Society of Automotive Analysts
Strategic Planning Summit
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The Center for Automotive Research (CAR)

Automotive industry contract research and service organization (non-profit) with more than 30 years experience forecasting industry trends, advising on public policy, and sponsoring multi-stakeholder communication forums.

• CAR conducts leading edge Research that impacts the future of the global automotive industry.

• CAR hosts Events and Conferences that engage industry leaders in the discussion of critical topics.

• CAR’s Affiliates — automotive manufacturers and suppliers benefit from advance access to research results, exclusive networking, and participation in working groups.
CAR Research Themes
(current iteration)

- **Mobility Networks** - investigating passenger and cargo models for access, purchase, and operation
- **Public Policy Initiatives** – exploring the regulation, legislation, and economic incentives to deliver societal goals
- **Industry Impact** – understanding financial and human capital, global trade and investment and economic development
- **Human Capital Needs** – assessing the industry’s stock and future need of human talent and skills
- **Product and Manufacturing Technology Requirements** – evaluating future product designs, materials, engineering, procurement, manufacturing, and sales/service
- **Industry 4.0 Futuring** – mapping tomorrow’s industry, product, and manufacturing and business processes transformation
Industry Meeting Current CAFE Mandate CAGR; It is Keeping up with the Future is the Question

Source: NHTSA 2009, NHTSA 2011, and NHTSA 2014
Midterm Evaluation (MTE)

Three Step Process

- 2012: Final Rule 2017-2025 Standards
- 2016: Draft TAR For public comment
- 2018: Proposed Determination / NPRM For public comment
- 2018: Final Determination
- 2018: Final Determination due by April 1, 2018 (no joke)
Gasoline Prices (Real)
January ‘03 – June ‘16

Source: EIA
Positive Economic Factors/CAFE Headwinds

For every $1,000 increase/decrease in PDI, small car/electric vehicle share will decrease/increase by .50 percent.

Increase/decrease in gasoline prices by $1.00 per gallon results in an increase/decrease in the small car/EV market share 1.1 percent.

For every 100 basis point increase/decrease in unemployment rate, small car/electric vehicle share will decrease/increase by .6 percent.
U.S. Light Vehicle Sales By Cars and Trucks

Source: BEA
Segment Breakdown - U.S. LV Sales Percent Change
July YTD 2016 vs July YTD 2015

- Total: 1.1%
- Small CUV: 38.5%
- Van: 22.1%
- Pickup: 6.1%
- SUV: 4.8%
- Middle CUV: 4.0%
- Large CUV: -2.5%
- Large Car: -3.4%
- Small Car: -6.7%
- Luxury Car: -9.4%
- Middle Car: -9.7%

Source: Ward’s Automotive Reports
## 2025 Pathways Diverge Between Agencies

<table>
<thead>
<tr>
<th>Agencies’ Technical Assessment Report Assumptions, 2025</th>
<th>GHG</th>
<th>CAFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbocharged and downsized gasoline engines</td>
<td>33%</td>
<td>54%</td>
</tr>
<tr>
<td>Higher compression ratio, naturally aspirated gasoline engines</td>
<td>44%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>8-speed and other advanced transmissions</td>
<td>90%</td>
<td>70%</td>
</tr>
<tr>
<td>Mass reduction</td>
<td>7%</td>
<td>6%</td>
</tr>
<tr>
<td>Stop-start</td>
<td>20%</td>
<td>38%</td>
</tr>
<tr>
<td>Mild hybrid</td>
<td>18%</td>
<td>14%</td>
</tr>
<tr>
<td>Full hybrid</td>
<td>&lt;3%</td>
<td>14%</td>
</tr>
<tr>
<td>Plug-in hybrid electric vehicles</td>
<td>&lt;2%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Electric vehicle</td>
<td>&lt;3%</td>
<td>&lt;2%</td>
</tr>
</tbody>
</table>

Environmental Protection Agency and National Highway Traffic Safety Administration Technical Assessment Report Table E5-3
And with Industry – Particularly with Electrification

Regulators say few electrics needed...

Industry greatly disagrees,

– expecting 5 to 10 times more electrification.

2025 Light-duty Vehicle Fleet

Advanced Gasoline Vehicle Technologies

Electrification
- Strong hybrids 3%
- EV/PHEVs 4%
U.S. Electrified Light Vehicle Sales and Take Rate
1999 – 2016 June YTD

Note: Electrified vehicles consist of BEV, HEV and PHEV
Source: Ward’s Automotive Reports, HybridCars.com and CAR Research; EIA
Gasoline Saved for Incremental Fuel Economy Improvement
And the Customer Demands a Three-Year Payback

(area under curve represents total fuel saved for that increment per year at 12,000 miles per year)

Source: CAR Research
Technology Pathway and Relative Cost

The steps get bigger

Cost ($/lb.)

Net Mass Reduction = (Mass Reduction) – (Weight add-back)
Which truck is more expensive to lightweight?

The lightweighting cost and vehicle performance varies significantly for each of these vehicles.
# Weight Add-Back

<table>
<thead>
<tr>
<th></th>
<th>Cars – 4.71%</th>
<th>Trucks – 4.88%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>2.45%</td>
<td>1.85%</td>
</tr>
<tr>
<td>Performance*</td>
<td>2.26%</td>
<td>3.03%</td>
</tr>
</tbody>
</table>

AVERAGE % cost reduction per year

Net Mass Reduction = (Mass Reduction) – (Weight add-back)

*Performance – NVH, torsional rigidity, handling
Learning Curves

<table>
<thead>
<tr>
<th>Time Period</th>
<th>AHSS/UHSS</th>
<th>Aluminum</th>
<th>Magnesium</th>
<th>Composites</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012-2021</td>
<td>0.80%</td>
<td>1.30%</td>
<td>1.13%</td>
<td>1.80%</td>
</tr>
<tr>
<td>2022-2027</td>
<td>0.56%</td>
<td>1.26%</td>
<td>0.88%</td>
<td>2.36%</td>
</tr>
</tbody>
</table>

Industry does NOT agree with the learning factors applied uniformly for all materials in the agency analysis
CAR Calculated Mandate Rate = 1.86

• Retail Price Equivalent = 1.5
• Corrected for dealership gross margin rate
• Corrected for vehicle sales tax
• Corrected for incremental consumer financing
• Corrected for incremental insurance costs
There is no average…

Manufacturers are pursuing many technology pathways. No two manufacturers have the same product and technology portfolio, nor fuel economy strategy. Therefore, applying an “industry average” for technology cost or implementation may be misleading. Some manufacturers will bear a much greater burden than other manufacturers.
### Impact on U.S. Automotive Industry, 2016-2025

<table>
<thead>
<tr>
<th></th>
<th>Long Run Demand Impact</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
</tr>
<tr>
<td>GAS Price/Cost of FE</td>
<td>$2.44/</td>
</tr>
<tr>
<td></td>
<td>$2,000</td>
</tr>
<tr>
<td>Total MV</td>
<td>$792</td>
</tr>
<tr>
<td>Expenditure</td>
<td></td>
</tr>
<tr>
<td>($Billion)</td>
<td></td>
</tr>
<tr>
<td>Impact of 2025</td>
<td>-</td>
</tr>
<tr>
<td>CAFE ($Billion)</td>
<td>-</td>
</tr>
<tr>
<td>(2025$)</td>
<td></td>
</tr>
<tr>
<td>Light Vehicle Sales</td>
<td>18.64</td>
</tr>
<tr>
<td>(Million Units)</td>
<td></td>
</tr>
<tr>
<td>Production (Million</td>
<td></td>
</tr>
<tr>
<td>Units)*</td>
<td></td>
</tr>
<tr>
<td>Automotive</td>
<td>862,000</td>
</tr>
<tr>
<td>Employment</td>
<td></td>
</tr>
</tbody>
</table>

*Include vehicles for export

**Sources:** CAR Research 2015
Thoughts and Observations to Align Market and Policy

• Raise gasoline/fuels taxes to ensure fuel economy technologies are a net benefit to consumers and to prevent a rebound in VMT . . . All the way to consider replacing the CAFE program entirely with a sufficient carbon tax on motor fuels.

• Provide strong hybrids (HEVs) and plugin hybrids (PHEVs) sacrifice less in terms of standard vehicle attributes and may result in a larger number of miles traveled on electricity than BEVs because of their potentially higher sales volumes and travel miles per year.

• Provide additional off-cycle credits for advanced fuel economy technologies to encourage commercialization by overcoming price inflation and to support the development of new supply chains for light-weighting materials and advanced ICE and EV components.

• Provide the industry an additional five years assuming further long-term development for customer needs to accept such vehicles and the industry to produce these technologies at a more affordable cost and develop an adequate infrastructure.