Upcoming EPA and California Policy Decisions: Creating A Platform for Cleaner, Low-Carbon Natural Gas Vehicles

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Twenty Years Ago, There Was No Such Thing As A Clean Diesel…

Standing behind this bus could be more dangerous than standing in front of it.

Diesel fumes can kill. Demand clean-fuel buses. Call 1-800-NICE-RIDE.
…Today, All New Heavy-Duty Diesel Engines Should Be Clean
...But People Are More Concerned Than Ever...
...Don’t Lose Hope...
New Policies Are Creating Opportunities for Extremely Clean Heavy-Duty Natural Gas Vehicles

- Policy Opportunities Lie Ahead
  - EPA/NHTSA Phase 2 Proposal
  - California’s Suite of Policies
  - EPA’s new Ozone NAAQS
- Near-Zero, “Power Plant Equivalent” Natural Gas Engines Are Coming
- Renewable Natural Gas Creates An Even Bigger Win-Win Opportunity
Overview of the GHG and Fuel Economy Phase 2 Proposed Rule

- Proposal covers medium- and heavy-duty vehicles, engines, and trailers
  - Model years 2021-2027 (trailers start in 2018)
- Expected Benefits include:
  - 1B metric tons of GHG emissions eliminated
  - 1.8B barrels of oil conserved
  - $170B in fuel costs saved
  - $230B in net health and environmental benefits
Per Vehicle Fuel Consumption and CO₂ Improvements in the Phase 2 Proposal

All values, except HD Pickups and Vans, are relative to MY2017 baselines. HD Pickups and Vans are relative to MY2018-2020 standards.
Phase 2 Proposal is Fuel-Neutral, But Some Provisions Will Help Advance Natural Gas Trucks

- Maintains Phase 1 approach to compliance pathway flexibility for CH₄, N₂O, and CO₂
- Resolves longstanding issue of methane leakage from crankcases
- Codifies best practices for LNG refueling to reduce methane emissions during LNG refueling
Ozone Alert: At 70 ppb, 40% of the U.S. Population Will Live in an Ozone Nonattainment Area

Counts in Nonattainment for Potential 8-Hour Ozone Standard (0.07 ppm)
National Ambient Air Quality Standards

Concentration > 0.07 ppm
Non-Attainment Counties: 460
Non-Attainment Population: 129,002,717

Source – United States EPA <http://www.epa.gov/airtrends/values.html>
Map © Gladstein, Neandross & Associates / June 2014 / gladstein.org
California Has A Broad Suite Of Transportation Policy Goals

- 50% petroleum displacement by 2030
- Reduce NOx emissions and smog (EPA NAAQS; Oct. ‘15)
- Eliminate toxic diesel PM
- Reduce GHG emissions by 80% by 2050 (AB 32)
- Reduce GHG emissions from various waste streams (landfills, dairies, MWW, etc.)
- Reduce short lived climate pollutants (e.g., black carbon, methane)
- Drive economic development and job creation via in-state biofuel production
- Create fuel cost savings for California fleet operators and businesses
- Advance California’s transportation technology leadership
Natural Gas Advances All Of These Policy Goals

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California Sustainable Freight Strategy Should Advance These Goals Through A Comprehensive Approach to Goods Movement

- Issued by Governor Brown on July 17, 2015 under Executive Order B-32-15
- Requires multiple agencies to develop an integrated action plan by July 2016
- Plan will establish clear targets to:
  - Improve freight efficiency,
  - Transition to zero-emission technologies, and
  - Increase competitiveness of freight system
Key Provisions for the Natural Gas Transportation Sector

• Lower the carbon intensity of the freight sector to achieve an 80% GHG emissions reduction from 1990 levels by 2050
• Achieve up to a 50% reduction in fossil fuel use by cars and trucks by 2030
• Optional low-NO\textsubscript{x} standard for heavy-duty truck engines
• Develop LNG fueling infrastructure for ocean going vessels, harbor craft, and locomotives
• Potential renewable natural gas standard
Despite Lack of HD Battery Electric Trucks, “Power Plant Equivalent” Engines are Coming

- GNA survey: No signs of significant deployment in battery electric Class 7 or 8 HD trucks for long-haul service by 2030
- But California’s Optional Low-NOx Emission Standard (0.02 g/bhp-hr) is equivalent to a battery electric truck charged from a modern combined cycle gas turbine (CCGT) power plant
- “Near-Zero” or “power plant equivalent” emissions are coming
"Power Plant Equivalent" Natural Gas Engines Are Being Certified

Pursuant to the authority vested in the Air Resources Board by Health and Safety Code Division 26, Part 5, Chapter 2; and pursuant to the authority vested in the undersigned by Health and Safety Code Sections 39515 and 39516 and Executive Order G-14-012;

IT IS ORDERED AND RESOLVED: The engine and emission control systems produced by the manufacturer are certified as described below for use in on-road motor vehicles with a manufacturer’s GVWR over 14,000 pounds. Production engines shall be in all material respects the same as those for which certification is granted.

<table>
<thead>
<tr>
<th>MODEL YEAR</th>
<th>ENGINE FAMILY</th>
<th>ENGINE SIZES (L)</th>
<th>FUEL TYPE</th>
<th>STANDARDS &amp; TEST PROCEDURE</th>
<th>INTENDED SERVICE CLASS</th>
<th>ECS &amp; SPECIAL FEATURES</th>
<th>DIAGNOSTIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>GCEHX0540LBJ</td>
<td>8.9</td>
<td>CNG/LNG</td>
<td>Diesel</td>
<td>MHD</td>
<td>TBI, TC, CAC, ECM, EGR, TWC, HO2S</td>
<td>EMD+</td>
</tr>
</tbody>
</table>


Following are: 1) the exhaust emission standards or family emission limit(s) as applicable, under 13 CCR 1956.8; 2) the SET and L&H values under the applicable exhaust emission standards and test procedures for heavy-duty diesel engines and vehicles (Test Procedures); and the corresponding certification levels, for this engine family. "Diagnosis" CO, SET and NTE certification may have been demonstrated by the manufacturer as provided under the applicable Test Procedures in lieu of testing. (For flexible- and dual-fueled engines, the CERT values in brackets [ ] are those when tested on conventional test fuel. For multi-fueled engines, the STD and CERT values for default operation permitted in 13 CCR 1956.8 are in parentheses.)

<table>
<thead>
<tr>
<th>g/bhp-hr</th>
<th>HC</th>
<th>NOx</th>
<th>CO</th>
<th>PM</th>
<th>HCHO</th>
</tr>
</thead>
<tbody>
<tr>
<td>STD</td>
<td>0.14</td>
<td>0.02</td>
<td>0.01</td>
<td>15.5</td>
<td>1.5</td>
</tr>
<tr>
<td>CERT</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>NTE</td>
<td>0.21</td>
<td>0.03</td>
<td>0.02</td>
<td>19.4</td>
<td>0.02</td>
</tr>
</tbody>
</table>

* g/bhp-hp = grams per brake horsepower-hour; FTP = Federal Test Procedure; SET = Supplemental emissions testing; NTE = Not-to-Exceed; STD = Standard or emission test cap.

*HC = Hydrocarbons; NOx = Nitrogen Oxides; CO = Carbon Monoxide; PM = Particulate matter; HCHO = Formaldehyde.
“Power Plant Equivalent” Engines Will Be Critical to Ozone Attainment

Mobile Source NOx Emission Reductions to Achieve 8-Hr Ozone Air Quality Standards (2023)

<table>
<thead>
<tr>
<th>Category</th>
<th>Baseline</th>
<th>Needed by 2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>HHD Trucks (&gt;33,001 lbs)</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>Ocean Going Vessels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LHD Trucks (8,501-10,000 lbs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freight Locomotives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MHD Trucks (14,001-33,000 lbs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harbor Craft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LHD Trucks (10,001-14,000 lbs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cargo Handling Equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aircraft</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Key Sectors: Medium and Heavy-Duty Trucks, Freight Locomotives, Harbor Craft, Ocean-Going Vessels, and Cargo Handling Equipment.
“Power Plant Equivalent” Engines Can Provide Near-Term Smog Relief to Communities
“Power Plant Equivalent” Engines Should Actually Be Cleaner Than The Grid in Many States

Percent Coal-Fire Generation by State

Note: States with red bars are likely to contain ozone nonattainment areas if the ozone NAAQS is set at 70 ppb
Increasing renewable natural gas use creates an even greater opportunity for near-term, large-scale progress on multiple policy goals.
RNG Outperforms All Other Options in Total Carbon Intensity

Source: PG&E, CA LCFS Final Regulation Order, 4/15/10
Adding RNG Helps California Meet its Petroleum Reduction Goal

Benefits from Cutting Petroleum Use in Half by 2030
- **Lower Pollution**
  - In California, the production, refining, and use of petroleum accounts for almost half of greenhouse gas emissions, 80 percent of smog-forming pollution, and over 95 percent of cancer-causing diesel particulate matter.
- **Stronger Economy**
  - Oil dependence costs the U.S. an estimated $300-500 billion annually ($35-55 billion in California).
  - Reducing energy use and improving vehicle efficiency cuts costs and improves economic productivity and competitiveness.
  - A diverse mix of domestic and local fuel supplies stabilizes energy prices, improves economic resilience, and creates new investments, businesses, and jobs.
- **Meet Health Standards and Climate Change Goals**
  - Studies show a 45-55% petroleum reduction in 2030 sets California on a path to meet its 2050 climate change goals.
  - Meeting federal health-based air quality standards likely requires additional petroleum reductions.

How we get there
- **Already on Our Way**
  - Existing policy will reduce petroleum use in cars and trucks by more than 30% in 2030.
  - Planned activities over the next two years can achieve significant additional petroleum reductions.

Build on California’s Climate Change and Air Quality Framework
- **Building on existing efforts**, California can cut petroleum use from cars and trucks in half by 2030:
  - Build high-speed rail and continue supporting community planning to reduce vehicle miles travelled.
  - Continue current levels of light-duty and heavy-duty vehicle efficiency improvements.
  - Strengthen the Low Carbon Fuel Standard to continue reducing fuel carbon intensity.
  - Continue providing strong market support for zero-emission vehicles and renewable fuel production through carbon pricing and other incentives.

Sample path to 50% petroleum reduction in 2030
An approach to 50 percent petroleum reduction could include:
- Reducing growth in vehicle miles travelled by 4%: increasing on-road fuel efficiency of cars to 56 mpg and heavy-duty trucks to about 7 mpg; and at least doubling use of alternative fuels like biofuels, electricity, hydrogen, and renewable natural gas. (ARPA analysis)

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**Million Gasoline Gallons Equivalent**

- **Non-petroleum**
- **Petroleum**

**Chart**

- **Current Conditions**
- **Reducing VMT Growth & Continued Vehicle Efficiency**
- **More biofuels, electricity, hydrogen, natural gas**

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**Sources:**
- California Environmental Protection Agency | AIR RESOURCES BOARD
- [www.gladstein.org](http://www.gladstein.org)
RNG Can Help HD Sector Do Its Share To Meet Upcoming LCFS Requirements
Replacing Diesel with RNG Reduces BC and Captures Methane

Figure 2: California 2013 Methane Emission Sources
- 3% Rice
- 20% Landfills
- 26% Manure Management
- 4% Wastewater
- 9% Pipelines
- 6% Oil & Gas Production
- 3% Industrial & Misc

Figure 3: California 2013 Black Carbon Emission Sources
- 5% Fireplaces
- 1% Cooking
- 6% Industrial Fuel Combustion
- 31% Ag. Burning
- 6% On-Road Transportation
- 10% Off-Road Transportation

HD DIESEL
In-State, Technically Recoverable RNG Can Displace >2/3 of Annual Diesel Use

Statewide Diesel Fuel Consumption (million gallons per year)

- HHDVs: 2,228 (64%)
- MHDVs: 603 (17%)
- LHDVs: 320 (9%)
- MDVs: 23 (1%)
- LDVs: 47 (2%)
- Other: 46 (1%)
- Buses: 211 (6%)

Source: EMFAC 2014 - Calendar year 2015 (diesel); GNA analysis (RNG)
Adding RNG to “Big Blue Bus” Fleet Was Key To Meeting Santa Monica’s Sustainability Goals

City of Santa Monica GHG Inventory

MTCO2e/yea

- 5,000
- 10,000
- 15,000
- 20,000
- 25,000
- 30,000
- 35,000
- 40,000

Power
Stationary Combustion
Transit Fleet
Other Fleet
TOTAL

Baseline  With RLNG

53% REDUCTION!

79% REDUCTION!
Conclusions

• EPA and California policy initiatives will drive reductions in heavy-duty diesel emissions and fuel consumption in years to come

• Natural gas engines are starting to meet the Optional Low-NOx Emission Standard (0.02 g/bhp-hr) —equivalent to a CCGT power plant

• Power plant equivalent engines will be needed to meet upcoming ozone requirements and provide relief to communities with chronic ozone problems

• These natural gas engines should be cleaner than the grid in many states

• Combining ultra-low NOx engines with renewable natural gas is a strategy that can help achieve multiple policy goals at once—and is available to cities and fleets now

• California policy and funding should support increased near-term deployment of power-plant equivalent technologies and RNG fuels to meet these objectives
For More Information…

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  – (212) 849-6861