2008 DOE Vehicle Technologies Merit Review

Drivers and Directions

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This presentation does not contain any proprietary or confidential information

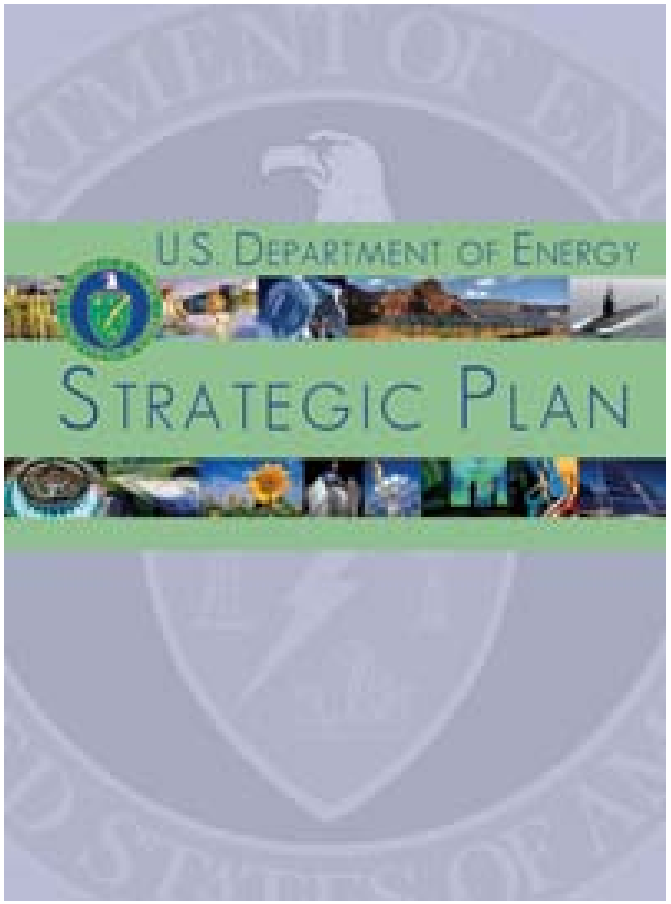
Outline

- Strategic Plan and Goals
- Planning Context
- Executive and Legislative Drivers
- Vehicle Technologies Structure
- Programmatic Accomplishments
- R&D Approach
- Budget
- Summary

DOE Strategic Plan

FCVT Supports DOE's Energy Security Strategic Goal

- Energy Security Strategic Goal
  - Goal 1.1 – Energy Diversity
    - Reduce dependence on energy imports, particularly oil in the transportation sector…
    - Collaborate globally with governments and scientists to expedite the development and deployment of unconventional energy resources…
  - Goal 1.2 – Environmental Impacts of Energy
    - Develop technologies to reduce vehicle emissions by improving efficiency and greatly expanding the use of clean fuels…



Goals for Vehicle Technologies

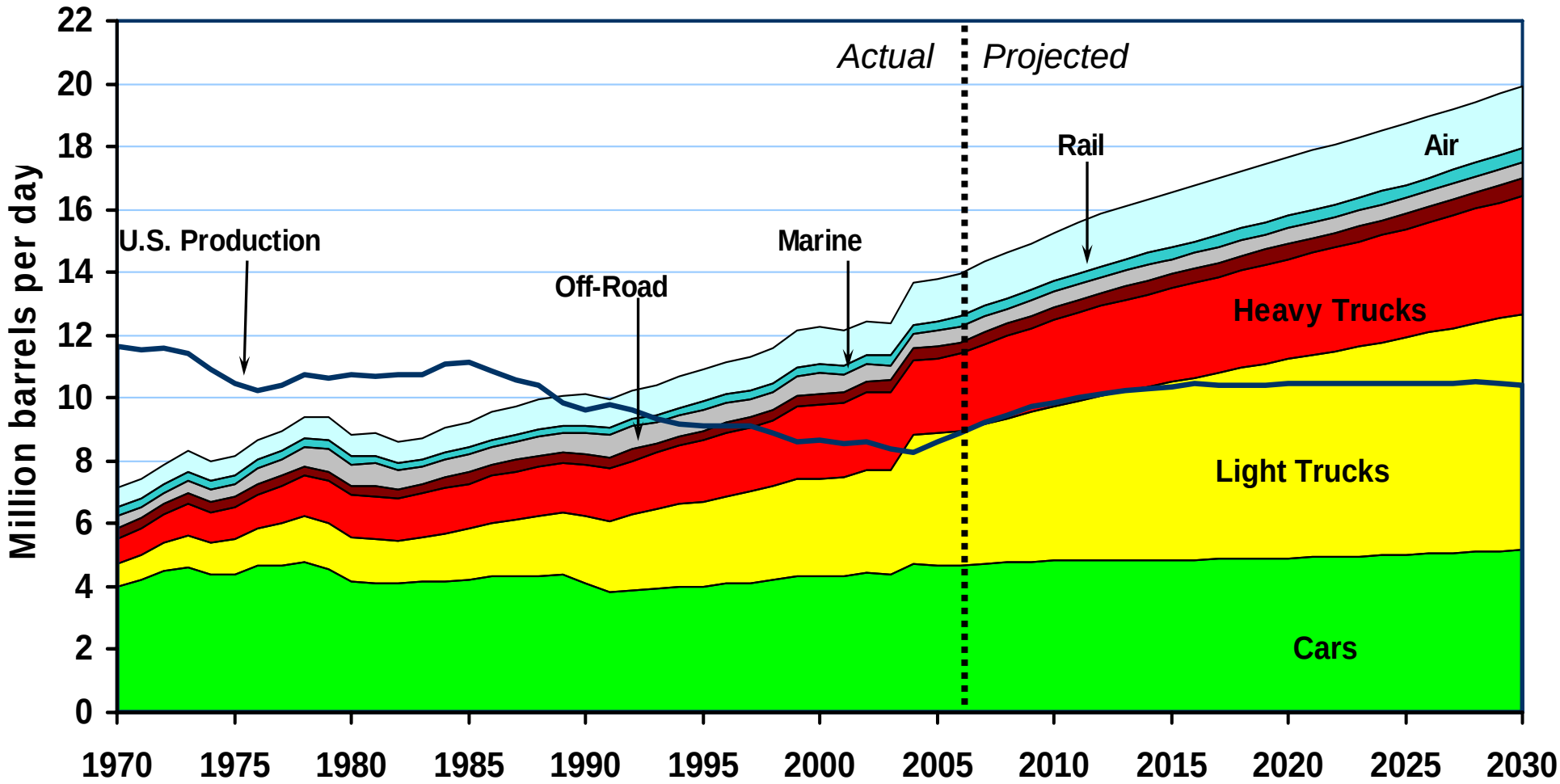
Develop technologies that enable cars and trucks to become highly efficient, through improved power technologies and cleaner domestic fuels, and to be cost and performance competitive. Manufacturers and consumers will then use these technologies to help the nation reduce both energy use and greenhouse gas emissions, thus improving energy security by dramatically reducing dependence on foreign oil. The benefits will include:

- **Saving 4 to 6 million barrels of oil per day,**
- **Reducing greenhouse gas emissions by 50%, and**
- **Enabling U.S. manufacturers to be competitive in the global market.**

Planning Context – Oil Production vs. Consumption Gap

Transportation Oil Use

U.S. Petroleum Production and Consumption, 1970-2030

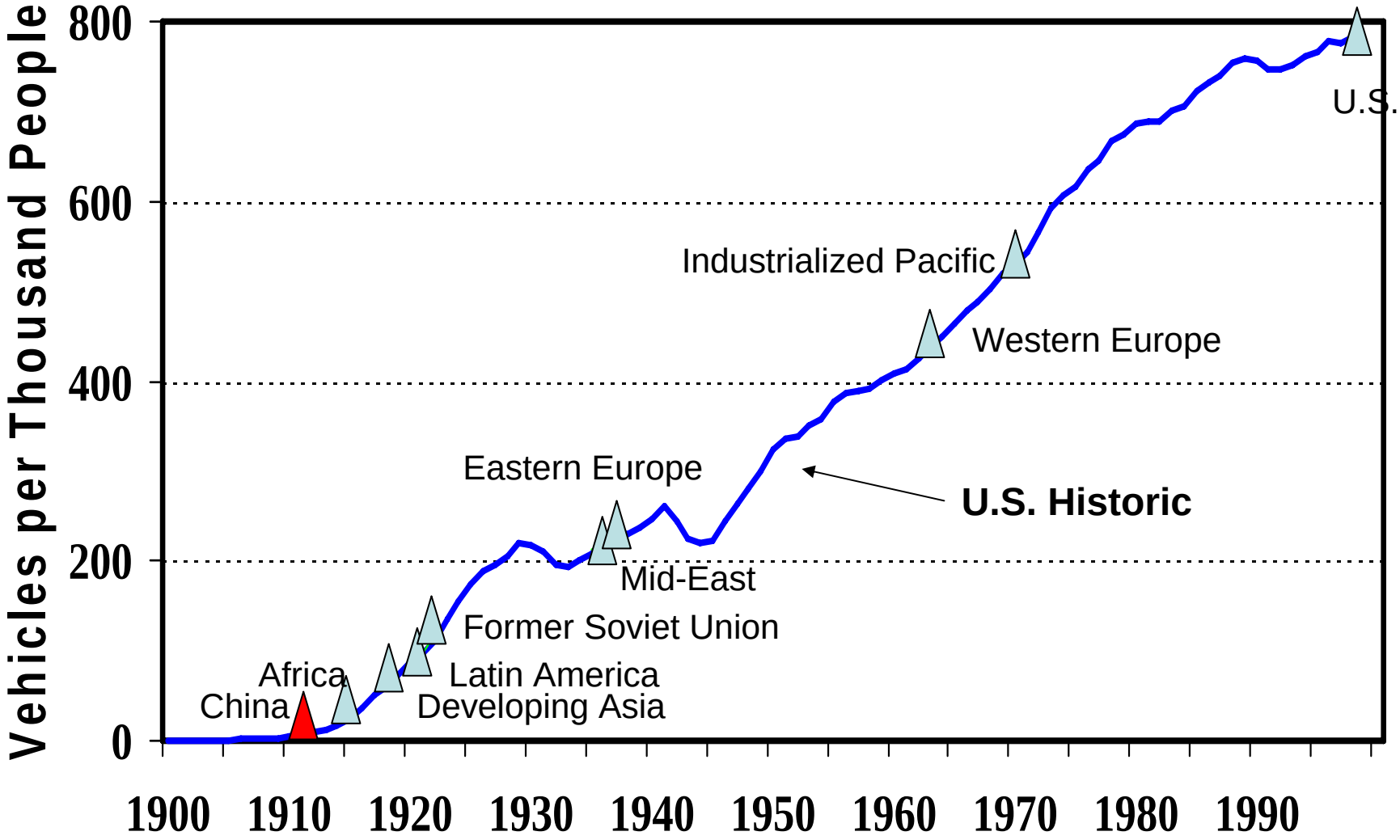


Source: TEDB No. 26 and AEO 2007

Peaking Oil is an Issue

- U.S. conventional oil production peaked in the early 1970s
- While there isn't complete agreement on the date, most analysts do agree we'll reach the peak of world oil production within the next 20 years
- Once the peak is reached, prices WILL go up, and the petroleum remaining will go to the highest bidder (or whoever has already locked it up)
- For more info on peaking oil, see Robert Hirsh's report at: http://www.netl.doe.gov/publications/others/pdf/Oil_Peaking_NETL.pdf
- As petroleum prices increase, cost-effectiveness of non-conventional petroleum sources should improve, potentially resulting in increased production from these sources
- Increased consumption in China and India will add additional pressure on prices

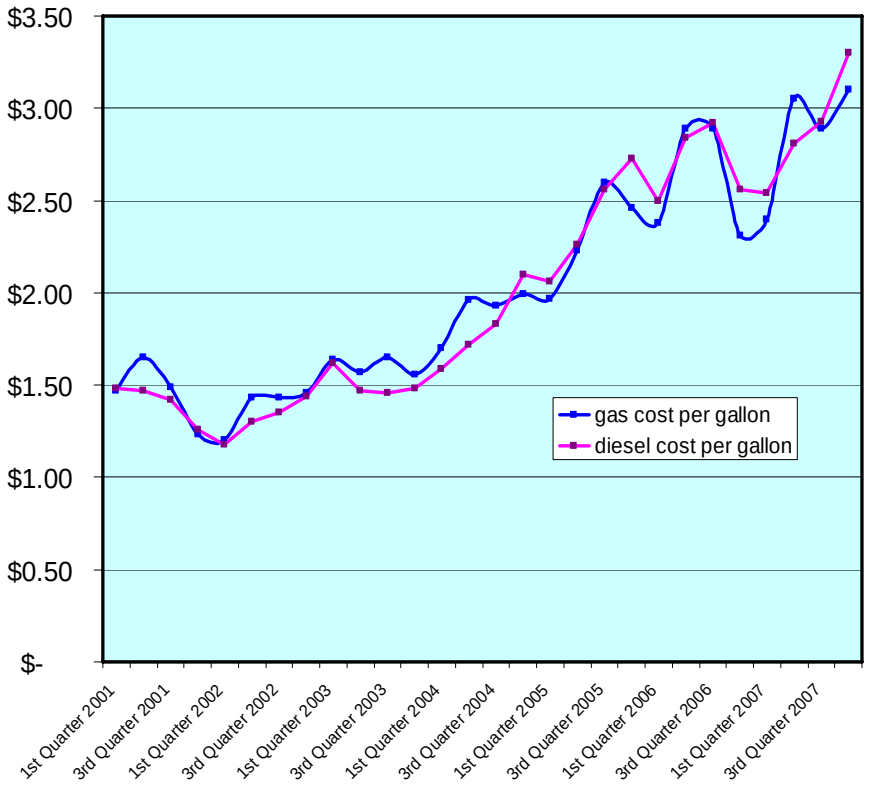
Global Growth in Transportation Accelerates the Demand for Oil



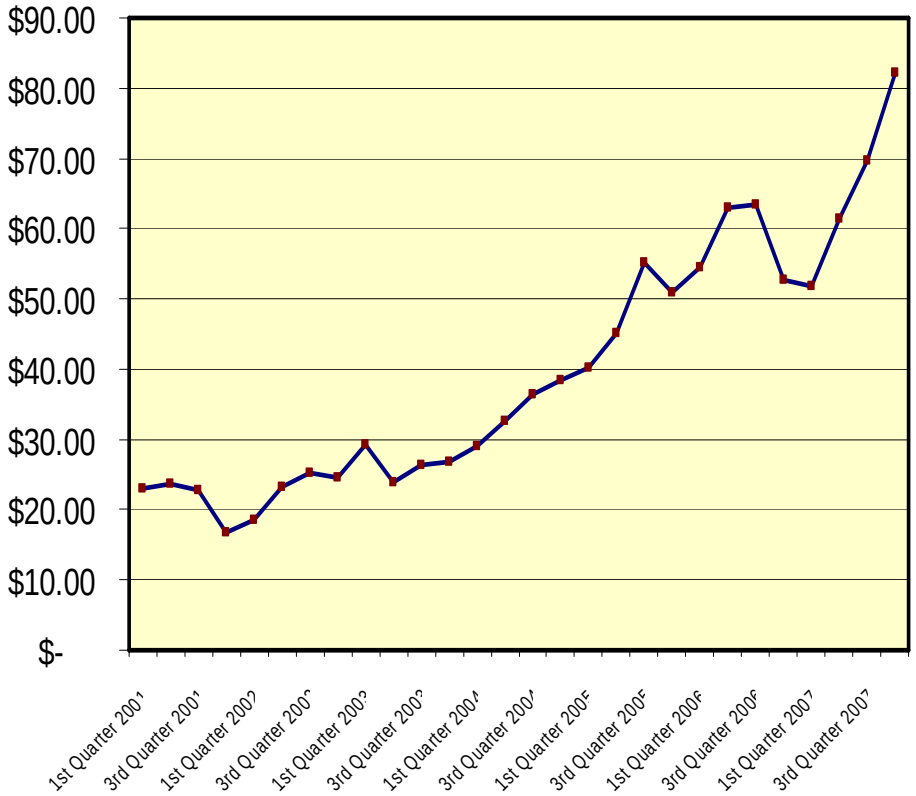
China, with **23.5** vehicles per 1000 people, is where the U.S. was in **1915** – but this is changing fast. Passenger vehicle sales in **2001** were **860,000**, in **2006** **4.2M**, and are projected to rise to **7.5M** in **2011**. China is now the **2nd largest** automotive market. [Automotive News Global Market Data Book, May 2007]

Fuel Price Trends are Clear

U.S. Quarterly Average Gasoline and Diesel Prices Per Gallon 2001-2007



U.S. Quarterly Average Oil Cost in Dollars Per Barrel 2001-2007



U.S. retail fuel prices have risen to the $3/gallon level, and have stayed there for a while now – it is doubtful they will drop significantly

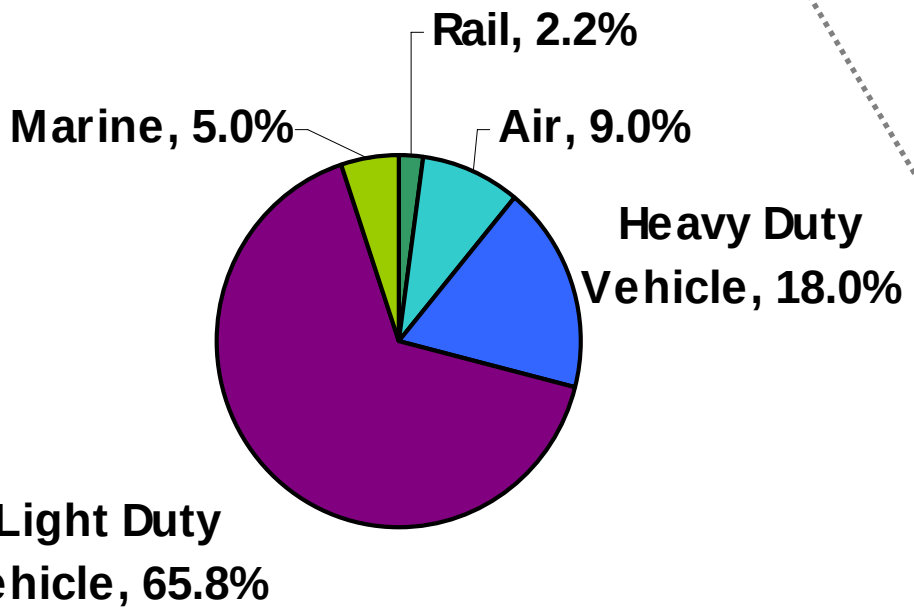
Similarly, U.S. petroleum prices now hover around the $80-100 per barrel range, and are unlikely to decrease to the level seen at the beginning of this decade.

Data Source: EIA

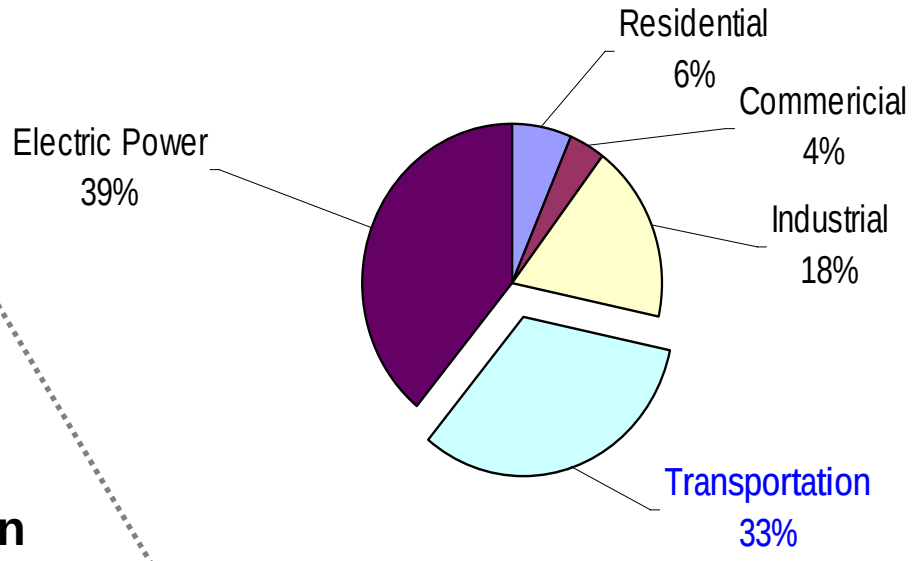
Transportation Oil Consumption and Contribution to Greenhouse Gases

The transportation sector accounts for 2/3 of the oil use in the U.S. and is the fastest growing petroleum consuming sector.

U.S. Transportation Oil Consumption



United States
Carbon Dioxide Emissions by End-Use Sector

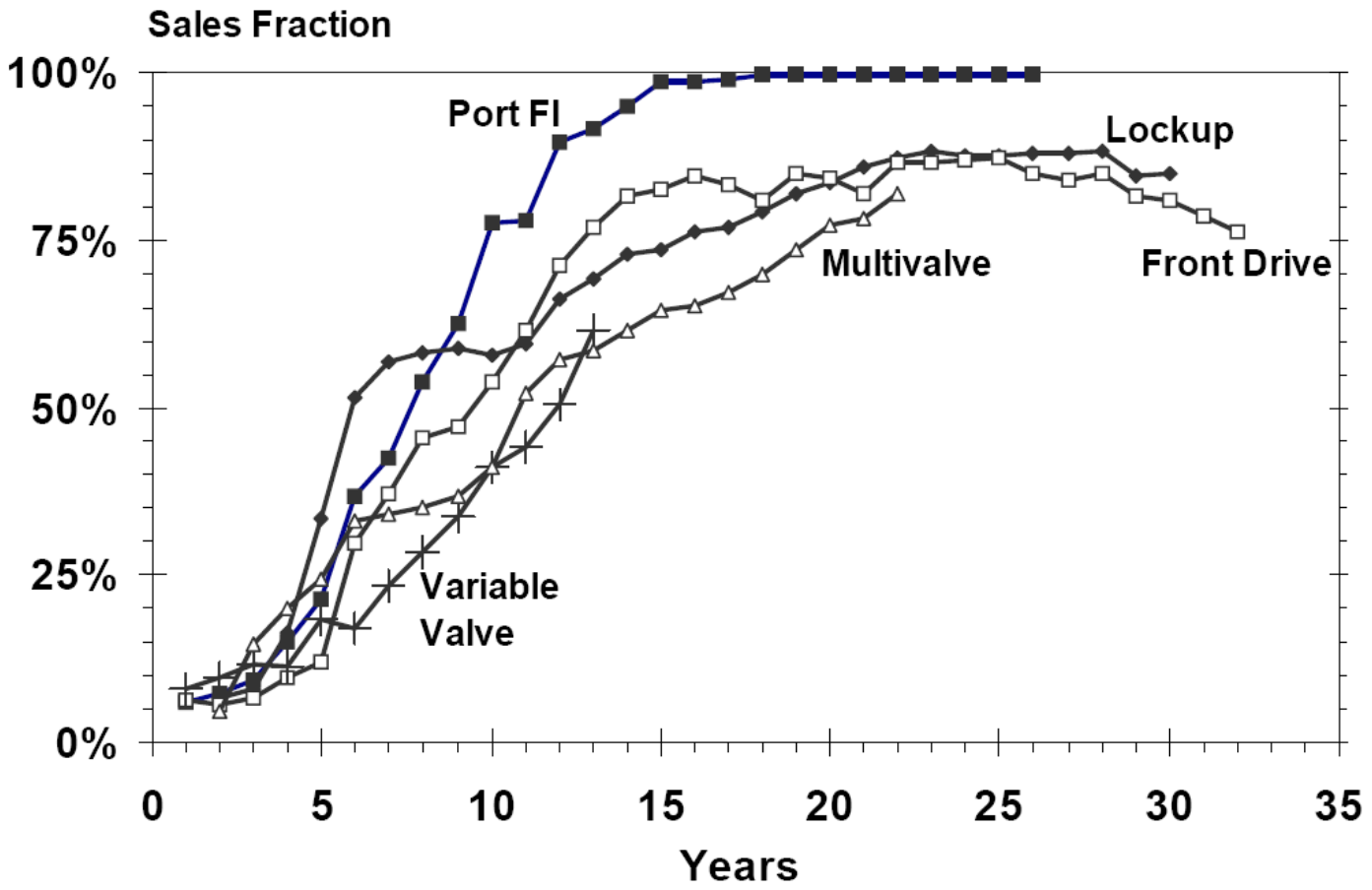


The transportation sector accounts for 1/3 of the carbon dioxide released in the U.S.

Source: TEBD No. 26

Lead-Time Significant for Technology Development

It takes about 15 years for a technology to reach maximum penetration in new vehicle sales and another 15 years for the technology to be ubiquitous.



Industry Perspective

The Auto Industry is increasingly concerned with developing "green" vehicle technologies.

From an *Automotive News* Editorial (written by publisher Keith Crain), February 4, 2008: "*Although the United States is in a green-technology race, its role in developing alternative-vehicle technologies and the hydrogen automobile could dwindle unless there is more investment. Industry executives warned that Germany, China and Japan are investing heavily in green technologies and could surpass the United States. If that happens, global automakers will follow the technology and the money overseas, taking jobs, infrastructure, suppliers and the technology initiative with them…. Automakers need to make green-technology leadership a competitive advantage…. Universities must enhance green-technology curricula and research.*"

Industry Perspective

The consumer has a vital role

Warren Brown – *Washington Post* 2/17/08: *"The new CAFE bill has the same flaw as the old CAFE bill. It does not ask consumers to do one thing, pay one thing, give up one thing or participate in any meaningful way in fuel conservation. That, in fact, is why the new CAFE bill was drafted. The old one succeeded at improving technical fuel efficiency…It's easy enough: Increased technical fuel efficiency plus cheap gasoline equals increased consumer demand for all that gasoline provides and supports and, thus, increased gasoline consumption…You can start by telling consumers the truth -- that increased global demand for oil soon will turn the car-buying equation upside down. The most fuel-efficient cars will come with higher prices, because those are the cars that will have the highest value in a world increasingly thirsty for oil."*

Executive and Legislative Drivers

- January 2007, State of the Union Address
  - President announces 20 in 10 initiative, focused on reducing gasoline demand by 20% in 10 years (2017)
    - Three-quarters from increased utilization of alternative fuels
    - One-quarter from increased fuel efficiency
- December 2007, Congress Passes and President Signs the Energy Independence and Security Act of 2007 (EISA, P.L. 110-140)
  - Expanded Renewable Fuel Standard (RFS)
  - Increased Corporate Average Fuel Economy (CAFE)

EISA: Renewable Fuel Standard

- Expands the Renewable Fuel Standard to 36B gal/yr of renewable fuel by 2022 (vs. 7.5B gal/yr by 2012, from EPAct 2005)
- Fuels include:
  - Corn ethanol
  - Advanced biofuels
    - Cellulosic ethanol and ethanol from other non-corn biomass sources
    - Biomass-based Diesel (Biodiesel)
    - Biogas
    - Butanol and other alcohols from biomass
    - Other fuels from cellulosic biomass
- EPA will develop regulations to implement
- Corn Ethanol limited to 15B of 36B gallons in 2022 – remaining 21B gallons is Advanced Biofuels
- Biodiesel must be at least 1B gallons in 2022

EISA: Corporate Average Fuel Economy

- Increases CAFE levels to 35 mpg overall by 2020 – estimated to save 0.9M barrels per day by 2020, and 2M barrels per day by 2030
- DOT/NHTSA to develop implementing regulations
- Continues to allow separate standards for passenger cars and light trucks
- Manufacturers can still separate results for domestic and import passenger cars
- Flexible Fuel Vehicle credit continues at current 1.2mpg credit level through 2014, then ramps down to complete phase-out after 2019
- Fines – half goes to DOT to administer CAFE program, half goes to DOT to provide grants for manufacturing conversion for advanced technologies
- Calls for development of Medium- and Heavy-Duty fuel economy standards, after completion of a National Academies of Science study

EISA: Other Vehicle Technologies-Related Provisions

- Biofuels utilization R&D – higher ethanol blends, biodiesel, biogas, optimizing FFVs
- Electric drive R&D and transportation electrification – leading to demonstration of advanced electric drive vehicles like PHEVs
- Energy Storage R&D – to support electric drive vehicles
- Lightweight Materials R&D – for improving vehicle efficiency without sacrificing safety
- Deployment – renewable fuel infrastructure grants, retail refueling station issues, and modifications to fleet programs
- Manufacturing conversion grants and loans – to support/encourage retooling for advanced technology vehicles and components

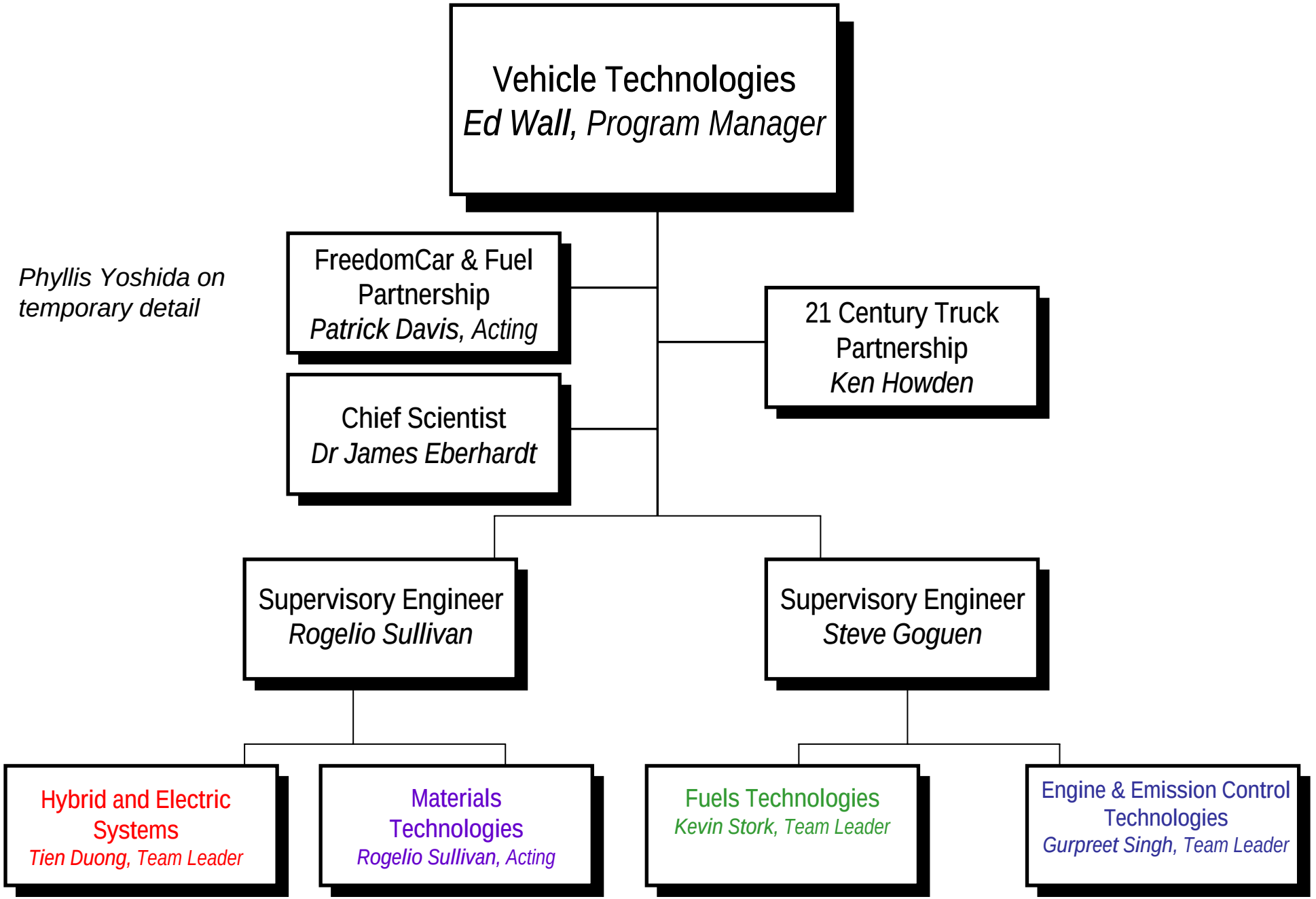
Greenhouse Gas Legislation – *Under Consideration*

- S.2191, America's Climate Security Act of 2007
- Focused on reducing U.S. greenhouse gas emissions from now through 2050 through establishment of an emissions registry (administered by EPA) and then capping emissions. Banking and trading programs also established.
- Focuses primarily on emissions up-stream from vehicles – fuels and vehicles production.
- Includes award program to assist vehicle and component manufacturers in retooling for advanced technologies (cleaner, high efficiency)
- Also calls for EPA to conduct transportation sector review of GHG emissions
- Cleared Senate EPW Committee in early December 2007, and sent bill to floor for debate. Debate not yet held. Prospects for passage unclear at this time.

State Activities

- States are also creating their own drivers for action. Many have put in place their own:
  - Legislation, including biofuels blending requirements (for ethanol and/or biodiesel) or even state-level RFS programs
  - Regulations
  - Executive Orders (such as for state fleet operations)
  - R&D, Demonstrations, and Deployment for advanced vehicle technologies
  - Funding mechanisms for advanced technology vehicles

Vehicle Technologies Structure



Diverse Portfolio of Clean, Efficient Technologies

Vehicle Systems

- Aerodynamics
- Rolling Resistance
- Accessory Loads
- Systems Analysis and Target Setting

Tech Introduction

- EPAct
- Legislative & Rulemaking
- Clean Cities
- Validation
- Student Competitions
- GATE

Hybrid Propulsion

- Hybrid Electric Systems
- Power Electronics
- Advanced Batteries
- Inverters/Controllers
- Motors

Materials Technologies

- Lightweight Structures
- Metal Processing
- Composite Development
- Processing and Manufacturing
- Design Data Test Methods
- Recycling Technology
- HTML

Fuels Technologies

- Bio-Based Fuels
- HCCI Fuel Characteristics
- Fischer-Tropsch Fuels & Blendstocks
- Advanced Lubricants

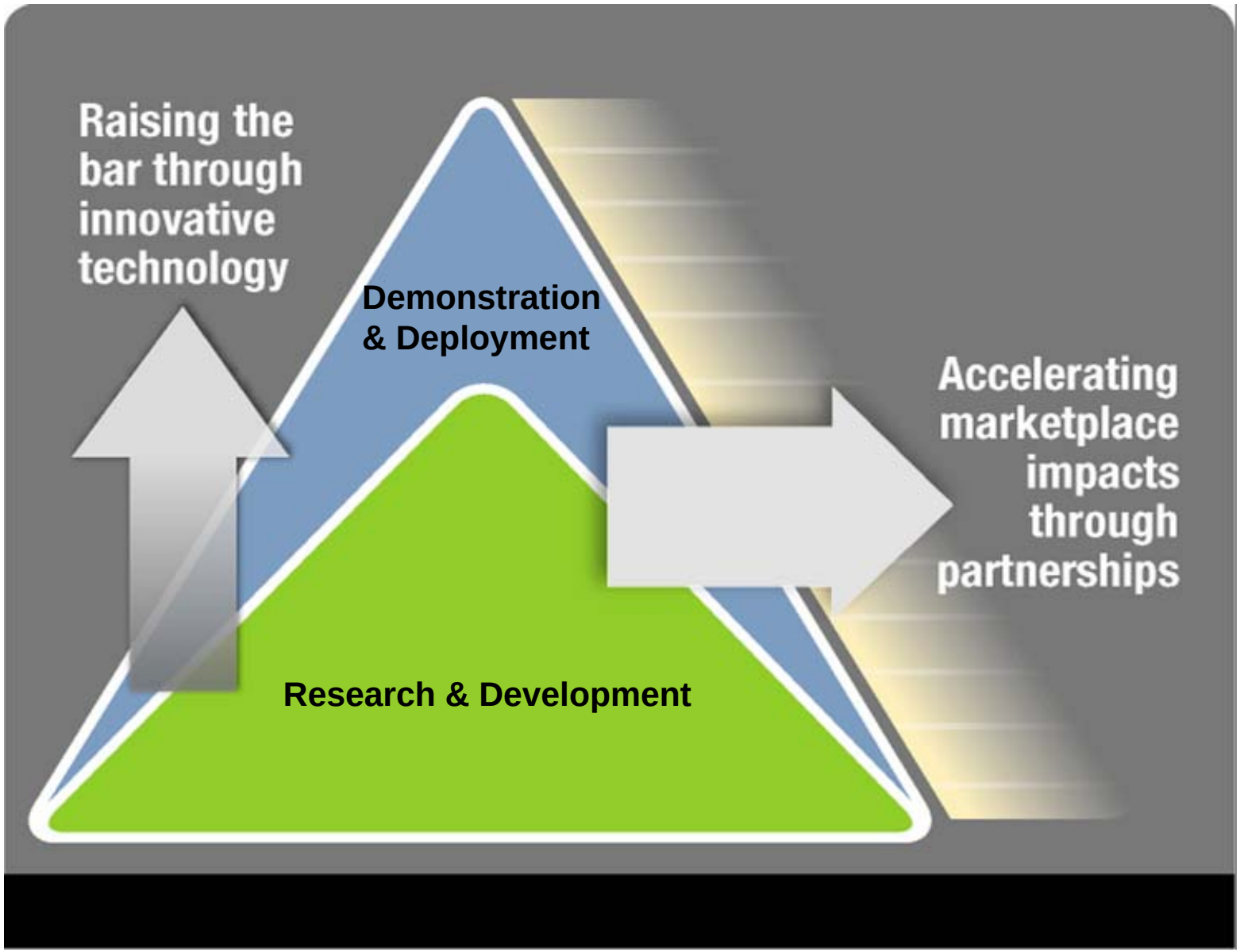
Advanced Combustion Engines

- Low Temp. Combustion R&D
- Emission Controls
- Light- & Heavy-Duty Engines
- Waste Heat Recovery
- Health Impacts

Programmatic Accomplishments

- Awarded six agreements to examine optimizing engines for high efficiency operation on ethanol.
- Initiated a testing activity to study the effects of gasoline blended with up to 20% ethanol in legacy vehicles.
- Awarded five contracts for Li-Ion battery development for PHEVs.
- Light-duty diesel engine developed in cooperation with DOE to be introduced by Cummins/Dodge in 2009.
- PHEV demonstration solicitation process is on-going – 1st phase of proposals received by 2/13, and 2nd phase is due by 4/30.

Overcoming Our Addiction Begins with Efficiency & Fuel Substitution R&D

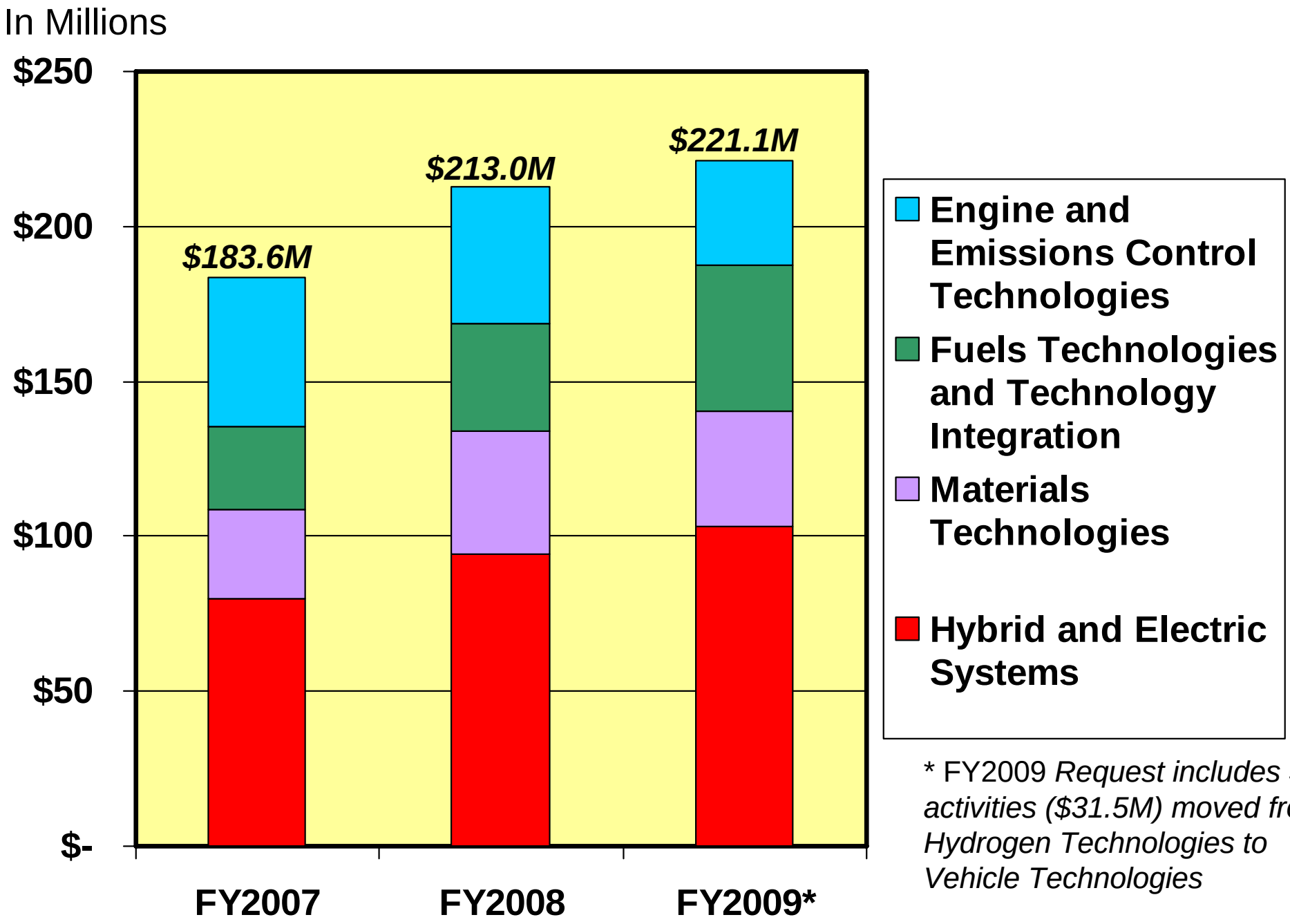


Technology Barriers

Vehicle Technologies Program Efforts Seek to Overcome These Hurdles

- Components & Systems
  - Cost
  - Performance
  - Size and weight
  - Reliability
- High Volume Manufacturability
- Deployment & Infrastructure

Budget



* FY2009 *Request includes 3 activities ($31.5M) moved from Hydrogen Technologies to Vehicle Technologies*

Emphasis Going Forward

- Performing the R&D associated with Plug-In Hybrid Electric Vehicle systems and components to support their demonstration and deployment
- Energy Storage R&D
- Conducting the R&D and deployment activities necessary to ensure that the increased amounts of renewable fuels under the expanded RFS can be used when they hit the market
- Deployment of Advanced Technologies – including light-duty diesel education and outreach activities

This Week's Merit Review

- This is the first time we've presented our entire Program at once. We've asked you here this week to provide us your input on our full range of activities.
- We intend to use this input to help us make decisions.
- We greatly appreciate your commitment of time to help us.

THANK YOU