

BENEFITS INNOVATIVE NO_x SOLUTIONS FOR GAS TURBINES

CLEANER POWER WITHIN REACH

*Ultra-low
emissions*

*Prevention
vs. cleanup*

*Proven
reliability*

*Commercially
available
today*

Xonon®
Cool Combustion

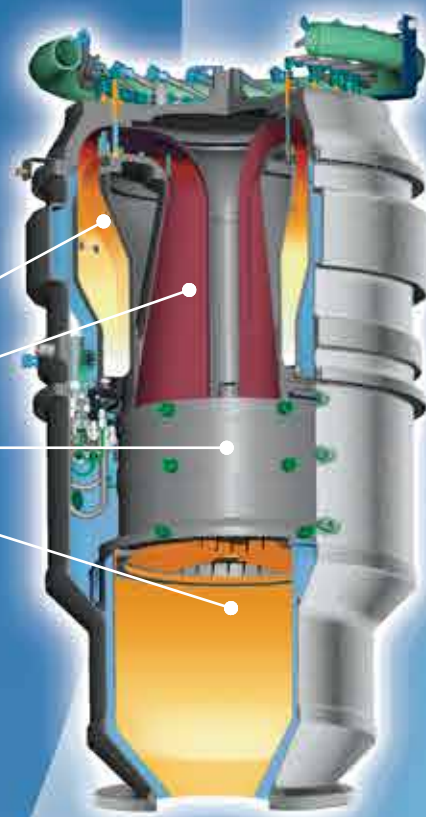
Cool is Cleaner

< 3 ppm NOx
< 6 ppm CO
< 2 ppm VOC

Through its proprietary catalytic combustion technology, Catalytica Energy Systems offers an innovative pollution prevention solution for ultra-low NOx emissions power generation.

Xonon Cool Combustion for gas turbines represents a significant breakthrough, enabling combustion of hydrocarbon fuels at lower temperatures than conventional flame-based combustion systems. Such "cooler" temperatures are below the threshold at which NOx begins to form. As a result, Xonon limits NOx formation to less than 3 parts per million (ppm), facilitating compliance with the most stringent emissions regulations and eliminating any need for downstream exhaust cleanup.

The Xonon solution also enables complete burning of the fuel to deliver extremely low emissions of other regulated air pollutants: carbon monoxide (CO) and volatile organic compounds (VOC).

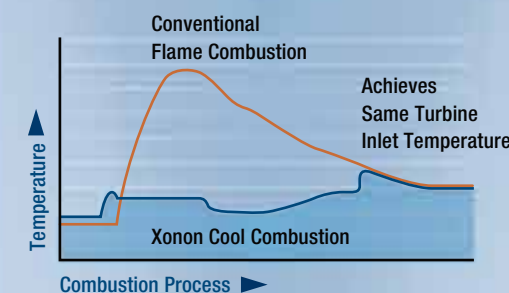


Our Xonon catalyst module is at the heart of the most advanced on-engine solution for ultra-low NOx emissions.

Xonon Cool Combustion maintains turbine performance

Xonon Cool Combustion maintains turbine efficiency and performance without reaching the high peak temperatures that create NOx in flame-based combustion systems. The Xonon solution maintains a controlled temperature profile throughout the combustion process to achieve the optimal turbine inlet temperature required to power the turbine with minimal combustion "noise." As a result:

- There is no de-rating of the engine power nor any reduction of the engine thermal efficiency when compared to other low-NOx combustion systems.
- Turbine inlet pressure and temperatures are the same as for DLN systems.
- Fuel consumption is not increased.
- There is no added back pressure on the turbine. (SCR's can increase engine back pressure, which reduces power output and increases fuel consumption.)
- There is no parasitic power requirement.



Xonon maintains turbine efficiency and performance but without the high peak temperatures of flame-based combustion that create NOx.

Tried and True

Xonon Cool Combustion is a proven, enabling solution for ultra-low emissions. A Xonon-equipped 1.4 megawatt (MW) Kawasaki gas turbine has been operating on the commercial electricity grid as part of a field demonstration at Silicon Valley Power (SVP). For more than 18,000 hours, the Xonon-equipped turbine has generated clean, reliable power, serving the electricity needs of 1,500 households in surrounding communities.



"Today's society demands an ever increasing supply of clean power—Xonon's success has helped our customers and community in that pursuit."

Larry Owens
Division Manager
Customer Services
Silicon Valley Power
City of Santa Clara, California

commercially available today

Xonon is commercially available today through our partner **Kawasaki Gas Turbines-Americas**. Kawasaki's GPB15X genset, featuring a 1.4 MW M1A-13X gas turbine equipped with Xonon Cool Combustion, offers a combined heat and power solution that is ideally suited for power applications where small footprint, low emissions and high reliability are required. A growing number of commercial Xonon-equipped GPB15X sites are now in operation or under construction.



Kawasaki GPB15X (1.4 MW)

Sonoma Developmental Center:

A Xonon-equipped GPB15X has been operating since November 2002 at Sonoma Developmental Center in Eldridge, California as part of a combined heat and power application for a 120-building campus. Since entering service, the unit has been operating on a 24/7 basis, with NOx emissions consistently and substantially below its 3 ppm guarantee. Importantly, the air permit for this operation was secured in less than 14 days.

"We've been extremely pleased with how the Xonon-equipped Kawasaki turbine has performed. In addition to being very economical to operate, the emissions performance has more than lived up to expectations. We took basically 20 ppm of NOx off what our old system was emitting and got it down to around 1 ppm... [Xonon] really is fantastic technology."

Mary Lavin
Energy Resource Specialist
Sonoma Developmental Center
Eldridge, California

Awards and recognition

The Xonon operation at Silicon Valley Power has been supported and recognized by a number of important industry organizations as well as Federal and State agencies including the California Air Resources Board (CARB), the California Energy Commission (CEC), the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), the Electric Power Research Institute (EPRI) and the Gas Technology Institute, many of which have participated in its funding.

- EPA Awards
 - "Achieved in Practice"
 - Clean Air Excellence Award
 - Environmental Technology Verification
- CARB Pre-certification



Silicon Valley Power: The field demonstration at SVP, a municipally-owned utility serving the City of Santa Clara, California, has validated the performance and reliability of our Xonon Cool Combustion system on a gas turbine under full-scale commercial operating conditions. Since its installation, the Xonon-equipped gas turbine has consistently delivered NOx emissions less than 3 ppm. In May 2003, an 8,000-hour endurance run was completed on this unit, validating a next-generation Xonon catalyst module based on advanced materials and processing.

GE10 (10 MW)



in development

As a result of the tremendous opportunity that this technology offers the power industry, Xonon Cool Combustion is now being adapted to larger gas turbines.

Spearheading these development programs are leading gas turbine manufacturers **GE Power Systems** and **Solar Turbines**, a division of Caterpillar.

The Xonon® Difference

Xonon Cool Combustion™ offers a breakthrough pollution prevention approach for gas turbine power generation, enabling ultra-low nitrogen oxides (NOx) emissions of less than 3 parts per million. Xonon offers inherent user and community benefits over other NOx control alternatives for gas turbines such as lean pre-mix combustion (e.g. dry-low NOx—DLN) or downstream exhaust cleanup systems (e.g. selective catalytic reduction—SCR).

Assess the alternatives...	Ultra-low NOx solutions < 5 ppm		
	DLN (9 to 25+ ppm)*	DLN + SCR	Xonon
Cost-effective	✓		✓
Prevents formation of NOx			✓
Achieves ultra-low emissions		✓	✓
Achieves ultra-low emissions during combustion			✓
Achieves ultra-low emissions w/out costly, burdensome cleanup			✓
Minimizes other pollutants (CO, VOC)			✓
Small footprint	✓		✓
Avoids toxic reagents	✓		✓
Maintains turbine efficiency	✓		✓
Minimizes combustion “noise”			✓

*Today’s most advanced DLN, or lean pre-mix, combustion systems can achieve NOx levels no lower than 9 ppm for newer commercial systems and no lower than 15 to 25 ppm for most other systems.

A better solution for achieving ultra-low NOx emissions

- Pollution prevention as opposed to downstream cleanup
- Maintains gas turbine efficiency—the pressure drop associated with exhaust cleanup systems can negatively impact turbine performance
- Applicable to a variety of gas turbine sizes and configurations, including both simple cycle and cogeneration applications
- Less costly—lower initial capital cost and more cost-effective than downstream cleanup over the operating life of the turbine
- No additional space, ancillary equipment or labor required
- Well received by both regulatory agencies and the public at-large

A solution that creates no adverse impacts on the environment

- Achieves less than 3 ppm NOx, 6 ppm CO, 2 ppm VOC emissions in gas turbine power production.
- Eliminates the need for downstream exhaust cleanup systems (e.g. SCR)
 - ♦ No toxic or hazardous reagents to handle, store or transport through the community (e.g. ammonia)
 - ♦ No secondary emissions (e.g. no ammonia slip)
 - ♦ No secondary waste streams
- Mitigates community opposition to new power projects
- Facilitates the permitting and siting process so projects get on-line faster

A solution that enables the use of small gas turbines for distributed generation

- Eases the environmental challenges associated with siting power projects in densely-populated areas, meeting the most stringent emissions requirements by delivering an ultra-low NOx solution without use of toxic chemicals
- Reduces the requirements for emissions offsets (offset availability delays many new projects today)
- Eliminates operating restrictions, providing improved economics for the power producer
- Accommodates on-site power projects in urban areas with limited space because no additional square footage is needed—the solution is integrated directly within the gas turbine

Catalytica Energy Systems designs, develops, manufactures and services advanced products for the energy and transportation industries with a focus on cost-effective solutions for reducing nitrogen oxides (NOx) emissions from combustion-related applications. Proprietary technologies based on 37 patents granted or filed include the application of catalysts to combustion systems and next-generation fuel processors. Xonon Cool Combustion™ is a commercially available pollution prevention technology that enables natural gas-fired turbines to produce ultra-low emissions power through a proprietary catalytic combustion process. Research and development efforts underway include adaptation of the core Xonon technology to offer NOx reduction solutions for mobile, off-road and stationary diesel engines, and the development of fuel processing systems for PEM fuel cells used in automotive applications.

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