
Heavy-Duty Diesel Emission Control Technologies to Achieve Future Emission Reduction Goals

Mid-Atlantic Diesel Collaborative

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Conference Call

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Manufacturers of Emission Controls Association

www.meca.org



MECA Overview

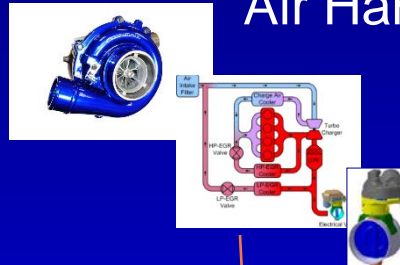
- Technology Voice for the Emission Control Industry with Air Regulatory Agencies and Stakeholders since 1976
- 39 member companies commercializing emission control and combustion efficiency technologies for all sizes of internal combustion engines.
- Meeting future emission challenges requires a systems approach including engine, exhaust controls and fuels.

MECA Portfolio Covers Criteria and GHG Emission Control Technologies

Fuel Combustion
Controls



Air Handling



Filters &
Substrates



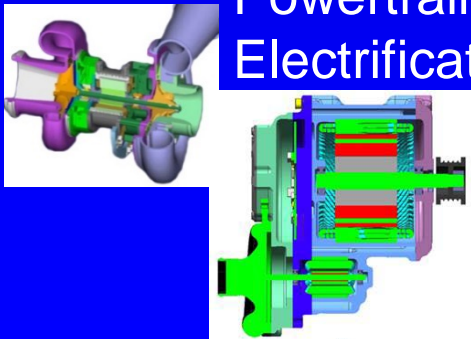
Advanced
Exhaust Controls



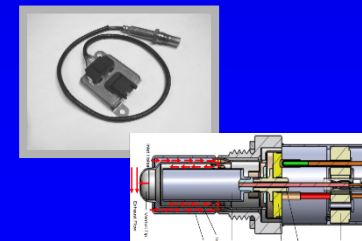
Evaporative Controls



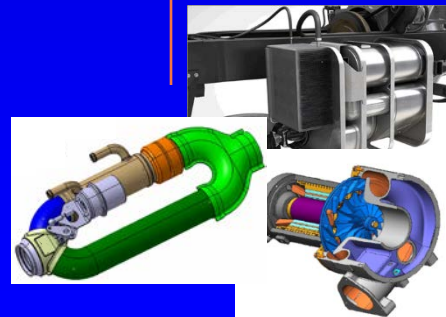
Powertrain
Electrification



OBD Sensors



Waste Heat Recovery



Clean Diesel Technology Driven By a Decade of U.S. EPA Mobile Source Emission Regulations

Average Benefit:Cost = 20:1

Tier 3 Light-Duty

final rule 2014

fully phased in 2025

Diesels held to same standards as gasoline vehicles

Diesel sulfur 15 ppm



Ocean-going Vessels

final rule 2009; IMO ECA in 2010

**ECA: 1000 ppm Sulfur in 2015;
80% lower NOx by 2016**

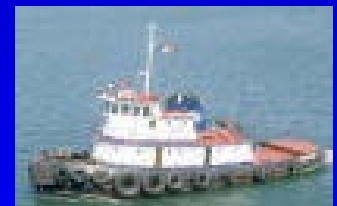


Heavy-Duty Highway

final rule 2000

Sulfur 15 ppm

fully phased in 2007-2010



Locomotive / Marine Tier 4

final rule 2008

15 ppm Sulfur

fully phased in 2017



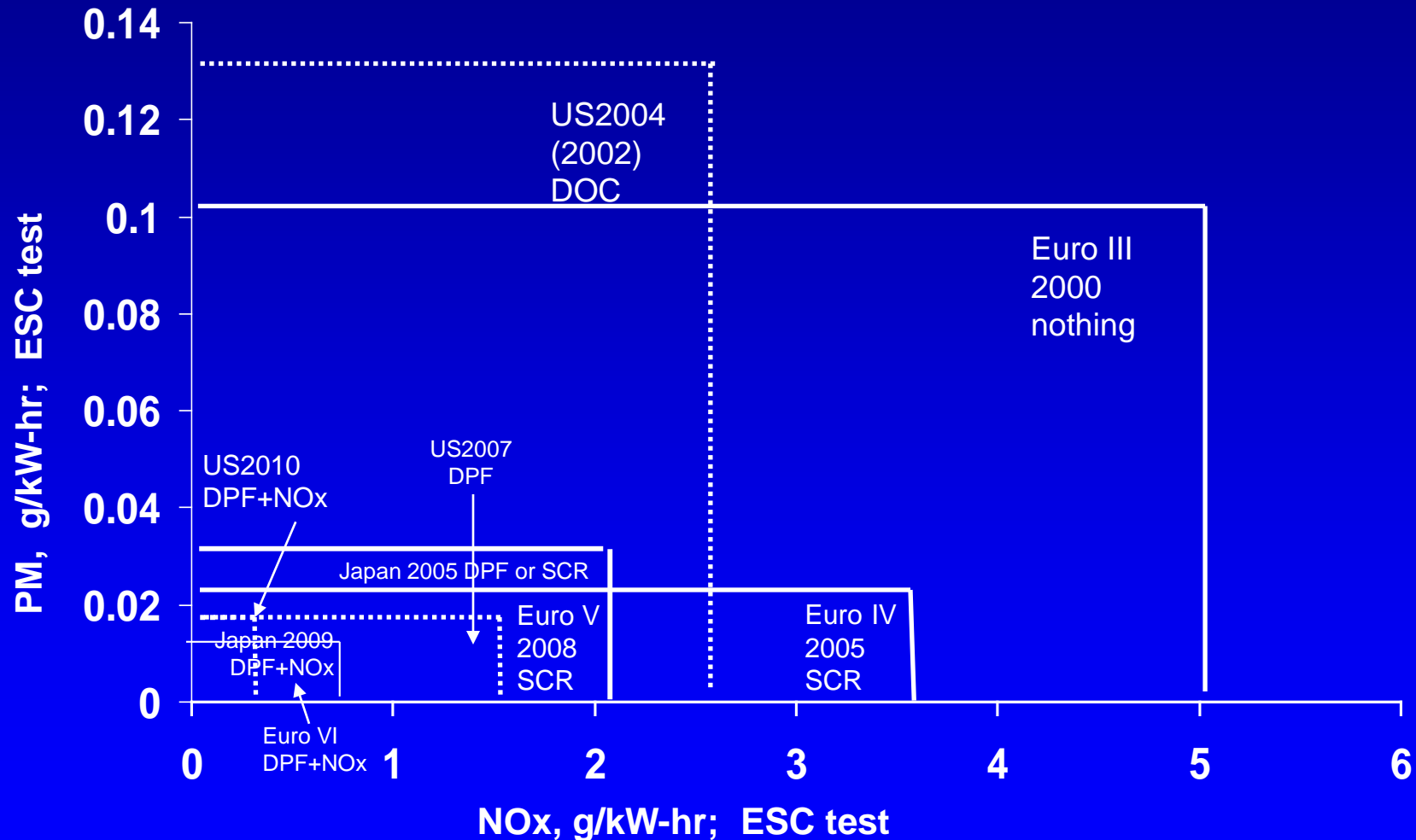
Nonroad Diesel Tier 4

final rule 2004

Sulfur 15 ppm

fully phased in 2015

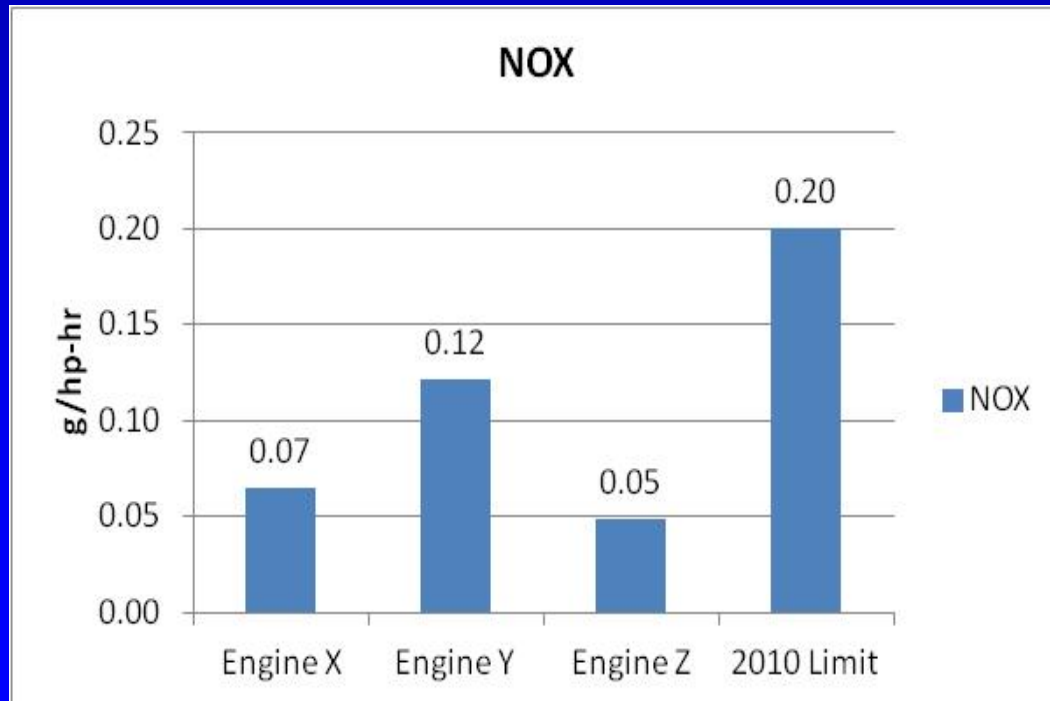
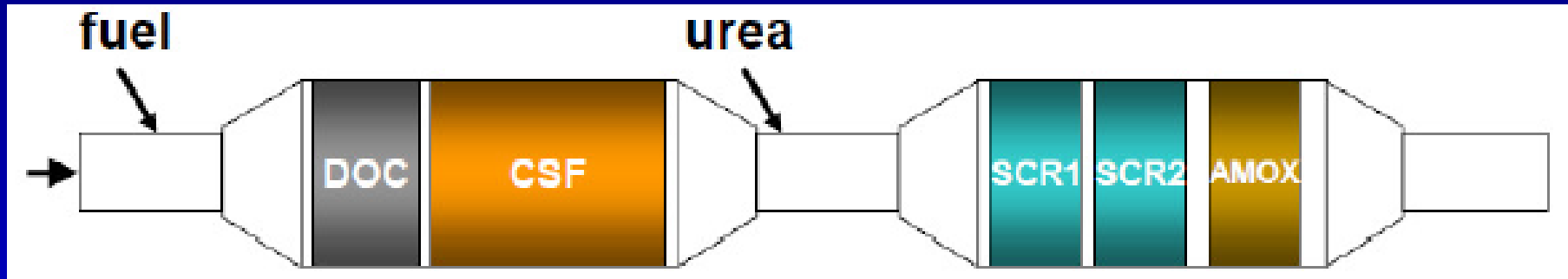
Heavy-Duty Diesel Regulations have Tightened Around the World



SCR Becoming a Dominant NOx Control Technology for Mobile and Stationary Engines



Diesel Emission Controls Have Evolved Since 2010

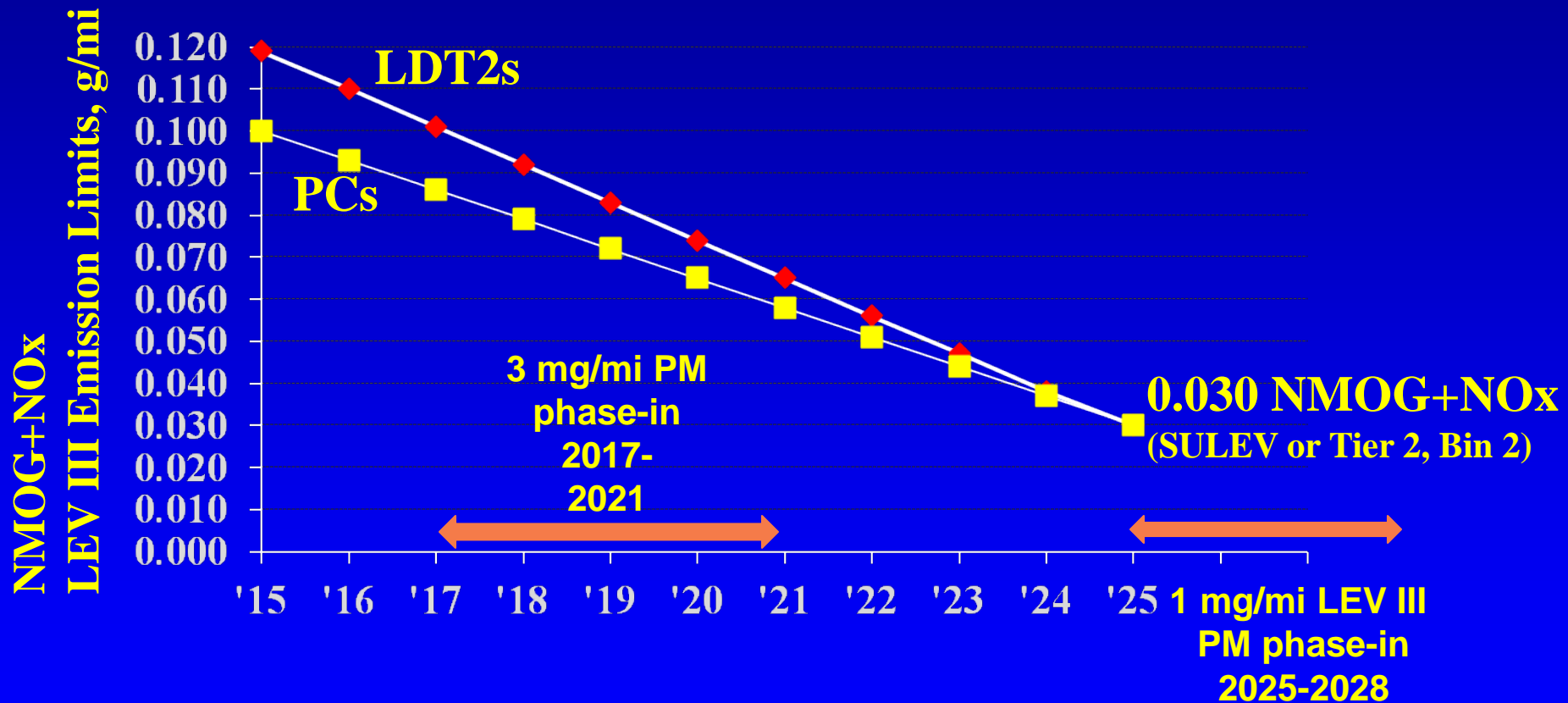


Oxidation catalyst
PM filter (DPF/CSF)
Selective Catalytic Reduction
Ammonia oxidation catalyst
Urea dosing
Sensors and control units

Must last over 435,000 miles

ACES Phase 2 Study looked at 2010 Technology

LEV III/Tier 3 Resets the Emissions Performance Bar for Light-duty Vehicles – Drives Innovation



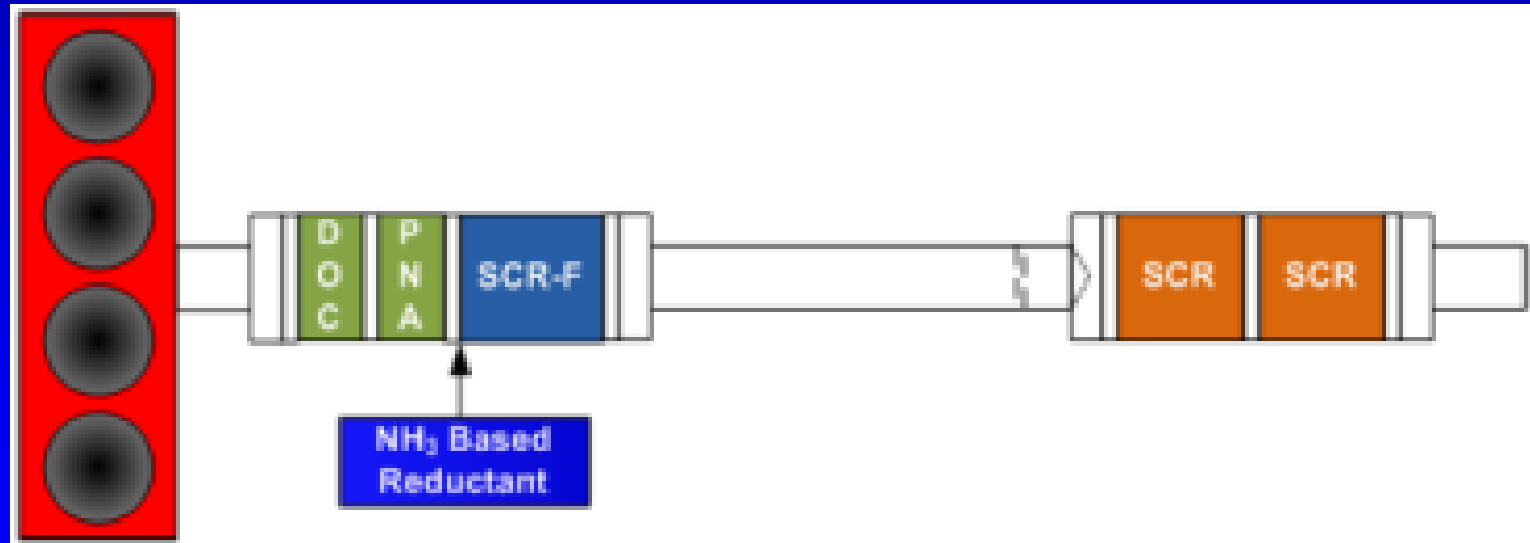
CARB Voluntary Heavy-Duty Low NOx Standards

NOx Level g/bhp-hr	% Below Current Standard
0.2 (Current)	
0.1	- 50%
0.05	- 75%
0.02	- 90%

Where are Diesel Exhaust Technologies Heading?

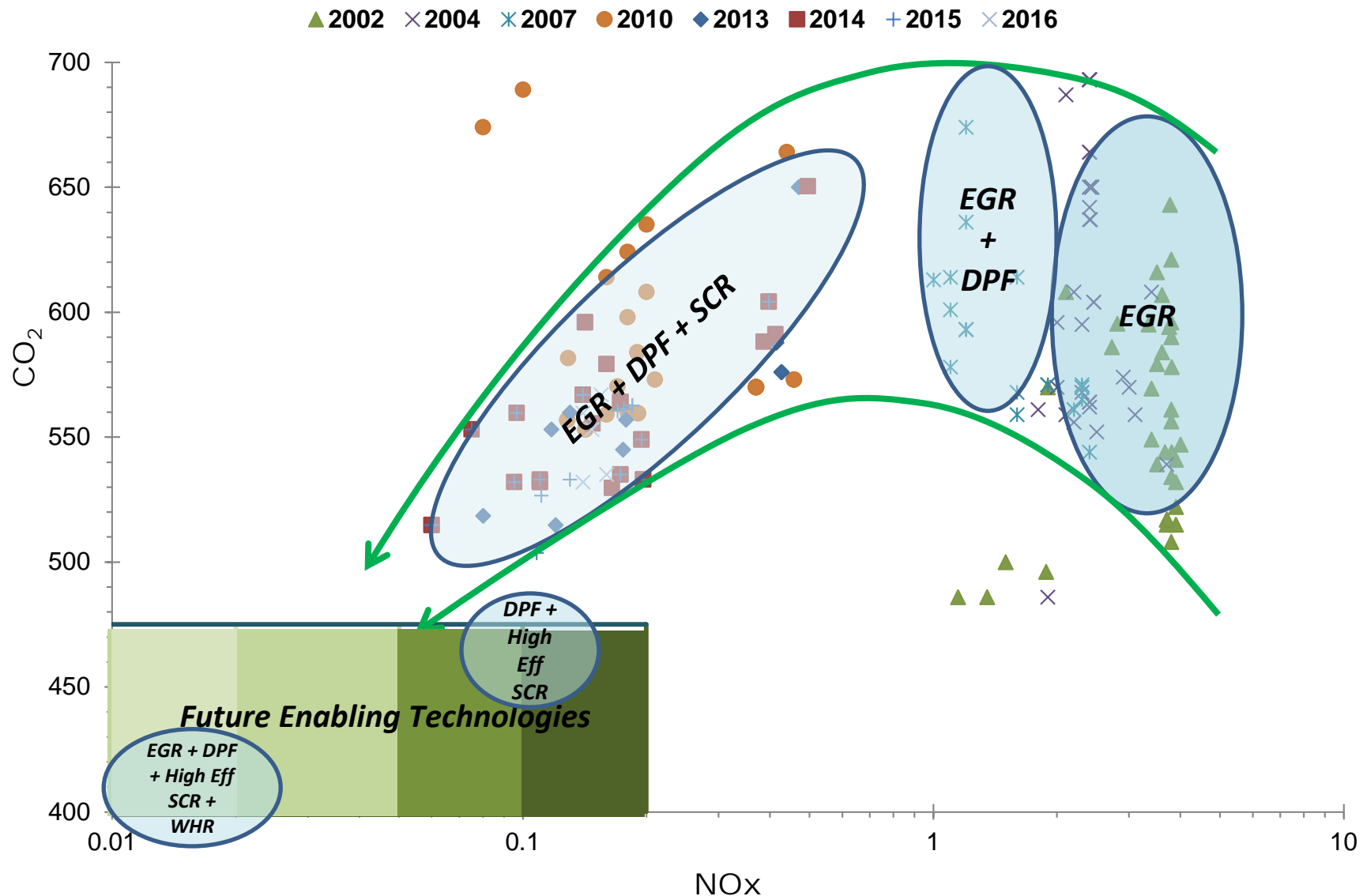
- Improved cold start performance
- Thermal management
- Fast catalyst heat-up
- Low temperature catalyst activity
- High NOx conversion
- Reduced backpressure
- Minimize soot regeneration

SULEV NOx Levels Demonstrated on Light-Duty Diesel Vehicles



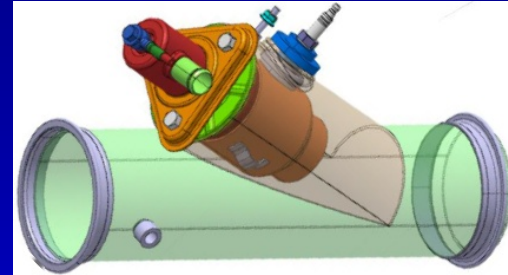
Cummins DEER 10-2012

CO₂ vs. NO_x of Certified HD Engines

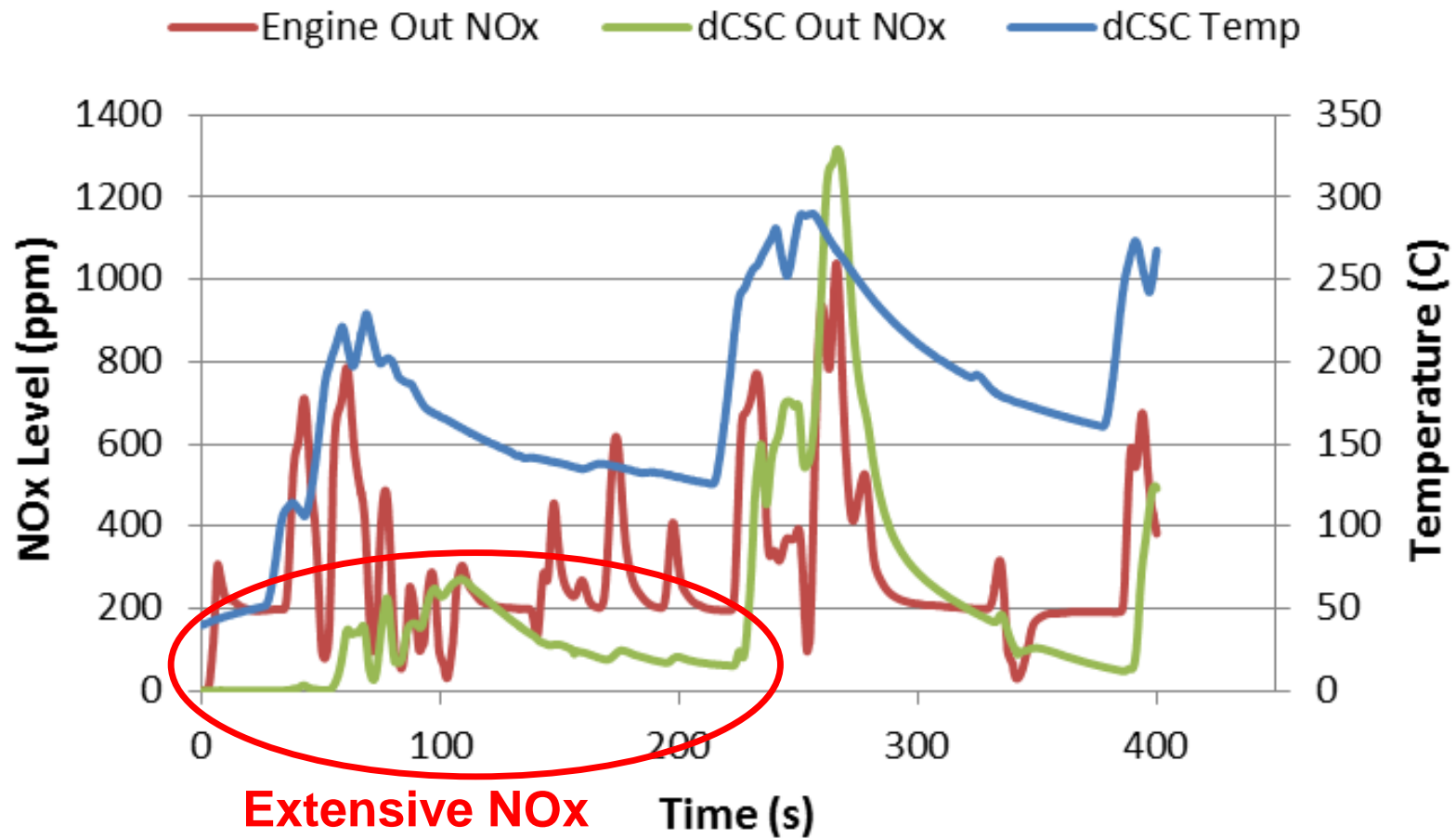


Active and Passive Thermal Management is Important for Cold Start and Low Temperature Operation

- Passive and Active thermal management
- Dual wall pipes and insulation
- EGR By-Pass Valve (EBV)
- Turbine By-Pass Valve (TBV)
- Close coupled catalysts

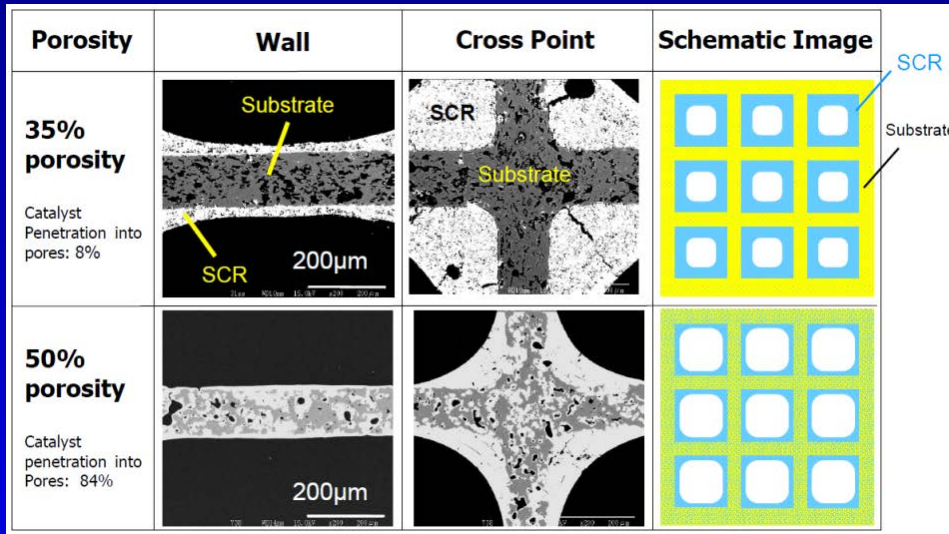


Passive NOx Adsorber Catalyst Replaces DOC



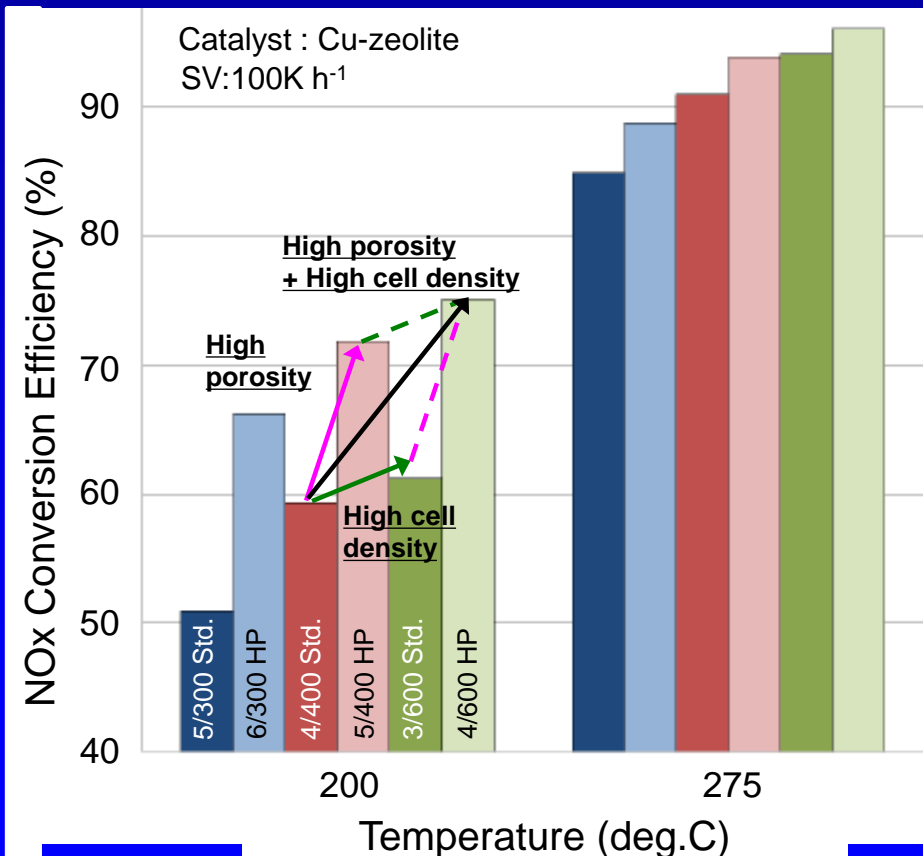
**Extensive NOx
storage at very low
temperature**

Substrates Optimized for Catalyst Loading, Low Backpressure and Low Thermal Mass



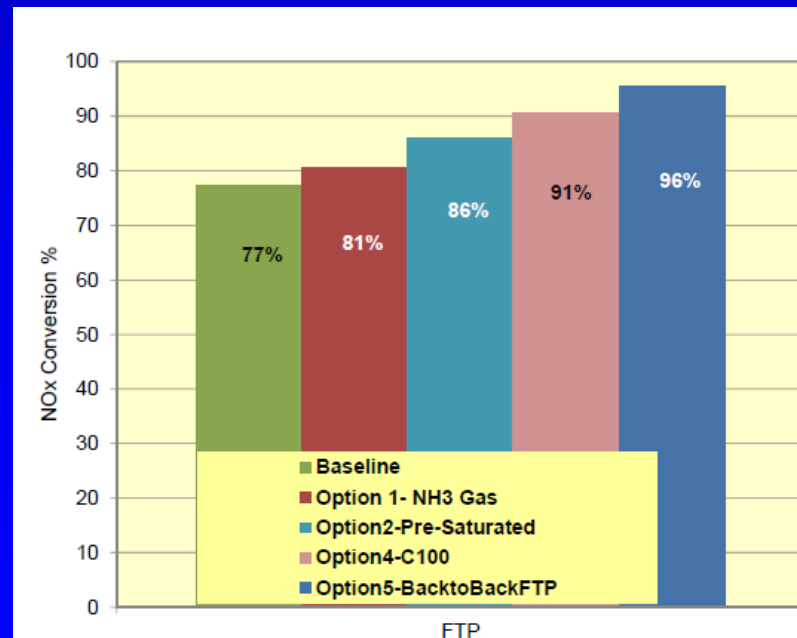
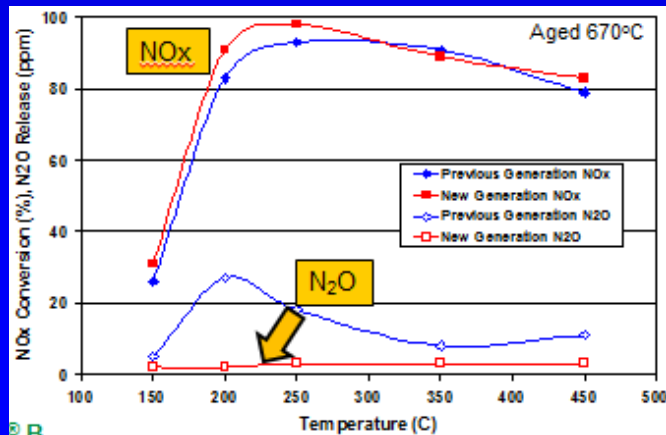
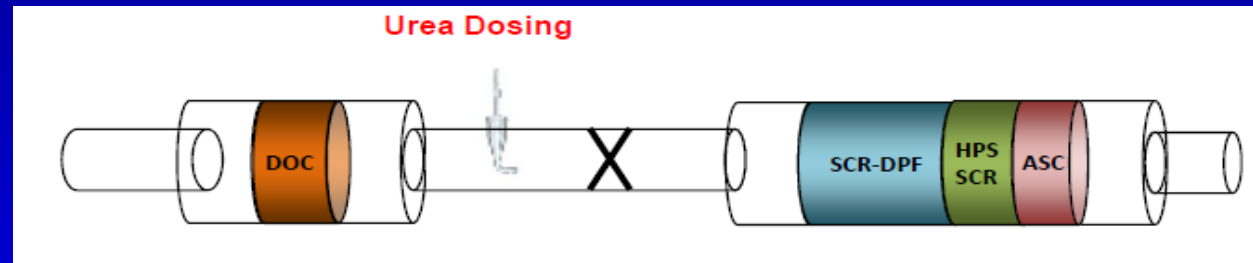
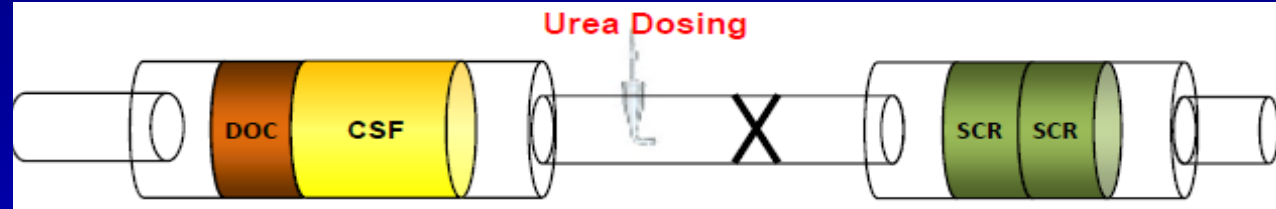
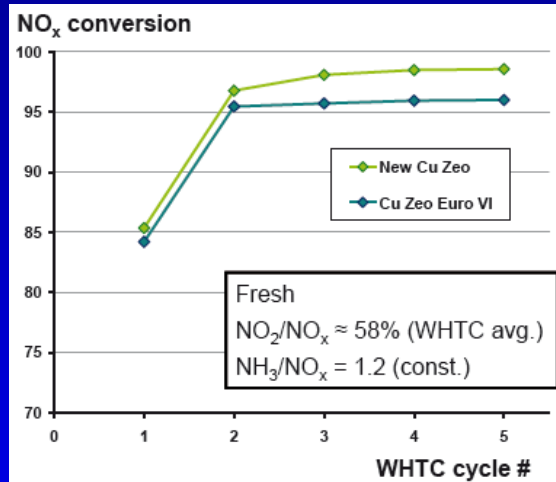
CTI 2012 NOx Reduction

- High porosity incorporates catalyst into cell wall
- Lower backpressure for efficiency
- High cell density, thin wall designs reduce thermal mass
- Fast heat-up and earlier urea injection



SCR Catalyst Improvements, Thermal Management and Urea Dosing Control Give High Conversion

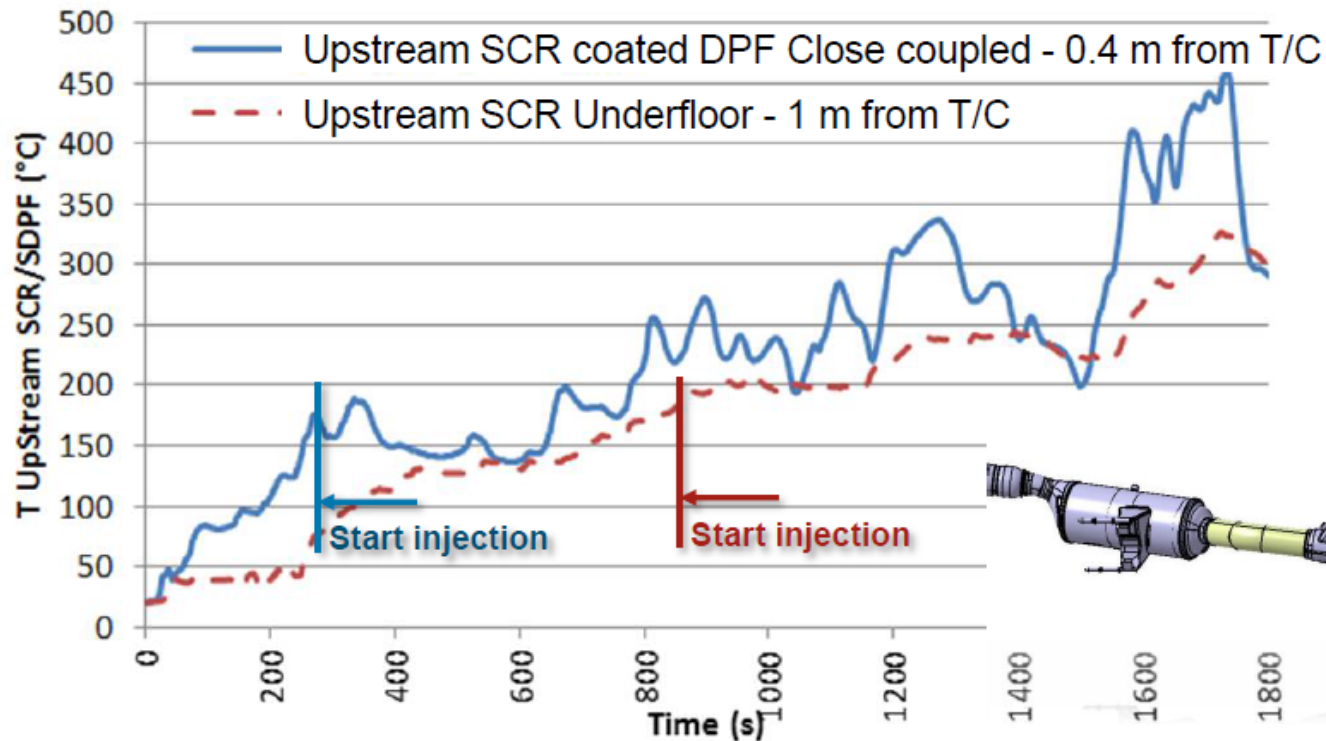
Cu-SCR with Improved Low Temperature Efficiency



SAE 2014-01-1525

SCR Coated DPFs Commercialized on Light-Duty

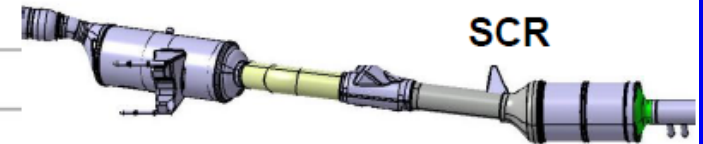
WLTC – Exhaust Gas Temperature



Close coupled
SCR



Underfloor
SCR

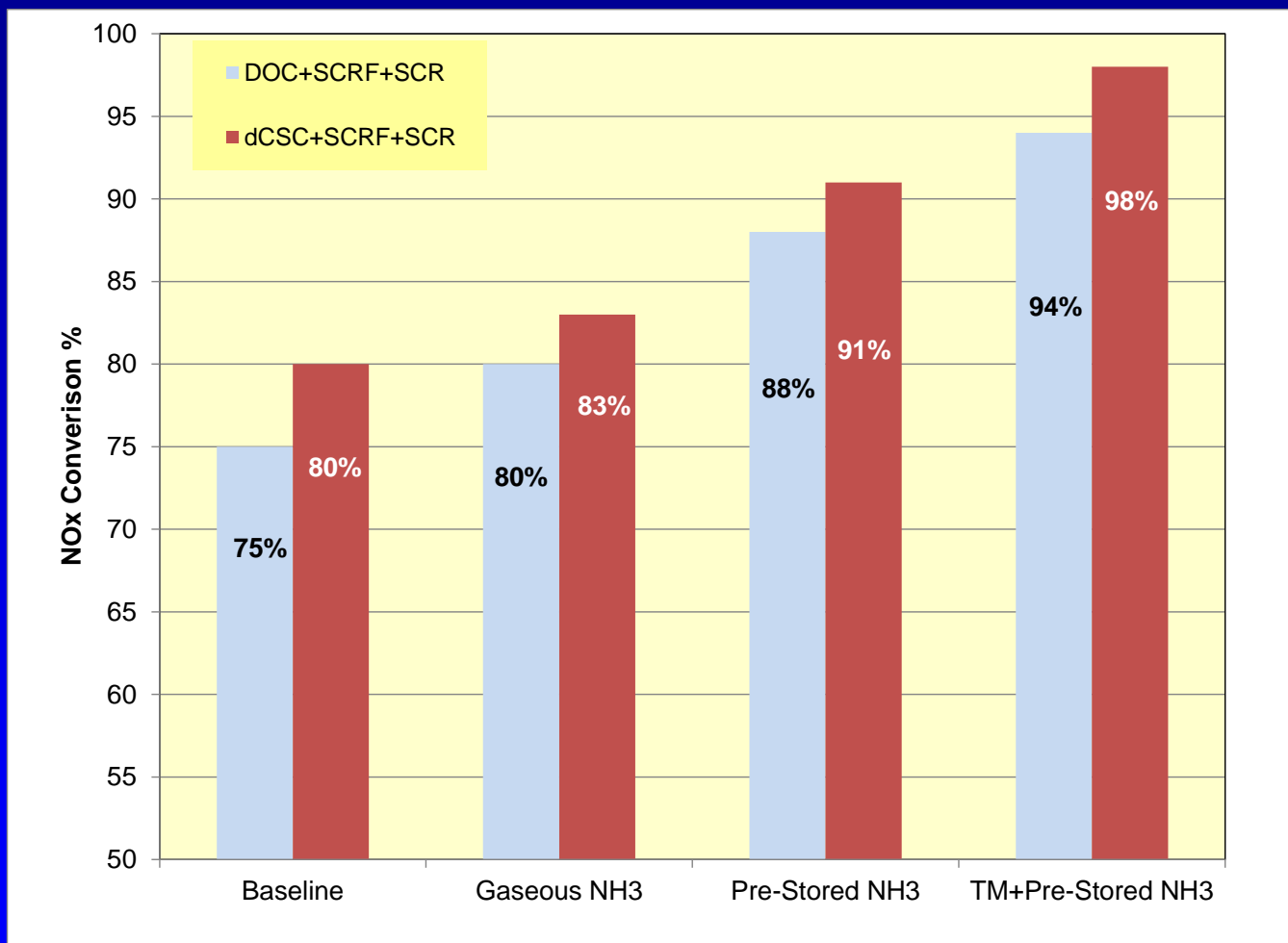


SAE 2015-01-1020

ARB/MECA HD Low NO_x Test Program

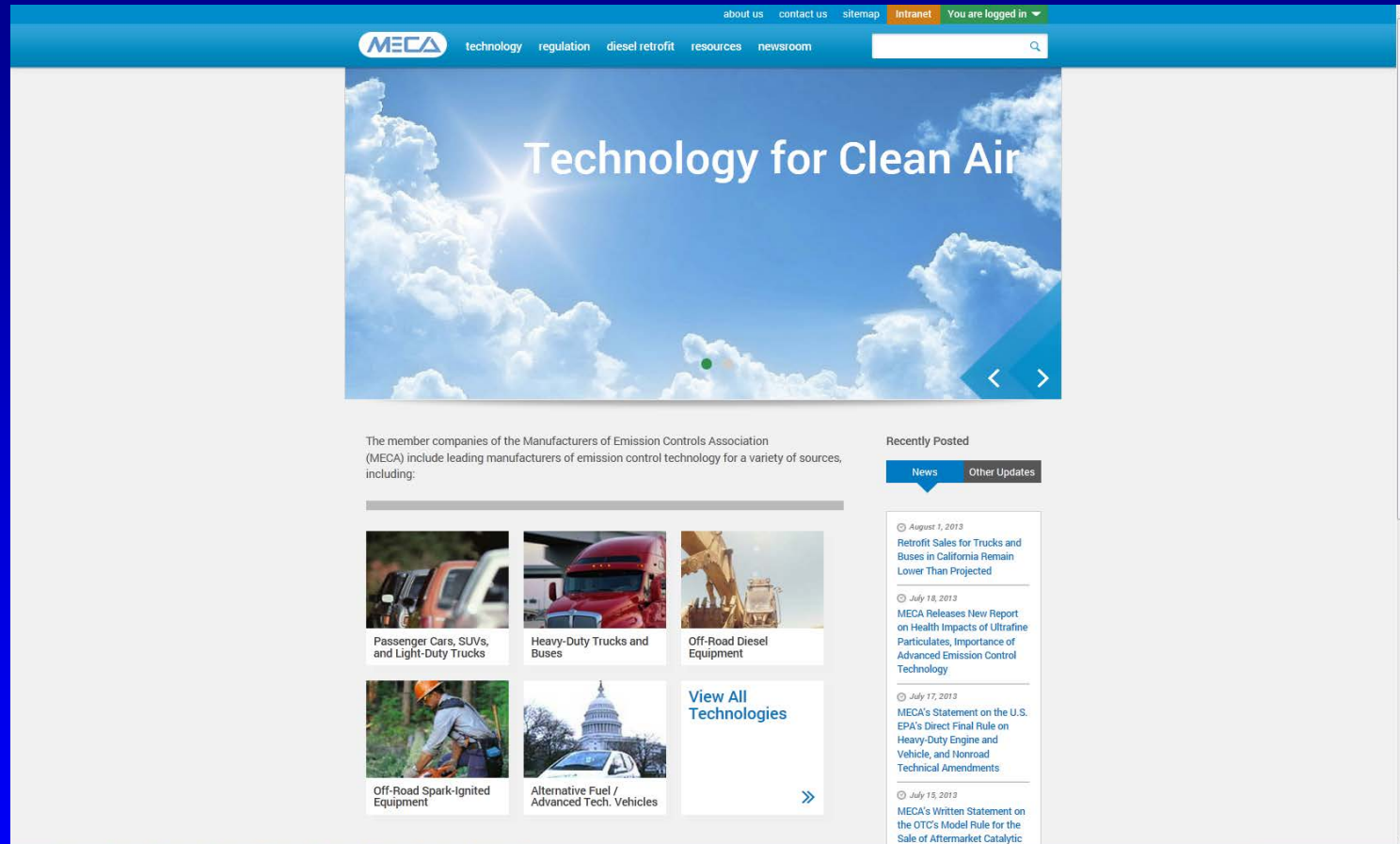
- Demonstrate 90% NO_x reduction (0.02 g/bhp-hr NO_x emissions) on heavy-duty diesel and stoichiometric CNG engines
- What's needed to achieve 0.020 g/bhp-hr from state of the art diesel engine equipped with advanced efficiency technology
 - 95% efficiency for cold start
 - 99% for hot start
 - 99% on steady-state cycle
- Engine calibration combined with exhaust control development
- System integration and demonstration
 - Emissions demonstrated over full useful life (435K miles, 22,000 hours)
 - Demonstration on certification cycles, as well as Vocational cycle with sustained low-load and low temperature operation
 - No negative impact on CO₂ emissions

Cold-Start Technologies Demonstrated on Heavy-Duty Engines



MECA Modeling Study Showed Cost Effective Emission Reductions from Heavy-Duty Engines

- On a national basis, potential NOx reductions from heavy-duty engines amounts to 223,000 tons in 2030, 490,000 tons in 2050 or 1,300 tpd.
- MECA incremental cost of on-road HD mobile controls range from \$3,000-\$4,000/ton.
- Tier 3 projected to deliver 750 tpd by 2030 at \$2,400/ton
- Known stationary controls from EGUs cost around \$12,000
- Regulations drive technology development for co-optimization of criteria and GHG emission reductions



- Your emission control technology resources on the web