Westport GX LNG Engine Development

Technology Manufacturer
Westport Innovations
Kenworth Truck Company

Co-Participants
Port of Los Angeles, Port of Long Beach, South Coast Air Quality Management District, California Energy Commission

Project Objective

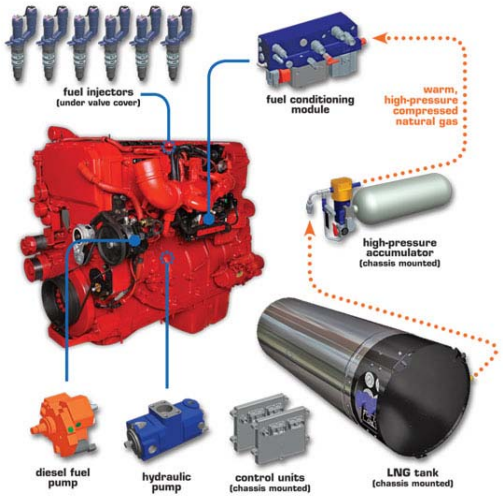
Westport Innovations (Westport), developer of the High Pressure/Direct Injection (HPDI) liquefied natural gas (LNG) fuel system technology, developed an LNG 15-liter heavy-duty truck engine that was certified to the 2010 on-road NO_x emission standard of 0.2 grams per brake horsepower-hour (g/bhp-hr). The 400- and 450-horsepower rated heavy-duty engines are based on the 15-liter Cummins ISX diesel engine platform and are designed to satisfy the performance requirements of class 8 tractors that provide drayage service at the Ports.

The GX LNG heavy-duty engine development project had three primary objectives:

1. Development and certification of a 2007 LNG high-pressure direct-injection engine to 0.6 g/bhp-hr NO_x by early 2008;
2. Establish the manufacturing capacity to produce LNG trucks in a high volume truck production facility;
3. Certification of a 0.2 g/bhp-hr NO_x (2010 standard) compliant truck by early 2010 for deployment in mid-2010.

Technology Description

Westport's HPDI technology facilitates the use of natural gas as an engine fuel while retaining typical diesel engine combustion, power, and torque. The technology differs from other natural gas engines through the absence of spark plugs. A patented injector delivers a small amount of diesel fuel (approximately 6% by energy content) and high pressure natural gas directly to the engine combustion chamber, where the diesel fuel acts as the ignition source.



LNG fuel for the Westport GX engine is stored in the LNG tank mounted to the chassis of the vehicle. The liquid natural gas is drawn from the tank using a proprietary LNG pump that is powered by an engine-driven hydraulic pump. The LNG is then vaporized using excess heat from the engine's coolant system.

Simultaneously, a diesel fuel pump draws and pressurizes diesel fuel from its storage tank. Both the natural gas and diesel are then routed to a fuel conditioning module, where both fuels are pressure regulated, filtered, and sent to the fuel injector nozzles.

HPDI relies on late-cycle high pressure injection of natural gas into the combustion chamber. The natural gas is injected at the end of the compression stroke, similar to the diesel fuel in a diesel engine. Natural gas has a higher ignition temperature compared to diesel, so a diesel pilot injection is used to initiate combustion.

The benefits of the high pressure direct injection cycle include horsepower and torque output similar to a conventional diesel engine and fuel cost savings due to the high substitution of lower cost LNG as compared to diesel.

With the low emissions profile of natural gas and the high efficiency of the diesel combustion cycle, HPDI technology combines high energy efficiency with low emissions. The HPDI system extends beyond the fuel injection equipment, and is developed as a fully integrated system including fuel system management electronics, LNG tanks, and vehicle installation.

Results

The Westport GX demonstrated emission levels during certification testing at or below 0.2 g/bhp-hr NO_x in mid-2009. Westport worked closely with the U.S. EPA to finalize the deterioration rate for the engine. While this resulted in a slight delay in achieving final certification, the Westport GX heavy-duty LNG engine was granted a CARB Executive Order at the 0.2 g/bhp-hr NO_x certification level on July 6, 2010.

Benefits

The Westport GX LNG engine will accelerate NO_x emission reductions by achieving the final 2010 standard in early 2010. Diesel engines of a comparable displacement are not expected to meet the 2010 standard initially – engine manufacturers will instead use credits generated from family emission level (FEL) engines to offset the higher emissions of their large displacement on-road engines. Westport estimates emission reductions of at least 0.45 tons of NO_x per year per truck above the equivalent model year diesel truck, until the 0.2 standard is phased in for diesel engines. The LNG heavy-duty truck also emits 15 to 20 percent less greenhouse gases compared to diesel engines.

Project Costs

The total project cost for development and certification of Westport GX natural gas engine is estimated at $9,894,027. Westport contributed $7,144,027 of the project development cost (in-kind) and secured additional funding in the amount of $500,000 from Clean Energy, a provider of LNG fuel, to assist with integration of the engine and related fuel system. The California Energy Commission (CEC) provided $500,000 under the PIER program. Kenworth Truck Company was a key partner in the project and will provide in-kind contributions to assist with the future deployment of GX-equipped LNG trucks. The SCAQMD contributed $1.25 million, and the Ports of Long Beach and Los Angeles each contributed $250,000 in TAP funding.

Updated: April, 2011