Technology For Meeting Future Heavy-Duty Truck Standards

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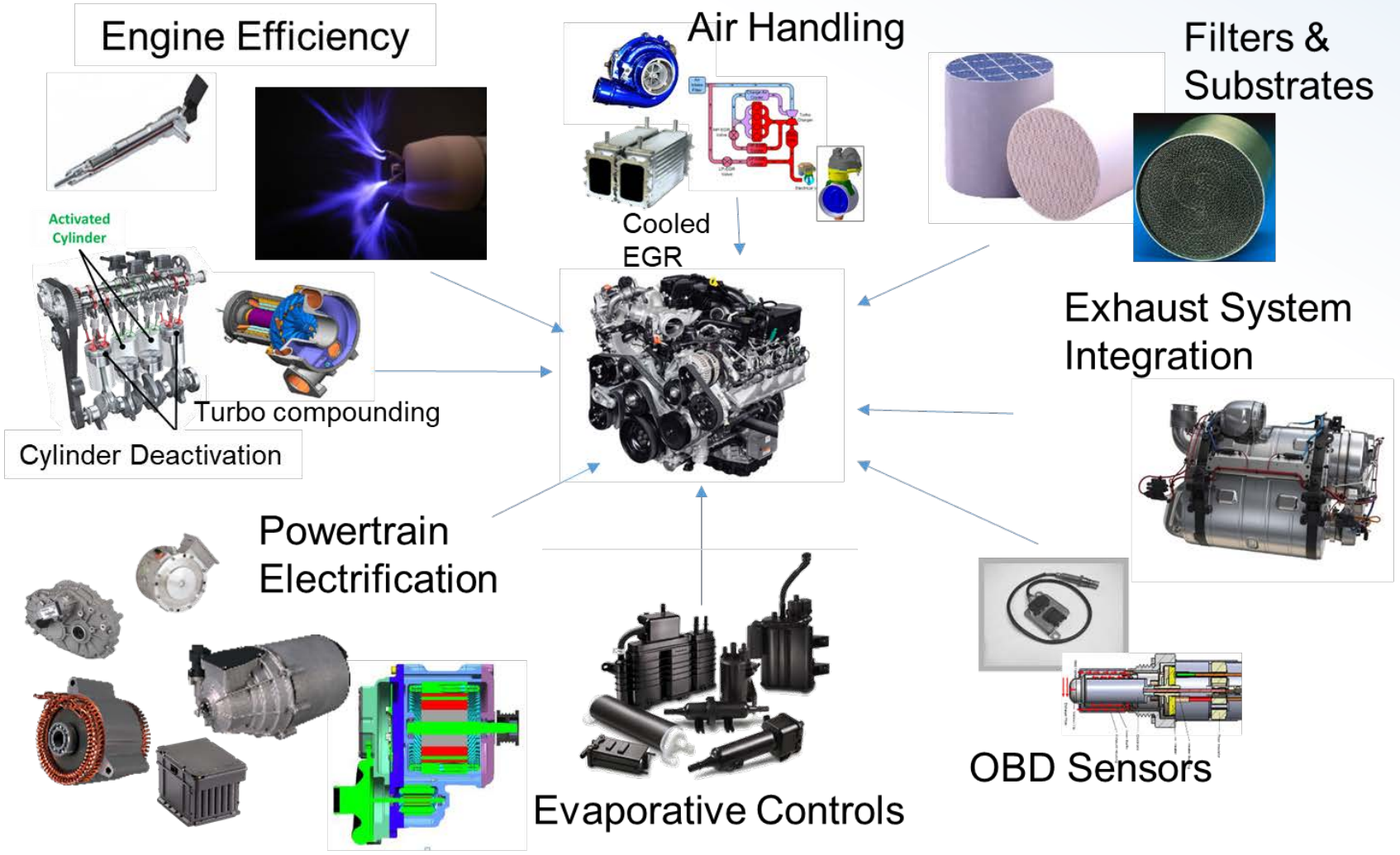
NACAA, OTC, NESCAUM Webinar

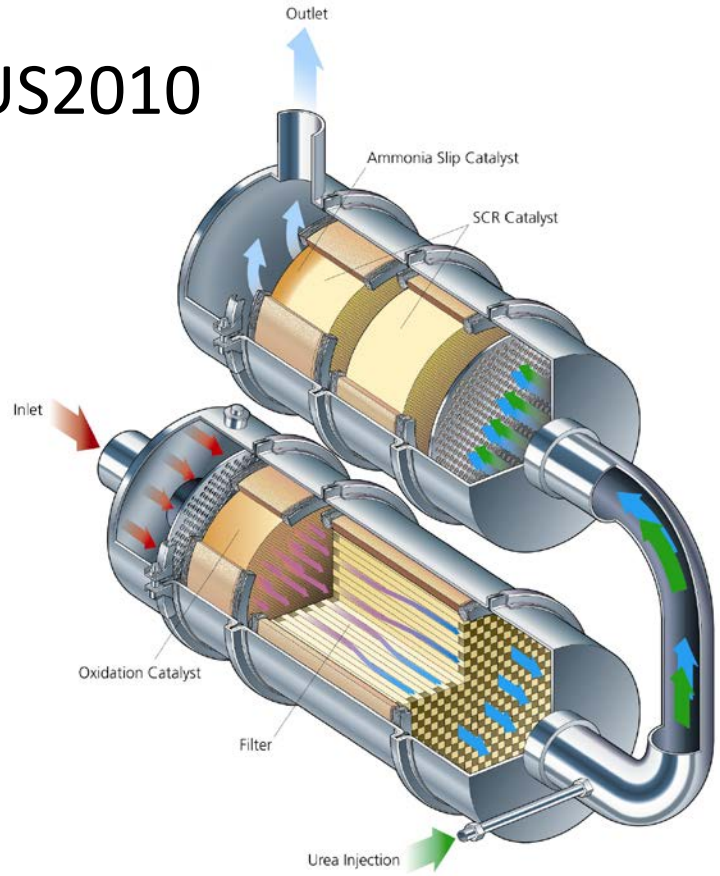
Who is MECA?

- Industry association founded in 1976 to be the technical voice for the suppliers of technologies that reduce criteria pollutant and GHG emissions from mobile sources.
- Primary mission is to inform regulators, state air agencies and NGOs about clean mobility options for reducing pollution and GHGs from all mobile sources (cars, trucks, off-road equipment, small engines, locomotives and marine)



Evolution of Heavy-Duty Exhaust Control Technology

US2010



Repackaged

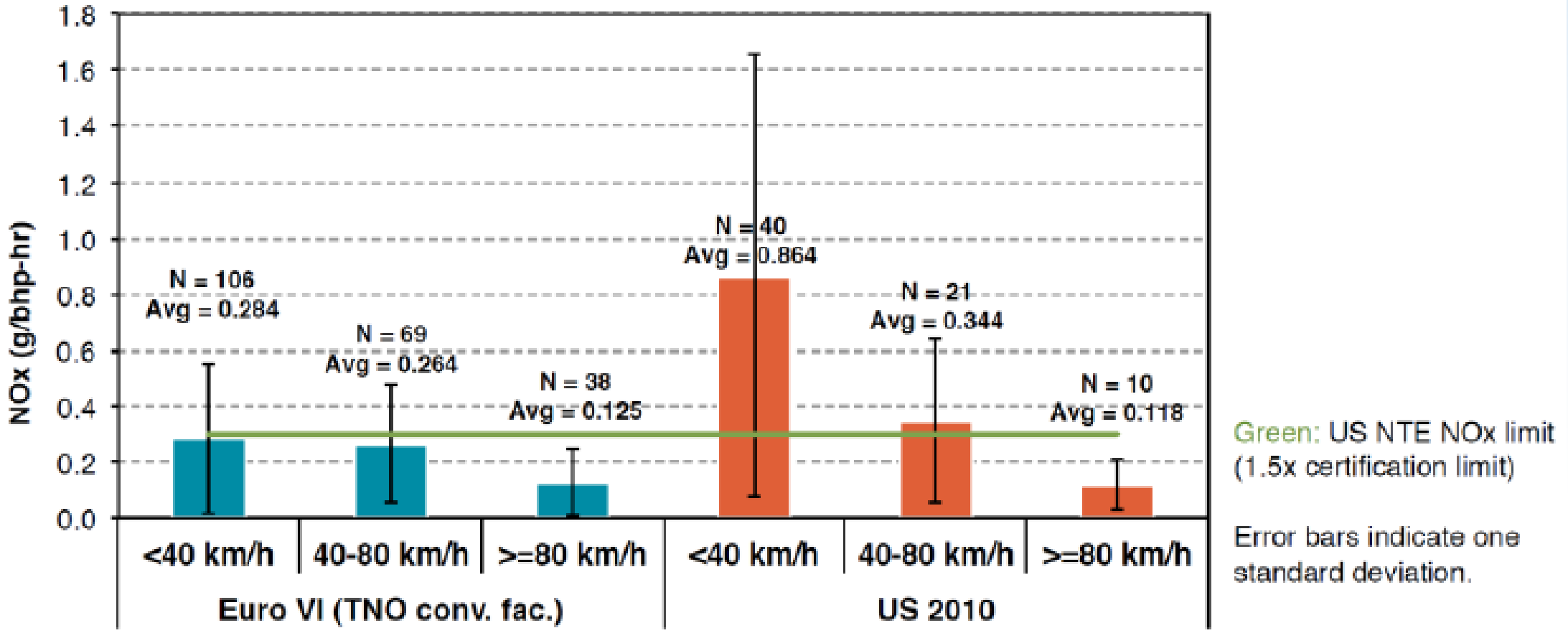
A natural optimization has resulted in 2019 systems being 60% smaller, 40% lighter, and cheaper than 10 years ago.

US2013

Downsized

US2019

U.S. Compliance Program Shows Need for Improvement



Source: ICCT, Integer 2017 Emissions Summit

Background for our Assumptions

- CARB's Mobile Source Strategy lays out path to NAAQS attainment by reducing HD truck emissions by 90% below US 2010 standards.
- In 2015 CARB and MECA initiated a technology test program at Southwest Research Institute to demonstrate feasibility of reducing tailpipe NOx by 90% while not increasing GHGs.
- In 2018 EPA initiated work on future national HD standards under the Cleaner Trucks Initiative (CTI) and in January 2020, published ANPR requesting comments on the merits of reducing NOx emissions from HD trucks by 50%-90% below today's standard of 200 mg/bhp-hr.
- Implementation of these new standards in 2027 to correspond with final HD GHG Phase 2
- NPRM is expected in September prior to completion of EPA's air quality analysis, so this work was done to inform our comments on the NPRM.
- The 2035 model year was selected to allow some fleet turnover to new standards while allowing for confidence in the modeling output.

Key Elements of Future Heavy-Duty Low NOx Regulation

- Tightens certification standards
  - Set tighter standard over the FTP (California expected to set limit at 20 mg/bhp-hr)
  - Addition of a low-load test cycle for certification
- New compliance procedure addresses real-world emissions
  - Replace current Not to Exceed (NTE) program with European style average window-based approach
- Increase warranty and durability to deliver value to truck owners
  - Extending warranty from 100,000 to 600,000 miles by 2031
  - Extending truck useful life of emission controls from 435,000 to 800,000 miles

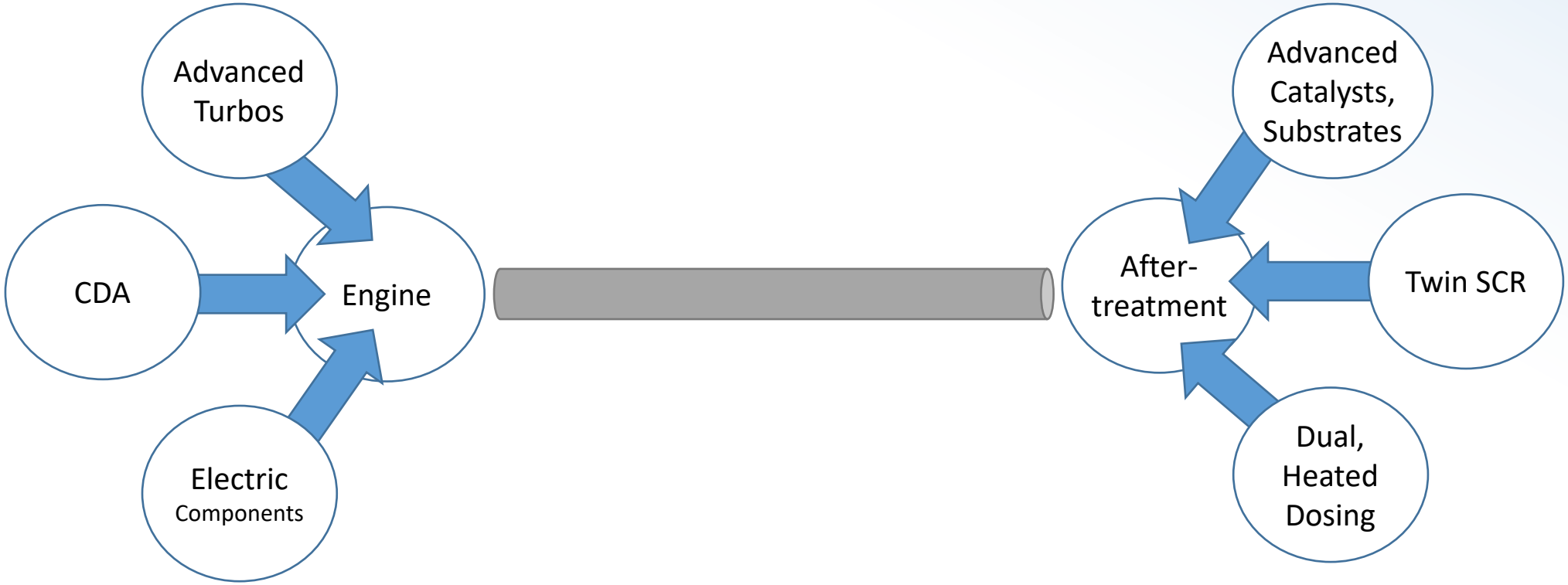
Modeled National CTI Scenario at same Standards Stringency as Proposed by CARB (September 26, 2019)

Modeled Certification Standards					
	NOx (g/bhp-hr)			PM (g/bhp-hr)	
	Current	(2024-26 MY)	(2027+ MY)	Current	(2024+ MY)
FTP Standard (g/bhp-hr)	0.2	0.05	0.02	0.01	0.005

Future Potential Certification Durability			
		Useful Life (Miles / Years)	
Engine Type	Gross Vehicle Weight Rating (GVRW)	Current	(2024+ MY)
Heavy-Duty Compression-Ignition (HDCI) Engine	Class 8 (Heavy) GVWR >33,000 lbs.	435,000 / 10	1,000,000 / 15
	Class 6-7 (Medium) 19,500 < GVWR ≤ 33,000 lbs.	185,000 / 10	550,000 / 15
	Class 3-5 (Light) 10,000 < GVWR ≤ 19,500 lbs.	110,000 / 10	550,000 / 15
Heavy-Duty Spark-Ignition (HDSI) Engine	GVWR >10,000 lbs.	110,000 / 10	550,000 / 15

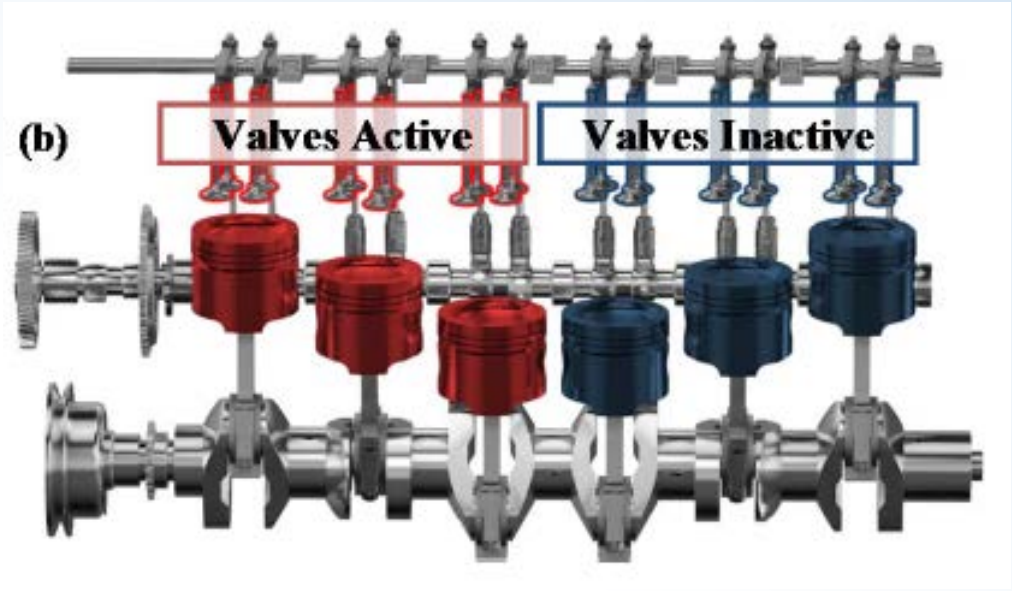
Meeting 90% Lower NOx Standards in all Operation for MY 2027

- A systems approach of technology will reduce NOx by 90% while also meeting Phase 2 GHG standards during al truck operations and duty-cycles.



Cylinder Deactivation Saves Fuel and Reduces NOx in Low Speed Operation

- Deactivating 2-6 cylinders makes the remaining cylinders work harder and more efficiently
- Shutting off all cylinders during idle or coasting keeps aftertreatment hot and stops pumping of cold air to catalysts
- CDA enables:
  - Fast heat-up of exhaust
  - Keeping exhaust hot at low loads
  - Lower engine out NOx
  - Reduced fuel consumption



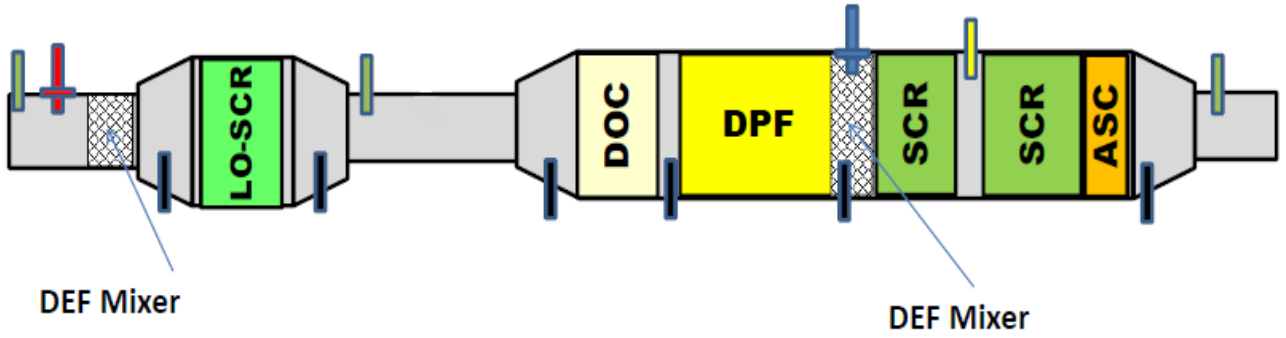
Drive Cycle	NOx Reduction Over Baseline	Fuel Savings Over Baseline
US Beverage Cycle	67%	5.0%
New York Bus Cycle	33%	7.8%
Orange County Bus Cycle	86%	3.2%

Future Exhaust Systems will be Similar to Today

- Technologies already on passenger cars will help trucks achieve lower emissions too.
- Better catalysts reduce NOx at low temperatures
- Moving catalyst closer to the engine gets it hot faster at start-up and keeps it hot at low speeds.

2027 Low NOx Emission Control System with Twin-SCR ensures ultra-low emissions over all driving conditions

Today's Emission Control System



Engine Testing is Demonstrating 90% NOx Reduction under all Truck Operation

- Same Technologies that deliver 90% NOx Reduction in rural and highway speeds exceed 95% in port operations and urban driving in populated areas.
- Fuel savings under all operations will reduce total cost of ownership for fleets.

MECA Predicts Cost-Effective NOx Reductions

$1,000-$5,000 per ton of NOx reduced

CURRENT COSTS & DURABILITY

based on 2010 standards

Cost of aftertreatment drops 2-3%/yr

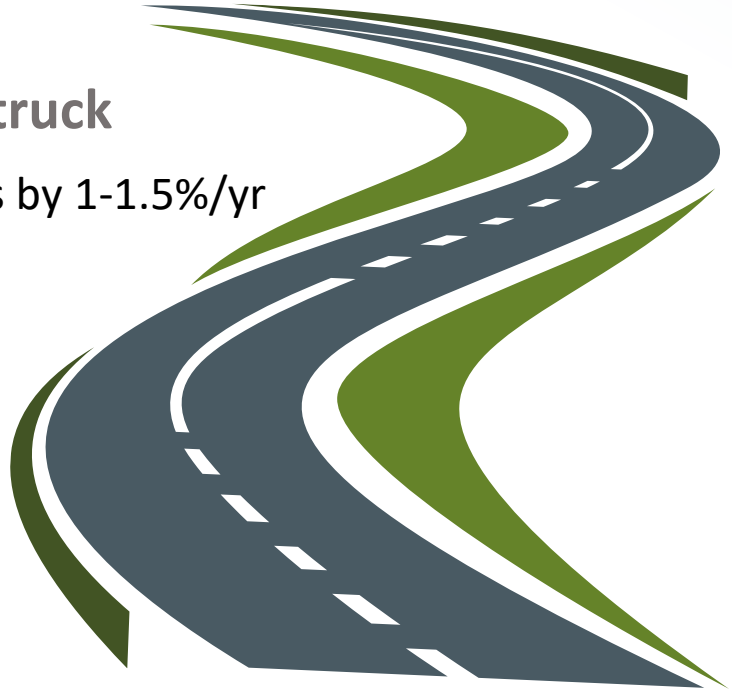
$2600 – $4600 estimated per truck

Historical Class 8 truck price increases by 1-1.5%/yr

$157,000

Warranty

100,000 miles or 5 years



PROJECTED COSTS & DURABILITY

based on proposed 2027 standards

Incremental technology cost

$3100 – $4800 estimated per truck

Average projected truck cost

$177,000

Warranty

600,000 miles or 10 years

NOx Reduction vs. 2010 standard

90%

Fuel savings through engine efficiency

$1,000/yr

Conclusions

- Years of testing have demonstrated that 90% lower NOx emissions from trucks are achievable
- Technology is already commercial on passenger cars
- Technology and regulatory changes will address real world emissions
- The reductions from trucks are cost effective compared to other control measures
- Air quality benefits of a modeled national truck rule will benefit a large portion of the country.
  - Modeling Summary: http://www.meca.org/resources/CTI_MOVESInventoryModelingProjectSummary_0620Final.pdf
  - MOVES Inventory report: http://www.meca.org/resources/OakLeaf_Final_Report_0620.pdf
  - AQ Modeling report: http://www.meca.org/resources/Alphine_Modeling_Report_Part_1-2_Final_0620rev.pdf
  - State inventory pivot tables: http://www.meca.org/resources/reports