Policy Matters: Perspectives on Automotive Technology and Fuel Economy

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Why are we doing this?

Policy rationales for fuel economy regulation:

- To reduce security & economic risks of oil imports: **YES**
  - We're not running out of oil, but it is in the national interest to limit economic exposure to cartelized market
- To reduce CO_2 emissions and the associated risks of climate disruption: **YES**
  - We have "run out of atmosphere" and the risks are growing
- To save consumers money: well, **NO**
  - Consumers do respond to fuel prices on their own, but market arguably takes care of this *private* concern.
  - Regulation to address *public* concerns that pushes CAFE beyond market-driven levels does save consumers money, even though it's a saving they often do not pursue on their own.
- **Core reasons similar to those for safety and emissions**

A Fuel Efficiency Horizon for U.S. Automobiles (study released September 2010)

Goal:

- Analyze new fleet levels attainable through 2035
  - Fundamentals-based analysis, 2005 baseline
  - Use transparent assumptions building on previously published engineering simulation results
- Assume success in ***revolution by evolution***
  - Ambitious but non-disruptive technology and design changes (analyzed only "grid-free" options)
  - How far can one get with optimal use of available technology, making fuel economy the design priority?
  - What are the implications of the resulting efficiency horizon for "revolutionary" alternatives?

Result: ***A tripling of new fleet efficiency is feasible and cost-effective by ~2035, without "plugging in"***

Family Haulers Then and Now

1975 Mercury Marquis

- 6.6L V8, 150 hp → 17 kW/L
- Rudimentary pollution control
- Seat belts
- 11 MPG (unadjusted CAFE-type rating)

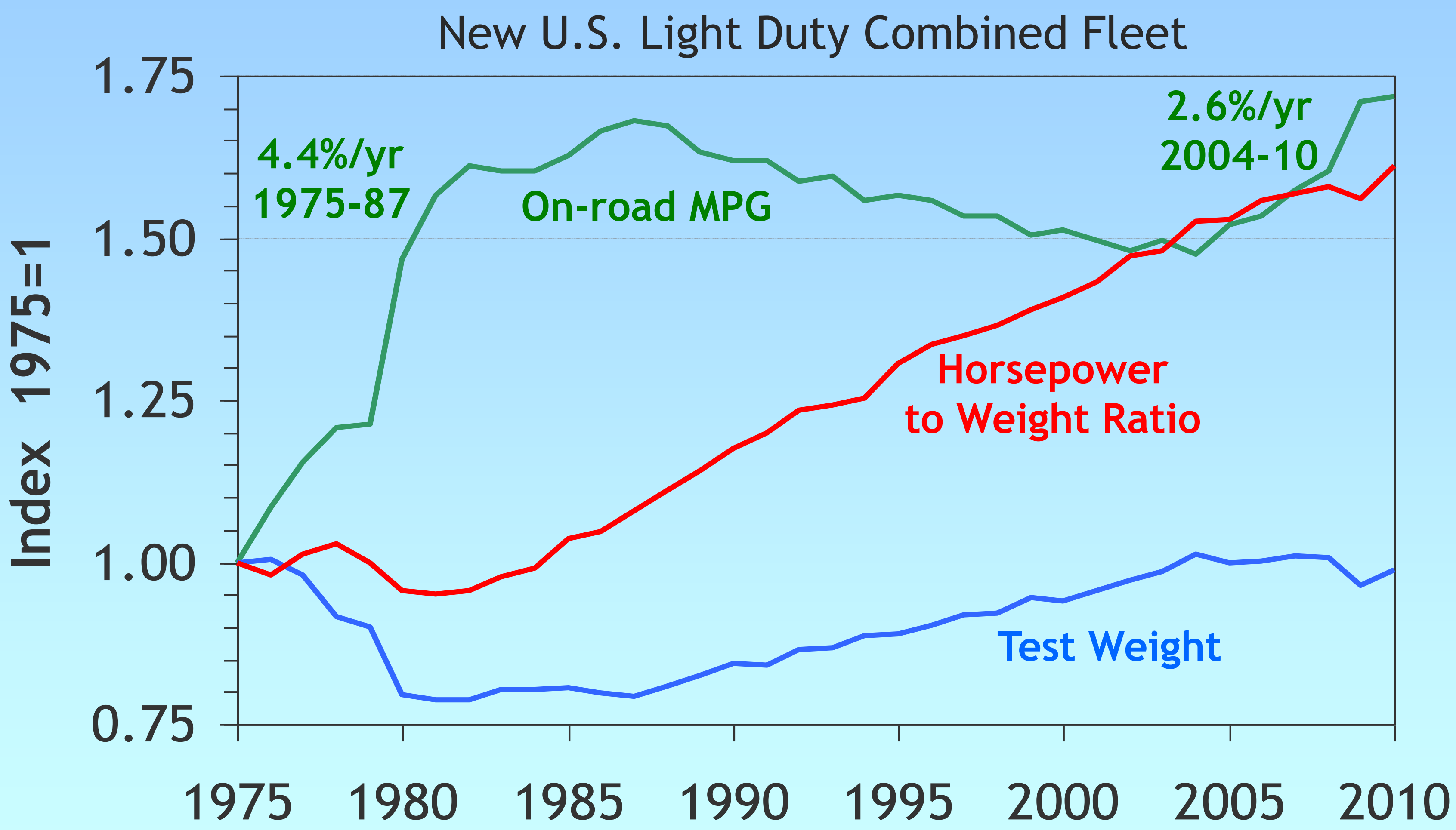
1990 Ford Aerostar

- 3.0L V6, 145 hp → 36 kW/L
- First-generation 3-way catalytic control
- Safety engineered structure meeting then-current FMVSS
- 23 MPG

2005 Ford Freestyle

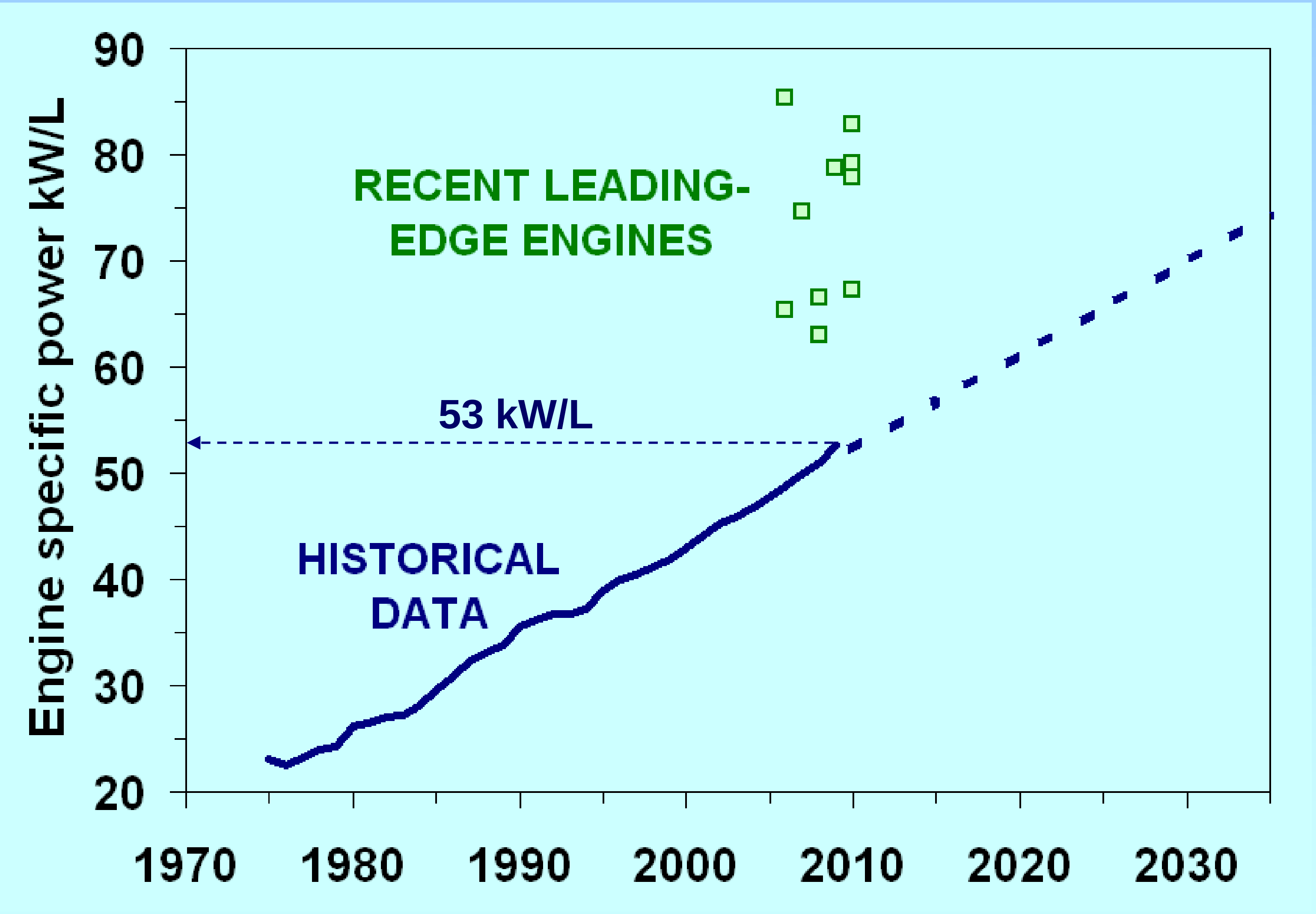
- 3.0L V6, 203 hp → 50 kW/L
- Ultra-low emissions
- Sophisticated safety features throughout
- 24 MPG

New fleet average fuel economy



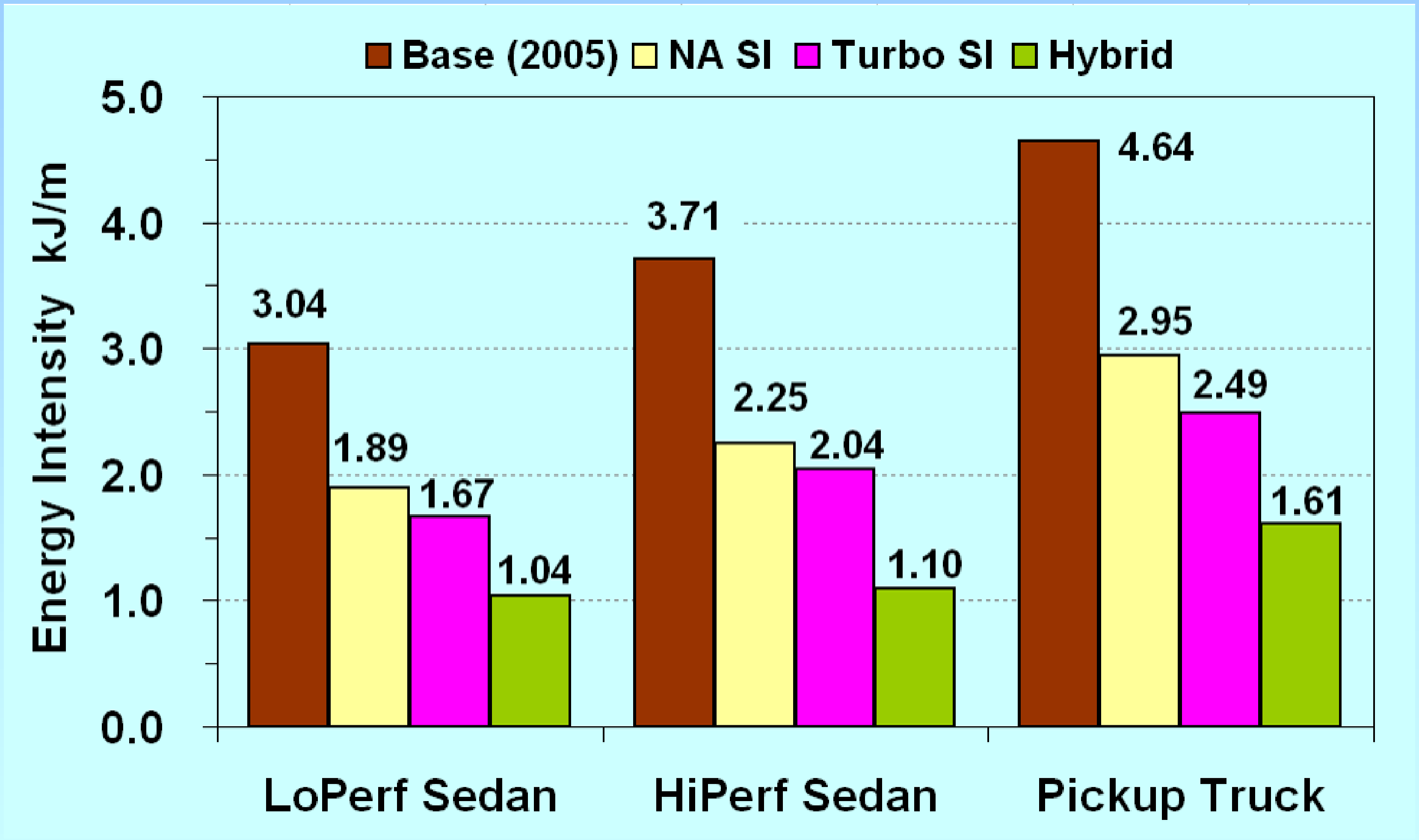
Source: U.S. EPA Fuel Economy Trends report 2010

Engine specific output trends



Source: EPA Fuel Economy Trends report; selections from Ward's 10 Best Engines, 2006-10

MIT simulation results



⇒ ***A factor of three reduction (i.e., 3x fuel economy) is in sight.***

Source: Kasseris & Heywood, SAE 2007-01-1605; to convert kJ/m to CAFE MPG, divide into 94.6.

Automobile efficiency is best viewed as a matter of *design priority*

- Technological progress has been steady and ongoing
  - Nearly all applicable technologies have multiple benefits
  - Whether fuel economy is gained depends on:
    - The design objectives of individual vehicles
    - The overall mix of vehicles sold
  - Until recently, most of the prior two decade's technology gains were used to enhance power and other amenities
- What path will auto efficiency follow going forward?
  - It is a market outcome that depends on jointly expressed priorities of consumers, automakers and policymakers
  - It is simplistic and misleading to characterize it as just a "customer acceptance" issue

Technical vs. *Compatible* Design Strategies for Vehicle Efficiency

TECHNICAL

- Tractive load reduction
- Engine efficiency
- Transmission optimization
- Hybridization

COMPATIBLE

- Creative downsizing
- Intelligent systems content
- Performance matching
- Packaging efficiency

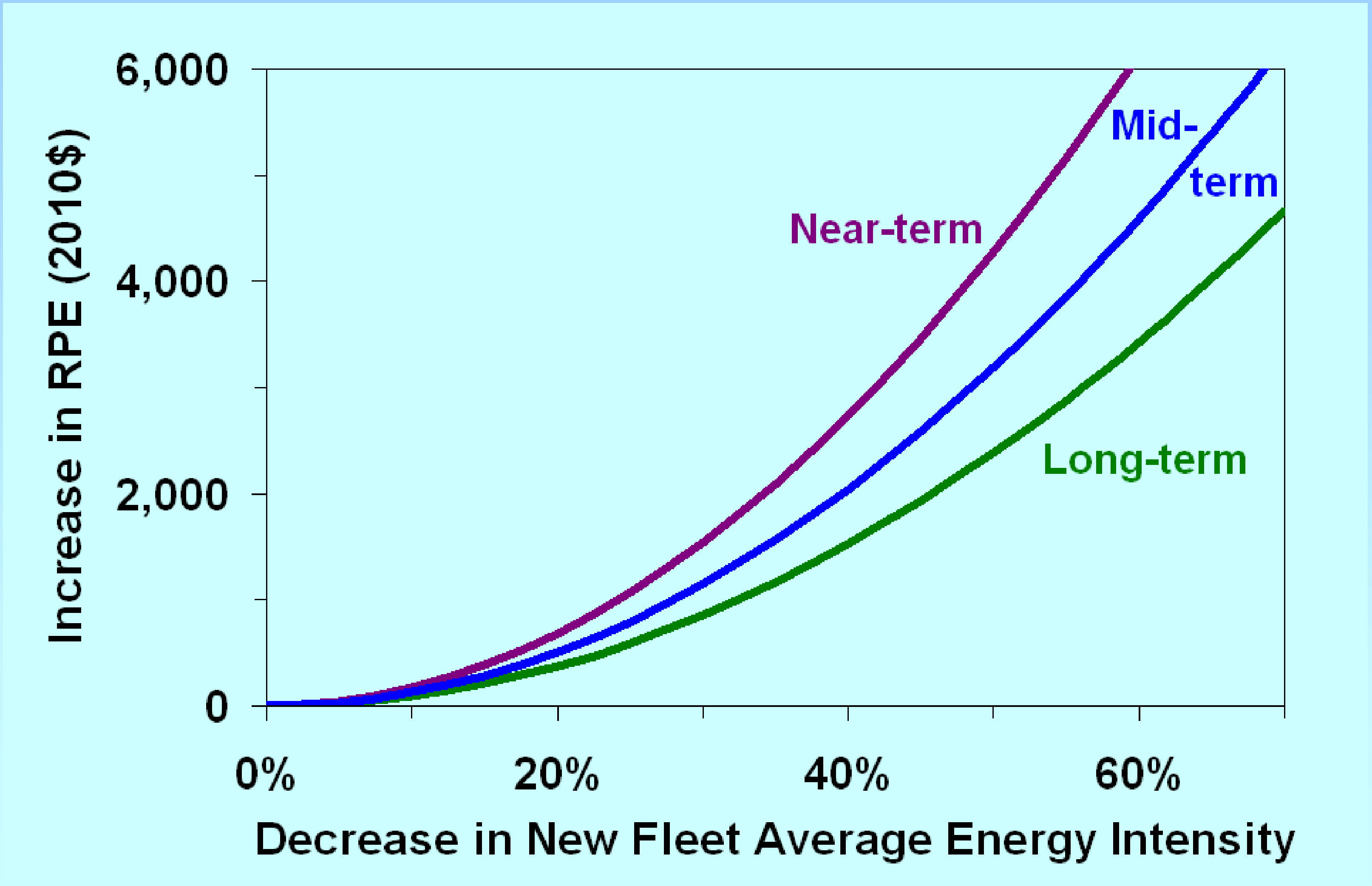
- *Compatible strategies emphasize features that enhance customer value in ways that are inherently less energy consumptive.*
- *May minimize difficult-to-recover costs of adding technology to raise fuel economy to levels higher than customers would choose on their own.*

Efficiency Horizon Cost Model

- Costs represented as:
  - Increasing (quadratic) for each additional step of fuel savings in any given year
  - Decreasing for a given level of savings over time
- Key references for cost inputs:
  - Near-term costs as estimated by EPA/NHTSA for current (MY 2011-16) CAFE rule
  - Declining long-term (2035) costs as estimated in MIT's "On the Road in 2035" study
  - Zero net cost for incremental mass reduction gradually phased in over study horizon (reaching 20% by 2035)
    - Less ambitious than Lotus Engineering (2010) study
- Result is a set of quadratic cost curves that shift rightward through time

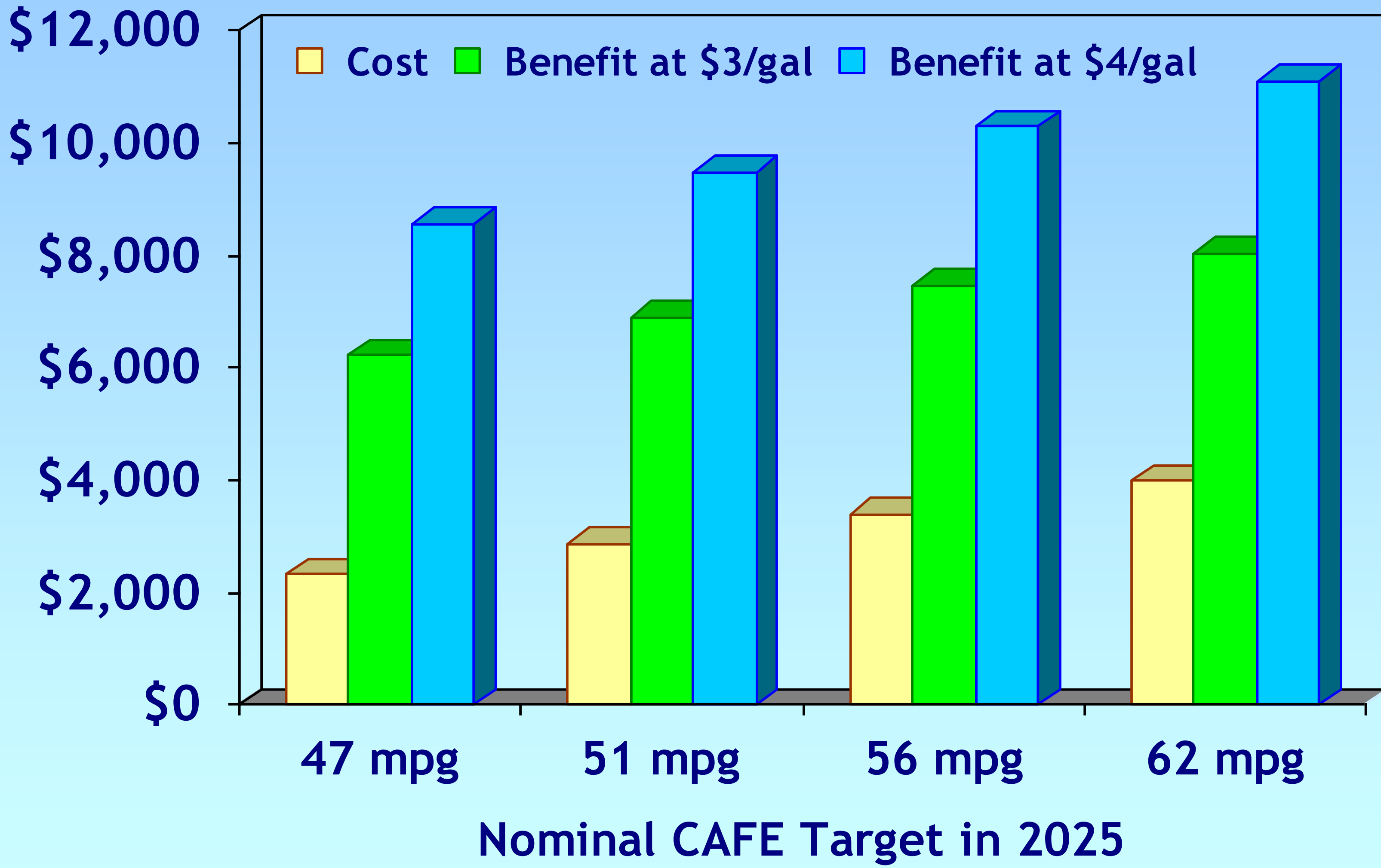
Cost curves

New fleet average Retail Price Equivalent (RPE)

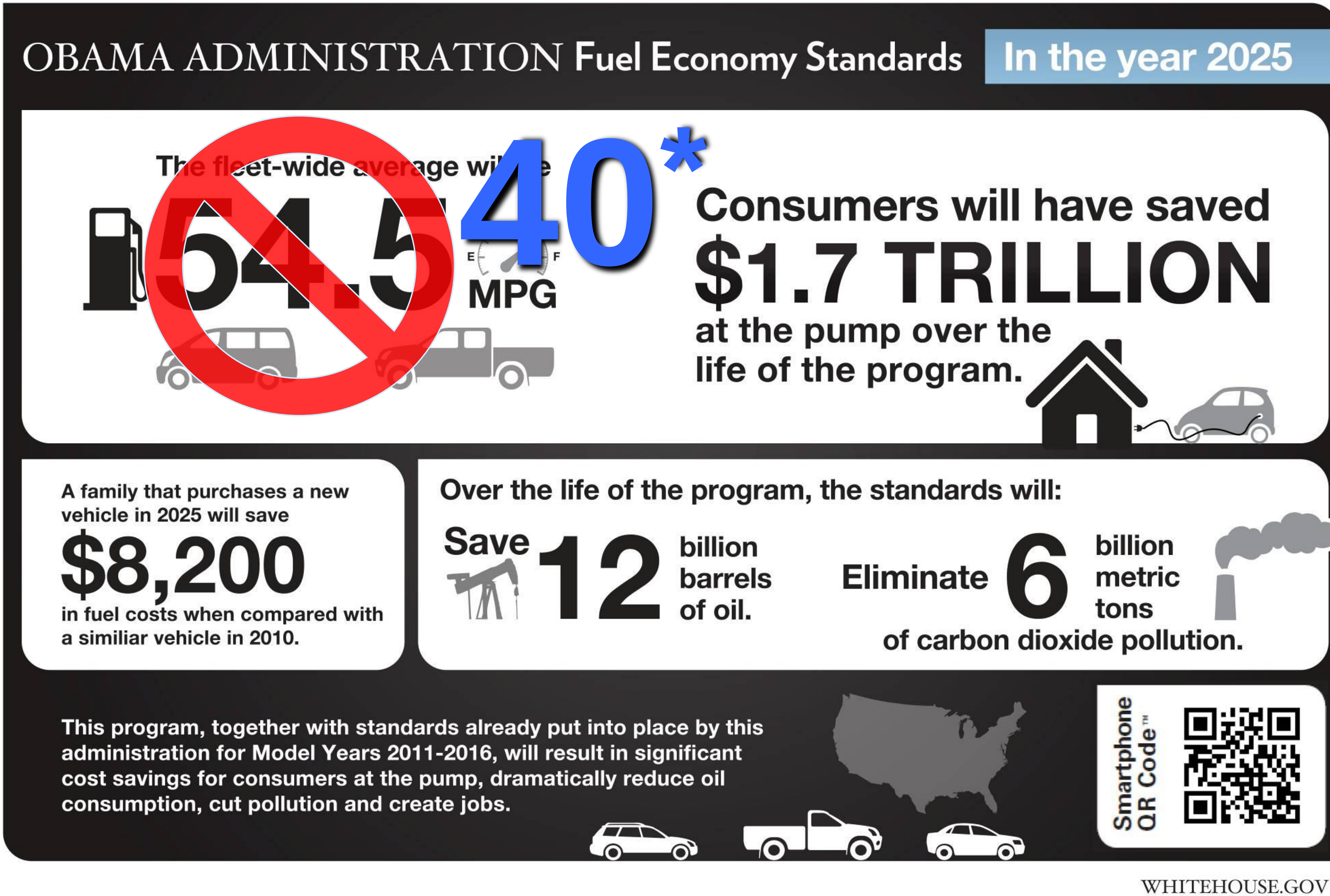


Source: *A Fuel Efficiency Horizon for U.S. Automobiles* (September 2010)

Costs vs. Benefits of Higher Efficiency



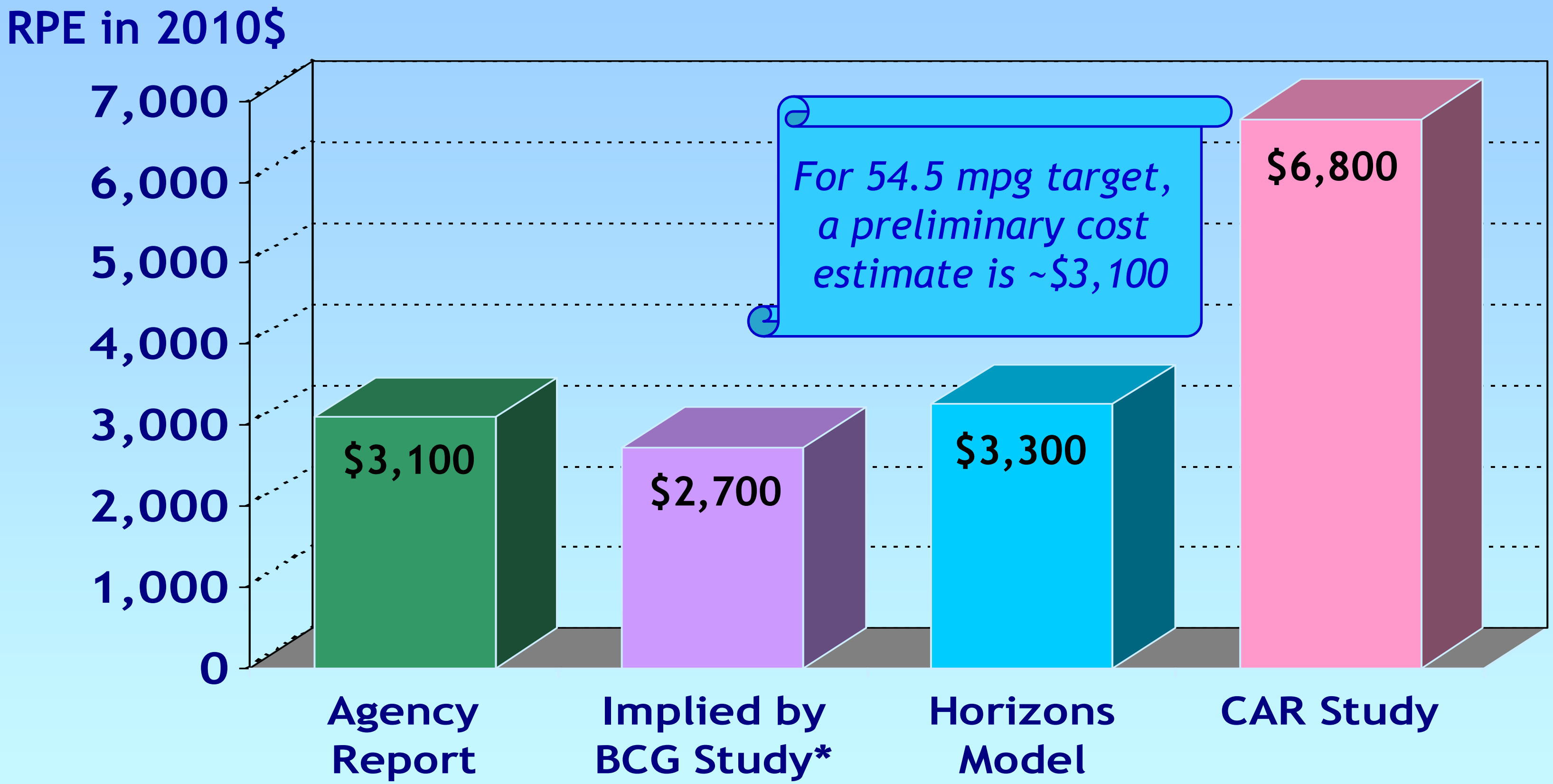
Efficiency Horizon model technology costs and discounted lifetime benefits (2010$)



*Plausible window-sticker rating, accounting for A/C credits and MPG shortfall.

Comparing Cost Estimates

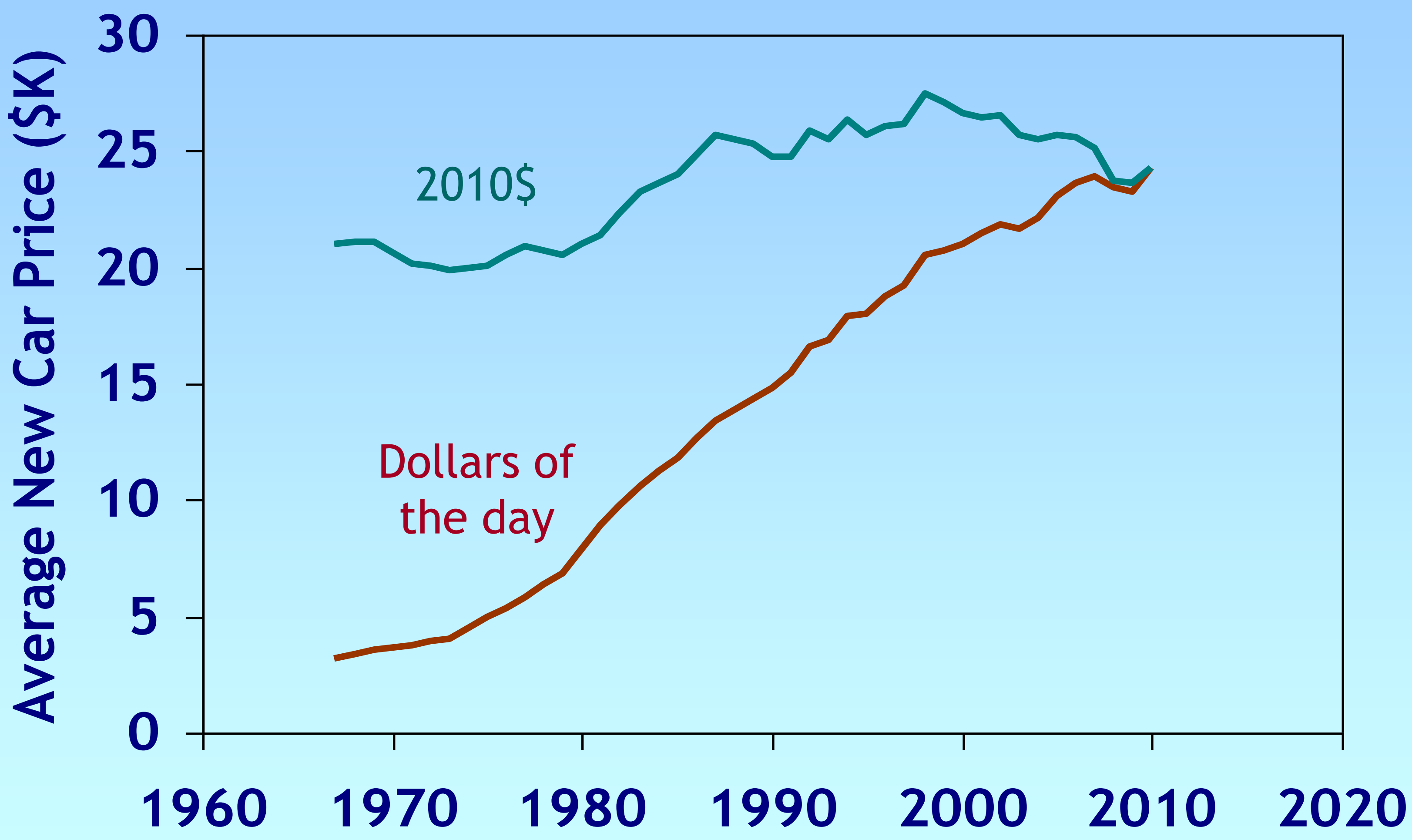
Projected cost of 56 mpg (nominal) in 2025 over MY 2010 fleet



Retail Price Equivalent (RPE) estimates from each study were adjusted relative to a common MY2010 baseline using costs from published CAFE rules and to 2010$ using GDP price deflator. Agency Report (Joint TAR, Sept 2010) value works from the estimate of $2,100 (2007$) for the lowest cost technology case (Path C), inflated to 2010$ and then adjusted upward by $997 to account for cumulative regulatory costs through the MY2012-16 Joint Rule.

*BCG-based estimate is extrapolation from their stated cost of ~$2,200 for a 40% CO_2 reduction.

New Car Price Trends

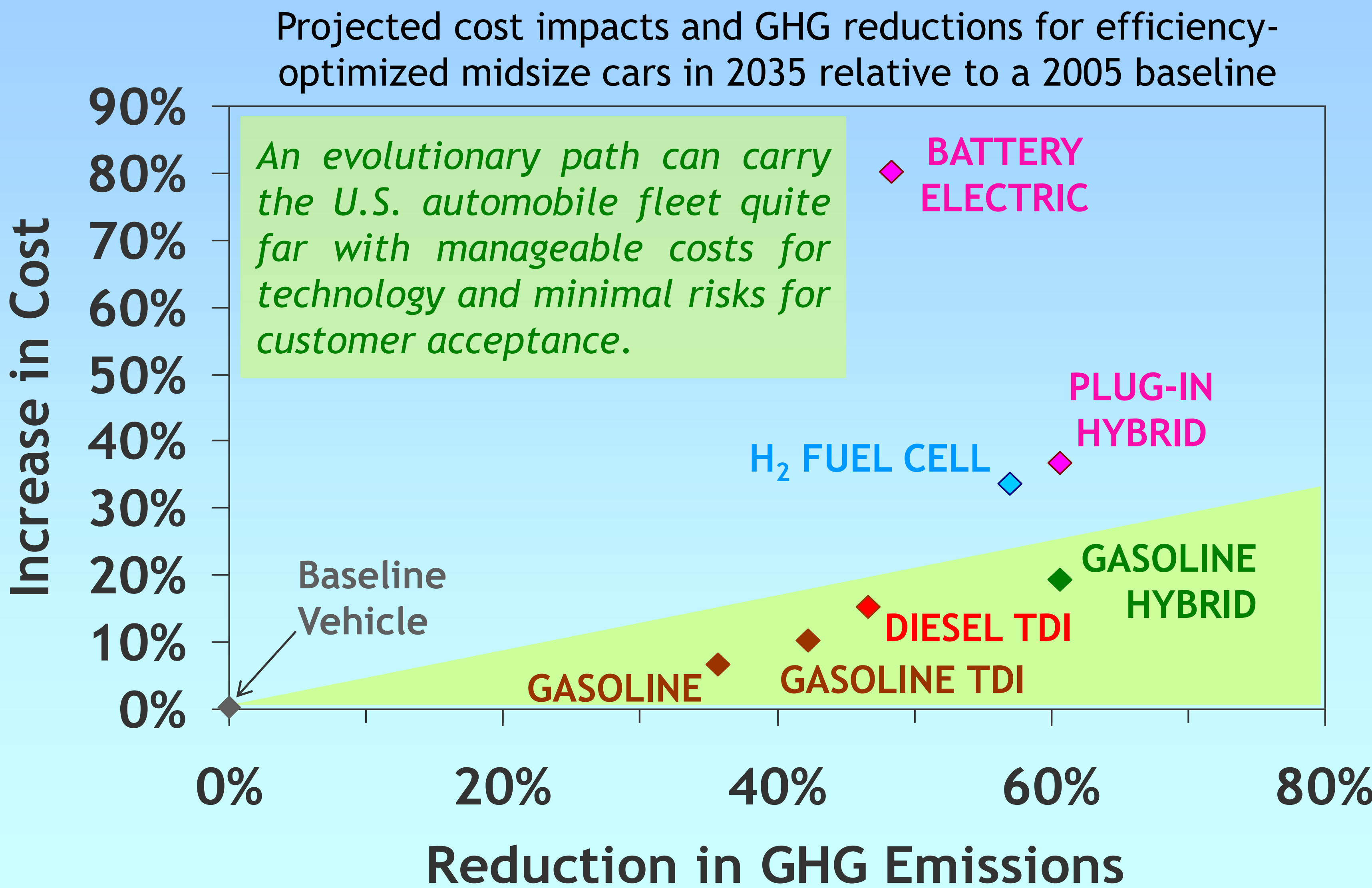


Source: BEA Average Transaction Price per New Car, via Ward's Yearbook 2011

Cost ≠ Price!

- Vehicle prices are a market outcome influenced by numerous factors, not just cost of technology
  - Vehicle demand elasticity, competition, overcapacity, open nature of U.S. market, productivity gains: all work to hold down prices even in the face of cost pressures
  - Automakers have limited ability to pass costs on to consumers
- Implications
  - It is simplistic to equate a marked-up technology cost (RPE) with an "added price consumers will pay" for new cars and trucks
  - No basis for projecting jobs impacts (one way or another)
  - ***Automakers invest and consumers save:*** it's no surprise that polling consistently shows strong support for higher CAFE; it's been a very good deal for consumers!

Relative Technology Benefits and Costs



Conclusions

- Fuel economy is first and foremost an issue of ***design priority***
  - It's not just technology, but how technology is used that matters
  - ***Efficiency compatible*** design and product strategies will be key
  - Historical rates of performance gain are not sustainable
- Up to 62 mpg is technically feasible and cost-effective by 2025
  - "Plug-in" electrification is not needed
  - Societal benefits exceed costs throughout this range
- Costs do not necessarily translate to higher consumer prices
  - Issue is one of up-front investments that require confronting trade-offs within constrained product development budgets
- Regulations in this range pose no jobs risk
  - U.S. automotive employment is determined by broader economic factors as well as fair trade and labor policies
- CAFE is necessary but not sufficient for a sound energy policy
  - Ultimately, *"**It's the carbon, stupid!**"* (in the fuel supply system)

Thank you!

- The report, ***A Fuel Efficiency Horizon for U.S. Automobiles***, can be downloaded from the University of Michigan Deep Blue archive at: http://hdl.handle.net/2027.42/78178

- For further information, contact:

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