Technology for Meeting the Low NOx Omnibus Regulations for Heavy-Duty Trucks

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www.meca.org

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Who we Are

- The **Manufacturers of Emission Controls Association (MECA)** is a technology-focused association representing ~40 member companies whose mission is to support policymakers and key stakeholders with technical information on the capability and cost-effectiveness of clean mobility technologies for reducing criteria pollutants and greenhouse gas emissions from all mobile sources.

- The **Advanced Engine Systems Institute (AESI)** consists of a subset of MECA members and works in conjunction with MECA on advocacy-related activities in the pursuit of world-class emission regulations here in the US.

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Discussion Summary

- The ACT and Omnibus should drive all trucks to be as clean as possible to maximize NOx and GHG reductions.
- By 2027 a 0.02 g/bhp-hr limit is feasible using a systems approach of engine and aftertreatment technology based on improvements to today's emission control designs.
- MECA and AESI support the staff proposal with some minor changes to several provisions that could result in higher NOx emissions.
- Omnibus ZEV credits should not reward compliance with ACT and allow higher emitting diesel trucks until 2030.
  - We estimate that between 2024-2030 credits generated in the low NOx rule by complying with the ACT would allow nearly 17,000 diesel tractor trucks on the road at more than double the emissions.
  - MECA supports early year credits to provide some limited compliance flexibility for earlier implementation of Omnibus and ACT.
- We support a 50-state optional pathway to deliver greater NOx reductions and earlier technology introduction, however a limit of 0.1 g/bhp-hr is not representative of technology feasibility in 2024.

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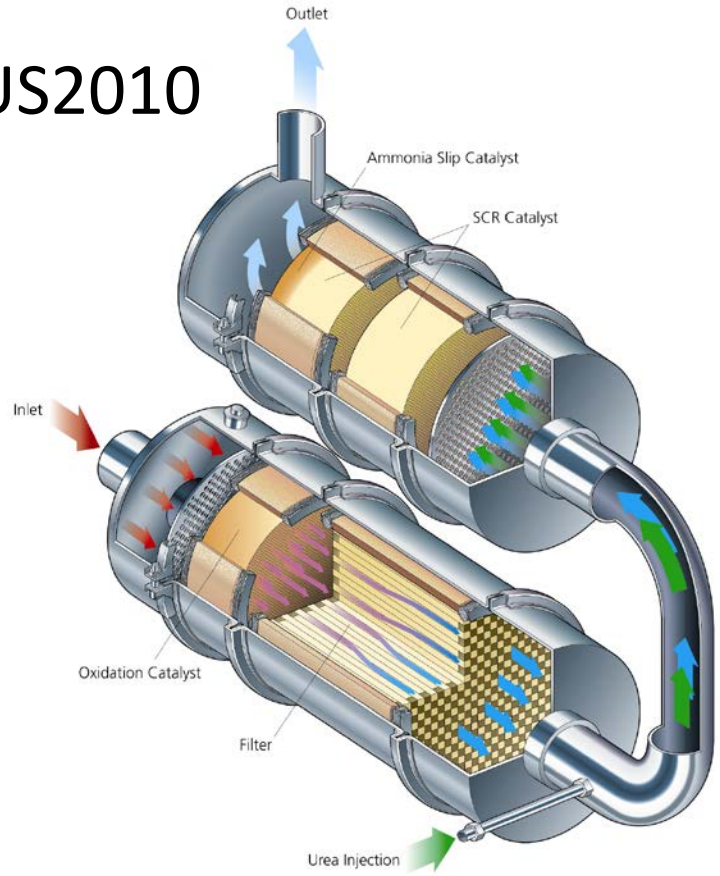
Evolution of Heavy-Duty Exhaust Control Technology

US2010



Repackaged

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

US2013

Downsized

US2019

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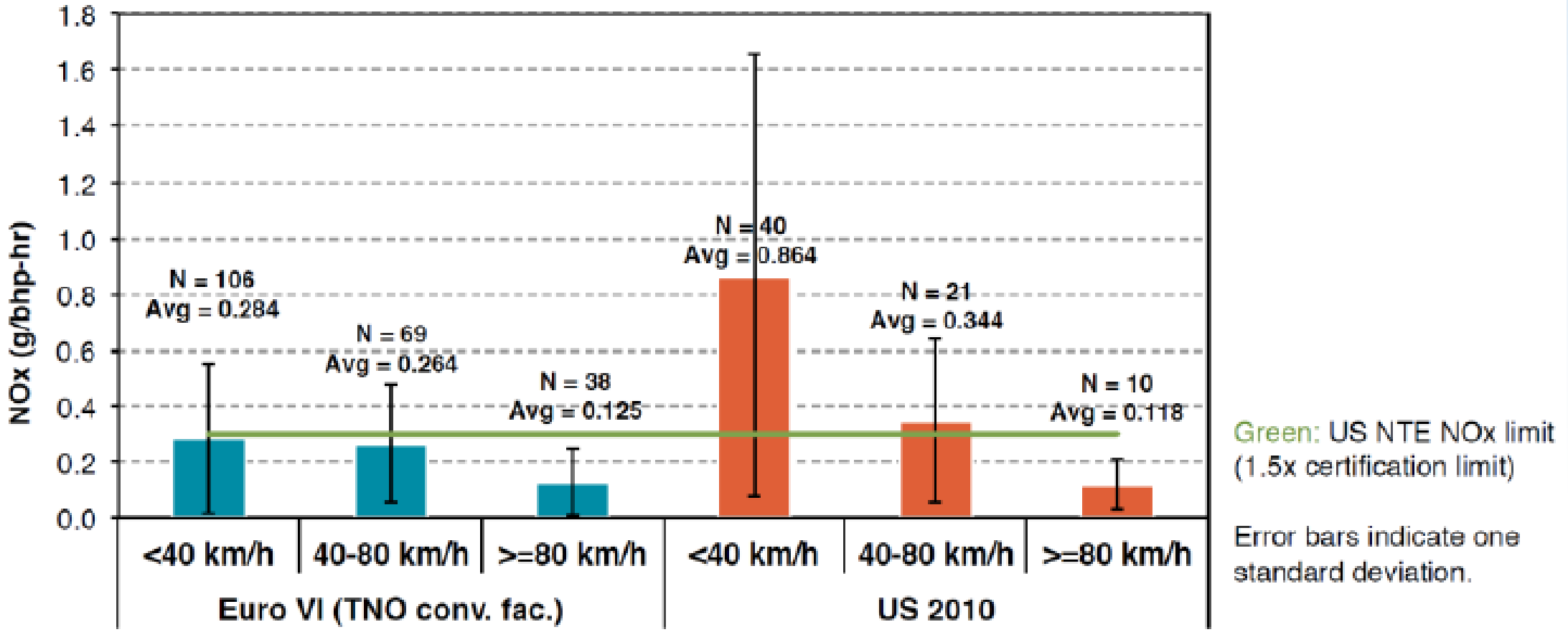
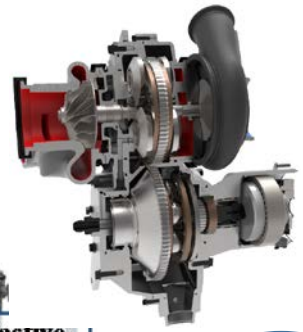
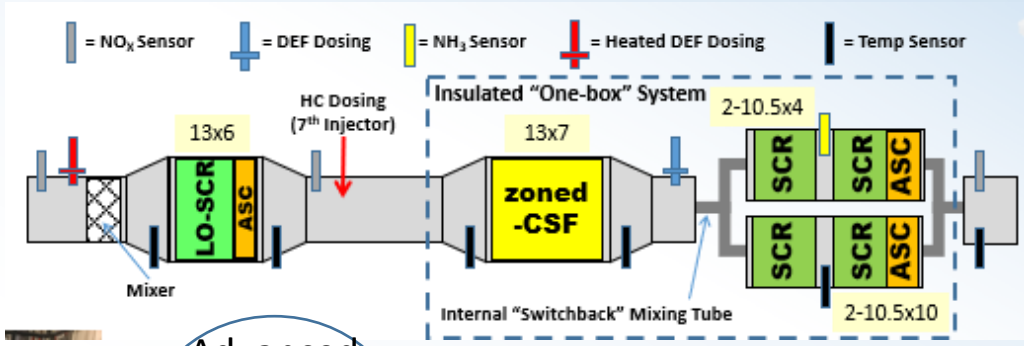
Omnibus will Address Gaps in Compliance Program

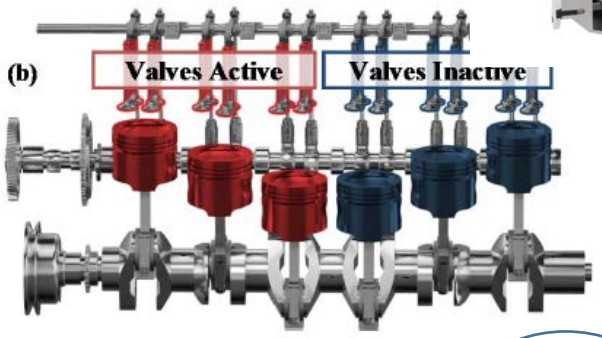


Source: ICCT, Integer 2017 Emissions Summit

System approach will Deliver 90% Lower NOx Emissions During Real-World Operation by MY 2027







Advanced Turbos

CDA

Engine

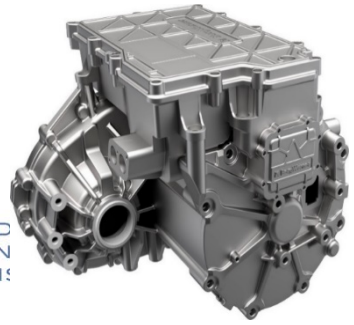
Electric Components

Advanced Catalysts, Substrates

After-treatment

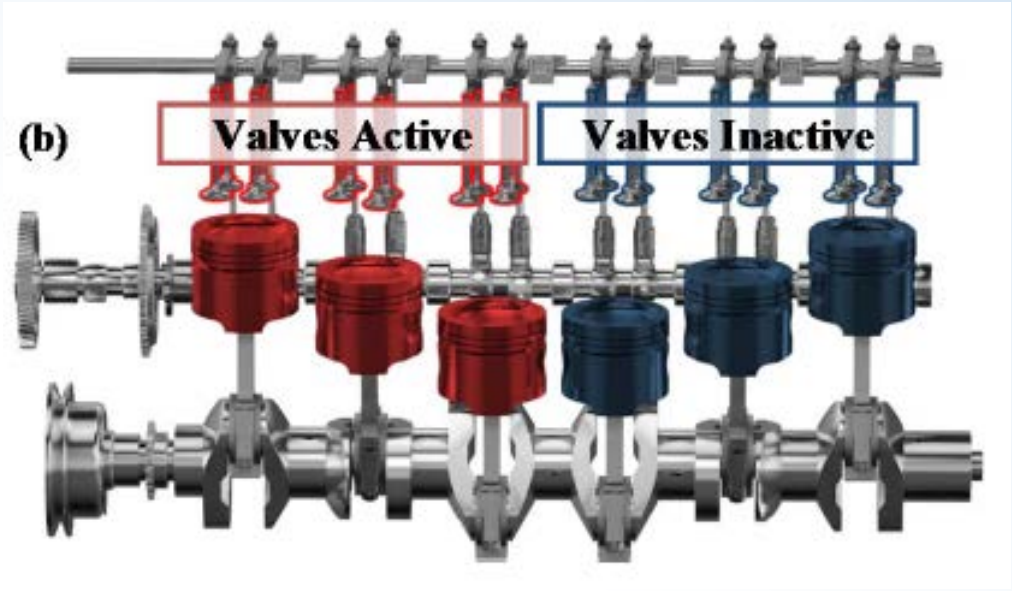
Twin SCR

Dual, Heated Dosing



Cylinder Deactivation Reduces NOx and CO_2 under all Operating Modes

- 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%

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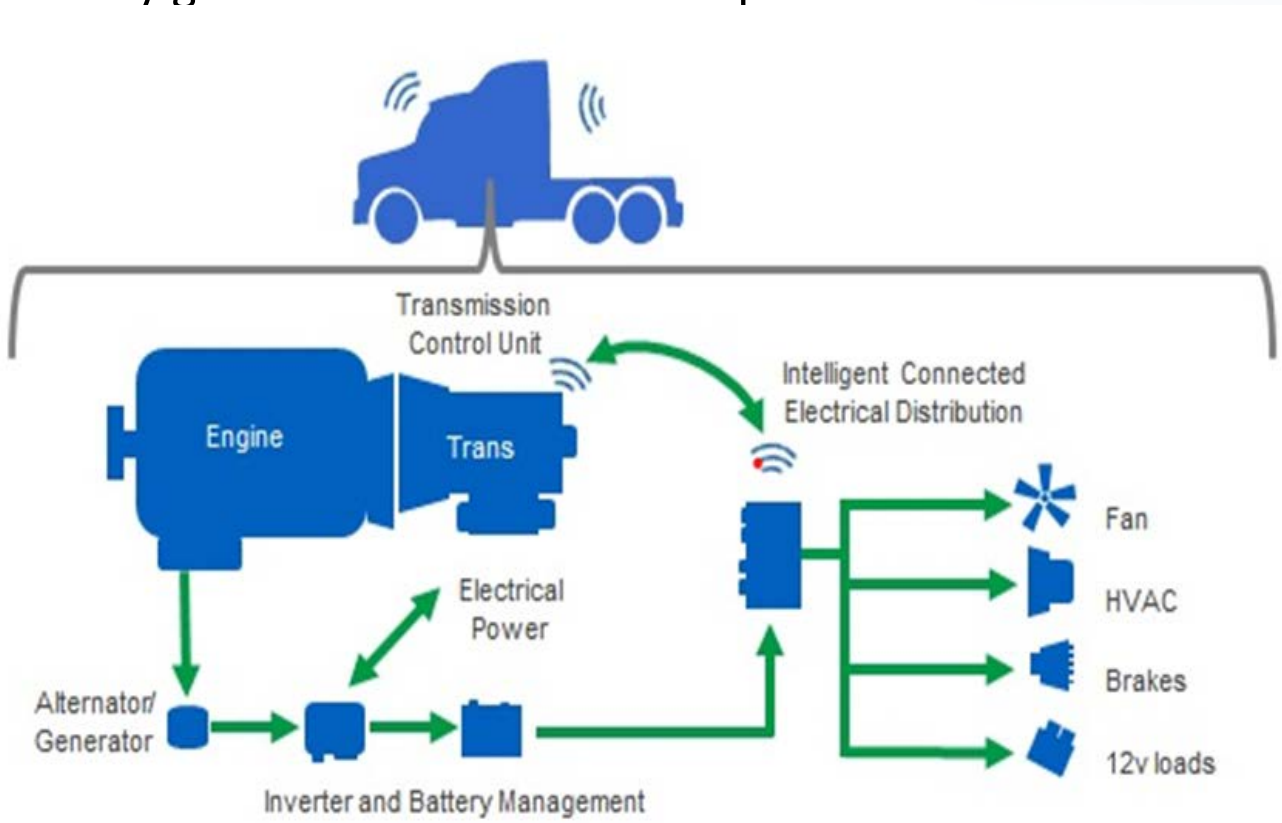
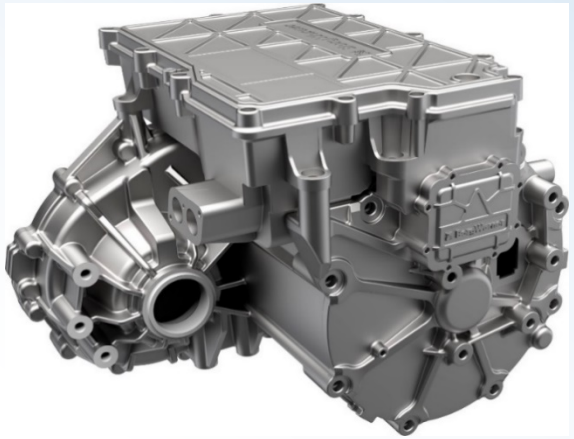
Electrification will Deliver CO_2 and NOx Benefits from Line Haul Trucks in 2027

- Electrified vehicles enable capture and use of braking energy and efficiency gains from electrified components





Integrated Electric Drive

The types of components that may be electrified include:

- electric turbos
- electronic EGR pumps
- AC compressors
- electrically heated catalysts
- electric cooling fans
- oil pumps
- coolant pumps

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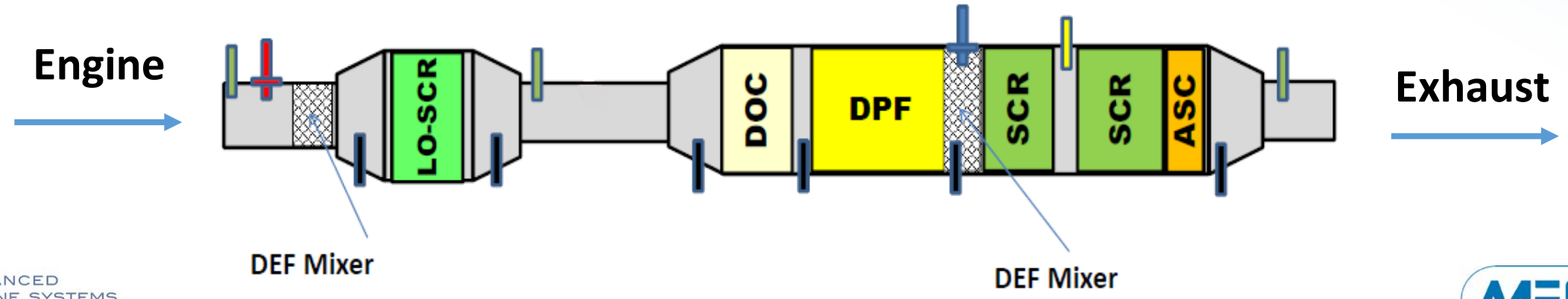
Future Exhaust Systems will be Similar to Today

Technologies already on passenger cars will help trucks achieve low NOx emissions on cold-start and in low load operation.

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

Today's Emission Control System



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SwRI 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.
- Measured fuel savings under all operations will reduce total cost of ownership for fleets.

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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

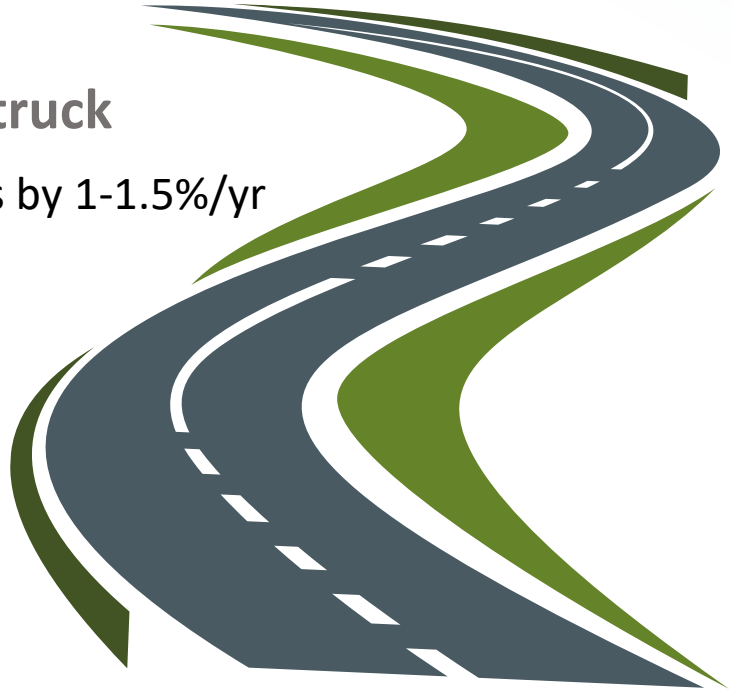
$2600 – $4600 estimated per truck

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 expected through improved engine efficiency

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Conclusions

- CARB's ACT and Omnibus rules are opportunity to achieve the maximum NOx reductions from all trucks.
- We support the staff's conclusion that a 0.02 g/bhp-hr NOx standard is achievable by 2027 and the same technologies will deliver real world emission and GHG reductions.
- Compliance with the ACT should not be rewarded in the Omnibus rule and could allow higher emitting diesel trucks to be sold in California through 2030.
- MECA believes the 50-state optional program could achieve early NOx reductions and allow flexibility for industry to prepare for stringent standards in 2027.
- The proposed 50-state voluntary limit is too generous.

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