Future GHG/CAFE Standards and Technology Transformation

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February 13, 2013
Contents

• Context
  – Old paradigm
  – New paradigm: 2025 EPA GHG/NHTSA CAFE standards

• EPA Technology Projection Pathway for Meeting 2025 Standards

• Current Technology Trends

• Conclusions
Context
The Old Paradigm

IT ONLY GETS 20 MPG
BUT, IN A HUNDRED YEARS,
THAT'LL BE VASTLY
IMPROVED.
New Standards for a New Paradigm
(2-cycle fuel economy values, assumes CO$_2$ stds met with FE technology)
## EPA/NHTSA National Program
(cars and light-duty trucks)

<table>
<thead>
<tr>
<th></th>
<th>MY 2010 Baseline</th>
<th>MY 2016 Compliance</th>
<th>MY 2025 Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CO₂ emissions standard</strong></td>
<td>351 g/mi</td>
<td>250 g/mi [35.5 mpg]</td>
<td>163 g/mi [54.5 mpg]</td>
</tr>
<tr>
<td><strong>CAFE standard</strong></td>
<td>25.3 mpg</td>
<td>34.1 mpg</td>
<td>48.7-49.7 mpg</td>
</tr>
<tr>
<td><strong>Real world fuel economy</strong></td>
<td>20 mpg</td>
<td>27 mpg</td>
<td>40 mpg</td>
</tr>
</tbody>
</table>
Structure of the Standards

• Standards are footprint-based
  – Footprint = area defined by where the tires touch ground
  – Each vehicle footprint has a CO₂ and fuel economy target, with smaller vehicles having more stringent targets and larger vehicles having less stringent targets
  – Each manufacturer has a unique fleetwide compliance level depending on the footprints of the vehicles that it sells

• Separate footprint curves for cars and light trucks
  – See next slide for example

• “54.5 mpg” and benefits based on footprint projections
  – Actual stringency and savings could be higher or lower depending on whether vehicle size increases or decreases
CO$_2$ Target Curves for Passenger Cars
# MY 2025 CO₂ and CAFE Targets
## Selected U.S. Vehicle Models

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Example Model</th>
<th>Example Model Footprint (sq. ft.)</th>
<th>2025 CO₂ Emissions Target (g/mile)</th>
<th>2025 CAFE Target (mpg) –not label</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cars</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compact car</td>
<td>Honda Fit</td>
<td>40</td>
<td>131</td>
<td>61</td>
</tr>
<tr>
<td>Midsize car</td>
<td>Ford Fusion</td>
<td>46</td>
<td>147</td>
<td>55</td>
</tr>
<tr>
<td>Fullsize car</td>
<td>Chrysler 300</td>
<td>53</td>
<td>170</td>
<td>48</td>
</tr>
<tr>
<td><strong>Light-duty Trucks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small SUV</td>
<td>4WD Ford Escape</td>
<td>43</td>
<td>170</td>
<td>48</td>
</tr>
<tr>
<td>Midsize crossover</td>
<td>Nissan Murano</td>
<td>49</td>
<td>188</td>
<td>43</td>
</tr>
<tr>
<td>Minivan</td>
<td>Toyota Sienna</td>
<td>56</td>
<td>209</td>
<td>39</td>
</tr>
<tr>
<td>Large pickup truck</td>
<td>Chevy Silverado (extended cab)</td>
<td>67</td>
<td>252</td>
<td>33</td>
</tr>
</tbody>
</table>
Technology Credits and Incentives
Under EPA GHG Standards

• Credits
  – Air conditioner efficiency and refrigerants
  – Off-cycle (e.g., stop-start, active aerodynamics)

• Incentives
  – Hybrids, other advanced technologies in full-size pick-up trucks
  – Multiplier in MY 2017-21 allows EV/PHEV/FCVs and CNG vehicles to “count” as more than one vehicle in compliance
  – 0 grams/mile compliance for EVs, PHEVs, and FCVs, i.e., not count “upstream” electricity generation GHG
    • 2017-21—unlimited use of 0 grams/mile
    • 2022-2025—0 g/mi up to sales thresholds and then “net upstream”
Mid Term Evaluation of 2022-25 Standards

MY 2017

Standards final unless changed by rulemaking

MY 2025

MY 2017-2021 Final

MY 2022-2025 Augural

Joint Technical Assessment Report
(draft no later than November 15, 2017)
EPA Technology Projection Pathway for Meeting 2025 Standards
Technology Projections
What EPA Did

- Comprehensive review of the technical literature
- Multiple meetings with OEMs and key suppliers
- Sponsored state-of-the-art research
  - Vehicle simulation
  - Hardware cost “tear down”
  - Vehicle materials and mass reduction
- Algorithm to “rank” individual technologies and technology packages by GHG cost effectiveness
- Projected most cost-effective way to meet future standards, other things being equal
Technology Projections
What EPA Did Not Do

• We can not predict the future with precision
• We can not foresee technology innovation that has not yet occurred
• We can not account for major changes due to
  – Change in oil and gasoline prices
  – Market tradeoffs for various vehicle attribute tradeoffs
    • Performance, size, utility et al vs fuel economy
    • The very different driving experience with EVs
  – Cultural attitudes
    • Climate change
    • Oil conservation/independence/”Buy USA” fuels
How Will Automakers Comply?

• Standards do not mandate specific technologies, rather automakers can choose which technologies to adopt

• EPA projection for lowest-cost MY 2025 compliance
  – Major “across-the-board” improvements for gasoline vehicles
    • 90+% downsized, turbocharged, direct injection engines
    • 90% 8-speed transmissions
    • Lightweight materials to reduce mass by 8% (average)
    • Better tires, aero, accessories, etc.
  – Moderate increases in hybrids
    • 26% share for “mild” hybrids (like Chevy Malibu, Buick LaCrosse)
    • 5% share for “strong” hybrids (like Toyota Prius, Ford C-Max)
  – Small market share for plug-in vehicles
    • 2% share for EVs/PHEVs
One Pathway for Compliance

Engines and Transmissions

- Direct Injection
- 8 speed Transmission
- Turbocharged and Downsized

MY 2011
MY 2016
MY 2021
MY 2025
One Pathway for Compliance

Turbocharging

- 18 Bar BMEP or less
- 24 Bar BMEP
- 27 Bar BMEP

<table>
<thead>
<tr>
<th>Year</th>
<th>18 Bar BMEP or less</th>
<th>24 Bar BMEP</th>
<th>27 Bar BMEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>MY 2011</td>
<td>5%</td>
<td>5%</td>
<td>0%</td>
</tr>
<tr>
<td>MY 2016</td>
<td>30%</td>
<td>10%</td>
<td>0%</td>
</tr>
<tr>
<td>MY 2021</td>
<td>40%</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>MY 2025</td>
<td>20%</td>
<td>70%</td>
<td>5%</td>
</tr>
</tbody>
</table>
One Pathway for Compliance

Battery Electric Technologies

Note the scale difference
Will Consumers Buy New Technology?

• New 2025 vehicle will cost about $2600 more than 2011
• Good economic payback at $4 gasoline
  – Loan: positive monthly cash flow
  – Cash: payback in 2-3 years
  – Vehicle life: $3-$4 savings for $1 technology investment
• Strong support from consumers and consumer groups
  – 300,000 comments, of which 99+% were supportive
  – Consumers Union, Consumer Federation of America
• Alan Mulally, CEO, Ford, Sept. 2012
  – “This is fantastic, this is why we feel so good that we have worked together to have regulations in line with what our customers really do want.”
Current Technology Trends
Advanced Gasoline Technologies Are Gaining Market Share

% of Sales

- Gasoline Direct Injection
- Turbocharged or Supercharged
- 6 Speed Transmission
- Continuously Variable Transmission
- 7+ Speed Transmission
- Hybrid

2007

2012
More High Fuel Economy Vehicle Choices

![Bar Chart](chart.png)

- SUVs, Pickups, Minivans, Vans > 20 MPG
- SUVs > 25 MPG
- Cars > 30 MPG
- Cars > 40 MPG

Number of Models

- 2007
- 2012
More Advanced Technology Choices

The bar chart shows the number of models for different types of vehicles from 2007 to 2012.

- Hybrid: 2007 - 14, 2012 - 30
- Diesel: 2007 - 5, 2012 - 10
- Electric: 2007 - 0, 2012 - 5
- PHEV: 2007 - 0, 2012 - 2
- CNG: 2007 - 0, 2012 - 1
- Fuel cell: 2007 - 0, 2012 - 1
Many Current Models Meet Future CO₂ Targets
(by class, assumes improvements in A/C systems)
Many Current Models Meet Future CO$_2$ Targets
(by technology, assumes improvements in A/C systems)
% 2012 Fleet That Meets Future CO₂ Targets (assumes improvements in A/C systems)
Conclusions

• The new GHG/CAFE standards will be one critical factor (but not the only one) influencing technology transformation in personal vehicles

• EPA did our most comprehensive technology assessment ever, but we do not claim to be able to predict the future with precision

• Recent technology market trends are encouraging

• Sergio Marchionne, CEO, Fiat/Chrysler, Aug. 2011
  – The new 54.5 mpg standard is “very doable....The power-train guys are an incredible pool of talent. Let them do their jobs.”