- Technology enabler for additional electrical/electronic devices

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Stationary Markets: Distributed Generation

- Distributed Generation (DG) is the production of power at or near the point of use
- Key advantages of Distributed Generation are:
  - The ability to add generation capacity in smaller increments
  - The ability to avoid installation of additional electrical power transmission capacity
  - The ability to cogenerate heat at the point of use
  - An ability to develop either a microgrid of several DG units or work the DG units in conjunction with the traditional grid in order to provide higher reliability
- DG is an emerging market and is not as clearly defined as the transportation market - particularly with respect to distribution channels

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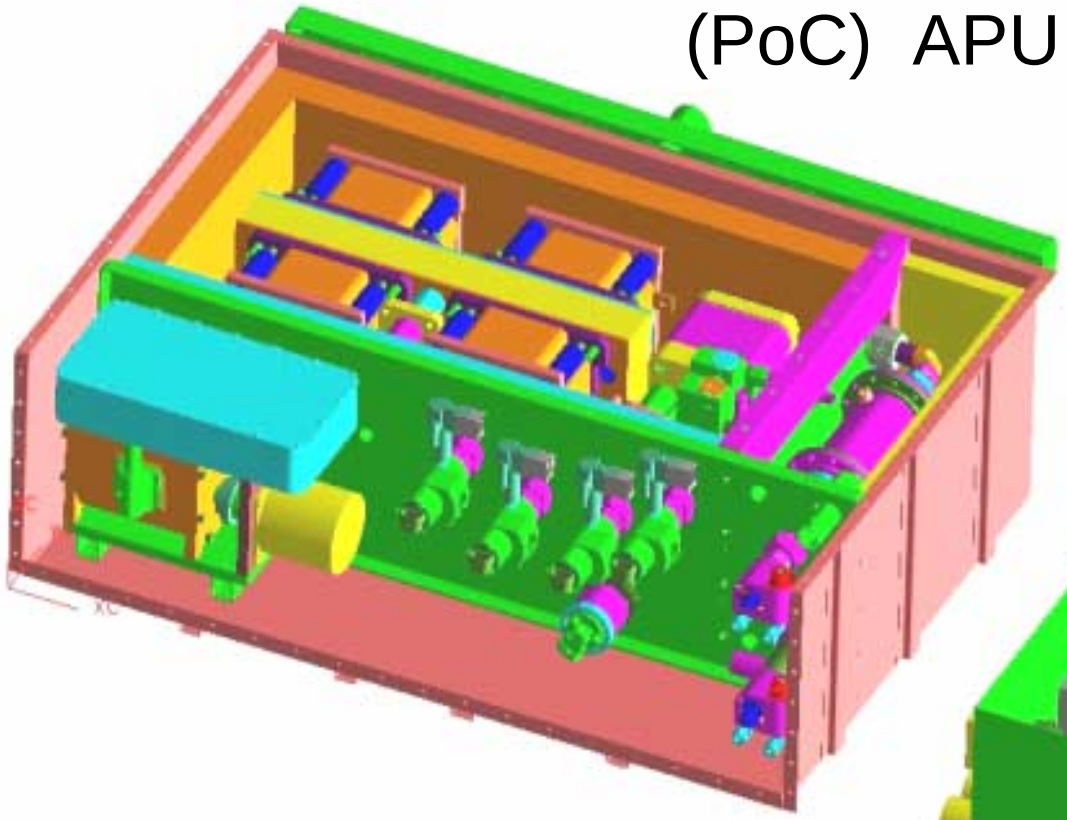
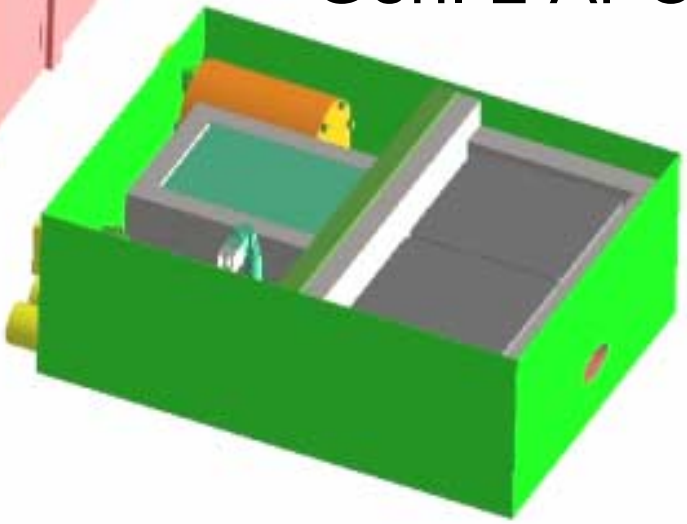
SOFC Auxiliary Power Unit Development Status

Proof of Concept (PoC) APU



Gen. 2 APU



Size reduction:
PoC: 152 Liters
Gen. 2: 50 Liters

Mass reduction:
PoC: 200 kg
Gen. 2: 50 kg

Thermal Cycles
Targets by application

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- In addition to the large reduction in system size and weight, the Delphi-Battelle cell and stack is designed to be thermally cycled.

- Thermal cycle requirements depend on application:

  - 2004 development goal: 100 cycles

  - Stationary market entry: 500 cycles
  - Stationary market mature: 2000 cycles
  - HD Automotive market entry: 3000 cycles
  - HD Automotive mature: 5000 cycles
  - LD Automotive market entry: 5000 cycles
  - LD Automotive mature: 10000 cycles

System Cost Targets - by application

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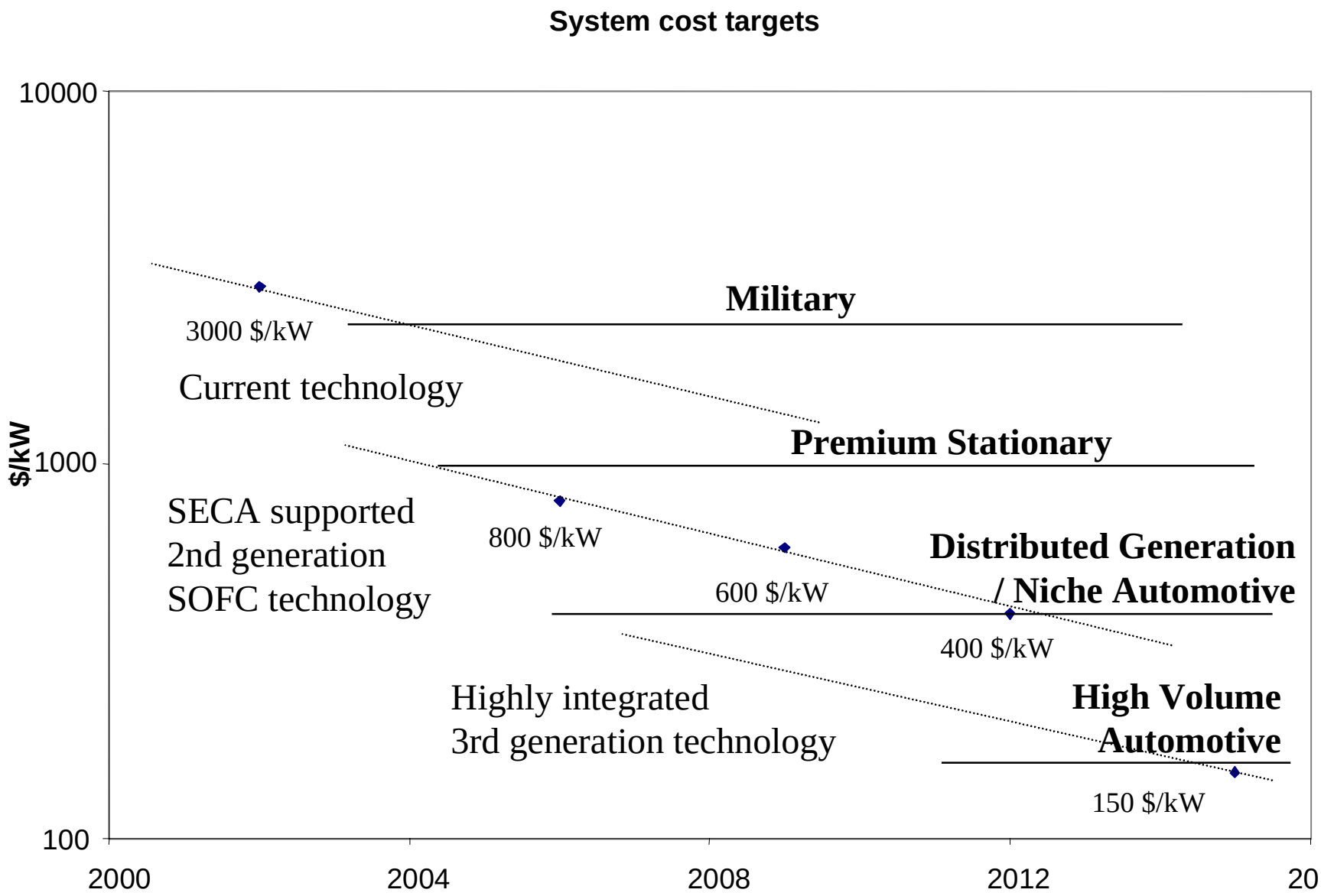

System Cost Targets - are they realistic?

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- Learning curve and incremental product and process innovations are likely to drive large cost reductions
- Disruptive changes in materials, product and processes are also required to meet high volume automotive goals:
  - less use of premium materials (thinner layers)
  - lower temperature operation
  - new metallic alloys and low cost processing techniques
  - highly integrated reformer/stack/heat exchange
  - simplified balance of plant
  - integrated controls and power electronics
  - model based controls
- High volume potential of automotive applications may accelerate cost reduction and result in higher volume stationary applications which will accelerate cost reduction further.

Synergies with Delphi's SOFC program: Hydrogen Enrichment / SULEV ICE

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Strategies:

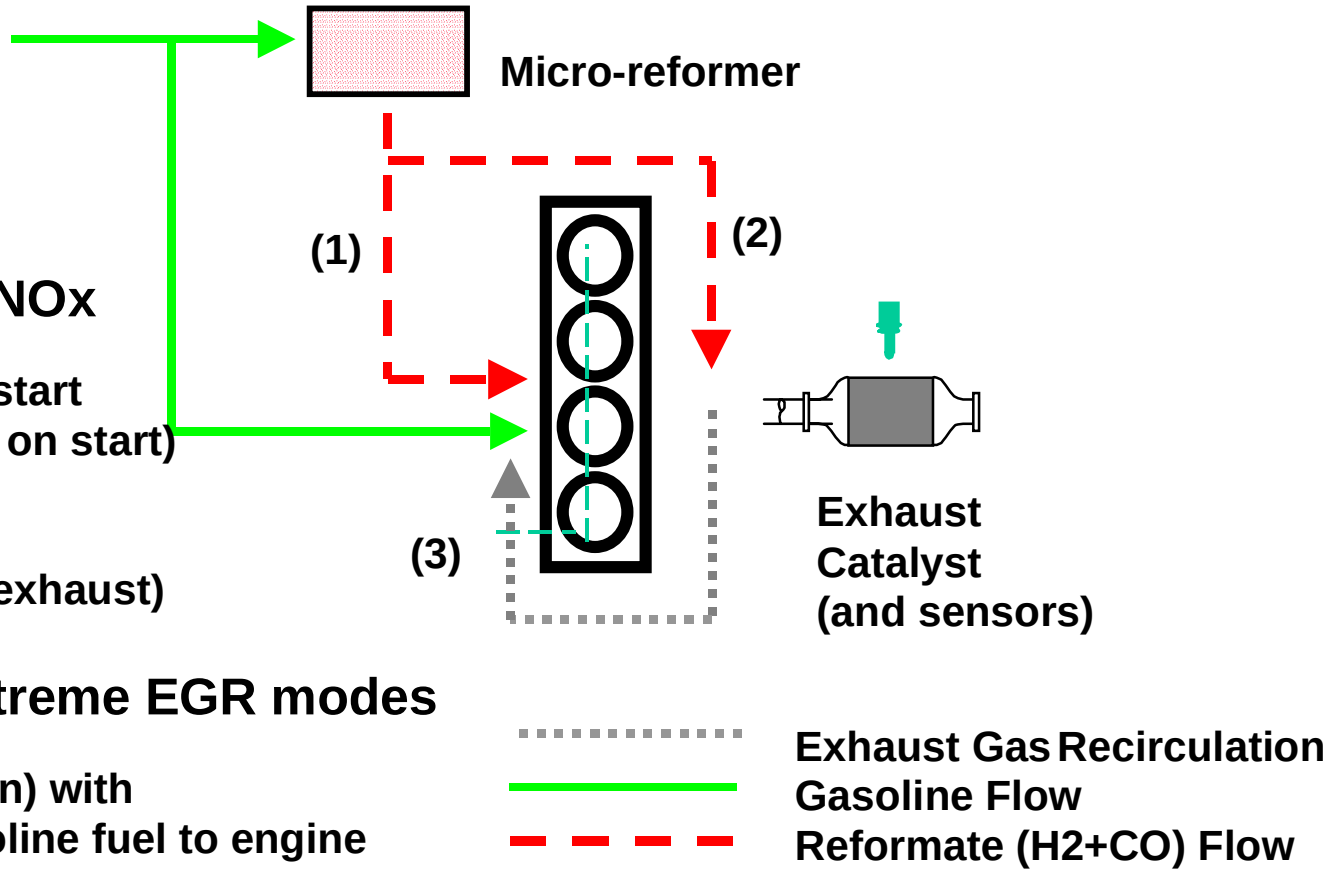
Start: Nearly zero HC and NOx

(1) Extremely low emission cold start on reformate (only fuel to engine on start)

(2) Accelerated catalyst heating (reformate added to lean engine exhaust)

Run: low NOx – lean or extreme EGR modes

(3) High dilution (with EGR or lean) with partial reformate and partial gasoline fuel to engine



Super low emission gasoline engine EMS with a fast light-off micro-reformer

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Fast-startup reformer:

- This video shows the start-up of a prototype reformer in < 10 s. The project goal for SULEV ICE applications is < 2 s.
- SOFC and SOFC/ICE systems will contain this type of device.

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Summary

- Delphi is a Leading Global Systems and Component Supplier
- Delphi Provides Solutions to Customer Needs
  - Quality Focused
  - Evolving Manufacturing Footprint
  - Expanding Technical Resources
  - Customer Focused Marketing
  - Global Presence
- We believe that SOFC is a technology with promise that offers advantages over other power systems - especially in the 1 - 10 kW size range.
- Delphi intends to use both existing competencies and new technology to target the growing market for SOFC systems in stationary and automotive applications.

Driving Tomorrow’s Technology