A Path to More Sustainable Transportation

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Today’s cars and trucks are cleaner than ever: a key element of “sustainable transportation”

A large part of “sustainability” is reducing criteria pollutants (i.e., NOx, PM, HC and CO), to necessary levels

- **LD automotive manufacturers are in production and meeting the **LD Tier 2** standards**

- **All HD engine manufacturers have assured EPA that they are on track with product that meets the **HD2007** standards**

- **Non-Road Tier 4 vehicles achieving standards will round off the tools to meet the goal of cleaner air from mobile sources**
Other elements of Sustainable Solutions for the Transportation Sector

**ENVIRONMENTAL SUSTAINABILITY**
- Criteria Pollutants (health of the population)
- Climate Change (health of the planet)

**ENERGY SUSTAINABILITY**
- Geopolitics of Oil reserves (Stable, National Security)
- A finite supply w/ transition concerns (Available)
- Economic dependence on Oil (Affordable)
Is the Diesel on this path?  
– R&D progress to date

In the not too distant pass, the diesel questions were:

- With EPA’s stringent standards, is there a future for diesel?
- With a “practical limit” of diesel combustion not allowing engine-out NOx below 1.5 gm/hp/hr, can any NOx aftertreatment retain 80-90% lifetime effectiveness?
- How can we address climate change and improve fuel economy without jeopardizing health and safety?

Today the questions are:

- What is the lowest cost approach for a Tier 2 bin 5 diesel?
- Will Americans overcome their historical perception of the diesel, and consider a diesel in their family sedan (or SUV)?
- What is the most logical approach to fuel economy improvement, diesels or hybrids?
Clean Automotive Technologies
Under Development at the U.S. EPA’s National Vehicle & Fuel Emissions Laboratory

Advanced engine concepts
- Clean Diesel Combustion
- HCCI
- Free Piston Engines
- (Alternative Fueled Engines)
- (Efficiency Improving “Bottoming Cycles”)

Advanced Hydraulic Hybrid Vehicles & components
- Improved Hydraulic Components
  (pumps, motors, valves, accumulators, etc)
- Sport Utility Vehicle DEMO (Class 2)
- Urban Delivery Vehicle DEMO (Class 5-7)
- Heavier Utility Vehicles DEMO
  (Trash Trucks, Dump Trucks, Buses)
Diesel Options to Meet HD On-Road or LD Tier 2 Emissions Levels

- **NOx Adsorber Aftertreatment**
  - viable approach (primary path for compliance)

- **SCR Aftertreatment**
  - infrastructure, cost, significant compliance and enforcement concerns – engine manufacturers would be fully responsible for in-use compliance

- **HCCI Combustion**
  - technology approach not yet mature

- **Clean Diesel Combustion**
  Control NOx engine-out
  & Smoke/PM/HC with conventional aftertreatment
Comparing *Engine-Out NOx* of Conventional and EPA’s CDC diesels

Conventional Diesel 1.9L

CDC Diesel 1.9L

**NOx Engine Out (g/hp-hr)**

**BSNOx Map (g/hp-hr)**

NOx below .2 everywhere
EPA’s Approach to Clean Diesel Combustion NOx Control
Improving the Performance and Reducing PM from Clean Diesel Combustion

![Graph showing smoke number for different load and speed conditions.]

- Higher Load - Medium Speed
- Medium Load - Cruise Speed
- CDC as reported Nov 2002
- Improved CDC results
- Latest CDC Combustion
EPA’s Clean Diesel Combustion Air Management Configurations

2-Stage Boost Systems
## Clean Diesel Combustion
### Initial Vehicle Test Results

<table>
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<tr>
<th>Engine</th>
<th>Test Fuel Economy (mpg)</th>
<th>HC (g/mi)</th>
<th>CO</th>
<th>NOx</th>
<th>PM</th>
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**VEHICLE:** ~ 4,900 lb test weight

A larger-wagon or mini-van
EPA Clean Diesel Combustion Our Research is Continuing…

- Five CRADA/Technology Transfer partners active in developing this technology

- Continued refinement of combustion, boost, & fuel injection to better systems and approaches

- Transient calibration has not been as challenging as expected, but diesel NVH & drivability need more work

- Improving aftertreatment for PM, HC & CO reduction

- Continuing vehicle demonstrations beyond FTP & US-06 capability
For More Information

Information on the Regs – www.epa.gov/cleandiesel

Information on Technologies – www.epa.gov/otaq/technology

- Fact Sheet - *Clean Diesel Combustion: Clean, Efficient, and Cost Effective*

- Fact Sheet - *Hydraulic Hybrid Technology: A Proven Approach*

- Technical Information - *An HCCI Engine Power Plant for a Hybrid Vehicle*


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