Global Overview on Vehicle Fuel Economy and Emission Standards

Feng An, PhD, Executive Director
The Innovation Center for Energy and Transportation (iCET)
presented by Lucia Green-Weiskel

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Analysis of trends, issues and policy options
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The Innovation Center for Energy and Transportation (iCET, www.icet.org.cn)

Located in Beijing and Los Angeles, iCET is a China and California registered, non-profit, independent, leading policy center in low-carbon development and climate change.

- Low Carbon Transportation
  - Fuel Economy Standards for China
  - Green Car Online Rating System
  - Low Carbon Fuel Standards and Policies
  - Electric Vehicle Research and Promotion
- Clean Energy and Energy Efficiency Programs
  - Lighting technologies (LED light standards and related policies)
  - US-Jiangsu Green Partnership (solar energy)
- Climate Change Program
  - Energy and Climate Registry (ECR) in China
- Conferences and Outreach
China projects to be the #1 auto market this year, surpassing 11 million units.
Car market exploded in the past decade.

Annual growth in new car sales averaged about 24% since ‘92, trucks 10%, buses 15%
At least nine countries and regions have established or proposed motor vehicle fuel efficiency or GHG emission policies. Due to various historic, cultural and political reasons, different countries and regions chose to adopt different fuel efficiency or GHG standards.

<table>
<thead>
<tr>
<th>Country/region</th>
<th>Type</th>
<th>Measure</th>
<th>Structure</th>
<th>Test method*</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>Fuel</td>
<td>mpg</td>
<td>Cars and light trucks</td>
<td>U.S. CAFE</td>
<td>Mandatory</td>
</tr>
<tr>
<td>European Union</td>
<td>CO₂</td>
<td>g/km</td>
<td>Overall light-duty fleet</td>
<td>EU NEDC</td>
<td>Voluntary</td>
</tr>
<tr>
<td>Japan</td>
<td>Fuel</td>
<td>km/L</td>
<td>Weight-based</td>
<td>Japan 10-15</td>
<td>Mandatory</td>
</tr>
<tr>
<td>China</td>
<td>Fuel</td>
<td>L/100-km</td>
<td>Weight-based</td>
<td>EU NEDC</td>
<td>Mandatory</td>
</tr>
<tr>
<td>California</td>
<td>GHG</td>
<td>g/mile</td>
<td>Car/LDT1 and LDT2</td>
<td>U.S. CAFE</td>
<td>Mandatory</td>
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<td>Voluntary</td>
</tr>
<tr>
<td>Taiwan, South Korea</td>
<td>Fuel</td>
<td>km/L</td>
<td>Engine size</td>
<td>U.S. CAFE</td>
<td>Mandatory</td>
</tr>
</tbody>
</table>

* Test methods include U.S. Corporate Average Fuel Economy (CAFE), New European Drive Cycle (NEDC), and Japan 10-15 Cycle. See Appendix for more details.

Differences in test driving cycles are crucial
Revised Japanese Test Cycle – New JC08 Cycles

Structures of Fuel Economy/GHG Standards Vary Greatly Among Countries/Regions

- Fleet Average Target:
  - EU (CO$_2$ g/km)
  - Australia (L/100-km)
- Divided by Vehicle Categories
  - US, Canada (mpg) - Cars and LDTs,
  - California (CO$_2$ g/mile) - (PC/LDT1, LDT2)
- Based on Vehicle/engine attributes:
  - Vehicle Test Weight Bins
    - Japan (km/L) - 9 weight classes
    - China (L/100-km) - 16 weight classes
  - Based on Engine Size
    - Taiwan, South Korea (km/L)
  - Based on Vehicle Footprint
    - Newly adopted US, EU standards
Conversion factors from measures of different countries/regions to CAFE-equivalent MPG, EU-equivalent CO$_2$ in g/km, and California-equivalent CO$_2$ emission rate of g/mile

<table>
<thead>
<tr>
<th>Country</th>
<th>Cycle Type</th>
<th>Measure (Y)</th>
<th>Converted to CAFE-equivalent mpg</th>
<th>Converted to EU-equivalent CO$_2$ (g/km)</th>
<th>Converted to CA-equivalent CO$_2$ (g/mi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>U.S. CAFE Fuel</td>
<td>mpg</td>
<td>Y * 1.00</td>
<td>1/(Y) * 6,180</td>
<td>1/(Y) * 8,900</td>
</tr>
<tr>
<td>Taiwan</td>
<td>U.S. CAFE Fuel</td>
<td>km/L</td>
<td>Y * 2.35</td>
<td>1/(Y) * 6,227</td>
<td>1/(Y) * 3,783</td>
</tr>
<tr>
<td>South Korea</td>
<td>U.S. City Fuel</td>
<td>km/L</td>
<td>Y * 2.78</td>
<td>1/(Y) * 2,627</td>
<td>1/(Y) * 3,206</td>
</tr>
<tr>
<td>Canada</td>
<td>U.S. CAFE Fuel</td>
<td>L/100-km</td>
<td>1/(Y) * 235.2</td>
<td>Y * 6.2</td>
<td>Y * 37.8</td>
</tr>
<tr>
<td>California</td>
<td>U.S. CAFE CO$_2$</td>
<td>g/mi</td>
<td>1/(Y) * 8,900</td>
<td>Y * 0.69</td>
<td>Y * 1.00</td>
</tr>
<tr>
<td>European Union (gasoline)</td>
<td>NEDC CO$_2$</td>
<td>g/km</td>
<td>1/(Y) * 6,180</td>
<td>Y * 1.00</td>
<td>Y * 1.44</td>
</tr>
<tr>
<td>European Union (diesel)</td>
<td>NEDC CO$_2$</td>
<td>g/km</td>
<td>1/(Y) * 7,259</td>
<td>Y * 1.00</td>
<td>Y * 1.44</td>
</tr>
<tr>
<td>Japan</td>
<td>Japanese Fuel</td>
<td>km/L</td>
<td>Y * 3.18</td>
<td>1/(Y) * 1,946</td>
<td>1/(Y) * 2,803</td>
</tr>
<tr>
<td>China, Australia</td>
<td>NEDC Fuel</td>
<td>L/100-km</td>
<td>1/(Y) * 265.9</td>
<td>Y * 29.2</td>
<td>Y * 33.5</td>
</tr>
</tbody>
</table>

Test Cycle Conversion Factors

Standardized Comparison of International Fuel Economy and GHG Standards

- US
- CA
- CANADA
- EU
- AUSTRALIA
- JAPAN
- CHINA
- S.KOREA

- California (Phase III)
- United States (Obama Plan)
May 19th Presidential Announcement

- Harmonized national policy on light-duty vehicles
  - EPA to set first-ever GHG standards for MY2012-2016
  - NHTSA to increase CAFE standards for MY2012-2016
  - California and 13 other states agree federal compliance will be deemed compliance with California standards
  - Automakers agree to dismiss litigation

- Notice of Upcoming Joint EPA-NHTSA Rulemaking
  - Target of 250 g/mi CO2 for MY2016 vehicles
  - This is equivalent to 35.5 mpg, but CAFE standard will likely be somewhat lower
**Historical Importance**

- First-ever federal vehicle GHG standards
- Likely one of the “biggest” federal rules ever
  - 900 MMT of cumulative CO2 savings
  - 1.8 billion barrels of cumulative oil savings
  - $60 billion of cumulative incremental vehicle costs
  - $200 billion of cumulative consumer fuel savings
- Unprecedented cooperation
  - EPA and NHTSA standard-setting
  - Automakers/UAW and States/environmental groups

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**EPA MY2012-2016 GHG Standards Structure**

- Vehicle tailpipe CO2 emissions minus credits for A/C-related CO2-e emissions reductions
  - Lower GWP refrigerants or reduced leakage
  - More efficient A/C systems
- Footprint-based GHG curves
  - Larger vehicles have higher GHG targets
  - Each manufacturer has unique fleetwide standard
- Retain separate car and truck standards
  - Include largest SUVs in trucks
  - Move small, 2WD SUVs from trucks to cars
- CAFE-like FFV credits through MY2015, then end
- No GHG fines, but temporary, less stringent standard for smaller automakers
California retains independence in making its own GHG standards

CARB is working on Pavely 2 Regulations for post-2016 – Likely 60-80+ MPG requirements for Ultra Low Carbon Vehicles (ULCVS)

Example of Possible* Ultra Low Carbon Vehicle Introduction Rates

* Not a prediction, but designed to show an example of what is needed to achieve 80% reduction by 2050

Road Map for 50% GHG reduction by 2050
PHEV/EV and Ultra Low Carbon Fuels are the Keys

[Graph showing passenger LDV sales over time for different types of vehicles]
De-carbonize transportation
Our only hope is to Decouple Carbon Emissions and Vehicle Ownership!

Conclusions

- Worldwide vehicle sales will continue to grow in the foreseeable future
- Oil consumption will continue to grow under BAU scenario
- A series of global fuel-efficiency programs have been undertaken
- However, current actions insufficient to make fundamental reversion of GHG growth, not to mention a 50% GHG reduction target by 2050
- Much more aggressive targets and strategies are urgently needed
- A paradigm shift and transformation to decouple carbon emissions from vehicle ownership is critical
- Will PHEVs/EVs and ultra-low carbon fuels be our best hope?