



“Green” Innovation for Global Vehicle Markets... How Can SAE Help?

Dr. Andrew Brown, Jr., PE, FESD, NAE
2010 President & Chairman – SAE International
Executive Director & Chief Technologist – Delphi

16th. Directions in Engine-Efficiency & Emissions Research (DEER) Conference
Detroit Marriott at the Renaissance Center
Detroit , Michigan
September 27, 2010

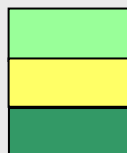
Introduction

- ◆ How do forecasts and trends effect the energy field and transportation industries?
- ◆ What research is needed to improve fuel efficiency and reduce emissions of light, medium duty and heavy duty vehicles?
- ◆ What are the future technologies for internal combustion engines, and how will they enter the marketplace?
- ◆ How does SAE support the increasingly global development of vehicles?

Regional and Global Trends - Summary

Trend	North America	Europe	Asia Pacific		South America	Global Trends
			developed economies	growing economies		
Natural growth: Population, economical, infrastructural						
People live longer Larger, stronger elderly segment						
Generations X-Y: Echo boomers gain more influence, power						
Increased concern about safety, security, privacy						
Health care: Rising needs & cost						
8/5 > 12/6 > 24/7 - Less time, more stress						
Globalization Socio economic political redistribution						
Higher cost of natural resources						
Increasing environmental awareness / regulations						
Information explosion. Increased flow, volume, and dependence on internet						
Wireless world						
Social change in Europe						
Increasing adoption of advanced technology						
Cost as a driver						

Key



Primary regional trend

Secondary regional trend

Global trend

The Future is Safe, Green and Connected

MEGATRENDS

◆ People Megatrends

- Natural Growth
- People Live Longer
- Generations X & Y
- Increased Concern About Safety, Security and Privacy
- Health Care
- 8/5 > 12/6 > 24/7

◆ World Megatrends

- World Turmoil
- Globalization
- Higher Cost of Natural Resources
- Increasing Environmental Awareness/Regulations

◆ Technological Megatrends

- Information Explosion
- Wireless World

◆ Safe MEGATRENDS

- Traffic congestion in major metro areas around the world becomes worse—more accidents, longer commutes, higher stress level



◆ Green

- Fast growing economies: more fuel for mobile platforms
- Demand for electrical energy and related conventional resources far exceeds current capabilities

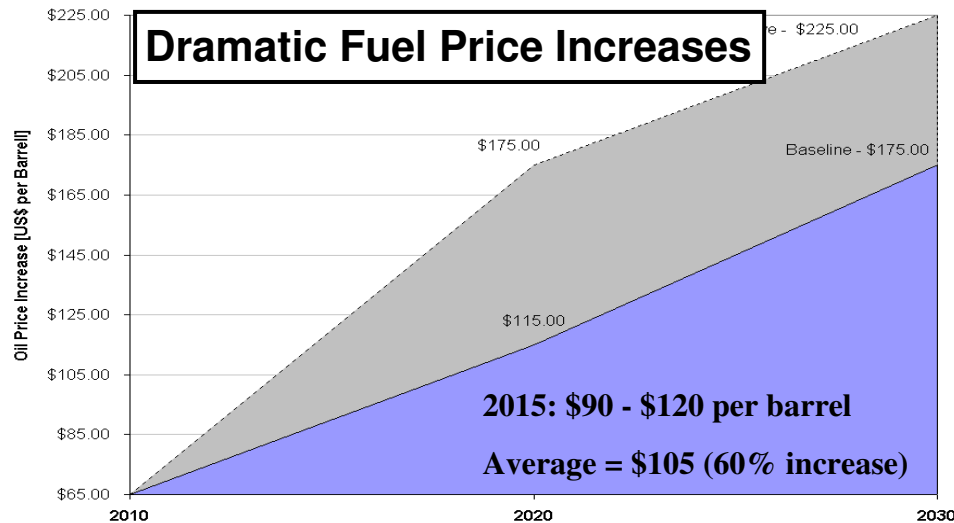


◆ Connected

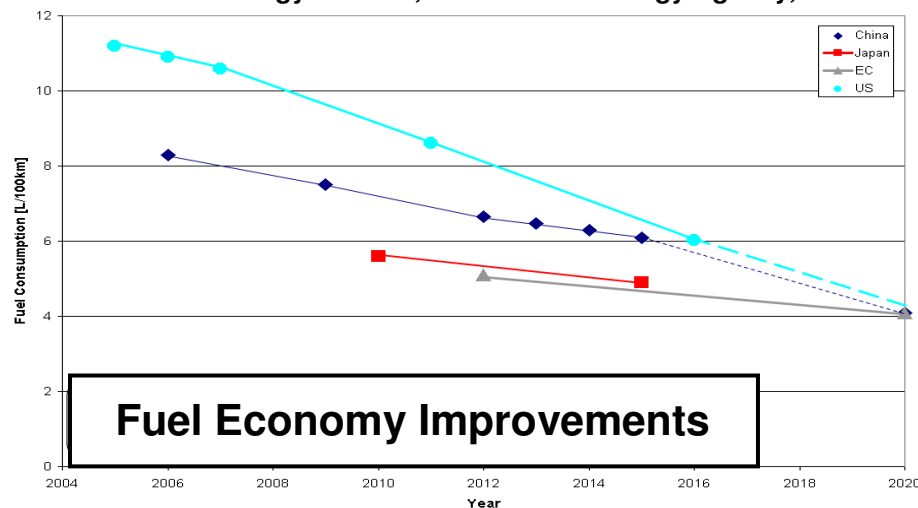
- Global demand for broadband access will continue to grow



Hybrid/Electric Vehicle Market Drivers



Source: World Energy Outlook, International Energy Agency, Nov. 2008

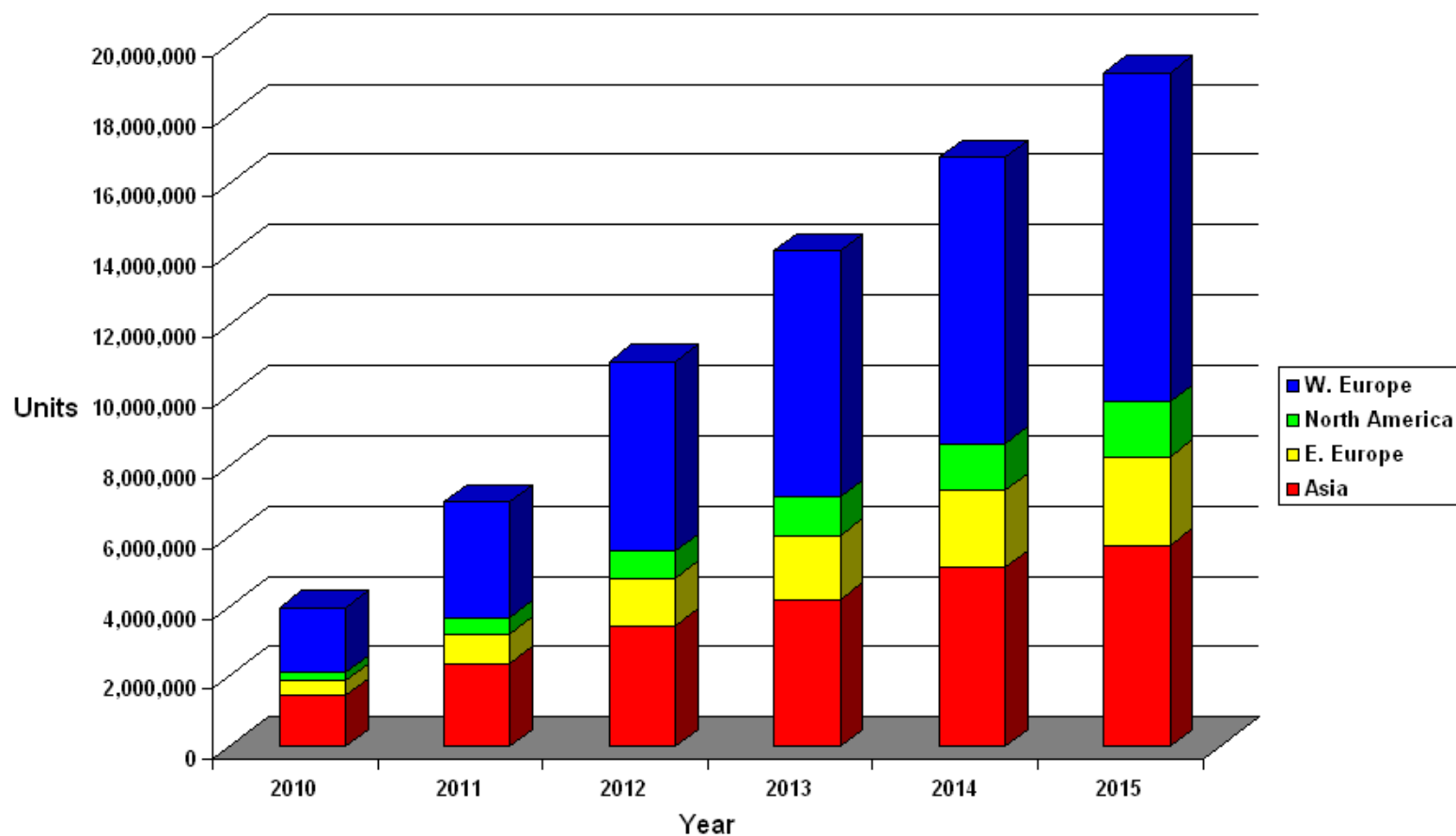


Policy & Market Drivers

- ◆ **Increasing global consumption and fuel price forecasts**
 - Consumers want fuel efficient vehicles
 - Growing concern of import oil dependency
- ◆ **Government regulations and incentives**
 - More strict exhaust gas emissions
 - Lower fuel consumption limits
 - Consumer incentives for purchase of HEV/EV vehicles
 - New technology investment support
 - Infrastructure investments
- ◆ **Vehicle makers need solutions to meet:**
 - Consumer preference/demands
 - Regulatory environment

Market Information

Global Production - ALL HYBRIDS



Source: IHS Global Insight

Technology Trends:

xEV Storage Requirements: Rationale

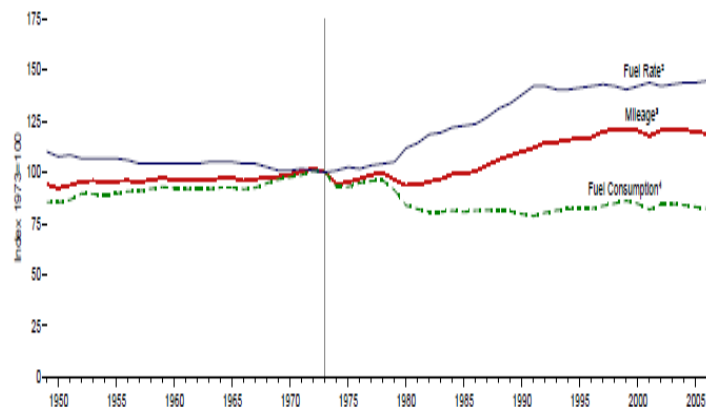
Category	Description	Why It's Important
Energy	Specific energy is the energy capacity per mass (Wh/kg). Energy density is the energy capacity per volume (Wh/L).	Energy translates into vehicle range. High energy is needed to provide adequate range within weight and space constraints. This is more important for PHEVs and EVs than for HEVs.
Power	Specific power is power capacity per mass (W/kg). Power density is the power capacity per volume (W/L).	Power translates into torque and acceleration. High power is needed to provide adequate boost in HEV applications. Power density is less important in PHEV & EV applications due to their larger high-energy battery.
Cost	Cost is most often discussed in per-energy (\$/kWh) and per-power (\$/kW) terms. The context (cell-level vs. pack-level) should be considered when discussing cost.	Cost is one of the largest obstacles to the commercialization of PHEVs and EVs. Energy storage cost represents a significant portion of vehicle cost for PHEVs and EVs, and must be reduced for these vehicles to become cost-competitive with traditional vehicles.
Lifetime	Lifetime is considered in terms of calendar-life and cycle-life. Cycle-life is further defined in terms of micro-cycles (small changes in SoC) and full-cycles (full discharge/charge).	HEVs operate in charge-sustaining mode and require sufficient micro-cycle lifetime. EVs operate in charge-depleting mode and require sufficient full-cycle lifetime. PHEVs have perhaps the most difficult requirements, requiring both micro- and full-cycle lifetimes. All vehicles require sufficient calendar life (15 years).
Safety	There are numerous aspects to safety, including operating temperature range, heat generation, and response to overcharging, short circuit, mechanical damage, etc.	Safety is important for the obvious reason that certain battery failure modes in automotive applications could be catastrophic.

Source: "Status and Trends in the HEV/PHEV/EV Battery Industry", David Anderson, Rocky Mountain Institute, Summer 2008

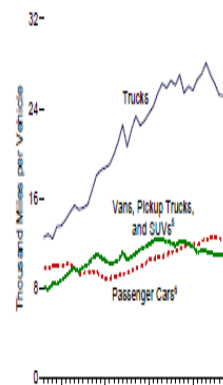
Medium/Heavy Duty Vehicle Market Fundamentals & Fuel Consumption

- MHDVs represent 26% of all U.S. liquid transportation fuels
- Increased more than consumption for other sectors

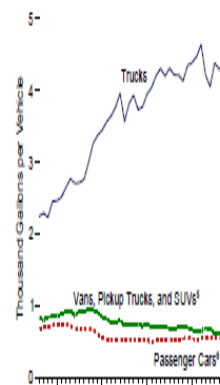
All Motor Vehicles,¹ 1949-2007



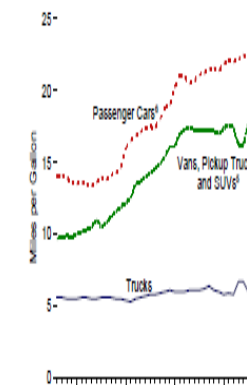
Mileage, 1966-2007



Fuel Consumption, 1966-2007



Fuel Rates, 1966-2007



MHDV fuel use is dominated by Class 8, Class 2b and Class 6

U.S. Medium and Heavy Duty Vehicle Population, Mileage and Fuel Use by Weight Class						
Vehicle Size	Population [millions]	Annual Miles [million miles]	Annual Fuel Use [million gallons]	% of Population	% of Annual Miles	% of Fuel Use
Class 2B	5.800	76,700	5,500	52.8%	35.1%	19.3%
Class 3	0.691	9,744	928	6.3%	4.5%	3.3%
Class 4	0.291	4,493	529	2.6%	2.1%	1.9%
Class 5	0.166	1,939	245	1.5%	0.9%	0.9%
Class 6	1.710	21,662	3,095	15.6%	9.9%	10.9%
Class 7	0.180	5,521	863	1.6%	2.5%	3.0%
Class 8	2.154	98,522	17,284	19.6%	45.1%	60.8%
TOTAL	10.992	218,580	28,444	100%	100%	100%
<small>SOURCE: Class 3 - 8 - U.S. Department of Commerce, Bureau of the Census, 2002 Vehicle Inventory and Use Survey; Class 2B - Davis, S.C. and L.F. Truett, Investigation of Class 2b Trucks (Vehicles of 8,500 to 10,000 lbs GVWR), ORNL/TM-2002/49, March 2002, Table 16. Class 3 - 8, 2002 Population; Class 2b, 2000 population</small>						

Technologies & Costs of Reducing Fuel Consumption

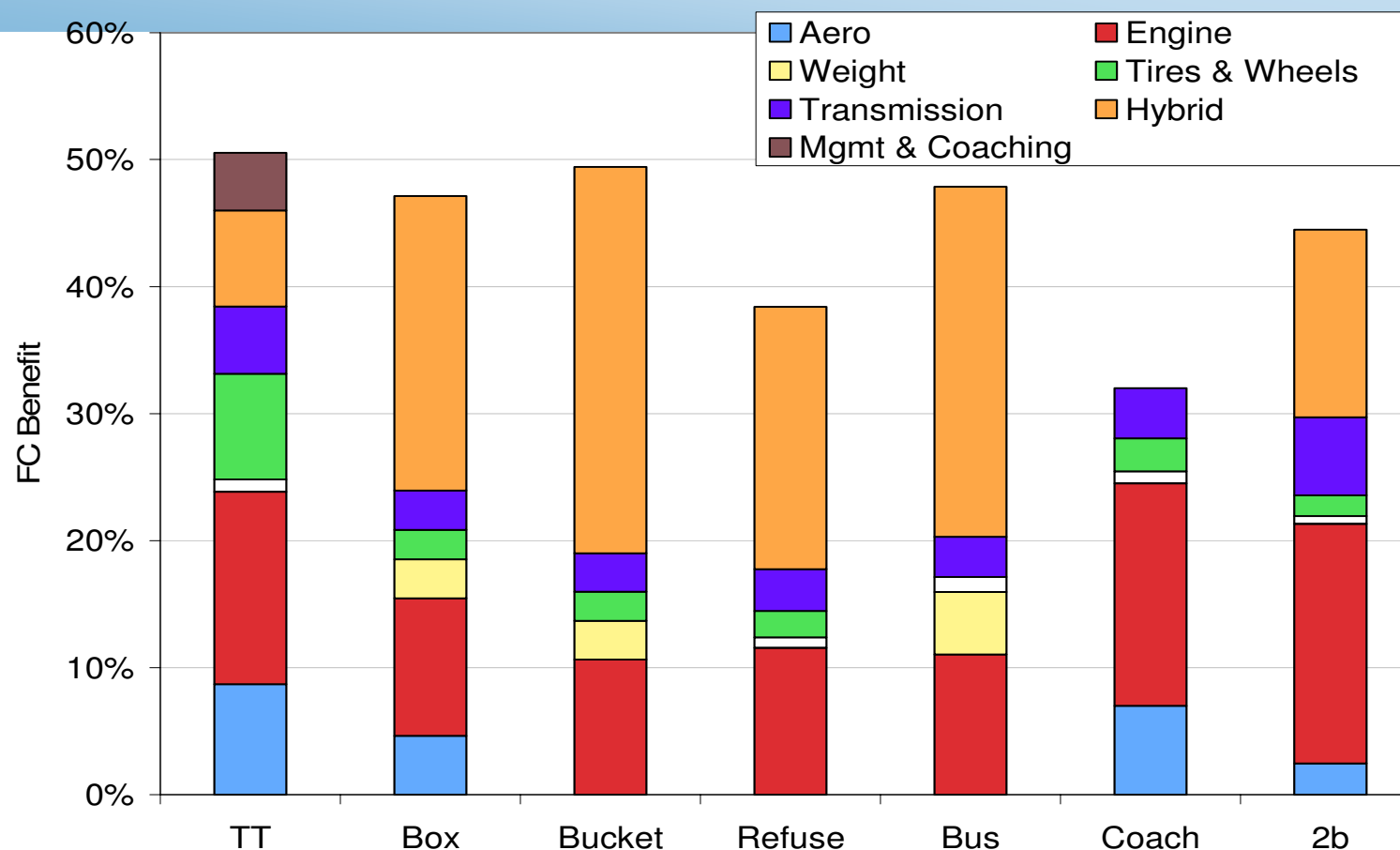


FIGURE S-1 Comparison of 2015-2020 New Vehicle Potential Fuel Savings Technology for Seven Vehicle Types: Tractor Trailer (TT), Class 3-6 Box (Box), Class 3-6 Bucket (Bucket), Class 8 Refuse (Refuse), Transit Bus (Bus), Motor Coach (Coach), and Class 2b Pickups and Vans (2b). Also, for each vehicle class, the fuel consumption benefit of the combined technology packages is calculated as follows: $\%FC_{package} = 1 - (1 - \%FC_{tech1})(1 - \%FC_{tech2})(1 - \%FC_{techN})$ where $\%FC_{techx}$ is the percent benefit of an individual technology. SOURCE: TIAX (2009) at ES-4

NHTSA's Proposal & Intent

- ◆ 21 May 2010, President Obama issued memorandum calling for coordinated regulation of the medium and heavy truck market
 - NHSTA will establish rules for Fuel Efficiency under authority from the US Congress in 2007
 - EPA will establish rules for emissions under authority from Supreme Court Ruling in 2007
- ◆ Propose new fuel efficiency rulemaking standards starting with medium and heavy trucks in the 2016 MY
- ◆ Seek voluntary compliance for 2014 & 2015 MY medium and heavy trucks
- ◆ Before proposals can be rolled out, an EIS (Environmental Impact Study) must be undertaken to ascertain direct, indirect, and cumulative impacts of such actions
- ◆ Any proposal must provide not less than 4 full years of regulatory lead-time and 3 years full model years of regulatory stability
- ◆ New rulemaking must be undertaken with consultation with the EPA (Environmental Protection Agency) and the Department of Energy (DOE)

SAE Mission & Role in “Green”

- ◆ Presidential Focus Areas for 2010 include:
 - Concentrate on lean, value-added activities for SAE and its constituencies
 - Advocate technology and policy issues relevant to SAE’s sectors
 - Forge stronger relationships with government and regulatory agencies
 - Lead sector efforts to sustain industry talent and competency
 - Enhance SAE’s global professional presence through locally driven business models and relationships

- ◆ These Focus Areas tie in with SAE International’s safe, green and connected initiatives. Programs, products and services are being revised and reinvigorated to provide solutions in these areas.
The goal: To help support the increasingly global development of vehicles.

- ◆ Proof-Points
 - Discussed SAE role with key government officials at the beginning of the year
 - Conducted first SAE Board Mtg. in Washington DC & met with Congressional leadership & staff
 - ASME/IEEE/ITSA/SAE Collaboration

How SAE Can Help

- ◆ Technical standards – improve safety, efficiency and cost-effectiveness of vehicles
- ◆ Conference and symposia – events across all three sectors in North America and around the globe
- ◆ Professional development programs
- ◆ Technical publications – technical research papers, authored books, electronic data compilations
- ◆ Programs, products and services focus on current and next-stage technology
 - Electrification – Hybrid Vehicle Technologies Symposium; J2836/1™ - Use Cases for Communication between Plug-In Vehicles and the Utility Grid
 - Electronics/connectivity – SAE Convergence 2010
 - Environment – trusted resource for accurate data and information regarding regulatory standards involving emissions and fuel consumption

How SAE Can Help

- ◆ SAE International reaches out to all of its constituents, including the federal government, to be a neutral voice on public policy and techno-political issues
- ◆ SAE International can be a catalyst to help provide better government understanding and knowledge of the mobility industry
- ◆ SAE International can help provide the information that legislators and government agencies need to make informed decisions regarding regulatory standards.
- ◆ SAE International has engaged top executives from across the aerospace, automotive and commercial vehicle industries
- ◆ This base of knowledge helps SAE stay on the forefront of trends that shape mobility engineering

6th SAE 2010 North American International Powertrain Conference



- ◆ Held Sept. 15-17 – Chicago
- ◆ Brings together executive-level leaders from industry and government
- ◆ Participation from DOE – including Patrick Davis
- ◆ Event Featured four breakout sessions with discussions:
 - How do we make electric vehicles 20% of the market considering infrastructure, battery technology, etc.?
 - How long with conventional powertrains continue to dominate the market and what impact does fuel economy have?
 - What will it take to make diesels feasible and affordable in the future?
 - What is the impact of fuel economy on medium and heavy-duty powertrains?

Break Out Group – Conclusions & Recommendations

◆ Electric Vehicles

- Reduce battery costs – suppliers work together on economies of scale, purchasing power
- SAE can assist in standardization of components (e.g. battery pack standards cell size and voltage) and educate consumer on how to select vehicles that best meet their needs.

◆ Conventional Powertrains

- ICEs will continue to dominate in 2030 due to efficiency improvement potential and prohibitive cost of alternatives
- Refocus CAFÉ from MPG to CO2 reduction
- Create a strategy that meets future regulations without heavy dependence on alternative propulsion systems (electrification)

Break Out Group – Conclusions & Recommendations

◆ Diesels – Feasible and Affordable

- Diesel is technically feasible but expensive
- No evidence of demand for diesel
- Roadblock – additional cost: need to reduce after treatment costs by 50% and engine costs by 30%
- SAE International should work with consultancy companies and government agencies to form industry group to investigate how to achieve these cost targets.

◆ Medium and Heavy-Duty Fuel Economy

- A diversity of system level solutions are needed to deliver fuel economy improvement for different segments
- System level optimization of the core powertrain is necessary
- Significant opportunities exist in vehicle integration (tires, aero, thermal management, transmission, etc.)
- Operator payback in Europe is faster because of increased fuel cost, which is driving implementation of CO₂ improvements
- Approach fuel consumption improvements at the system (vehicle) level
- Synthesize powertrain improvements with the system level low hanging fruit
- SAE International can help stimulate cooperation and support regulation at the system level

Summary

- ◆ Government and industry will continue to drive “green” products and processes into the future
 - Power Electrification
 - Materials
 - Reclamation/Re-usage
- ◆ Powertrain Electrification will be a major component of vehicle makers strategy for years to come in both the light and medium/heavy duty markets
 - Off-Road applications will increase as well
- ◆ Common standards will be necessary to advance the global market/s for green technology
 - Global partnerships will be key
 - SAE serves as the key conduit for global cooperation