



# Low-emissions technology

**Leadership in meeting global standards**



**Power  
Generation**

From prime power for mining and oil-and-gas operations in remote regions to standby and emergency power for hospitals, office complexes and factories in every corner of the globe, Cummins Power Generation provides reliable, efficient and easy-to-use power systems.

**Our commitment to clean air**

Cummins Power Generation is committed to meeting or exceeding all global air-quality regulatory standards for stationary and nonroad diesel engine-powered generators through 2017 and beyond.

**New technologies to reduce emissions**

The design and manufacture of all internal combustion engines – especially diesel engines – has changed significantly in the past decade.

Since the mid-1990s, the U.S. Environmental Protection Agency (EPA) and regulatory agencies in the European Union (EU) have required significant reductions of pollutants such as nitrogen oxides (NO<sub>x</sub>), hydrocarbons (HC) and particulate matter (PM) from diesel engines. These pollutants are precursors to smog and ozone in many populated areas of the world.

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Cleaner, quieter and more efficient

Cummins Power Generation has been in the forefront of the move to cleaner, quieter and more efficient diesel engine-powered generator sets in compliance with these new requirements. Our investment in and commitment to developing cleaner, quieter and more efficient diesel engines for nonroad and stationary engines used in generator sets has achieved impressive results.

- > Cummins Power Generation was the first manufacturer to introduce Environmental Protection Agency (EPA) Tier-2 and Tier-3 generator sets to the market – ahead of the regulatory deadline.
- > Cummins Power Generation was the first generator manufacturer to introduce European Union (EU) Stage IIIA and Stage II-compliant diesel engines to Europe.
- > Cummins Power Generation is a recognized leader in new technologies that reduce engine emissions. Our innovative Cummins Quantum engine technology system focuses on in-cylinder design improvements that eliminate pollutants before they are formed.

As a result of this effort to reduce exhaust emissions worldwide, Cummins Power Generation diesel engine generators are not only very clean, but also retain all of their performance advantages without exhaust aftertreatment strategies that add cost and complicate maintenance for end users.

### Meeting worldwide standards

As part of its global emissions strategy, Cummins Power Generation focuses on meeting or exceeding U.S. EPA and EU emissions standards, as these standards are the world's most stringent and all-encompassing. This strategy assures end-users of the best power generation solution for their application, regardless of country or continent.

Although many countries, including China, India, Japan and Singapore, now regulate emissions from stationary and nonroad diesel engines, these regulations vary from one country to the next. Industry organizations emphasize the need for harmonized standards worldwide – and regulations are trending in that direction.



## Award-winning diesel technology



Frost & Sullivan named Cummins Power Generation the recipient of the 2006 North American Diesel Engine Technology Leadership of the Year Award. The award recognizes Cummins Power Generation's advancements and market leadership in emissions technology.

“The company boasts an approach to engine emissions reduction based not only on best-in-class technology and design, but also on providing a product and cost that aligns with customer requirements.”



## EPA regulates four pollutants

The U.S. EPA has established four categories of allowable emissions – Tiers 1 through 4. Each increasing Tier level specifies lesser amounts of four specific pollutants that are permitted based on the number of grams per kilowatt-hour of the compounds present in diesel exhaust: nitrogen oxides (NO<sub>x</sub>); hydrocarbons (HC); carbon monoxide (CO); and particulate matter (PM).

NO<sub>x</sub> is a byproduct of combustion that combines in the atmosphere to create smog. NO<sub>x</sub> is controlled by reducing the combustion temperature inside the cylinder. HC and CO are minor constituents of diesel exhaust and are controlled by improving combustion efficiency. PM is made up of soot particles in diesel exhaust from unburned carbon and is controlled by optimizing the combustion temperature and improving combustion efficiency.

## Regulations by Tier levels

Emissions regulations are governed by EPA New Source Performance Standards (NSPS), which establish for the first time uniform federal standards for emissions from stationary generator sets. Effective January 1, 2007, requirements for stationary applications (which include standby generators) are harmonized with prevailing nonroad applications.

Tier levels apply to the horsepower rating of the engine. Beginning with engines built on January 1, 2007, all generators with engine ratings of 10-99 hp must comply with Tier 2 regulations; generators with engines in the range of 100-751 hp must comply with Tier 3 regulations; and generators with engines in the range of 752-3000 hp will require Tier 2 certification. Stationary engines over 3000 hp will remain at Tier 1 until 2011. Beginning in 2011 at Tier 4, emergency stationary diesel generators will not have to advance to standards that require aftertreatment.

## U.S. EPA nonroad and stationary emissions regulations schedule

Beginning January 1, 2007 denoted by the red bar, stationary and nonroad regulations are harmonized. All engines that are not certified to 2007 nonroad standards must be installed by the end-user by January 1, 2009.

### Genset Power:

kWm	(hp)	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
0 - 7	(0 - 10)		(7.5) / 8.0 / 0.80			(7.5) / 6.6 / 0.40										
8 - 18	(11 - 24)		(7.5) / 6.6 / 0.80			(7.5) / 6.6 / 0.40										
19 - 36	(25 - 48)		(7.5) / 5.5 / 0.60			(7.5) / 5.0 / 0.30					(4.7) / 5.0 / 0.03					
37 - 55	(49 - 74)		(7.5) / 5.0 / 0.40			(4.7) / 5.0 / 0.30				(4.7) / 5.0 / 0.03						
56 - 74	(75 - 99)		(7.5) / 5.0 / 0.40			(4.7) / 5.0 / 0.40				3.3 / 0.19 / 5.0 / 0.02		0.40 / 0.19 / 5.0 / 0.02				
75 - 129	(100 - 173)		(6.6) / 5.0 / 0.30			(4.0) / 5.0 / 0.30										
130 - 224	(174 - 301)		(6.6) / 3.5 / 0.20			(4.0) / 3.5 / 0.20				2.0 / .019 / 3.5 / 0.02			0.40 / 0.19 / 3.5 / 0.02			
225 - 449	(302 - 602)		(6.4)/3.5/0.20			(4.0) / 3.5 / 0.20				2.0 / .019 / 3.5 / 0.02			0.40 / 0.19 / 3.5 / 0.02			
450 - 560	(603 - 751)		(6.4)/3.5/0.20			(4.0) / 3.5 / 0.20				2.0 / .019 / 3.5 / 0.02			0.40 / 0.19 / 3.5 / 0.02			
>560	(>751)		9.2 / 1.3 / 11.4 / 0.54			(6.4) / 3.5 / 0.20				3.5 / 0.40 / 3.5 / 0.10 <small>0.67 / 0.40 / 3.5 / 0.10 (&gt;1207hp)<sup>a</sup></small>			(3.5) / 0.19 / 3.5 / 0.04 <small>0.67 / 0.19 / 3.5 / 0.03 (&gt;751hp)<sup>b</sup></small>			

NO<sub>x</sub> / HC / CO / PM (g/kW-hr)

(NO<sub>x</sub> + HC) / CO / PM (g/kW-hr)

[Conversion: (g/kW-hr) x 0.7457 = g/bhp-hr]

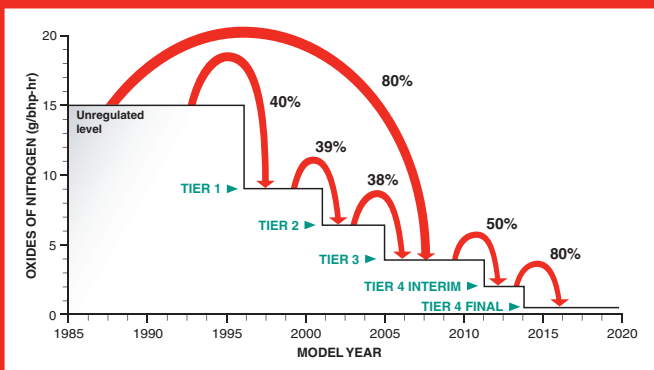
Separate NO<sub>x</sub> and HC standards separated by a slash.

Combined NO<sub>x</sub> and HC standards denoted in parentheses "( )".

■ Tier 1   
 ■ Tier 2   
 ■ Tier 3   
 ■ Tier 4 Interim   
 ■ Tier 4 Final

a. Applies to portable power generation >1207hp.

b. Applies to portable power generation >751hp.



## Percent Reduction of NO<sub>x</sub>

Since 1996, when U.S. EPA emissions regulations for nonroad diesel engines first went into effect, Cummins Power Generation has developed technologies that reduce the primary pollutants in the generator set diesel exhaust (primarily nitrogen oxide) by approximately 80 percent. These reductions have been accomplished through in-cylinder design improvements and precise control of the combustion process.

The real challenge in designing cleaner diesel engines is to reduce NO<sub>x</sub> and PM emissions while maintaining performance. The Cummins Quantum engine technology meets this challenge by reducing emissions without sacrificing engine performance or reliability, or complicating maintenance.

Most engine modifications that decrease NO<sub>x</sub> have a tendency to increase PM. The Cummins Quantum technologies reduce both NO<sub>x</sub> and PM during combustion while producing the highest possible power output. The Quantum technological approach has four key elements:

#### **Advanced in-cylinder combustion technology**

New combustion bowl geometry and multiple-event fuel injection capability provide more combustion control than ever before. This has resulted in improved or maintained power ratings without increasing engine displacement or fuel consumption. Optimizing the combustion process minimizes emissions without losses in power and performance or increasing mechanical stress.

#### **Advanced fuel injection systems**

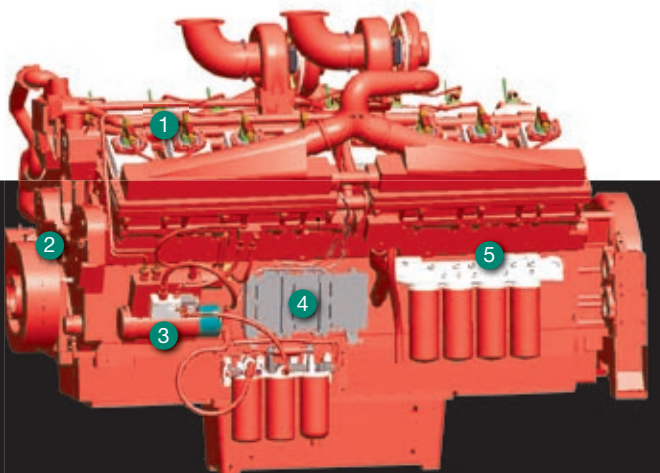
The Cummins modular common rail fuel injection system provides improved idle stability, cold-start, and response to transient load changes while maintaining power densities comparable to Tier 1 products. The new solenoid-controlled, electronically-actuated injectors precisely deliver fuel at 23,000 psi and provide fast response with multiple injection capability.

#### **Advanced electronic engine controls**

New electronic sensors and microprocessor-based controls have greatly improved fuel efficiency and power output while decreasing the production of both NO<sub>x</sub> and PM. By controlling fuel quantity, injection timing, turbocharger boost pressure and other factors, electronic engine controls maintain optimum combustion efficiencies by compensating for load, temperature, fuel energy content, barometric pressure and even engine wear.

#### **Durable, FCD cast iron pistons**

All of the high-horsepower Cummins engines utilize a new FCD (ferrous cast ductile) single-piece, cast iron piston for an increase in power cylinder durability of up to 15 percent. Ideally suited to advanced combustion enhancement processes, the FCD piston permits even expansion and contraction during thermal cycles.



Cummins Advanced In-Cylinder Combustion is the key technology enabler for maintaining or improving ratings without the need for increased displacement on all Tier 2 products – achieving fuel efficiency at or close to Tier 1 levels.

Features include:

- 1 New Modular Common Rail Fuel System with improved power delivery
- 2 New Advanced Engine Monitoring (AEM)
- 3 New high-efficiency fuel pump
- 4 Three new engine control modules with 3X faster processing power
- 5 High durability FCD piston/power cylinder

## Solutions for Tier 4 and beyond

The Cummins advanced in-cylinder combustion technology provides emissions solutions for Tier 2 and Tier 3 diesel generator sets through 2010, after which more stringent Tier 4 regulations are scheduled to take effect. To achieve the lower Tier 4 standards, exhaust aftertreatment with selective catalytic reduction (SCR) systems will be the likely solution. SCR systems have already demonstrated commercial success in numerous power generating applications, and Cummins has significant experience with designing, building and maintaining these systems.



Cummins Power Generation is committed to understanding and meeting customers' needs worldwide—through trusted local relationships, innovative solutions and dedicated customer service. This promise enables us to deliver power wherever, whenever and however it is needed.

With over 140 distributor locations in the United States and more than 500 around the globe, local Cummins Power Generation service and support is available 24/7, 365 days a year. These local distributors are your source for Tier-certified product solutions, applications assistance and emissions compliance information.



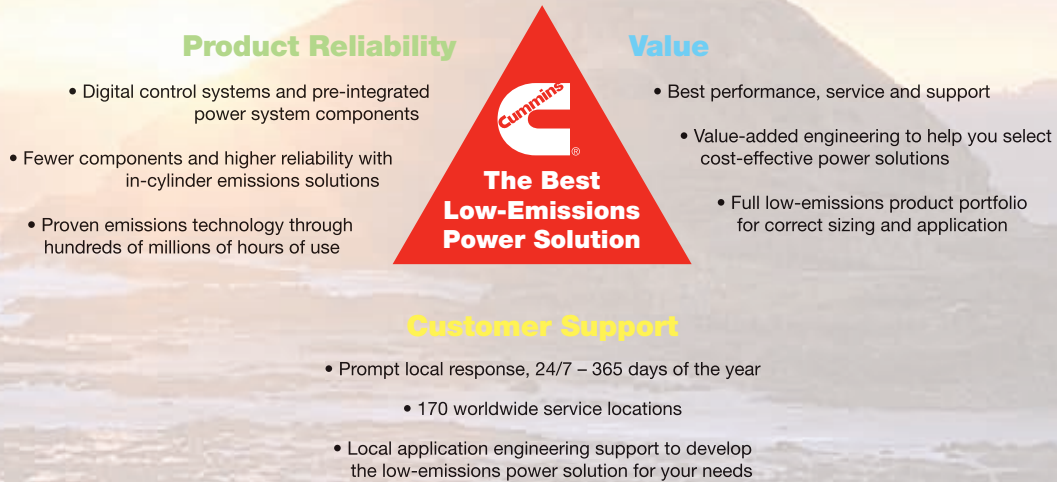
**Our energy working for you.™**



## Solutions triangle

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Only Cummins Power Generation offers you the best power solution with unexcelled reliability, high product and performance value, worldwide service and applications and emissions expertise.



**For more information on  
global emissions standards, visit:**

**[www.cumminspower.com/emissions](http://www.cumminspower.com/emissions)  
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**Or, contact your Cummins distributor.**

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