NATURAL GAS

ENGINE AND VEHICLE RESEARCH & DEVELOPMENT

FreedomCAR

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

The Next Generation Natural Gas Vehicle Activity

NGNGV IMPACT

The Next Generation Natural Gas Vehicle (NGNGV) R&D activity is leading important advances in natural gas vehicle (NGV) technology. NGNGV Phase I engine research projects demonstrated NO_x emissions well below EPA 2007 levels*, and two projects met EPA 2010 levels in medium-duty engines. NGNGV Phase II engine and vehicle projects covering a range of power and torque ratings are targeted to achieve EPA 2007/2010 emission levels in 2005. In addition, gaseous fuel expertise gained through the NGNGV activity and other government and industry NGV and infrastructure efforts is aiding the transition to a future transportation scenario based on hydrogen.

- **Medium-duty engine research projects have demonstrated NO_x emissions below 0.2 g/bhp-h**
- **Several medium- and heavy-duty projects targeted to achieve EPA 2007/2010 emission levels in 2005**
- **NGV R&D is aiding the transition to hydrogen vehicles**

NGNGV GOALS

Natural gas is an abundant domestic fuel. The U.S. Department of Energy supports NGV research through its FreedomCAR and Vehicle Technologies (FCVT) Program to help the United States reduce its dependence on imported petroleum. NGVs can also reduce emissions of regulated pollutants compared with diesel vehicles.

The NGNGV activity is supported by the FCVT Program, the South Coast Air Quality Management District, and the California Energy Commission. One goal of the activity is to develop advanced, commercially viable, medium- and heavy-duty natural gas engines and vehicles that will meet EPA 2007/2010 heavy-duty emission levels (Table 1) before 2007.

Table 1. EPA Heavy-Duty Highway Engine 2007/2010 Emission Standards

	Emission standard (g/bhp-h)	Percent of engine sales, MY 2007-2009	Percent of engine sales, MY 2010
PM	0.01	100%	100%
NO_x	0.20	50%	100%
NMHC	0.14	50%	100%

EPA—U.S. Environmental Protection Agency; g/bhp-h—grams per brake-horsepower hour; MY—model year; NMHC—nonmethane hydrocarbons; NO_x—oxides of nitrogen; PM—particulate matter.

* NGNGV projects are targeted to meet emission levels required by EPA standards. To fully meet EPA standards, engines must meet these low emission levels for the full useful life of the engine.

Another goal is to develop production-intent natural gas engines that meet current emission levels and can be deployed commercially in the near term to gain immediate petroleum displacement and emission reduction benefits.

R&D PROGRESS TO DATE

Phase I of the NGNGV activity included research on medium- and heavy-duty natural gas engines capable of demonstrating low NO_x and PM emissions. Phase I also included a natural gas vehicle market assessment and research on hot surface ignition for direct-injection natural gas engines. Figure 1 shows the emission results of the Phase I engine projects. Results of the hot surface ignition research have been published (see *Related Publications and Web Sites*).

ONGOING AND FUTURE R&D

Phase II of the NGNGV activity is underway (Figure 1). Phase II projects include R&D on engines and vehicles that are targeted to meet EPA 2007/2010 emission levels. Other Phase II engine projects are developing production-intent natural gas engines that meet current emission levels and can be deployed commercially in the near term.

Results of NGNGV R&D activities to date suggest that stoichiometric natural gas engines with three-way catalysts are one likely path to the ultra-low NO_x emissions required by the EPA in 2010. Lean-burn natural gas engines with emissions aftertreatment may offer benefits with regard to higher engine ratings (power and torque) and fuel economy. NGNGV R&D activities will continue to develop lean-burn and stoichiometric technologies that are durable and economically viable.

NGV IMPLEMENTATION

Implementation activities—such as on-road development, vehicle deployment, and emission testing projects—complement the NGNGV R&D activities. Implementation activities verify the in-service performance of natural gas engines and vehicles and facilitate their commercial readiness. DOE supports NGV implementation to expedite advanced NGV technology into the marketplace.

NGVs BEYOND 2010: AIDING THE TRANSITION TO HYDROGEN

Gaseous fuel expertise gained through the NGNGV activity and other government and industry NGV and infrastructure efforts is directly applicable to creating a future transportation scenario based on hydrogen. Challenges that are similar for

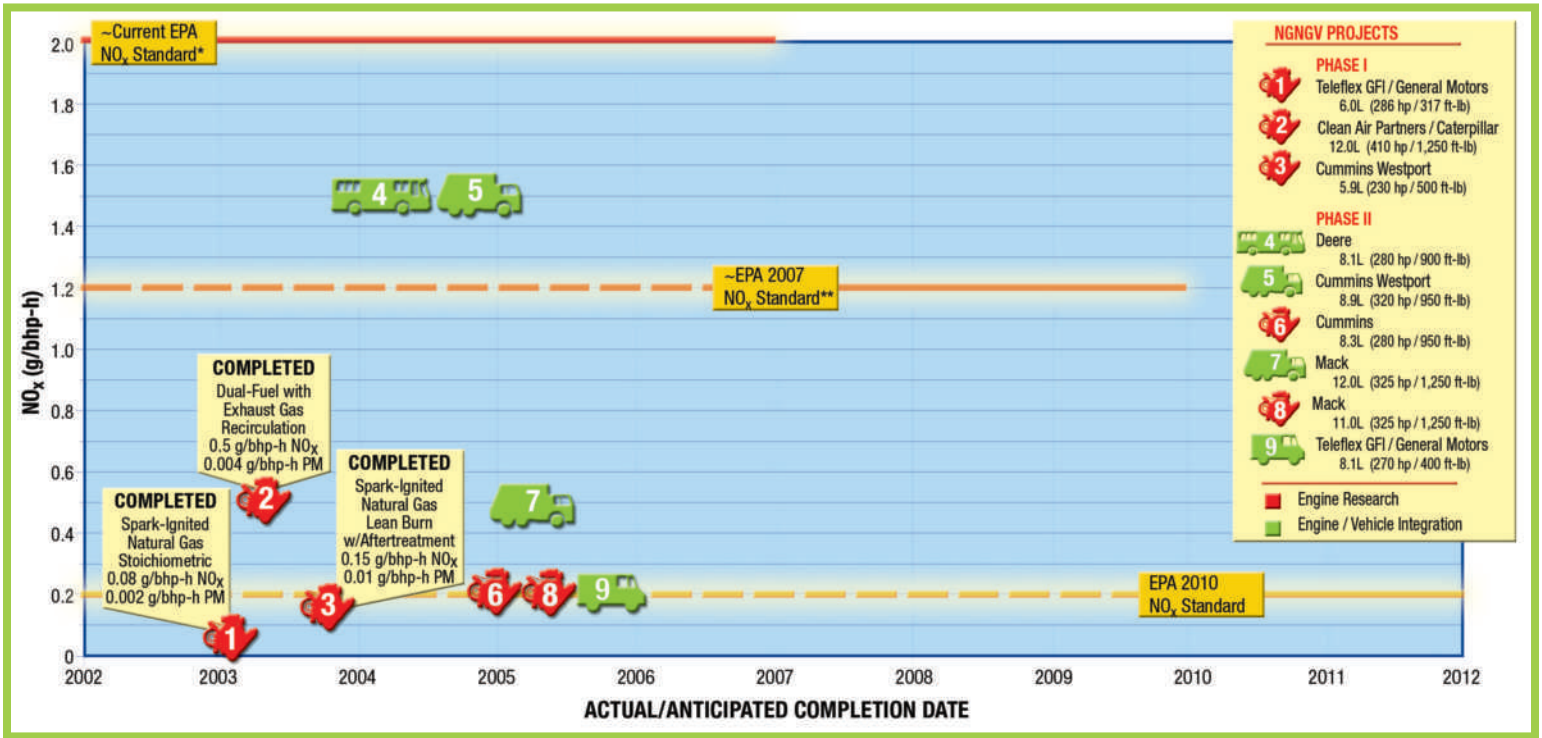

Figure 1. Results and Goals for NGNGV Engine and Vehicle Projects

Note: NOx emission goals are shown in Figure 1 because the EPA 2010 standard of 0.2 g/bhp-h NOx is considered to be the most challenging goal for heavy-duty engines. NGNGV projects are also expected to meet or surpass EPA 2010 standards for PM and NMHC (except for the near-term engine development projects, which are designed to achieve 0.05 g/bhp-h PM).

*This is an approximate NOx standard. Currently, the EPA combines NOx and NMHC emissions in a single standard. For more information on heavy-duty engine emission standards visit www.epa.gov.

**This is an approximate NOx standard. The EPA 2007 standard requires that 50% of heavy-duty engines sold achieve NOx emissions of 0.20 g/bhp-h (see Table 1) or that the average of all engines sold achieves the average of the current NOx standard and the 2010 NOx standard. For more information on heavy-duty engine emission standards visit www.epa.gov.

NGVs and hydrogen vehicles include engine R&D, onboard fuel storage and delivery, vehicle integration, fueling infrastructure, codes and standards, vehicle evaluation, and consumer awareness and perceptions. In addition, hydrogen vehicles are supported by many of the same OEMs, suppliers, and funding agencies that are in the established NGV network.

As an initial step in the transition, vehicles fueled by a hydrogen-natural gas blend (HCNG) can help build demand for a hydrogen infrastructure while reducing emissions. For example, in a project sponsored by DOE and the South Coast Air Quality Management District, an HCNG-fueled engine reduced NO_x emissions by 50% with no significant change in fuel efficiency compared with a CNG-fueled engine. Continuing work includes optimizing the hydrogen-to-natural gas ratio with regard to power, torque, durability, and fuel efficiency.

RELATED PUBLICATIONS AND WEB SITES

The following documents are available online from the Alternative Fuels Data Center at *www.afdc.doe.gov.* Hard copies are available from the Alternative Fuels Hotline at 1-800-423-1363 or hotline@afdc.nrel.gov:

- *Next Generation Natural Gas Vehicle Program Phase I: Clean Air Partners 0.5 g/hp-h NO_x Engine Concept*
- *Performance and Economics of Catalytic Glow Plugs and Shields in Direct Injection Natural Gas Engines for the Next Generation Natural Gas Vehicle Program*

The NGNGV activity is part of DOE's Natural Gas Vehicle Technology Forum. For more information, visit *www.ott.doe.gov/ngvtf.*

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