



A View From the Bridge



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Overview

PART 1: New GM

PART 2: Collaborative Model for Powertrain Development

PART 3: Integrated Systems Approach

- **Energy & Transportation**



July 10, 2009... just 40 days after filing

A New GM Launches



with a focus on
**Customers,
Cars and Culture**

more...



New GM

■ Stronger Brands and Dealers

- 4 Core Brands; 34 US nameplates
- ~3,600 dealers down from ~6,000



■ Stronger Balance Sheet

- US debt of ~11 billion (reduced from more than \$40 billion)
- 34 US Assembly, Powertrain and Stamping plants (down from 47)
- GM expects to increase capacity utilization from less than 45% in 2009 to nearly 100% in 2011
- US Employment reduction from ~91k at the end of 2008 to ~64k at the end of 2009



New GM*

“...Will continue and increase its investment and leadership in ***fuel economy*** and ***advanced propulsion*** technologies and is committed to ***meeting or exceeding new federal fuel economy and emissions regulations*** while contributing to the ***development of advanced engineering and manufacturing capabilities in the United States...***”

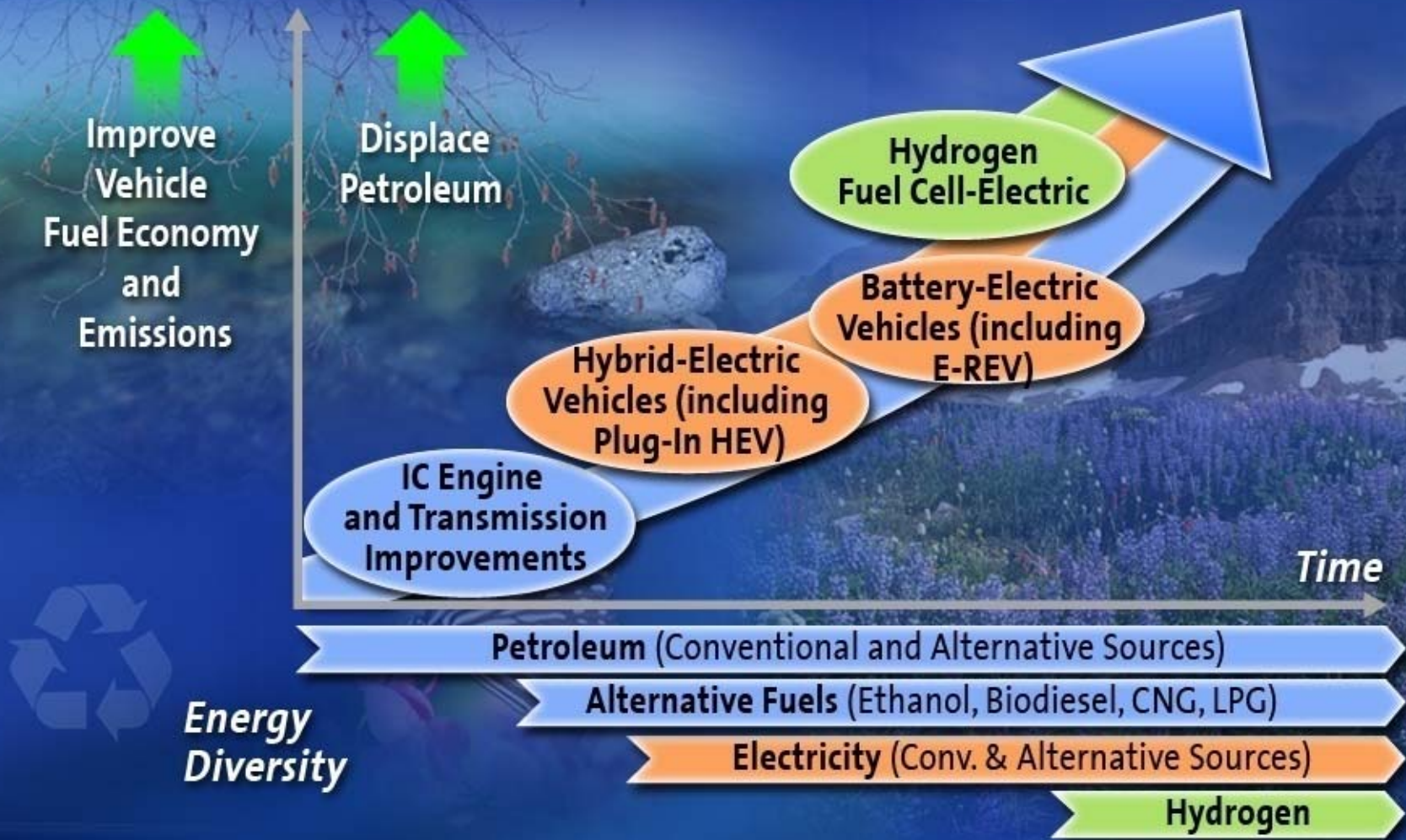


New GM*

“...GM will launch the ***Chevrolet Volt*** extended range electric vehicle in 2010, expects to have ***14 hybrid models*** in production by 2012 and will have ***65 percent of vehicles alternative-fuel capable*** by 2014.”



Advanced Propulsion Technology Strategy



Collaborative Model for Powertrain Development

Robust Supply Base

**Partnership Between
Automakers &
Energy Providers**



**Collaboration Between
Automakers, Academia &
Governments**

Engaging the Customer



Collaborative Model for Powertrain Development

- Great demand for technical work force with expertise in new regimes
- GM has initiated research and education programs at universities around world (Shanghai Jiao Tong University in China, University of Wisconsin, University of Michigan, Politecnico di Torino, Technical University of Vienna)
- GM has a number of key industrial partnerships with other OEM's – Ford, Chrysler, Daimler, BMW, SAIC, Suzuki
- GM has collaboration activities with all DOE labs, NIST, ARDEC, TARDEC, NREL, Ames Lab, Pacific Northwest National Lab, and EPA



“.....Need to run the business with more ***collaboration and shared structures.***”
Fritz Henderson, “Launch of New GM”,
July 10 , 2009



Collaboration with DOE

- **Collaboration with multiple labs**
 - **Oak Ridge National Lab, Sandia National Lab, Argonne, Brookhaven, NREL, Los Alamos National Lab, and Lawrence Livermore Lab**

- **Examples of successful collaboration**
 - **Development of Molybdenum free casting process at Oak Ridge National Lab for cost reduction**
 - **Research at Sandia Combustion Laboratory providing key insights into HCCI and Diesel technology**
 - **Plug-and-Play Model Architecture and Development Environment with Argonne Lab providing a key tool to model vehicle systems for system performance and optimization**
 - **Energy System Modeling at Sandia Laboratory to study well-to-wheel impact of ethanol usage**



Renewable Fuels Alliances

GM is engaged in the development of non food-based renewable fuels

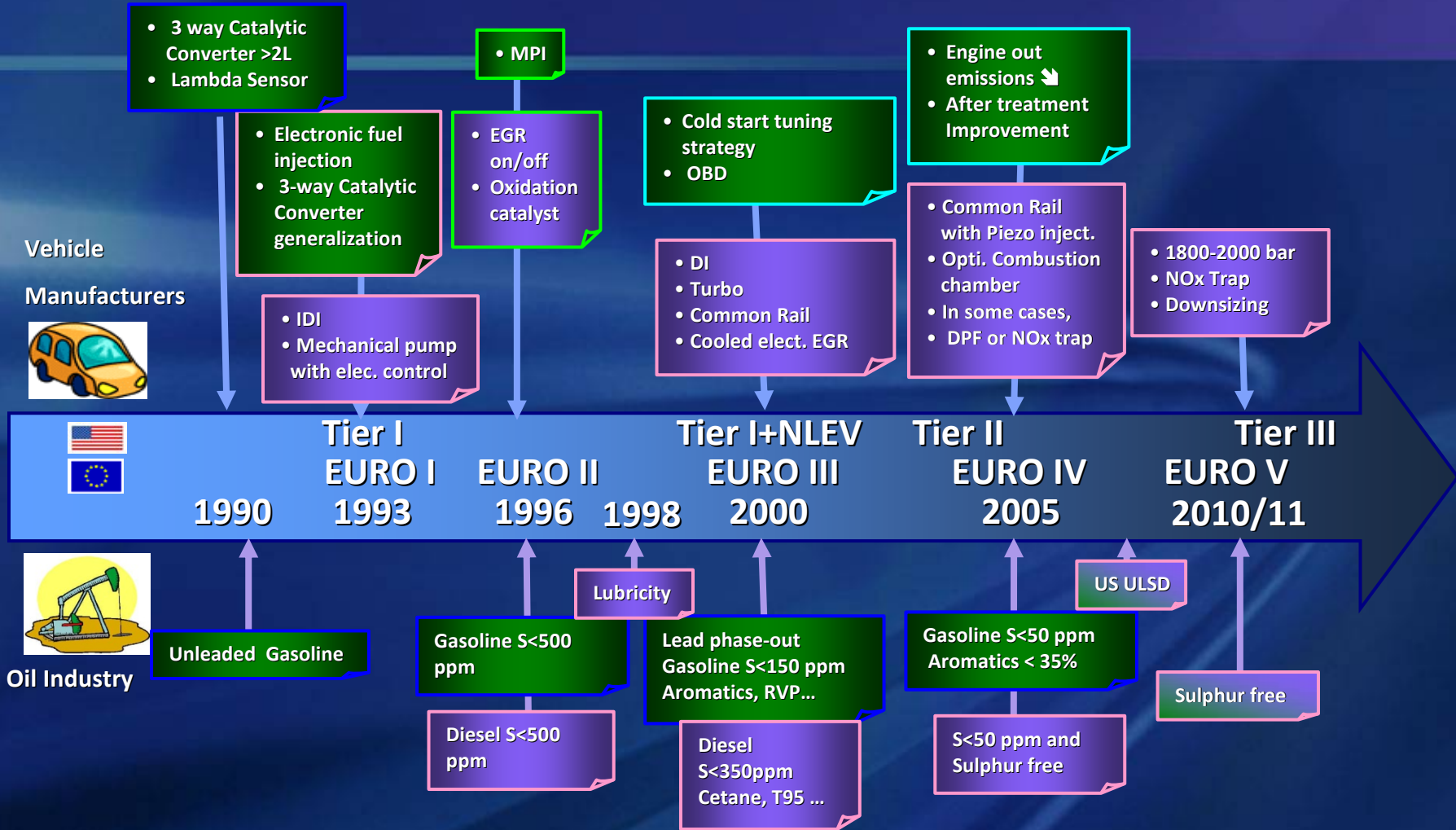
Strategic Alliances

- GM is committed to the rapid commercialization of “The Next Generation of Ethanol”
- GM has strategic alliances with two leading cellulosic ethanol start-ups, Coskata and Mascoma
- The processes used by these companies will make ethanol from non-food, renewable resources
- Fuel production cost goal: \$1.00-1.35/gallon



Collaboration with Oil Industry

Reduction in Emissions



Vehicle Energy Loss Breakdown

■ Efficiency = Work Output/Work Input

- 14% of Engine Shaft Work
- 4% of Fuel Energy

■ Typical Losses

- 22% in Engine Friction and Pumping
- 20% in Aerodynamic drag
- 14% In Tire Rolling Resistance
- 10% in Driveline/Brake Drag/Chassis
- 10% in Transmission
- 24% in Others



Chevrolet Malibu



Efficiency

Mechanical Efficiency

$$\frac{\text{Work Output}}{\text{Work Input}}$$



Perceived Efficiency

MPG

$$\frac{\text{Miles Traveled}}{\text{Cost}}$$

$$\frac{\text{Miles Traveled}}{\text{Gasoline Consumed}}$$



Chevrolet Volt / Opel Ampera

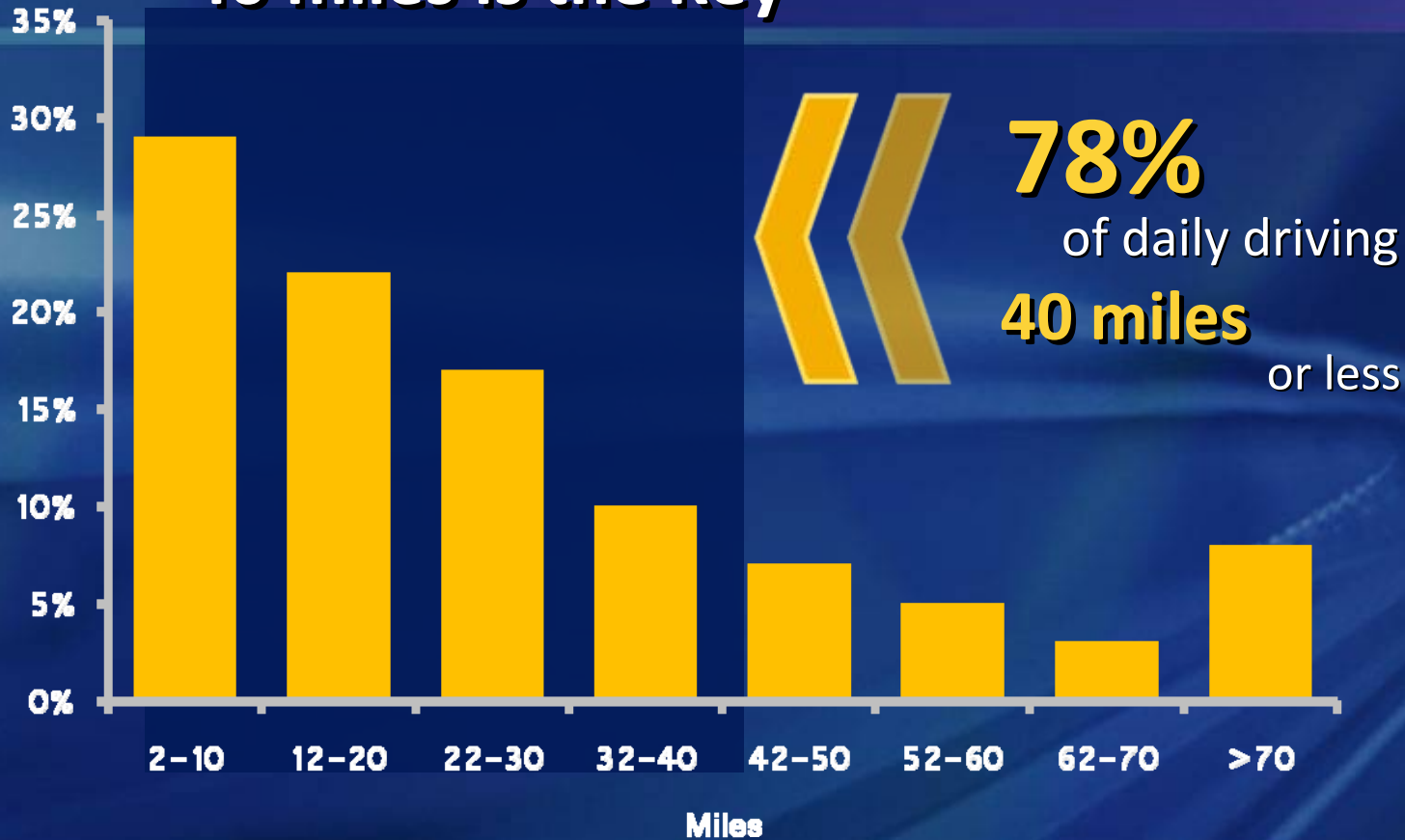


40 miles **BATTERY** Electric Drive **+** **400** miles **EXTENDED RANGE** Driving



Typical Daily Commute

40 miles Is the Key



Source: OmniStats Data by the US Bureau of Transportation



Perceived Efficiency with Electrification

- Perceived Efficiency = Cost/Mile

10¢ per mile **7¢ per mile** **1¢ per mile off-peak**
(2¢ on-peak)



The image shows two gas price signs on the left and a meter on the right. The left sign has prices for Self Serve: Regular Unleaded at 303 9/10, Plus Unleaded at 313 9/10, and Supreme Unleaded at 323 9/10. The right sign has prices for Self Serve: Regular Unleaded at 203 9/10, Plus Unleaded at 213 9/10, and Supreme Unleaded at 223 9/10. The meter in the center is a round, silver-colored device with a digital display showing '00000000' and several analog gauges. It is labeled 'KILOWATTHOURS' and 'R_f 13 9/10'.



Vehicle Electrification

Future requirements drive a progression towards increasing electrification



Conventional Engine/ Transmission

- Baseline
- SIDI
- 2-step valve
- HCCI
- Turbo boost
- 6 speed transmissions
- Active Fuel Management

Mild Hybrid

- Engine stop start
- Recoup braking energy
- Electric power assist

Full Hybrid

- Baseline plus:
- Engine operating point optimization
 - Electric launch
 - Limited pure electric drive

Plug-in Hybrid

- Baseline plus:
- Plug-in rechargeable
 - Significant electric drive

Extended Range Electric Vehicle

- Baseline plus:
- Full-function electric drive
 - Initial pure electric range

Fuel Cell Electric Vehicle

- 100% pure electric range
- No exhaust emissions

Functionality

Drive System

Mechanical with Electric Assist

Electric with ICE Generator

All Electric

Increasing Level of Efficiency and Reduced Emissions



Summary

GM's Advanced Propulsion Technology Strategy will...

- **Reduce fuel consumption and GHG emissions**
- **Be sustainable through energy diversity**
- **Displace petroleum**
- **Enabled by partnerships**



GM Papers

- **Panel Discussion – New Direction in Engine and Fuels – J. Gary Smyth**
- **Passive NH₃ SCR for Lean-Burn SIDI Engines – Wei Li**
- **Engine and Reactor Evaluations of HC-SCR for Diesel Nox Reduction – Richard Blint**
- **Development of Thermoelectric Technology for Automotive Waste Heat Recovery – Jihui Yang**
- **Improving Automotive Energy Efficiency by Developing Components for Distributed Cooling and Heating Based on Thermal Comfort – Jihui Yang**

