



U.S. DEPARTMENT OF  
**ENERGY**

**DEER 2011**

DETROIT OCT. 3-6

DIRECTIONS IN ENGINE-EFFICIENCY AND  
EMISSIONS RESEARCH CONFERENCE



U.S. DEPARTMENT OF  
**ENERGY**

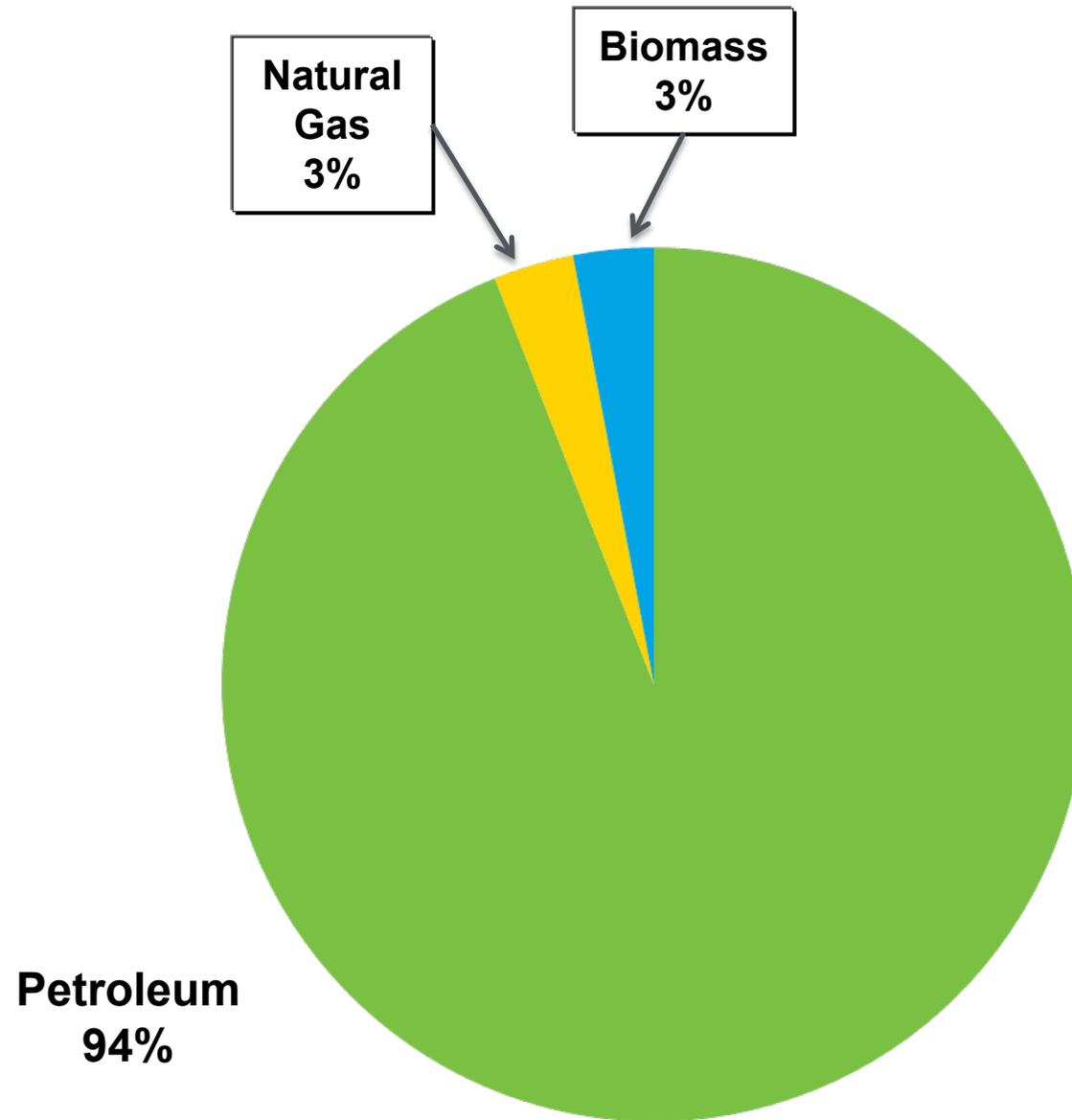


**David Sandalow**

Assistant Secretary

Office of Policy and International Affairs

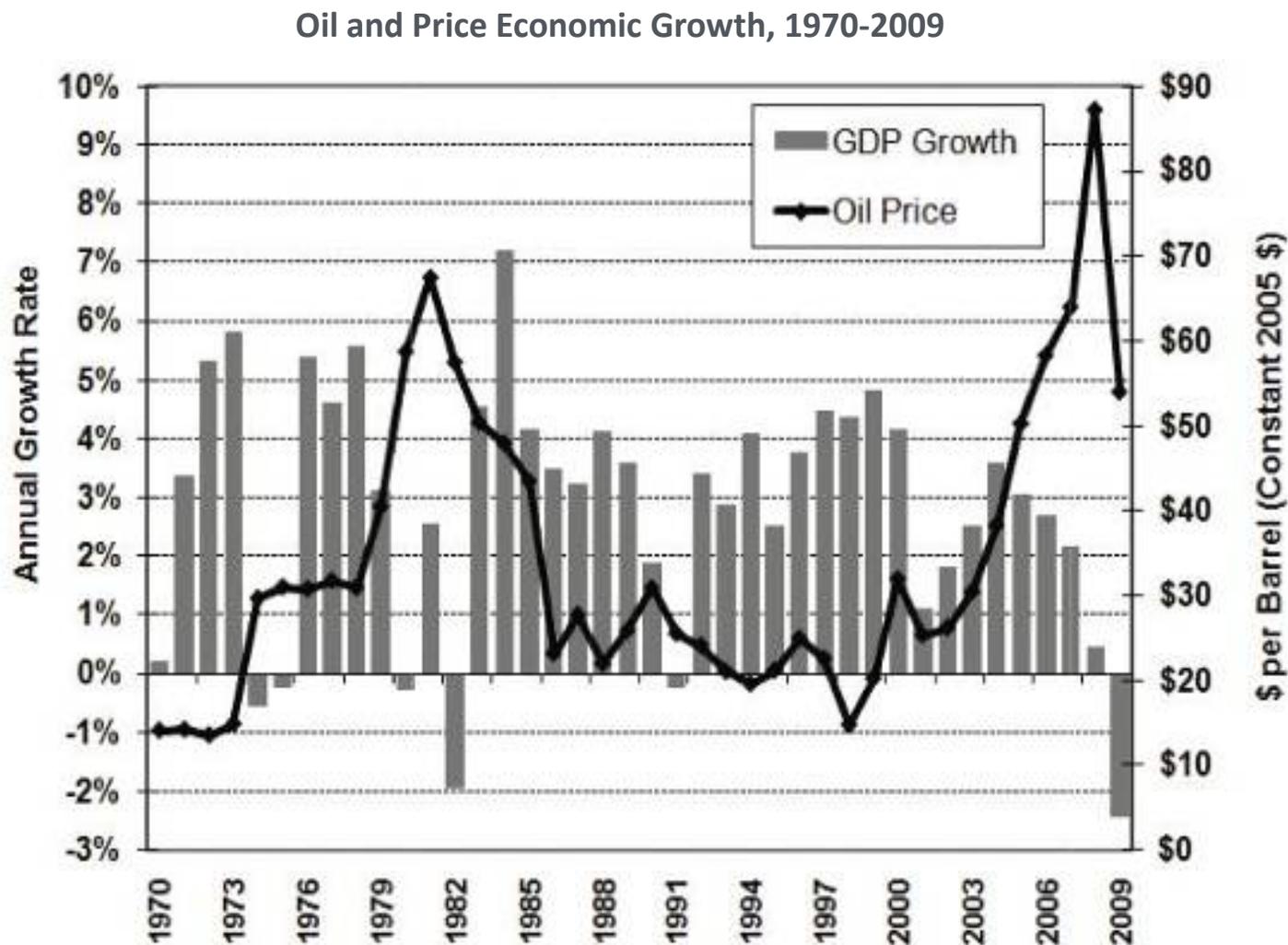
# Transportation sector depends on oil



**U.S. Transportation Fuel Share (2009)**

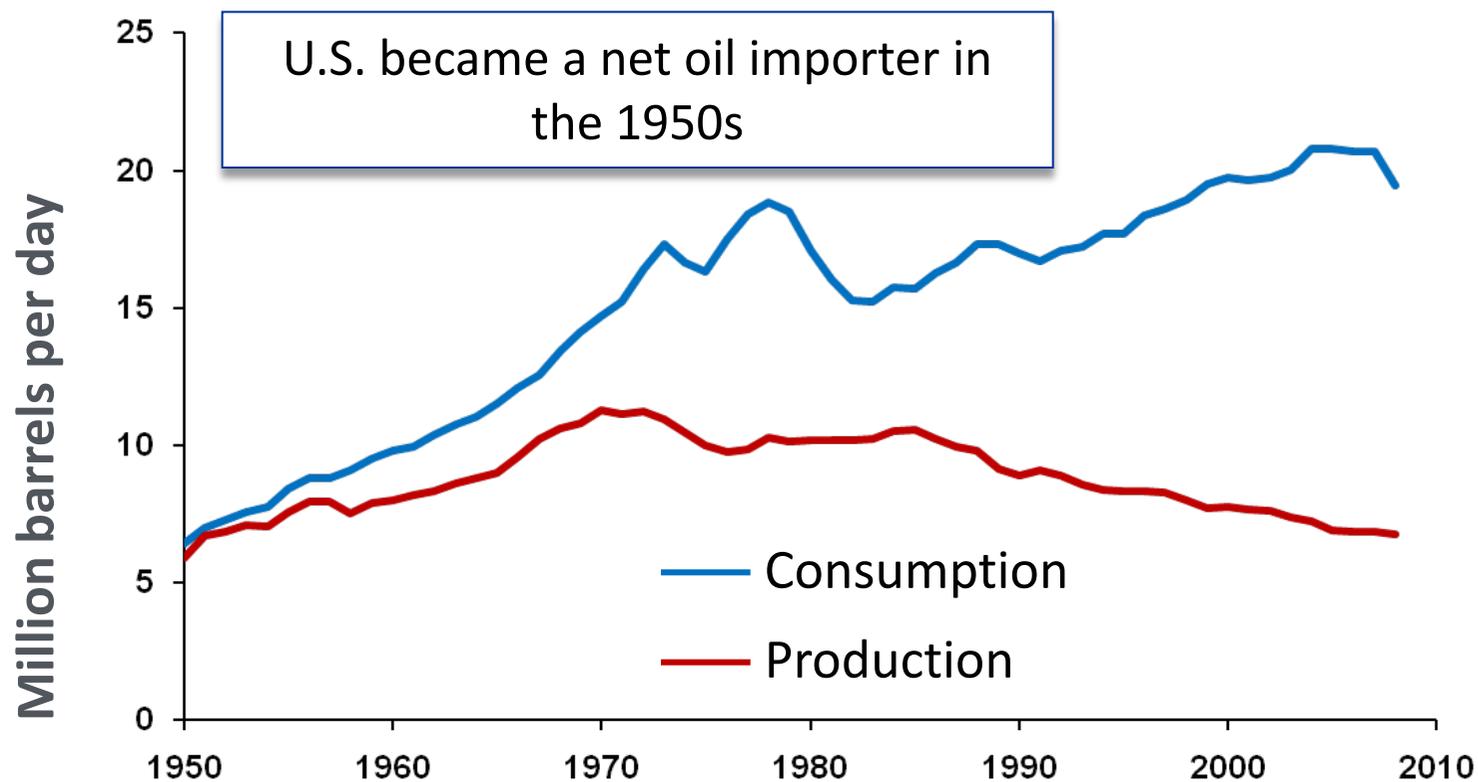
# Oil dependence puts our economy at risk

Five of the last five economic downturns have been preceded by oil prices increases

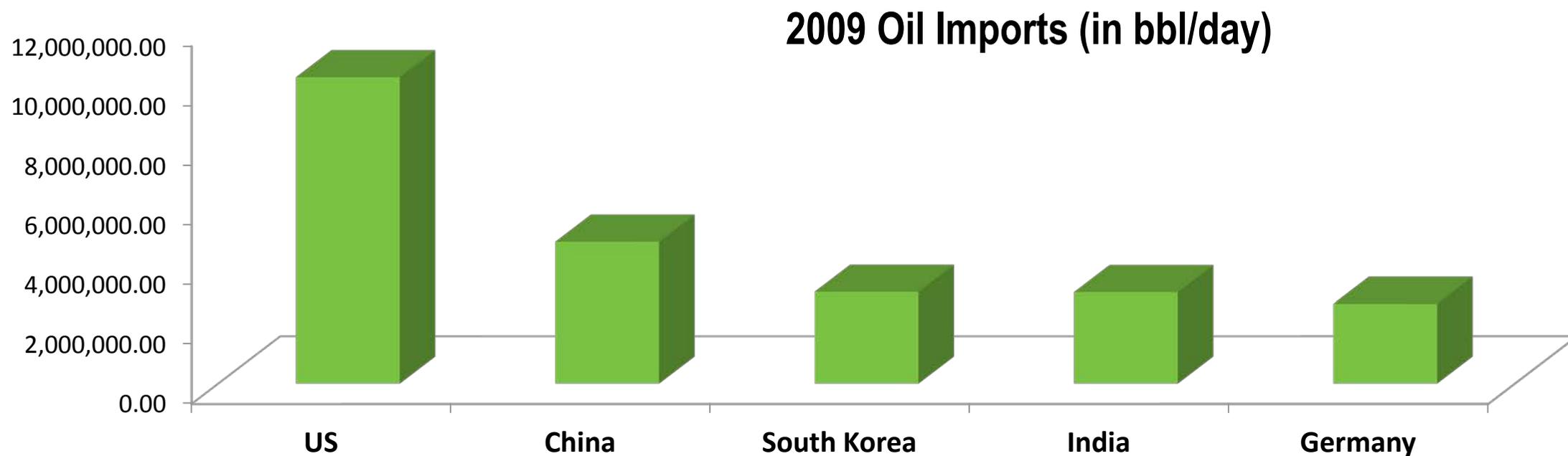


Source: Greene, D.L. and N. I. Tishchishyna, Costs of Oil Dependence: A 2000 Update, Oak Ridge National Laboratory, ORNL/TM-2000/152, Oak Ridge, TN, 2000, and data updates, 2010.

# US is the world's largest oil importer



US imports around **half of its oil**

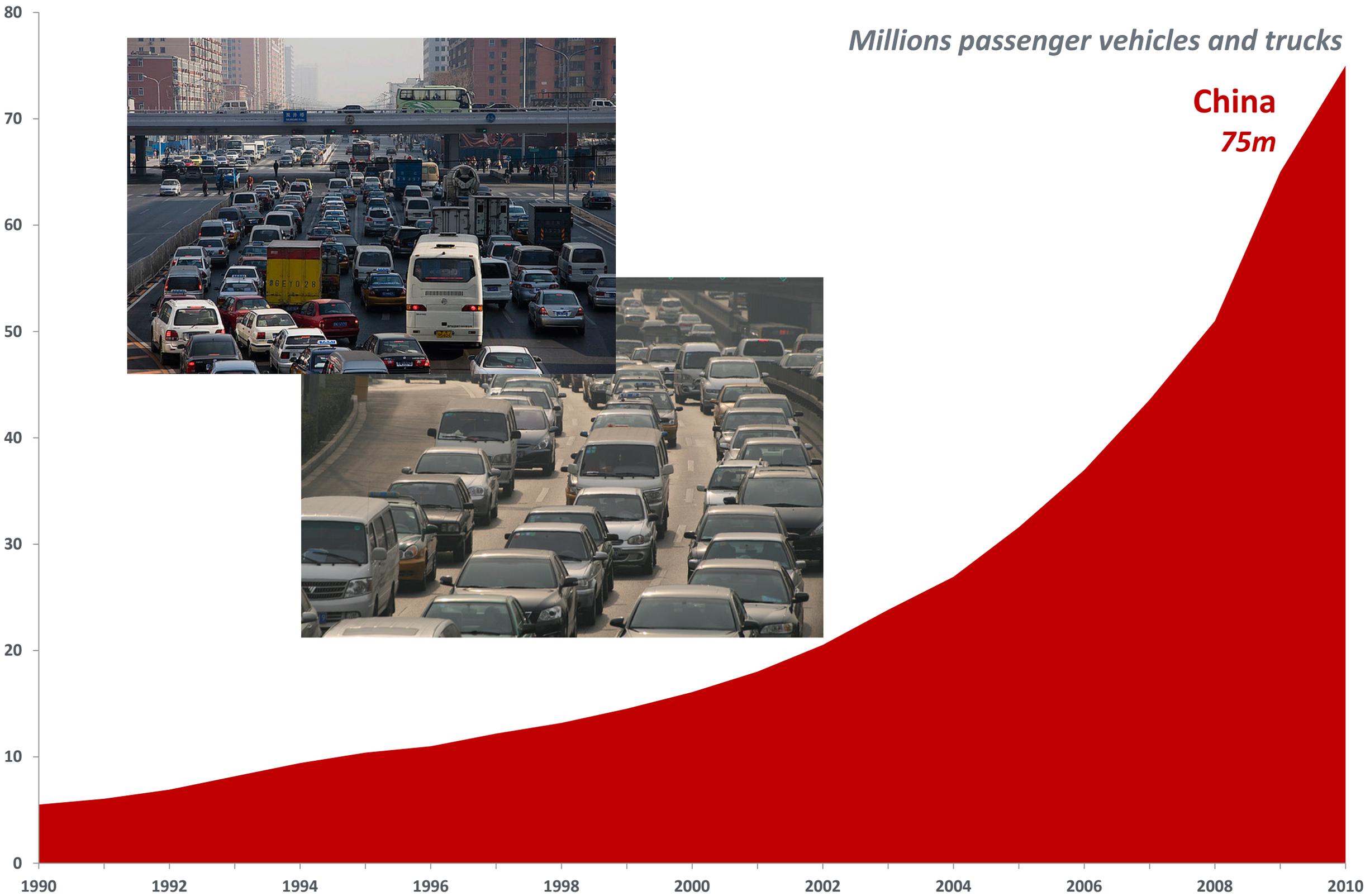


Source: Energy Information Administration (top), CIA World Factbook (bottom)

# China has a rapidly growing car market

*Millions passenger vehicles and trucks*

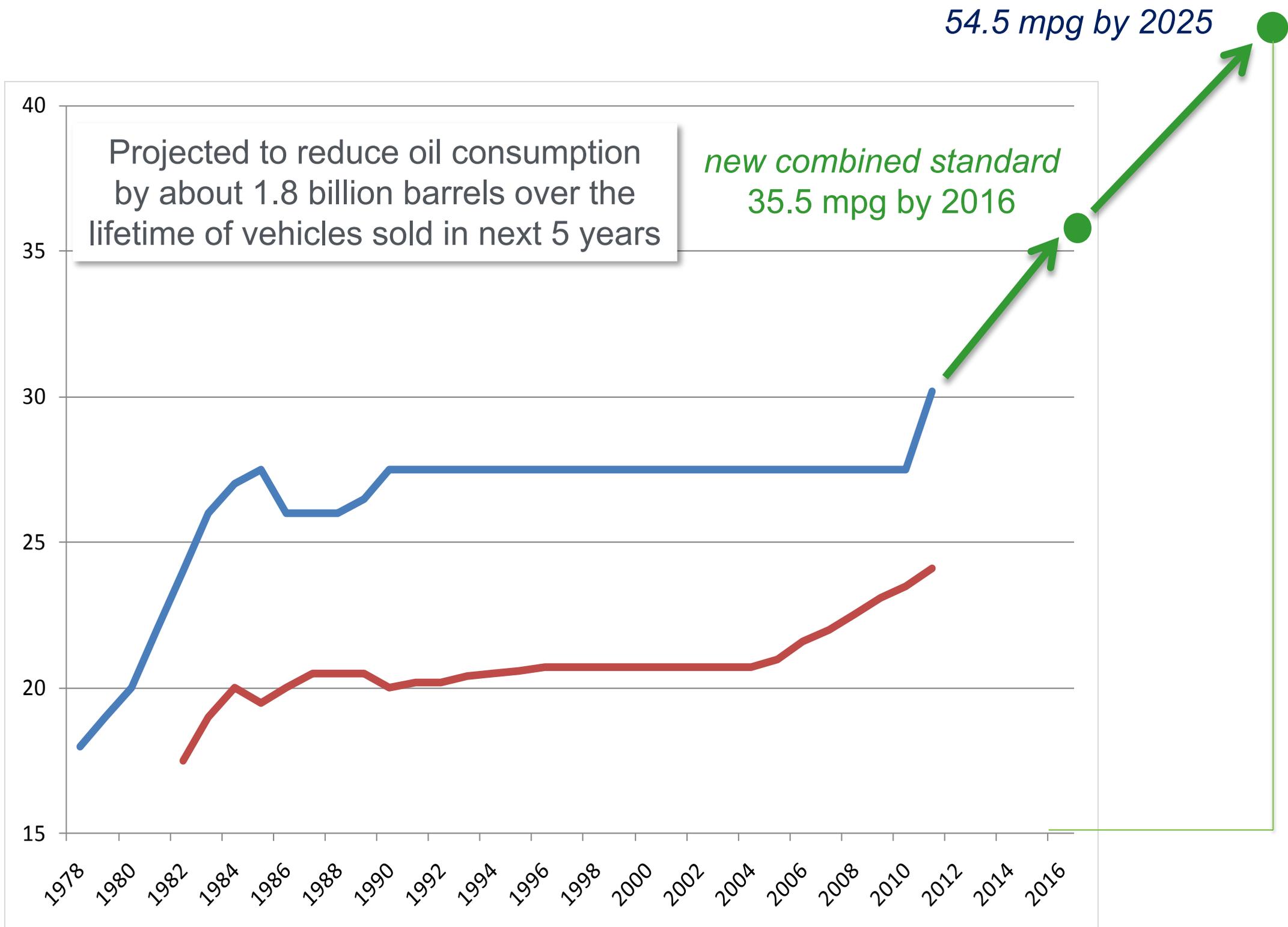
**China**  
**75m**



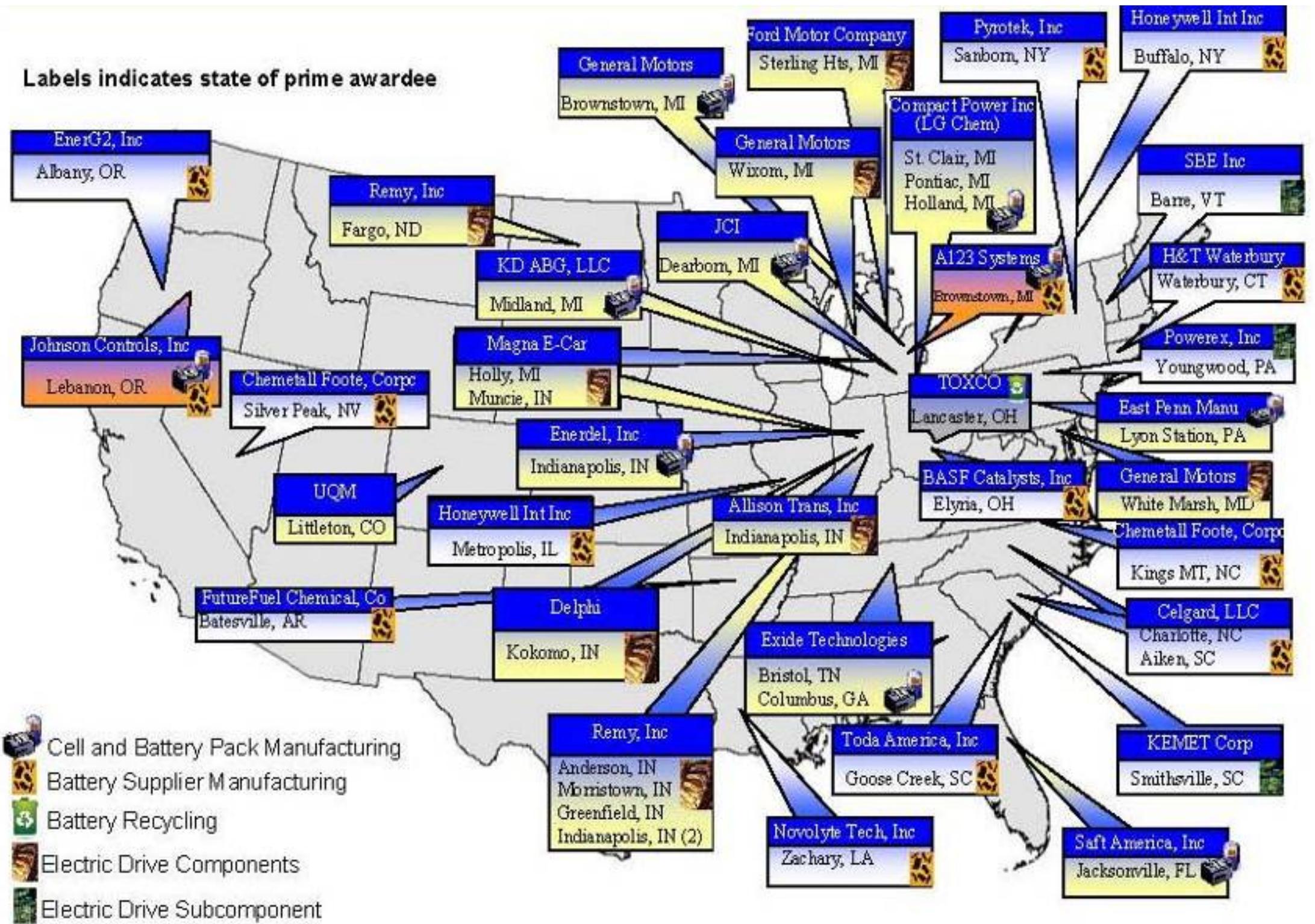
# The President's Plan for Transportation



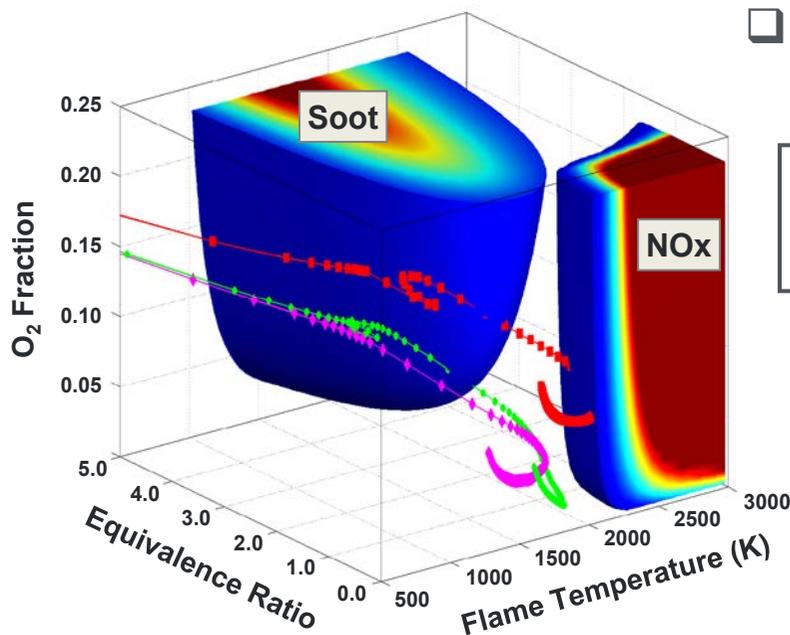
# New Fuel Standards



# Recovery Act - Battery and Electric Drive Award Distribution



# DOE's Vehicle Technologies Program



## Advanced Combustion Engines, Emission Controls, and Waste Energy Recovery

Current Efficiency 28% → >45% cars, >55% trucks%

## Electric and Hybrid Electric Vehicle Systems

Gasoline Hybrid - +40 % Better MPG

Diesel Hybrid – Double MPG

Plug-In Hybrid – 3 to 4 Times Better MPC

Electric Vehicles – Battery Energy Storage



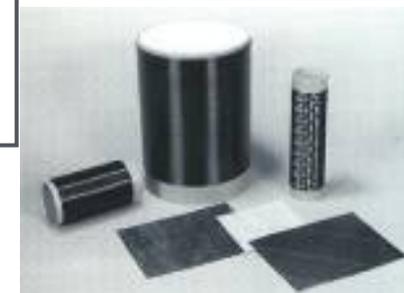
## Biofuels/Fuel Blends

Displaces Oil:  
1 Gallon Ethanol  
Replaces 0.7 gal  
of Gasoline



## Advanced Materials

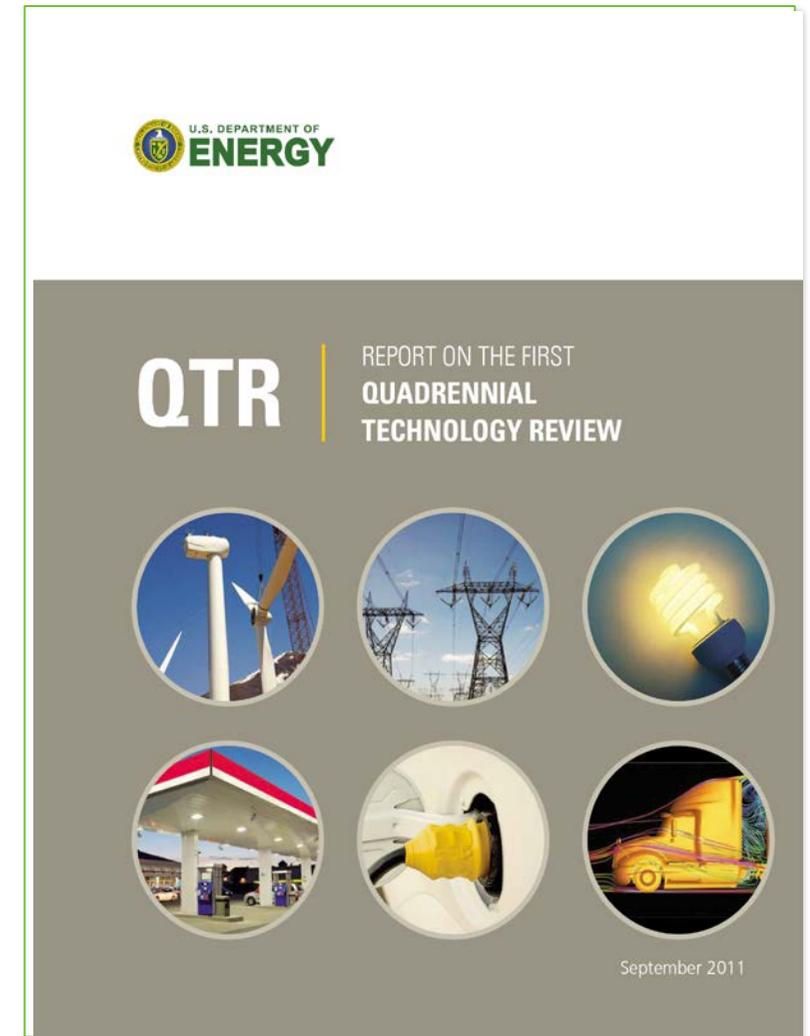
Lightweighting – 6% to  
8% better MPG per 10%  
Reduction in Weight (Up  
to 50%)



# DOE Quadrennial Technology Review (QTR) Report (Sept 2011)

Just released by Secretary Chu

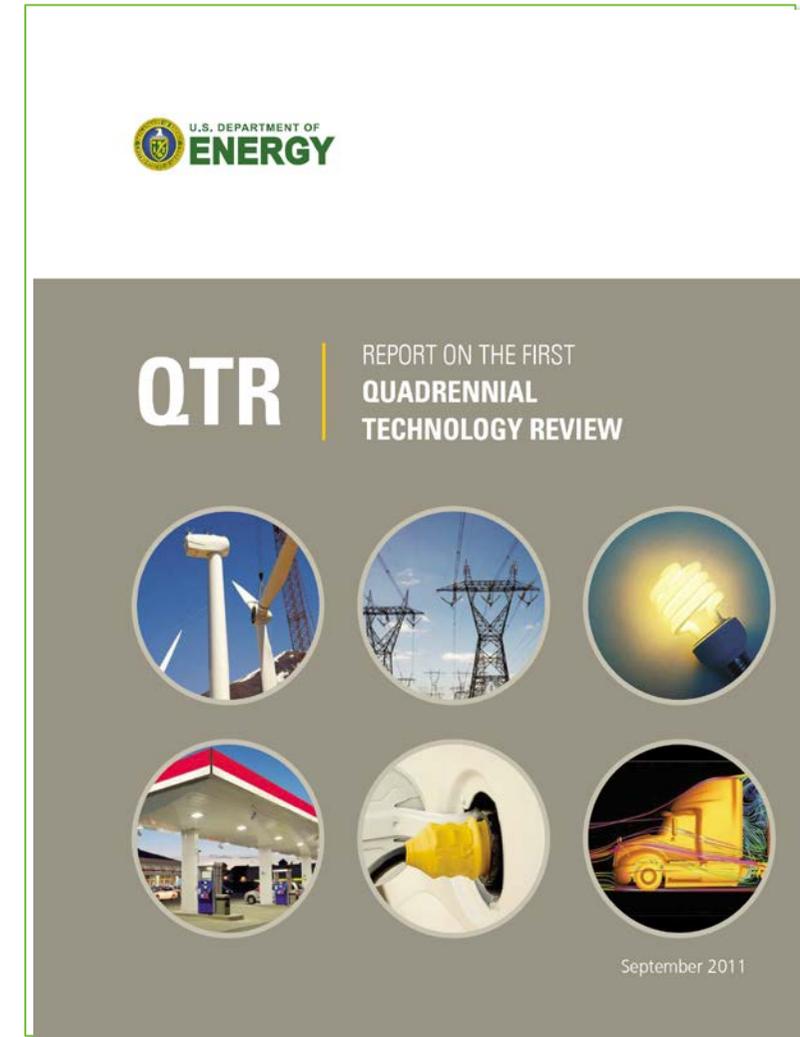
- Rigorous analysis of energy technology
- Recommends priorities in DOE's energy-technology programs



[www.energy.gov/qtr](http://www.energy.gov/qtr)

# QTR Report - On Improving Vehicle Fuel Efficiency

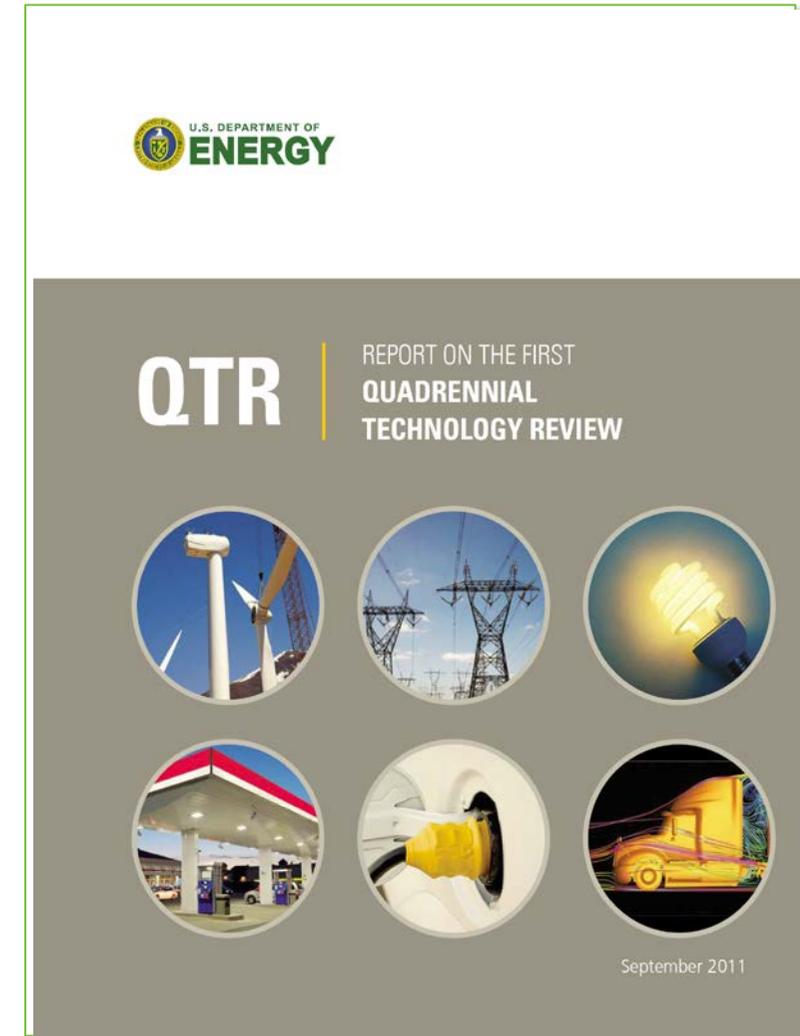
“There is significant headroom for DOE to work on increasing conventional vehicle efficiency by improving the internal combustion engine, by lightweighting, and by improving the aerodynamics of heavy-duty vehicles.”



# QTR Report - On Internal Combustion Engines

“The performance, low cost, and fuel flexibility of ICEs makes it likely that they will continue to dominate the vehicle fleet for at least the next several decades. ICE improvements can also be applied to both hybrid electric vehicles (HEVs) and vehicles that use alternative hydrocarbon fuels.

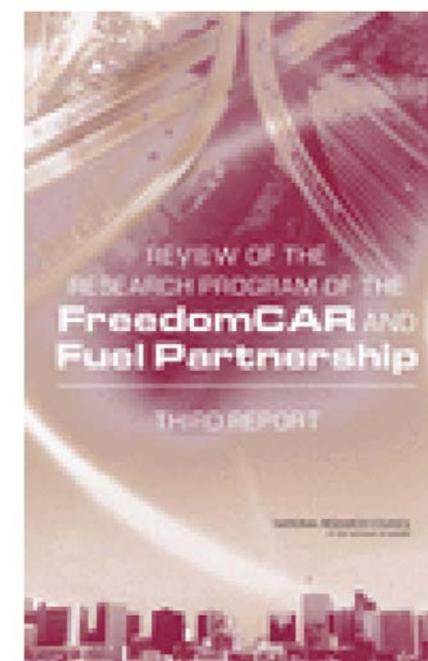
Within the vehicle efficiency portfolio, ICE improvements will receive the greatest emphasis, both because it contributes to light-duty and heavy-duty vehicle sectors and because DOE’s capabilities are well-aligned with the field’s technical needs.”



# Opportunity for Increased Internal Combustion Engine Efficiency

*Increasing the efficiency of internal combustion engines (ICEs) is one of the most promising and cost-effective approaches to improving the fuel economy of the U.S. vehicle fleet in the near- to mid-term.*

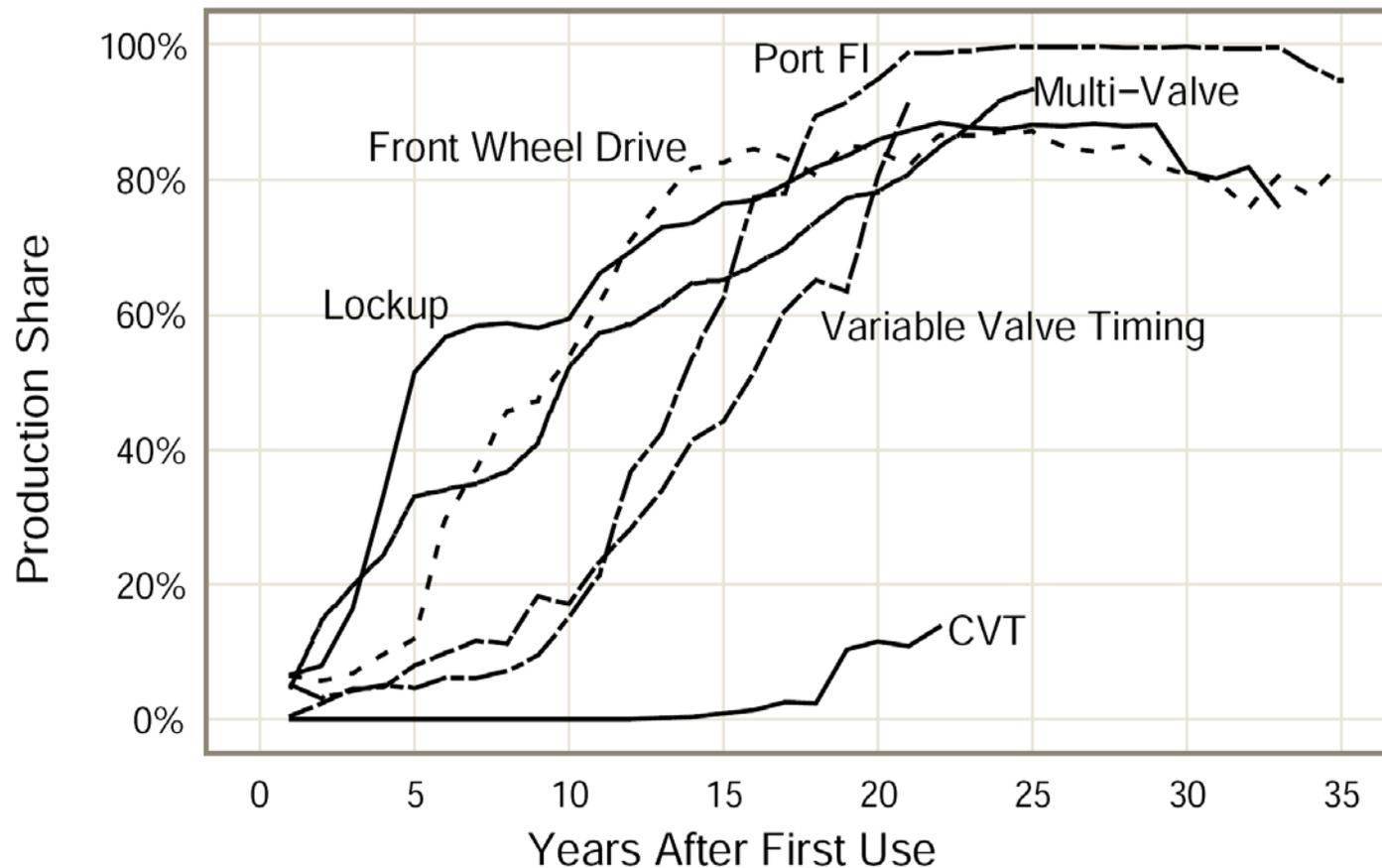
- ❑ “...*The internal combustion engine will be the dominant prime mover for light-duty vehicles for many years, probably decades ...*” NRC Report<sup>1</sup>
- ❑ Advanced engines in conventional, hybrid electric vehicles (HEVs) and plug-in hybrid electric vehicles (PHEVs) will maintain significant market share for several decades
- ❑ Medium-duty and heavy-duty commercial vehicles account for a quarter of the fuel used (mostly diesel fuel)
  - **No obvious alternative to ICE for over-the road trucks in the foreseeable future**



<sup>1</sup> *Review of the Research Program of the FreedomCAR and Fuel Partnership: Third Report*, NRC, 2010

# Realizing Benefits of Vehicle Technology Takes Time

**Vehicle Technology Penetration**  
Years After Initial Significant Use

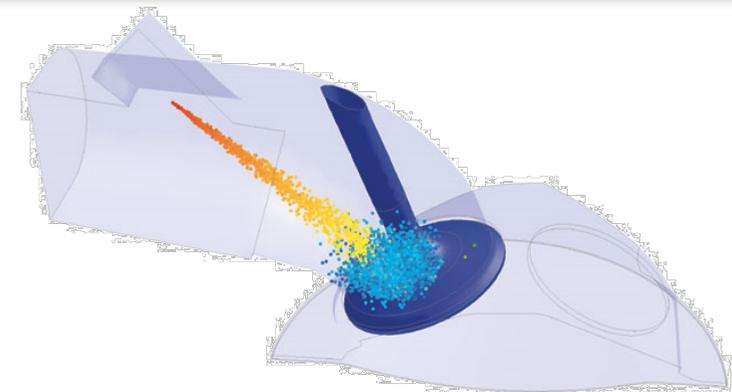


*It has taken about 15 years for a technology to prove itself and reach 40 to 50% of production, and another 15 years to maximum market penetration.*

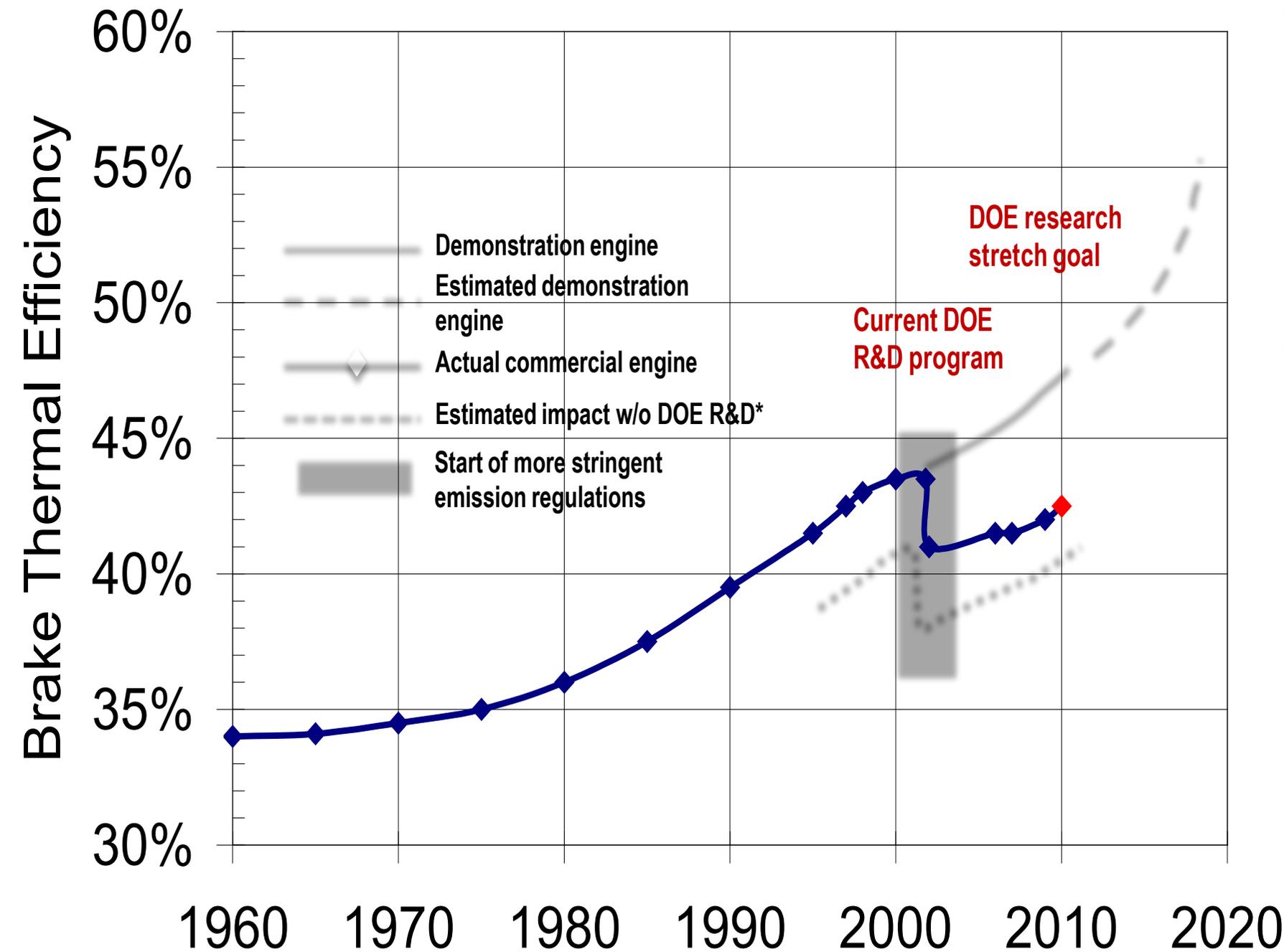
Light-Duty Automotive Technology and Fuel Economy Trends: 1975 Through 2010, EPA420-R-10-023, November 2010, p. 69

## U.S. Vehicle Market

- About 240 million vehicles on the road
- Approximately 11.5M new cars & light trucks sold in 2010; the average was 15.7 M/yr from 2002-2007
- Hybrid vehicles at about 3% of sales



# Progress In Heavy-Duty Diesel Engine Efficiency and Emissions

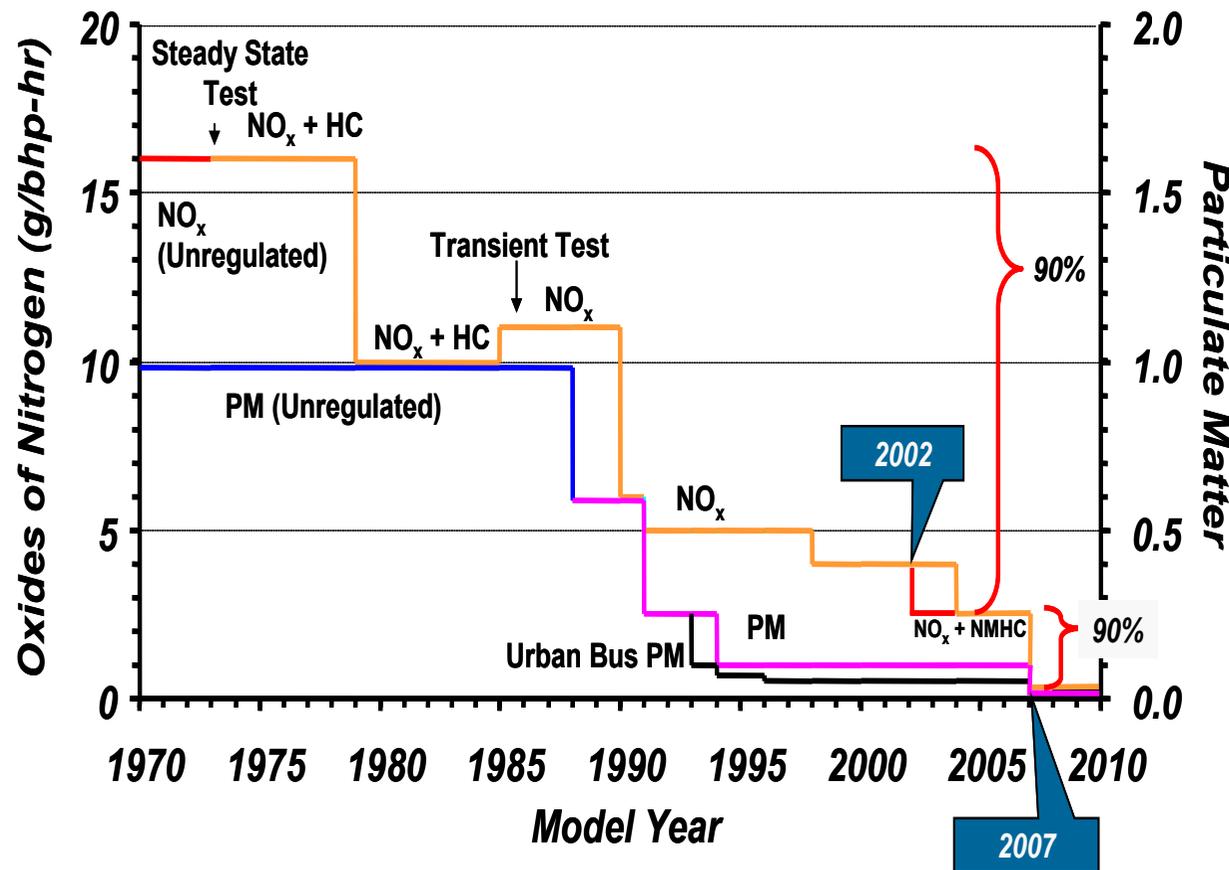


- DOE R&D improved thermal efficiency of over-the-road heavy-duty diesel engines by over 4.5% .
- Benefits from heavy-duty vehicles alone (1995 – 2007) represent an over 60:1 return on investment (ROI) of government funds for heavy-duty combustion engine R&D - total savings of over \$70B.

[Source: Retrospective Benefit-Cost Evaluation of U.S. DOE Vehicle Advanced Combustion Engine R&D Investments: Impacts of a Cluster of Energy Technologies, U.S. DOE, May 2010]

# Progress In Heavy-Duty Diesel Engine Efficiency and Emissions

## Historical Trend in Emissions from New Diesel Engines



*“We have been working with DOE on clean engine technology for the past 20 years. In fact, many of the technologies used in our engines today were developed in partnership with the DOE, our national labs, universities and other research institutions.”*

– Tim Solso

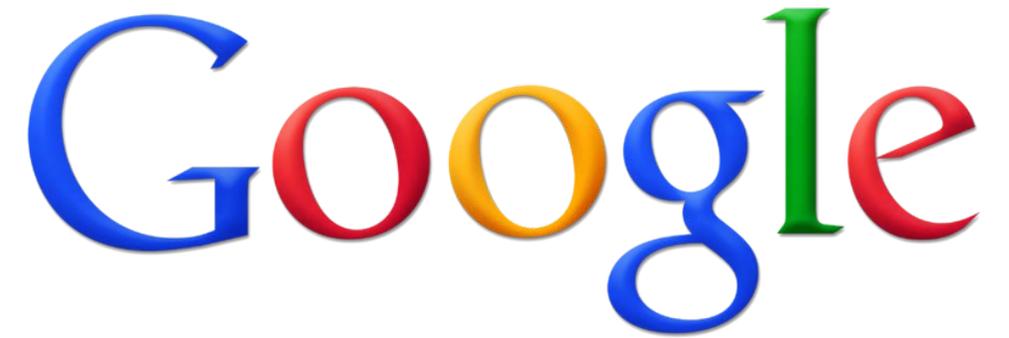
Cummins Chairman and CEO

June 2010

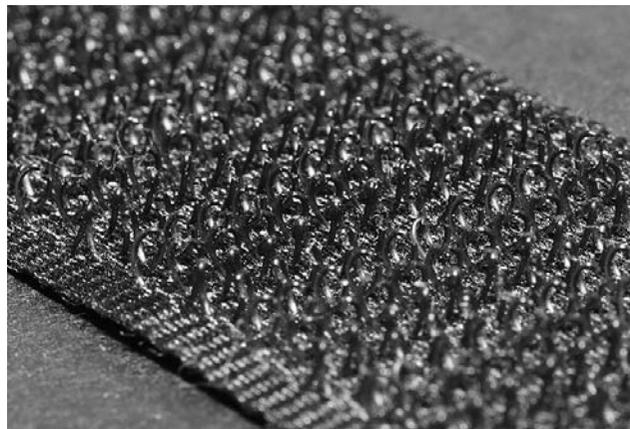
# Government funded research



**Internet**



**Teflon**



**Velcro**

