

**Remarks by John German, ICCT, at Hill Briefing on efficient vehicles and job creation
July 28, 2011**

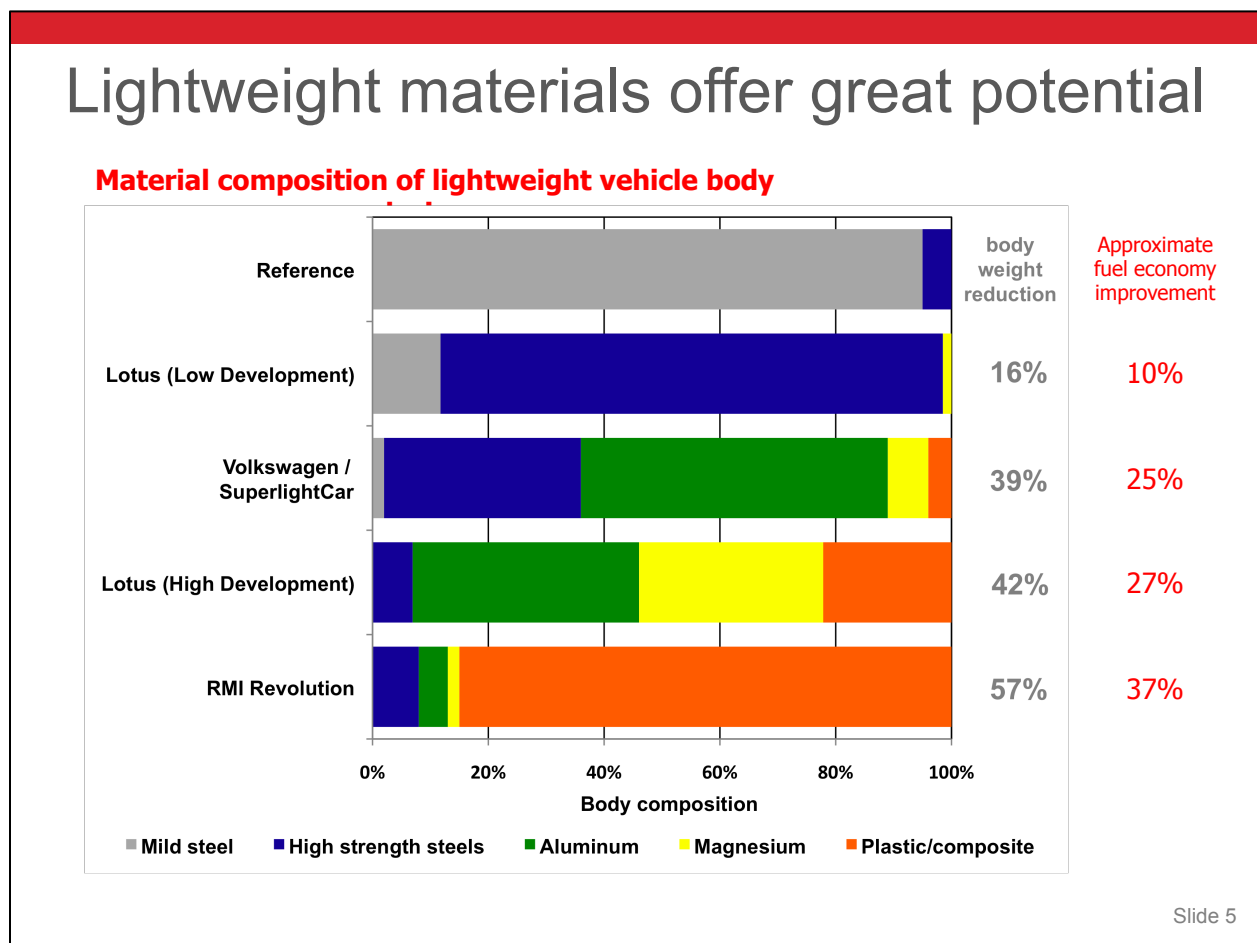
Good afternoon, Mr. Conyers and members of the House. My name is John German, Senior Fellow and Program Director for the International Council on Clean Transportation. Thank you for the opportunity to discuss energy efficient vehicles.

As you know perfectly well, the argument over CAFE standards turns on technology -- what is possible, what is not, and how much it will cost -- especially how much it costs. There is this tendency to think that the internal combustion engine has been around for 120 years and is tapped out, so we need to turn to exotic technologies. But the reality is that the pace of technology development just keeps accelerating, primarily due to developments in computer simulations, computer aided design, and computer controls. These improvements are wide-ranging and include development and continued implementation of currently available technologies, such as variable valve timing, cylinder deactivation, direct injected turbocharged engines such as Ford's EcoBoost, improved transmissions, better aerodynamics, and integrated starter systems.

More importantly, these advances in computer tools are opening the door to technologies that were never possible before. I want to focus on three upcoming technologies that offer substantial efficiency improvements: lightweight materials, boosted EGR systems, and low cost hybrid systems.

Manufacturers have long known the benefits of lighter materials and of the potential for compounded weight reduction. For example, if the body weight is reduced, then the suspension parts can be made smaller and lighter. These secondary reductions reduce both weight and cost, as they reduce material use. However, each vehicle has hundreds, if not thousands, of parts and how these parts interact affects not just safety, but also stiffness, rigidity, handling, noise, and vibration. Moving to a lighter material or reducing the thickness of a part has uncertain impacts on these consumer attributes. In the past, the only way to verify the impacts was to build up a prototype vehicle, which is very expensive

and time consuming. Sophisticated computer simulations are being developed that can assess these compound impacts and optimize the material composition and design of each part. This is revolutionizing the ability to reduce vehicle weight and is also enabling secondary weight reductions. Recent studies by Lotus in the US and the SuperlightCar study in Europe suggest that about 16% weight reduction is possible just with high-strength steel and over 30% weight reduction is possible with more extensive use of lightweight materials, such as aluminum, magnesium, and composites.

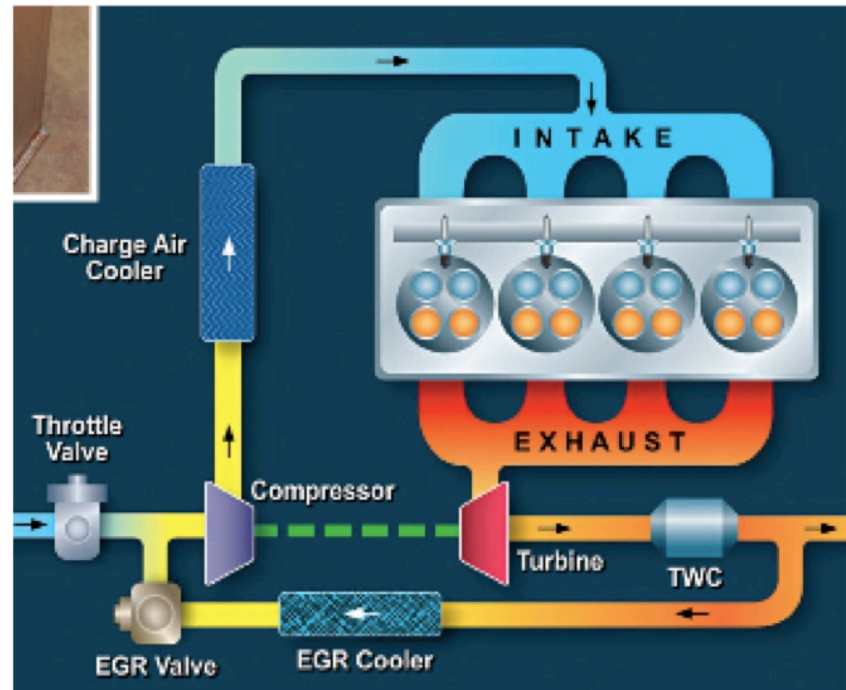


Another technology in development uses the turbocharge to boost not just intake air, but to also boost the amount of exhaust gas that is recirculated into the engine. This exhaust gas is inert and leads to highly dilute combustion and lower combustion temperatures, similar to running with a lean air/fuel ratio. The dilute combustion directly leads to improved

efficiency by reducing heat losses and enabling higher compression ratios. Turbocharger boost can also be greatly increased without detonation, allowing a smaller engine to be used for additional efficiency benefits.

Turbo-Boosted EGR Engines

- Highly dilute combustion – considerable efficiency improvement
- Advanced ignition systems required



Terry Alger, Southwest Research Institute, "Clean and Cool", Technology Today, Summer 2010

Hybrid vehicles offer substantial efficiency improvements by shutting the engine off at idle, capturing and reusing energy that is normally lost to the brakes, improving the efficiency of pumps and accessories, assisting with acceleration so that a smaller engine can be used, and optimizing the efficiency of the engine. However, their market penetration has been limited due to relatively high costs, currently estimated at about \$3,500 per vehicle. There are three significant improvements coming to hybrid vehicles that will not only boost efficiency, but will dramatically reduce costs.

First, every vehicle manufacturer that has not already invested in the input powersplit system used by Toyota and Ford is bringing out a simpler, lower cost hybrid system. Nissan, Hyundai, BMW, Mercedes, and VW are independently developing and introducing parallel hybrid systems with a single motor and two clutches, commonly referred to as P2 hybrids. These systems allow acceleration assist and regenerative braking comparable to the input powersplit system, but without the cost of two large electric motors and related power electronics. Studies by the National Academy of Sciences, the Massachusetts Institute of Technology, and the U.S. Environmental Protection Agency suggest that the P2 system will deliver 90-95% of the benefits of the input powersplit system at up to one-third lower cost.

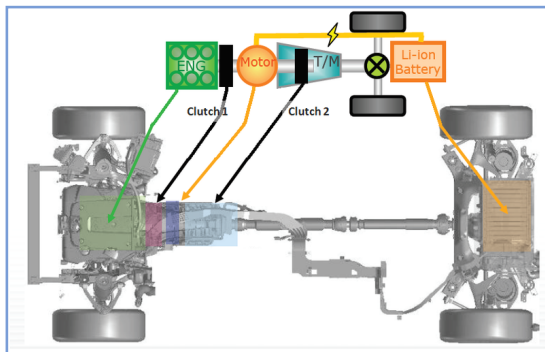
Second, manufacturers are just beginning to find ways to use the electric motor to optimize engine and transmission design and operation. An initial, widely used, step is to use an Atkinson cycle engine with higher efficiency and to make up lower power of the Atkinson cycle engine with electric motor assist. But there are many other synergies that have yet to be optimized. For example, efficiency could be improved and costs reduced substantially by integrating the electric motor into a manual transmission. It directly reduces the cost of the hybrid system by eliminating hybrid clutches. More importantly, it uses the electric motor to provide power while the computer shifts the manual transmission, allowing smooth shifts with no torque interruption while gaining the efficiency benefits and lower cost of a manual transmission.

Third, conventional hybrid batteries need to provide large amounts of power quickly for acceleration assist and to capture large amounts of regenerative braking energy, but do not need to provide this power for long periods of time. Current hybrid batteries are oversized, in order to provide high power rates without battery deterioration. Li-ion battery designs are in development that will have much higher power capability. These batteries should start becoming available around 2015 and will satisfy hybrid vehicle requirements with a battery a half, or even a third, the size of current hybrid batteries – with proportional cost reductions.

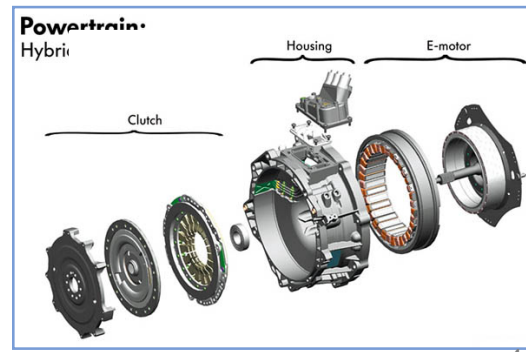
It will take until about 2020 for all of these hybrid improvements and cost reductions to be fully implemented, but once this occurs the cost of the hybrid system should drop to less than half of what it is today. This will make the cost acceptable to mainstream consumers and sales of hybrid vehicles should grow rapidly.

Hybrid Technology Advances

- New P2 hybrid – single motor with two clutches
 - Pre-transmission clutch: engine decoupling and larger motor
 - Nissan, VW, Hyundai, BMW, and Mercedes
 - Up to 1/3 lower cost than input powersplit with 90-95% of benefits
- Synergies with other technologies and optimized control strategies
 - Engine (Atkinson, Miller, lean-cruise, digital valve); optimization of engine and transmission operation; mass-reduction; use of manual transmission
- High-power Li-ion batteries – smaller, lighter, and lower cost



Nissan Fuga/M35 parallel hybrid layout



VW Touareg hybrid module

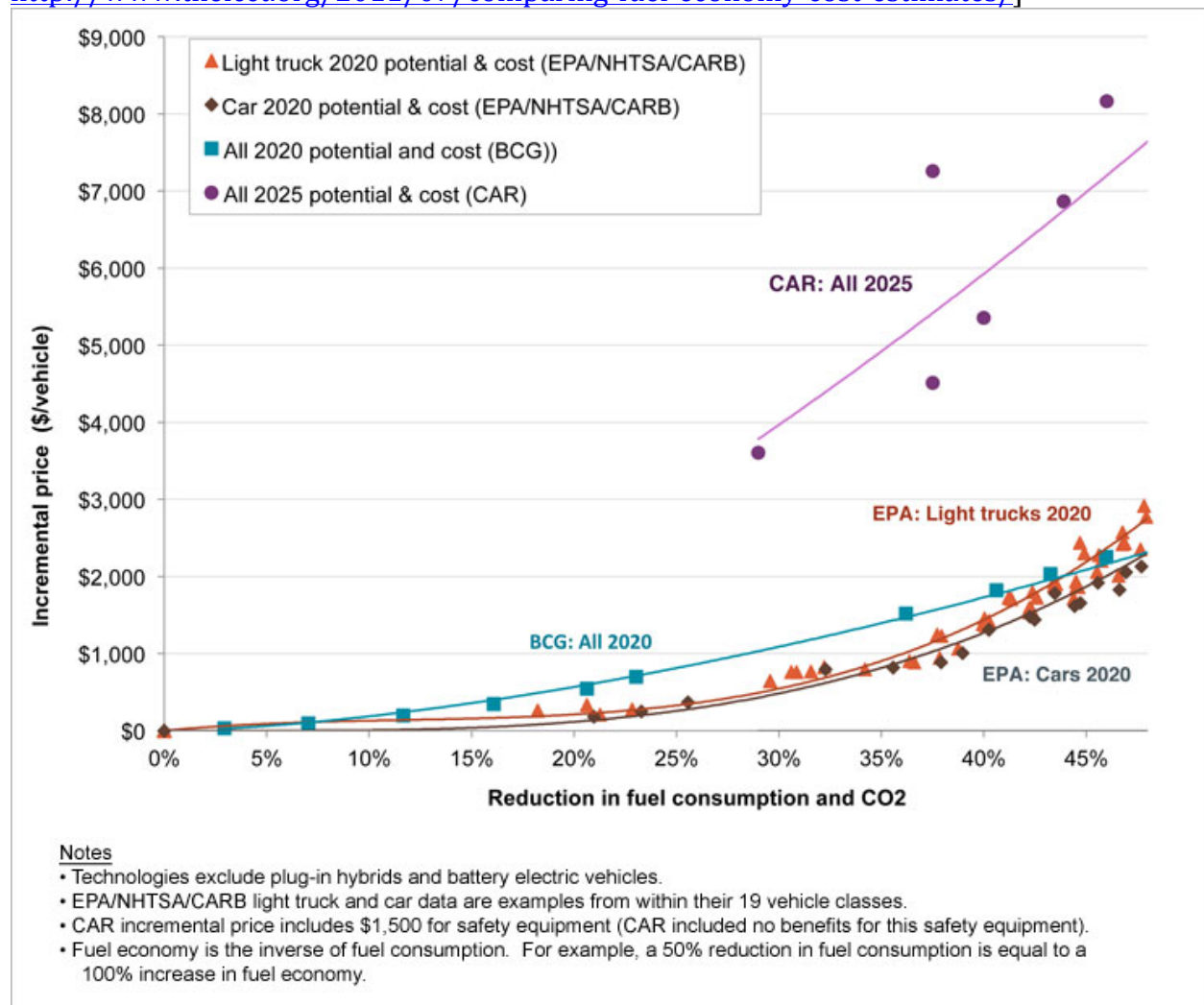
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If one wants to oppose fuel economy standards, one of the tricks is to simply ignore all of this future technology development and, instead, use studies that only include *current* technologies and *current* costs. Then you can claim that the only way to get to a 56 mpg standard is with a lot of expensive alternative technologies, such as plug-in hybrids and battery electric vehicles. This is precisely what the alliance and its allies have done. Many of the claims are based upon a 2011 study by the Center for Automotive Research (CAR). The CAR study based most of its analyses on a 2010 National Academy of Science report on

CAFE. The Academy report was a good report, but it clearly stated that it only assessed current technologies and current costs.

The impact of ignoring future technology development is illustrated in the graph below, which compares the cost of fuel consumption and CO₂ reductions from the 2011 CAR study to a recent report by the Boston Consulting Group (*Powering Autos to 2020*) and the 2010 US EPA and US DOT *Technical Assessment Report*, used by the Agencies as the basis for the White House proposal of 54-56 mpg. The BCG estimates are largely consistent with those from EPA/DOT; somewhat higher for modest technology increases, but a little lower for larger increases. The CAR estimates are over three times higher, even though they are for 2025 instead of 2020 and one would expect technology-driven costs to continue to decline in those five years. [For additional information, see:

<http://www.theicct.org/2011/07/comparing-fuel-economy-cost-estimates/>]



A realistic assessment of the future shows that incremental improvements in engines, materials, transmissions, and basic hybrid systems are all that is needed. In addition to the BCG study for 2020, studies by the University of Michigan and the Mass. Institute of Technology found that over 70 mpg can be achieved by 2035 without any plug-in hybrids or electric vehicles and at reasonable cost. Cost estimates ranged from about \$3000 for about 56 mpg by the BCG to about \$4,200 for about 74 mpg by the University of Michigan.

I also want to take a few minutes to address two common misconceptions and misrepresentations about vehicle fuel economy standards.

First, some of the carmakers and the Alliance of Automobile Manufacturers keep telling people that stringent standards require smaller, unsafe cars. There used to be some truth to this, in that standards were easier to meet with smaller vehicles. But that's simply not true now. As mandated by the 2007 EISA, the 2012-16 standards and the upcoming standards grade manufacturers on a footprint-based curve. Each manufacturer's goal is custom-calculated, based on that manufacturer's own product line. An automaker that builds smaller vehicles will have higher mileage goals and an SUV or truck with a larger "footprint" will not be required to get the same mileage as a small car. While the curves have not been proposed yet for 2025, the footprint curve for the 2016 standards established targets of 41.1 mpg for the Honda Fit compact car, 32.9 mpg for the Ford Escape small SUV, and 24.7 mpg for the Chevy Silverado pickup truck. Thus, there is no incentive for manufacturers to make vehicles smaller - the standards simply mandate that each of those vehicles, regardless of size, be as energy-efficient as possible.

The second common misconception is that the numbers used for CAFÉ purposes are NOT the same as the numbers used for fuel economy labels. The label values are heavily discounted from the CAFÉ values. An overall CAFÉ average of 56 mpg corresponds to about 41 mpg on the label. And a CAFÉ average of 70 mpg corresponds to about 50 mpg on the label. One concrete example – the Toyota Prius already achieves over 70 mpg for CAFÉ purposes.

In summary, manufacturers are already beginning to adopt technology improvements. But they need to do it at a faster clip. Reducing the amount of fuel used will not only directly put more money in consumer's pockets, but the reduced demand for fuel will also tend to reduce fuel prices and will improve our balance of trade. These *economy-wide* benefits are far larger than the cost of adding incremental improvements to vehicles.

I appreciate the opportunity to present my views and would be happy to address any questions you may have.

John German is a Senior Fellow and Program Director for the International Council on Clean Transportation. He spent eight years at Chrysler working on fuel economy issues in Powertrain Engineering, thirteen years doing research and writing regulations at the Ann Arbor, MI, EPA's Office of Mobile Sources' laboratory, and eleven years as Manager of Environmental and Energy Analyses for American Honda Motor Company.

Comments on the CAR June 2011 Report

<http://www.theicct.org/2011/06/comments-on-the-car-june-2011-report/>

Comparing fuel economy cost estimates for 2020–2025

<http://www.theicct.org/2011/07/comparing-fuel-economy-cost-estimates/>

Valuation of parameter-based vehicle emissions targets in the EU

<http://www.theicct.org/2011/07/evaluating-parameter-based-vehicle-standards-in-the-eu/>