Energy Efficiency, Energy Independence & Greenhouse Gas Emission Reductions

The Role of Diesel

[Diesel Technology Forum]
Why Diesel?

Because of its unique combination of energy efficiency, power, reliability, and durability, diesel technology plays a vital role in important sectors of the U.S. economy. More than 90 percent of commercial trucks are powered by diesel engines, as are two-thirds of all farm and construction equipment, and 100 percent of all freight locomotives, river barges and other marine work vessels. Diesel engines also power electric generators used for distributed generation or as emergency back-up power such as those used by hospitals.

Technologies and actions which promote energy efficiency, energy independence and greenhouse gas (GHG) emission reductions are increasingly attractive to national, state and local policymakers. Although diesel power, like other fossil fuel-based technologies, contributes to GHG emissions, its 20-40 percent greater efficiency also offers a viable and readily available strategy to help reduce these same emissions and the amount of fossil fuels used in the transportation sector.

Clean diesel is one of many technologies – including the use of biodiesel, ethanol and hybrid-electric power – that have potential for reducing energy consumption and GHG emissions. The following are some basic facts about diesel power and its relevance to these issues as policymakers consider options for addressing these national challenges.

Transportation and Greenhouse Gas Emissions

Carbon dioxide (CO$_2$) is one of six major GHGs recognized by the International Panel on Climate Change. Many of these gases are produced by both natural and human activities; however, particular attention has been given to CO$_2$ emissions since they account for the vast majority of manmade GHG emissions (83 percent in the U.S.).

Because CO$_2$ is the most prevalent of all manmade GHGs, the other five greenhouse gases — methane; nitrous oxide; hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulfur hexafluoride (SF$_6$) — are typically reported in terms of a CO$_2$ equivalent based on their global warming potential to provide a common unit of measure.

Source: Energy Information Administration.

According to the U.S. Environmental Protection Agency (EPA), the transportation sector is responsible for just over one-quarter of total domestic GHG emissions. Almost all of these CO₂ emissions come from the consumption of petroleum products: gasoline (60 percent), middle distillates (diesel fuel – 22 percent), jet fuel (12 percent) and residual oil (mostly marine – 3.1 percent).

When viewed by mode of travel, 62 percent of U.S. transportation-related GHG emissions came from light-duty vehicles used for personal transport:

- passenger cars – 35 percent;
- light-duty trucks – 27 percent (including SUVs, minivans and pickup trucks); and
- motorcycles – less than 1 percent.

Heavy-duty vehicles, including trucks and buses, were responsible for 19 percent of total U.S. transportation GHG emissions. Non-road sources accounted for 16 percent of all U.S. transportation-related GHG emissions including aircraft, boats, ships, rail and pipelines.

**Diesel’s Inherent Efficiency**

There are many ways to reduce GHG emissions generated by light- and heavy-duty vehicles, including energy efficiency improvements, the use of alternative fuels and the adoption of operational modifications such as anti-idling measures.

Diesel is the most efficient of all internal-combustion power systems. Because of the superior efficiency of the engine and higher...
energy content of the fuel, diesels typically deliver 20-40 percent more miles per gallon and 10-20 percent fewer GHG emissions than comparable gasoline vehicles. According to the EPA (www.fueleconomy.gov) a simple comparison between the diesel and gasoline versions of the Volkswagen Jetta demonstrate that the diesel model would travel 36 percent more miles on a tank of fuel and save $321 annually on fuel costs, while using nearly two fewer barrels of oil and emitting one less ton of GHG emissions each year. A similar comparison between the 2007 Mercedes E320 Bluetec diesel and its E350 gasoline equivalent finds even greater savings. The diesel model travels 43 percent more miles on a tank of fuel and saves $492 annually on fuel costs while using 3.2 fewer barrels of oil and emitting 1.5 fewer tons of GHG emissions each year.

More Clean Diesel Cars, Pickups and SUVs equals...

... Less Oil Consumption

The European Union has sought to capitalize on diesel’s inherent energy efficiency by offering tax incentives for the purchase and operation of diesel cars and trucks. Today diesel vehicles account for more than 40 percent of new vehicles purchased in the EU marketplace. Although EU transportation related GHG emissions grew 26 percent from 1990 to 2004, the average carbon dioxide emissions of new passenger cars were reduced by about 12 percent from 1995 to 2004. According to the European Environmental Agency, "The main reasons for the reductions since 1995 are fuel efficiency improvements, mainly in diesel-fueled vehicles, and a shift in fleet composition from petrol to diesel passenger cars." 5

For this reason, advanced clean diesel technology must remain a viable option for light-duty vehicles in the United States. In 2005, diesel vehicles accounted for 3.6 percent of the light-duty market in the U.S. This percentage is expected to triple, reaching more than 10 percent of the U.S. market by 2015 according to JD Power and Associates.

EPA estimates that if one-third of passenger cars in America were powered by diesel engines, the country would save up to 1.4 million barrels of petroleum per day – equal to the amount of oil the U.S. currently imports daily from Saudi Arabia.

Nevertheless, an expanding market for clean diesel cars will depend on a number of factors including regulatory stability for manufacturers, and continued research and development on improving exhaust control systems, particularly for smog-forming nitrogen oxides (NOx) and particulate matter. Some manufacturers are indicating that the 2009 and later year diesel vehicles will utilize a new emissions control technology known as selective catalytic reduction (SCR) which requires the use and replenishment of a chemical additive (urea). Other manufacturers will use lean-NOx traps with a hydrocarbon reductant based SCR which does not use urea. All options have challenges, but a variety of technologies are being developed to meet stringent U.S. and California emissions standards.

Clean Diesel’s Environmental Progress
In addition to CO₂, the use of diesel power contributes to the formation of several compounds such as carbon monoxide, sulfates and black carbon or soot particles. The reflective impact and atmospheric lifetime of these emissions are still being studied, but they are already subject to stringent government regulations. Diesel engine, equipment, fuel and emissions control technology manufacturers are working with EPA, state and regional governments and environmental organizations in a collaborative effort to reduce diesel-related emissions.

In October 2006, ultra-low sulfur diesel (ULSD) fuel became available nationwide, providing an immediate 10 percent reduction of fine particle emissions. The move to clean diesel fuel also enables the use of advanced engine controls and new particulate trap technology. By 2010, clean diesel technology will bring a 98 percent reduction in heavy-duty emissions since 1998, down to almost imperceptible levels. The first such vehicle to meet these standards, a Dodge Ram with a Cummins engine, is already available. Many older heavy-duty diesel vehicles can also benefit from clean diesel’s technological advancements, with retrofit options enabling emissions reductions from 25–85 percent.

Compounding Environmental and Efficiency Gains
Increased reliance on cars, trucks and SUVs powered by clean diesel engines instead of gasoline is but one of many ways to reduce light-duty GHG emissions. Greater use of bio-fuels can also contribute to reductions in petroleum use and GHG emissions. However, it is important to consider the operational ramifications, market potential and life cycle costs of such efforts.
One such concern is quality assurance. Any fuel that does not meet strict quality standards can hamper the performance of sensitive engine components and emissions control technologies. Most engine and vehicle manufacturers today permit the use of a B5 blend of bio-fuels — 5 percent soy-based biodiesel and 95 percent petroleum diesel. Efforts are underway between the National Biodiesel Board and vehicle and engine manufacturers to extend permitted fuel blends up to 20 percent bio-fuels in diesel (B20). Current biodiesel production levels remain insufficient to support even a national B2 standard, but if production continues to grow, a national B5 transportation fuel standard could result in a 4% reduction in CO2 life cycle emissions, while still avoiding most technology-based concerns.6

In the heavy-duty sector, the technology challenges of meeting new 2007-2010 emissions requirements have reduced the potential for achieving substantial further fuel efficiency improvements from the engine. As a result, lowering the amount of energy necessary to move the vehicle by reducing weight, aerodynamic drag, and rolling resistance offers the largest potential to increase fuel efficiency and reduce GHG emissions from trucks.

This fact has been recognized by EPA, resulting in its voluntary SmartWay program, which combines emissions reduction and fuel efficiency improvements through vehicle modifications and emissions technology upgrades to existing vehicles. SmartWay is working with the truck and rail industries to promote many of these modifications and new cleaner diesel vehicles to reach its goal of eliminating 33 to 66 million metric tons of CO₂ emissions, 200,000 tons of NOx emissions and save as much as 150 million barrels of oil per year by 2012 – enough oil to heat 17 million houses for a year.7

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6 http://www.biodiesel.org/resources/reportsdatabase/reports/gen/19980501-gen-203.pdf

Reduction in discretionary idling of commercial diesel engines is also an area of great potential for reducing fuel consumption and CO\textsubscript{2} emissions. The EPA estimates that long-duration truck and locomotive engine idling is responsible for 11 million tons of CO\textsubscript{2}, 5,000 tons of particulate matter and 200,000 tons of NOx annually. As a result, the diesel industry has developed auxiliary power units and other idle reduction technologies to help vehicle operators reduce idle time, fuel consumption and emissions.

The Promise of Diesel Hybrids
One area of significant promise for efficiency gains from commercial vehicles is the utilization of diesel hybrids. Fuel efficiency gains of 30-50 percent are possible by combining a smaller, fuel-efficient clean diesel engine with an advanced electrical or hydraulic system that uses regenerative braking and energy storage. Diesel electric hybrid commercial trucks are in the demonstration and early implementation phases in the school bus, package delivery, local trucking and utility sectors.

Diesel hybrids have also demonstrated significant efficiency gains in transit buses and is now the technology of choice for many transit districts around the country. A National Renewable Energy Laboratory (NREL) report comparing hybrid diesel buses with standard diesel-powered and CNG buses found a respective fuel economy improvement of 37 percent and 88 percent.\textsuperscript{8} Similar gains have been found when combining these technologies in certain truck markets such as the utility sector.

Continuous Improvement Meeting Industry and National Challenges
The diesel industry’s commitment to continuous improvement is bringing significant efficiency and emissions benefits. As a result, the performance of diesel vehicles and equipment is greater than ever before. These investments were sparked by stricter emissions standards for particulate matter and nitrogen oxides. Thanks to these performance enhancements, diesel vehicles and equipment can now be part of the solution to the challenges of energy security and growing GHG emissions, making this economic workhorse into an environmental workhorse.

\textsuperscript{8}http://www.nrel.gov/vehiclesandfuels/fleettest/pdfs/40125.pdf

According to a National Renewable Energy Laboratory report, diesel hybrid buses were found to operate at a 23 percent lower cost per mile than new CNG buses, due almost entirely to their better fuel economy.
The Diesel Technology Forum is a non-profit organization dedicated to raising awareness about the progress and potential of diesel technology in all applications. It represents the leaders of the diesel industry including engine and equipment makers, key component manufacturers, fuel producers and emissions control technology manufacturers.

The Forum brings together a broad range of diesel stakeholders including diesel users, public & environmental interest groups and government regulators to encourage the exchange of information, findings and ideas about the current and future use of diesel technology.

For more information, visit www.dieselforum.org

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