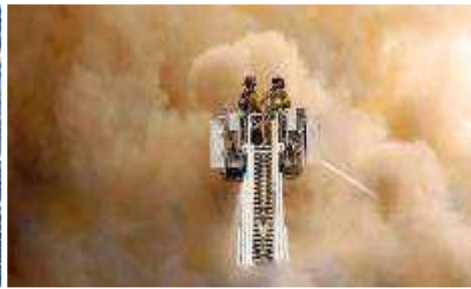


Automotive Lightweighting: Challenges & Opportunities

H.L. Snyder
DuPont



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Automotive Light Weighting : ... Challenges & Opportunities

**Understatements for Transportation:
Oil is becoming an issue**

Emission continue to be an issue

Importation of Oil is an issue for Many Countries

**Most solutions benefit from Light Weighting
Light Weighting is not new to automotive**

Lots of Opportunity for future Light Weighting

Lots of Opportunity for Material Science



Oil

... a Growing Issue for Automotive Industry

“One-fourth of all the oil consumed by humans in our entire history will be consumed from 2000 to 2010.”

Sperling, Daniel and Deborah Gordon, *Two Billion Cars: Driving Toward Sustainability*, Oxford University Press, 2009.

“Oil continues to account for more than 95 % of all the energy used for transportation in the United States.”

US Energy Information Administration



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Emissions a Continuing Issue for Automotive

... air quality in congested areas, Global Warming, etc

“According to the European Federation for Transport and Environment, transport CO₂ emissions in the EU grew by 35% between 1990 and 2006, while other sectors reduced their emissions by 3% on average during the same period. The share of the transport sector in CO₂ emissions grew from 21% in 1990 to 28% in 2006. Emissions from passenger cars and light commercial vehicles were responsible for approximately half of this.”

Issue is the Same in The U.S. and other Countries



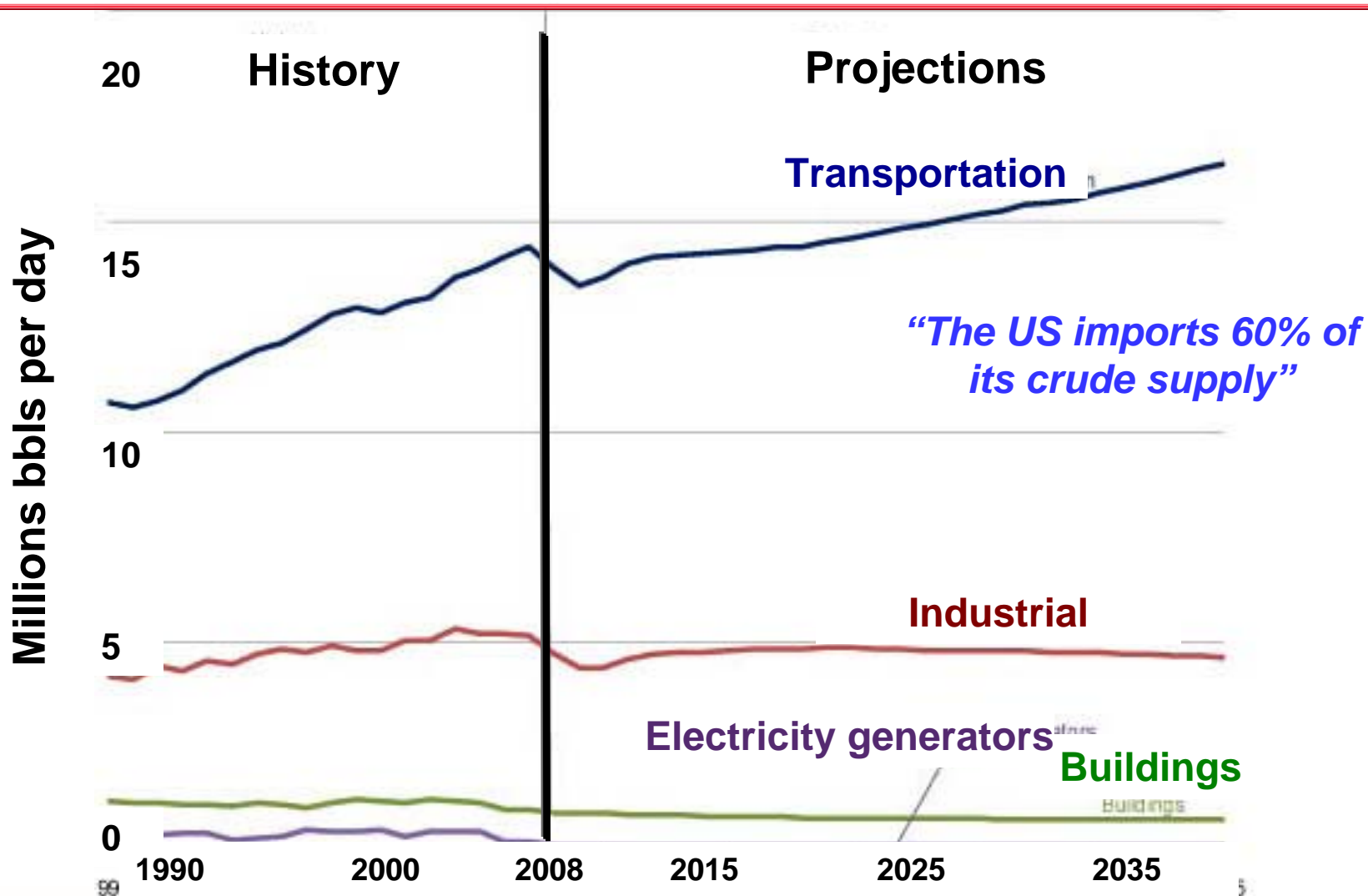
Yankun Hou, Yankun Hou, Ming Xu, Paul Gong and Leping Huang; Nomura; Electric Vehicles China; 2010

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U.S Trends in Liquid Fuel Usage

... Growth of Oil Importations is an Issue to Many Nations



Source: Steven E. Koon quoting : EIA, Annual Energy Outlook 2010

What do Consumers Think?

... Consumers are not the “Drivers” yet ... regulators are ... this could change

Most consumers do not truly understand or value GHG emissions (abstract)

However ...

- **Consumers value making less gas stops**
- **Consumers are concerned about cost of fuel**
- **Consumers value local air quality**
- **Consumers value national security & oil independence**

Stephen Popiel, Ken Kuraini, SAE 2011 Hybrid Vehicles Symposium, Anaheim, CA

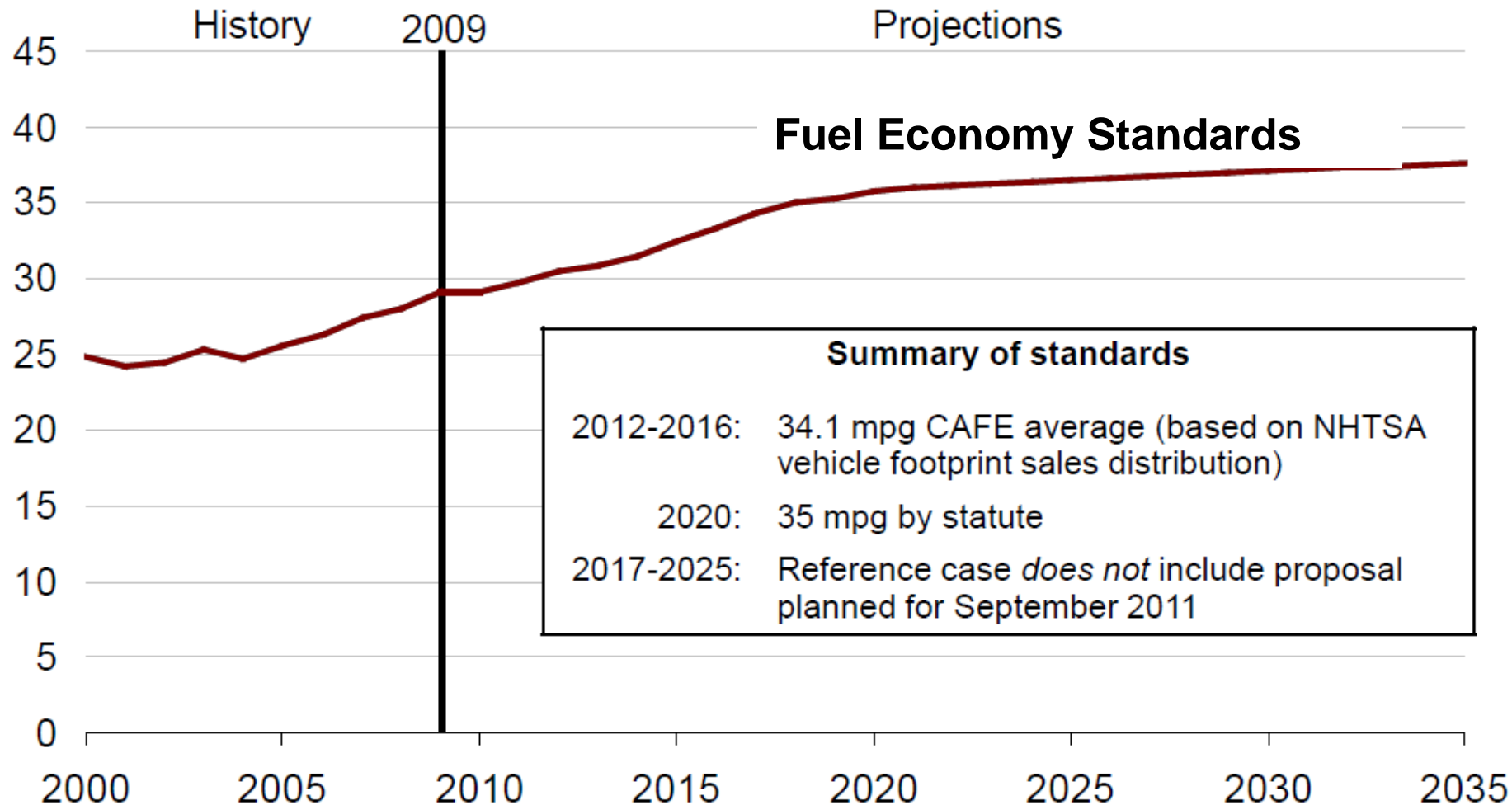


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So ... Regulator's are Impacting Vehicle Design

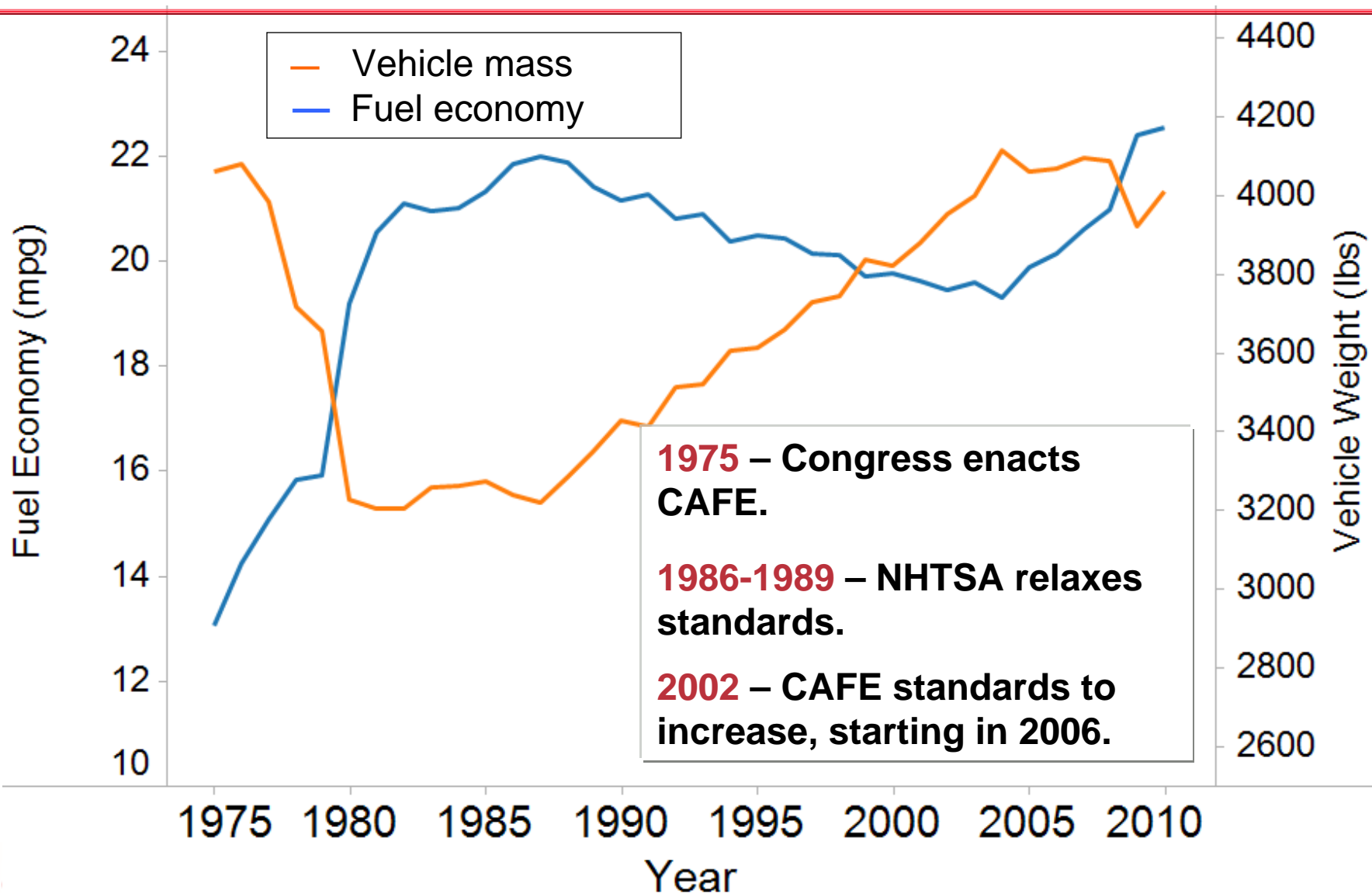
... *Fuel Economy is one focus area of Regulator's*

miles per gallon



Historical View on Weight vs Regulation

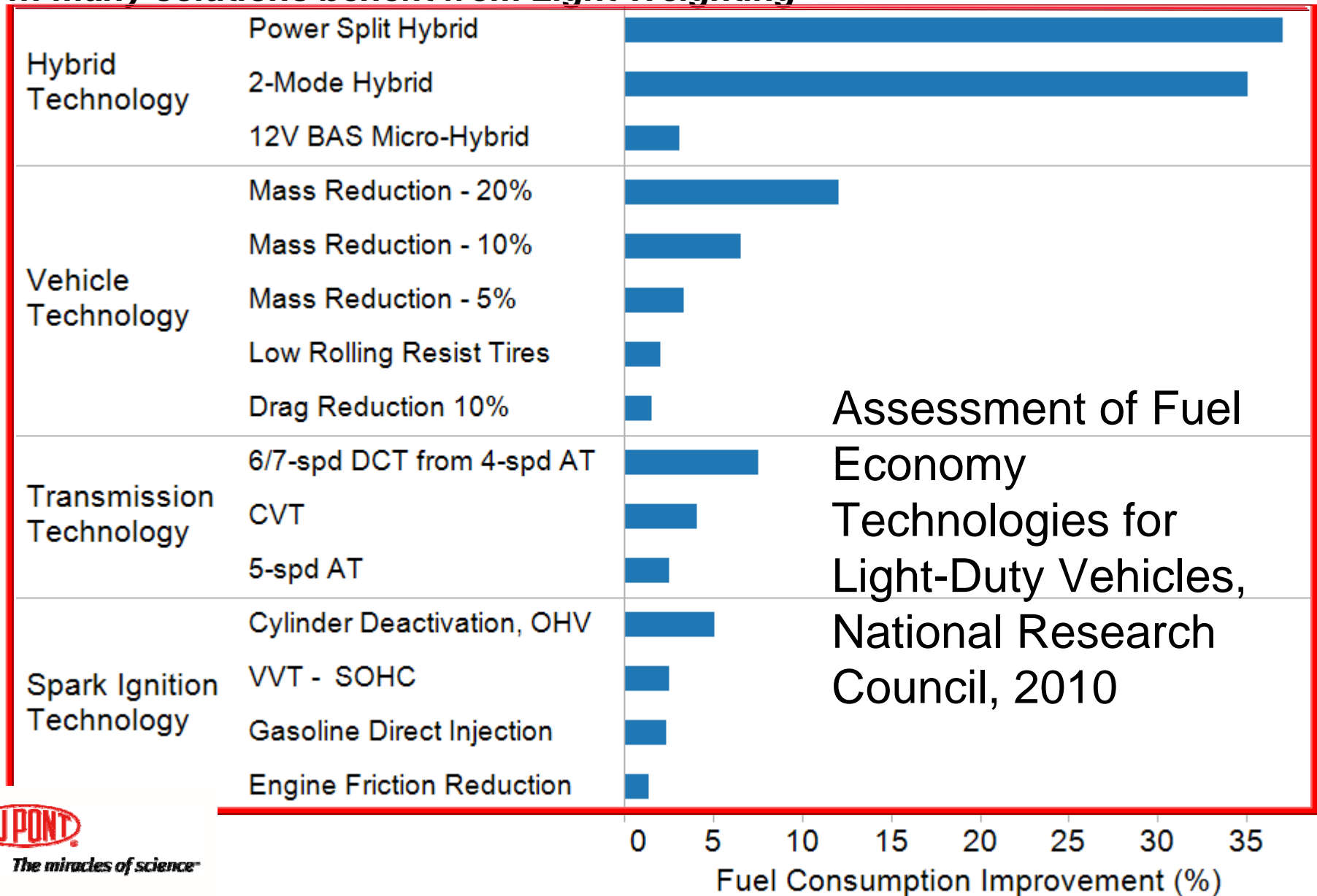
... anytime Fuel Economy is regulated Vehicle Wt goes down



There is not one Magic Bullet

... but most solutions need new materials

... many solutions benefit from Light Weighting



Automotive Has Experience Light Weighting

... experience with Plastics continues to grow

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August 18, 2008

OEMs cut weight, emissions with plastic parts

Plastics are set to grow faster than auto industry

weighing in

Plastics as a % of total weight of a medium-sized car in Europe

1975	6.0
1991	8.0
1998	11.5
2002	13.0
2007	18.0

Source: BASF

Bettina Mayer
Automotive News Europe

MUNICH ■ Leading plastics suppliers expect to benefit as automakers accelerate efforts to make their new generation cars lighter.

Plastics account for about 14 percent of a car by weight today.

At premium automaker BMW, plastics already make up 17 percent of the parts in new models, up from 12 percent in 1990.

The industry expects to see more plastics used in cars as automakers seek to reduce emissions and fuel consumption by cutting weight.

"The number of plastic parts going into a car will grow constantly," said August Achleitner, senior engineer at sports car maker Porsche.

Leading plastics suppliers such as BASF, Dow Automotive and SABIC Innovative Plastics are predicting above-average growth in their plastics and advanced plastics businesses in coming years. They expect that demand for plastics will grow faster than the auto industry as a whole.

Raimar Jahn, CEO of BASF's polymers division and head of BASF's automotive business, says that plastics will account for 19 percent of a car's weight by 2010.

US-based Dow Automotive predicts that, by 2015, the amount of plastics used will be two to three times higher than today.

Rising steel prices and pressure to cut weight from new cars is driving demand.

Plastic body panels weigh half as

much as steel ones.

But plastics also offer greater design freedom and make it easier for engineers to meet European pedestrian-protection laws. Experts also say plastics are more forgiving than steel in a collision.

"Engineers are well aware of the advantages of plastics," said BASF's Jahn. "That's why they are very quickly growing in the car."

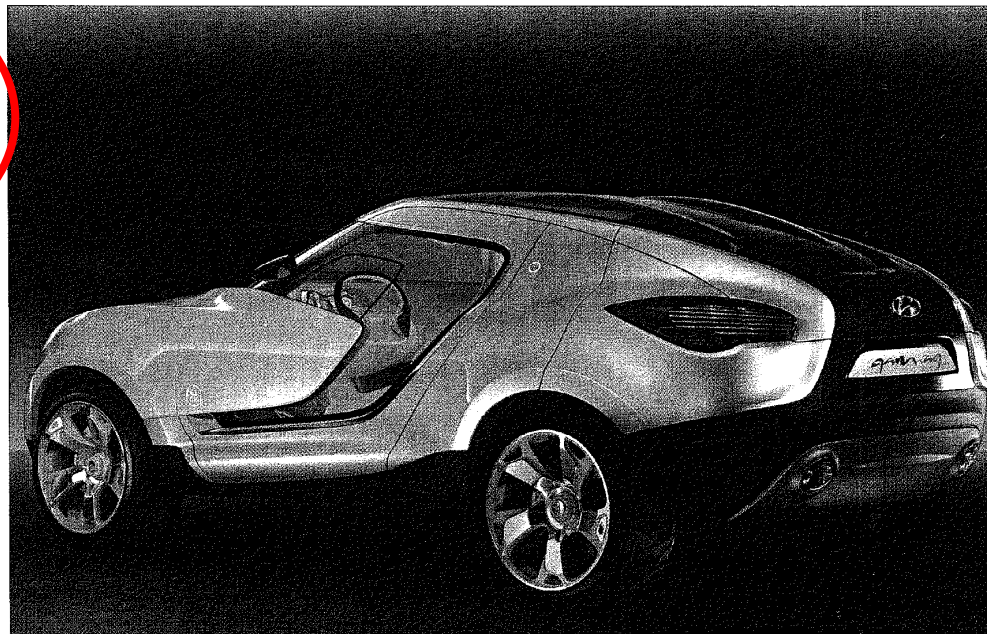
Every mid-sized European car now contains €165 worth of plastics manufactured by BASF, according to the German chemical giant. Dow Automotive says it has an average of \$30 (€19) worth of plastics in each of these cars.

Advanced plastic panels

Japanese and Korean carmakers, including relative newcomers Hyundai and Kia, appear most receptive to plastic parts and panels.

"They are typically more progressive in plastics," said Todd Prey, Dow Automotive's vice president for plastics. He said the car companies are less committed to steel than many of their competitors.

At the 2007 Geneva auto show, Hyundai Motor Europe used the Qar-



Hyundai used the QarmaQ concept at the 2007 Geneva auto show to preview advanced plastic body panels.

maQ concept to preview advanced plastic body panels, which the company says are similar to those planned for production models due between now and 2014.

Developed with SABIC Innovative Plastics, formerly GE Plastics, the QarmaQ was 60kg lighter than a car using traditional materials.

Powertrain and structural body panels are harder to substitute for plastics, not least because engineers have no ex-

perience using the material.

"That's a hurdle for a company that sells plastic, but also an opportunity for us to go to the automaker and become their leading designers for plastics, competing with the folks designing metal," Dow's Prey said. "It's our turn to jump in and offer them our solutions for the ultimate goal that is reducing weight."

Steelmakers say the advances made in plastics technology are not

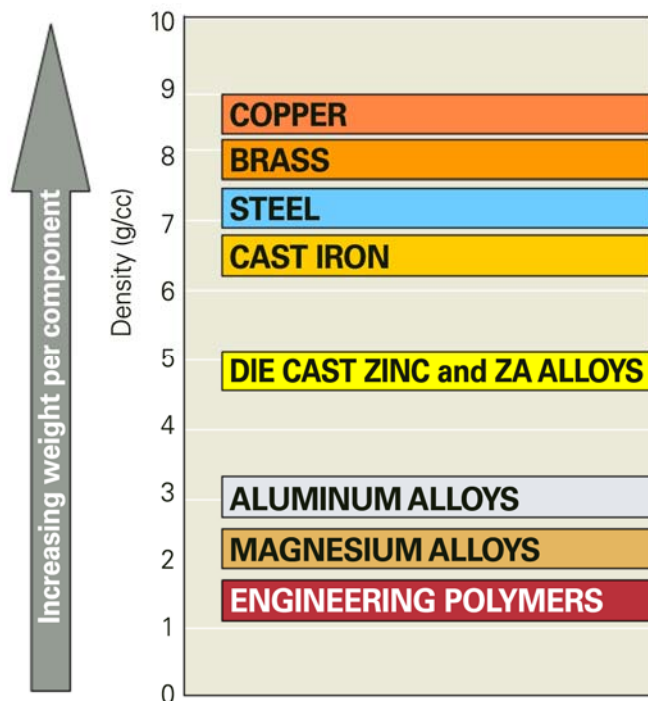
a threat. The average proportion of steel in car bodies in the lower-medium segment is still above 90 percent, said Bernd Overmaat, spokesman for German steel supplier ThyssenKrupp Steel.

ThyssenKrupp is developing thinner, stronger lightweight steel. It is also working on combining steel and plastic for use as body panels to ensure it remains competitive. **ANE**

Key Light Weighting Enablers

... higher temperature, high performing, lower total system cost plastics

Composite materials offer great potential to reduce mass



But...further penetration into powertrain applications increases temperature requirements.



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Zytel® Plus Example

...Nylon with 40 C Higher Services Temperature

... creates new opportunities for Plastic Led Light Weighting

... material science advances key to application penetration

ENGINE COVER.

Superior retention of properties despite hot-oil exposure. Excellent flow and surface aspect. Calcium chloride resistance.

TURBO CHARGER DUCTS.

Exceptional retention of mechanical properties despite hot air exposure. Excellent flow, surface aspect, and welding performance.

RESONATOR.

Superior retention of properties after air oven aging for improved weld strength and burst pressure resistance. Better fatigue and calcium chloride resistance.

OIL PAN.

Excellent retention of properties despite hot-oil exposure. Resistance to calcium chloride, stone impact and lower warpage.

AIR INDUCTION.

Superior retention of properties at high temperatures. Low warp. Improved weld strength and burst pressure resistance after aging. Excellent flow to enable thinner walls. Reduced cost and excellent surface aspect.

TURBO CHARGER END CAPS. (CHARGE AIR COOLERS).

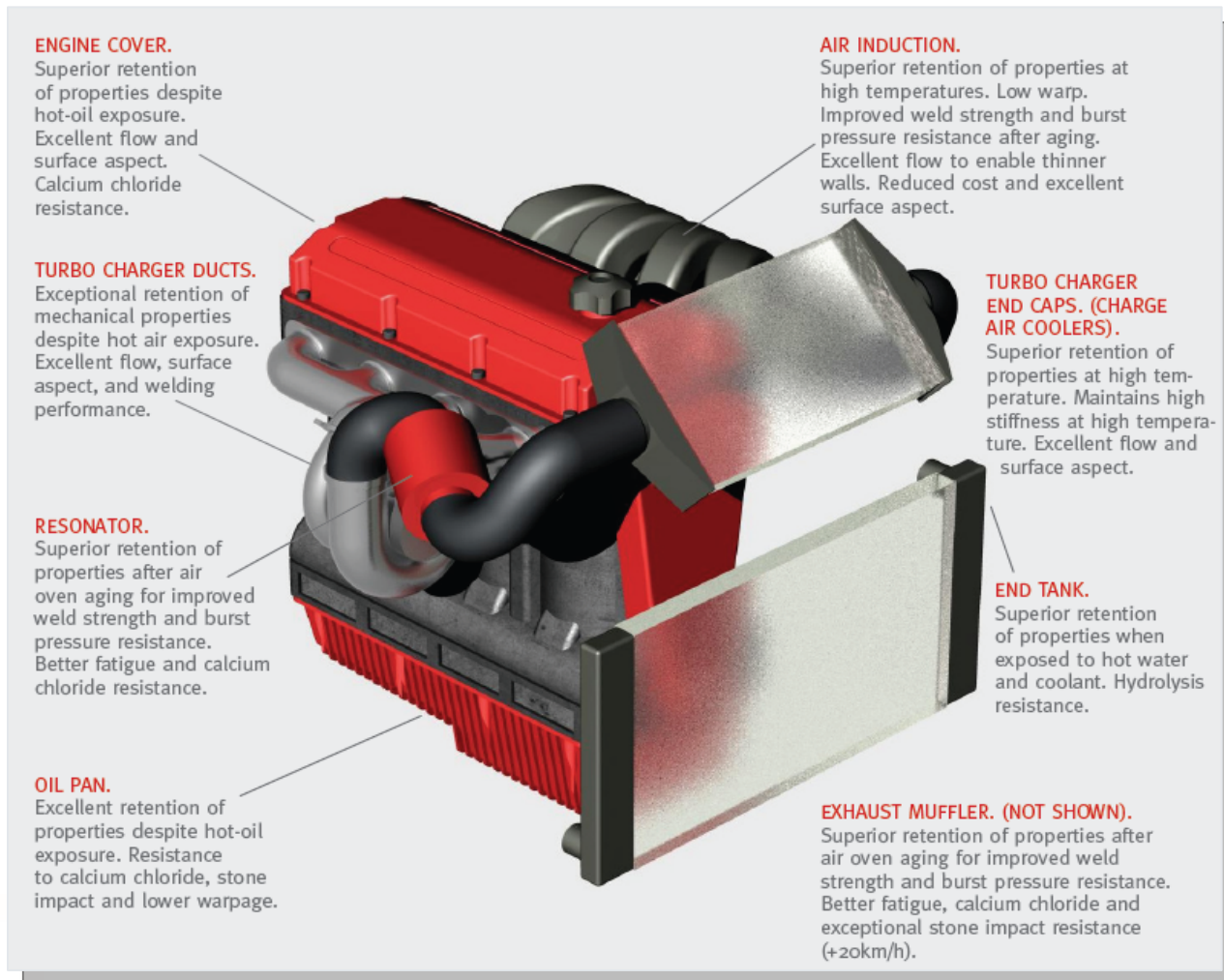
Superior retention of properties at high temperature. Maintains high stiffness at high temperature. Excellent flow and surface aspect.

END TANK.

Superior retention of properties when exposed to hot water and coolant. Hydrolysis resistance.

EXHAUST MUFFLER. (NOT SHOWN).

Superior retention of properties after air oven aging for improved weld strength and burst pressure resistance. Better fatigue, calcium chloride and exceptional stone impact resistance (+20km/h).



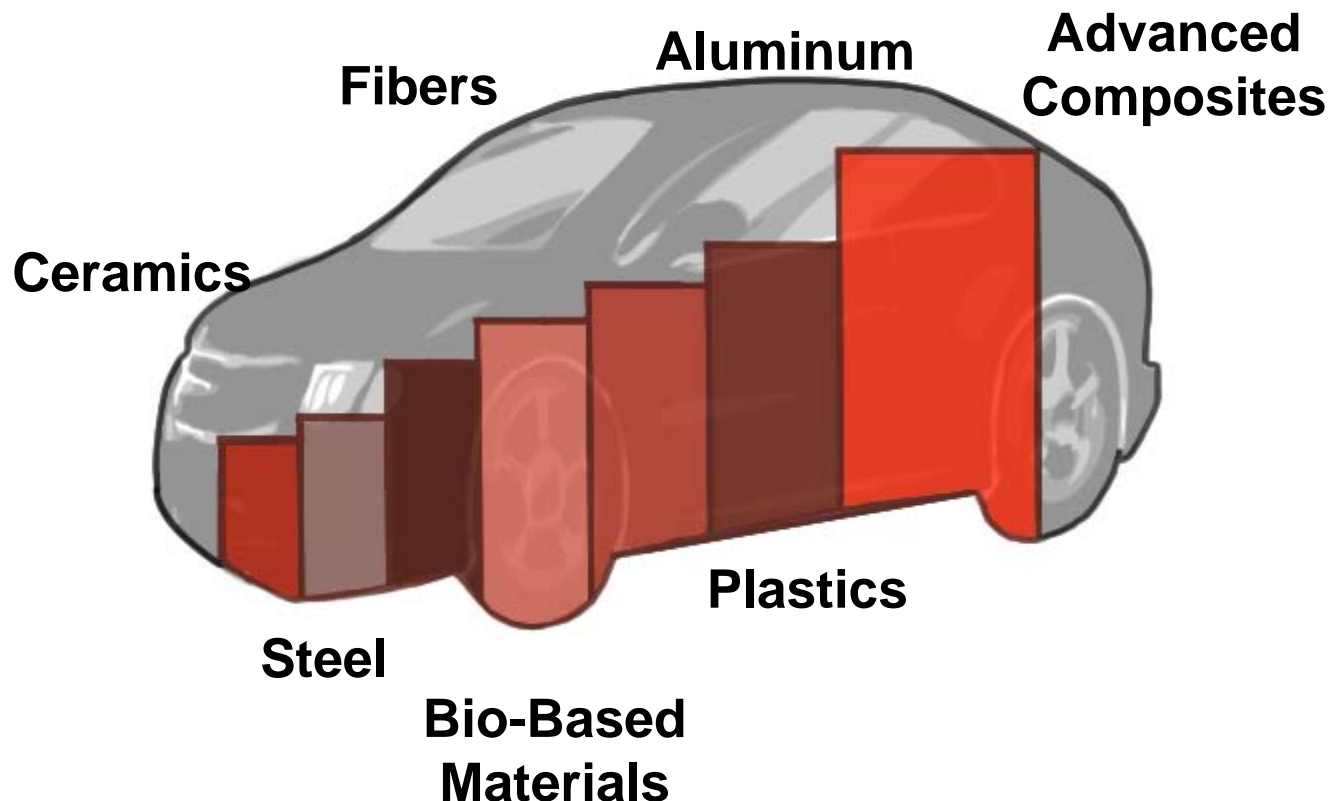
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Future Opportunities

... Materials “poised” for growth & Material Science Advances Needed

... Light Weighting is a Key Driver of Future Material Science

... Opportunities exist for all Materials



Source - 2011 DuPont Automotive/SAE survey of design engineers performed by Signet Research Inc.



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