

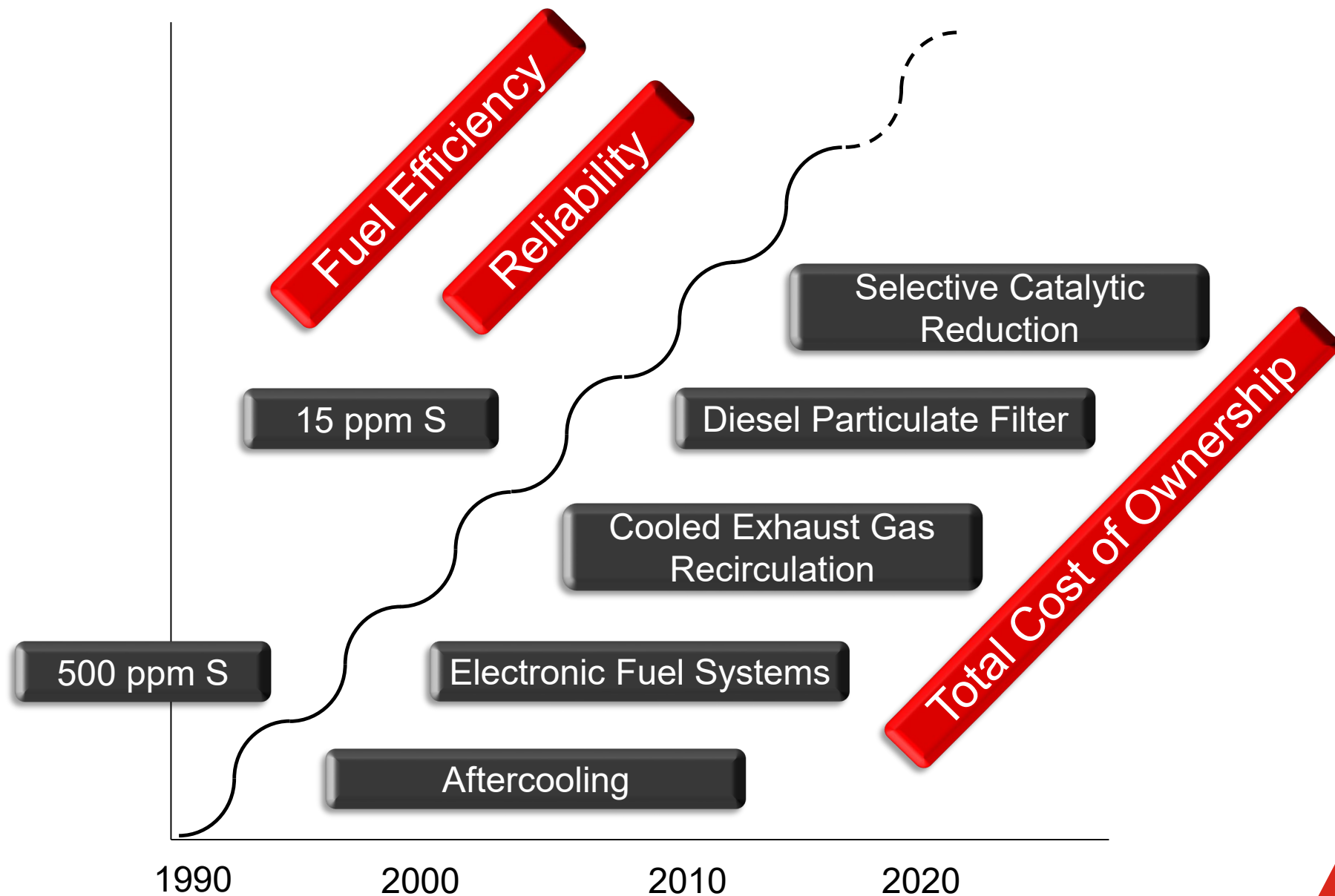
Enabling Technologies - Diesel through hybrid

David Dunnuck

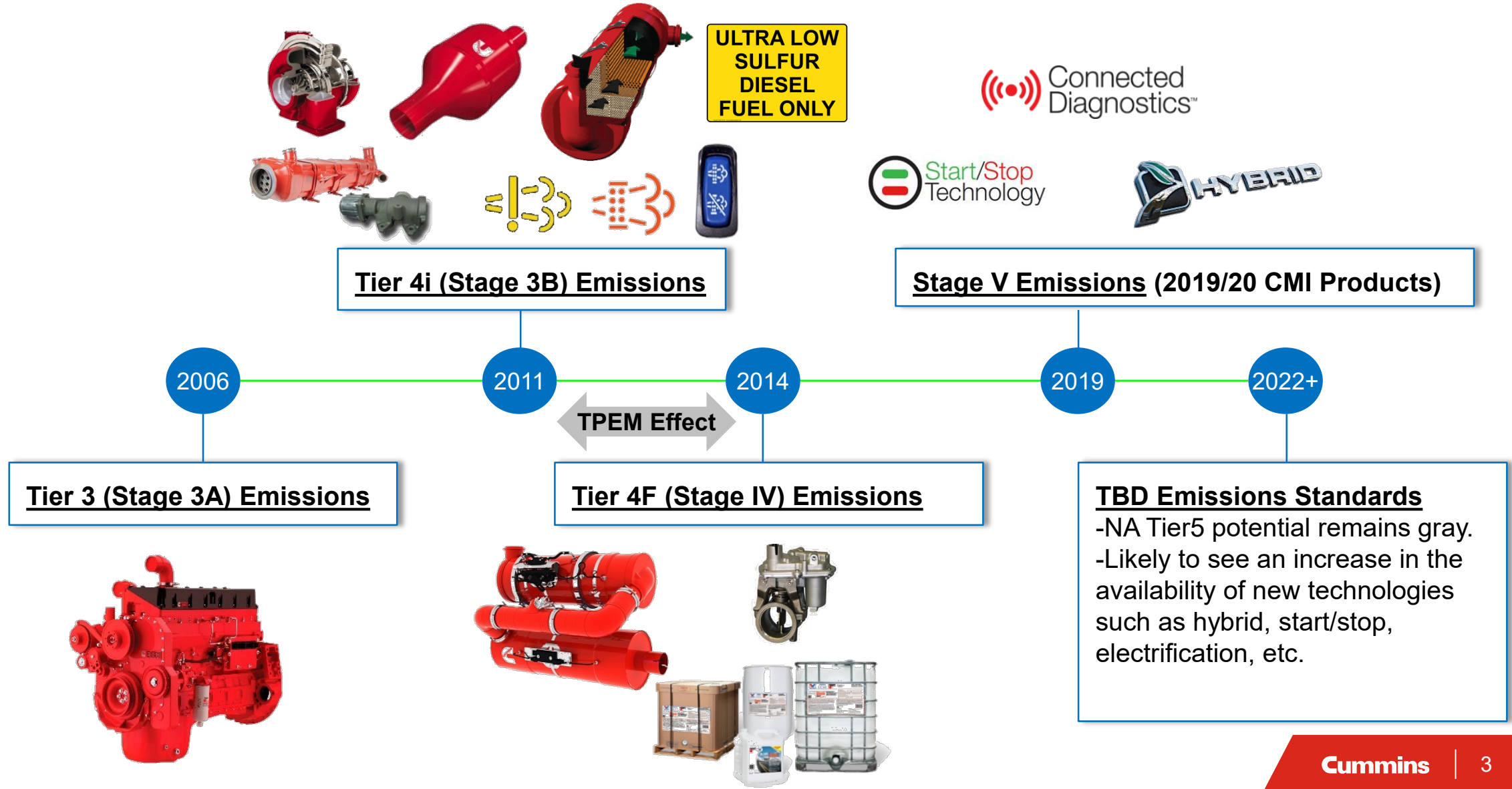
Executive Director – CES Research
and Engineering

January 2019

Evolution of Diesel Technology

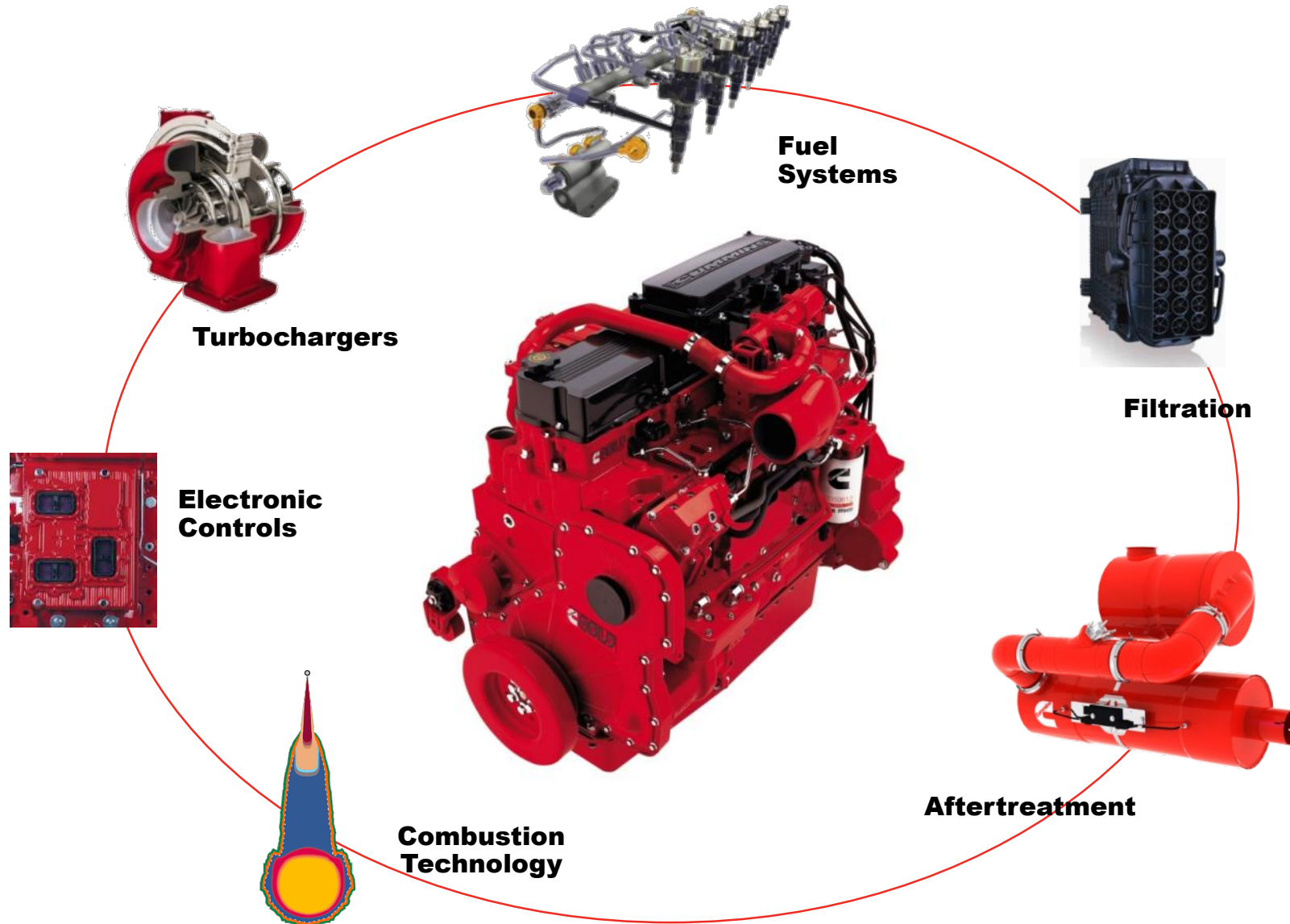


Technology Introduction - Recent Tiers



System Integration

Cummins design, build & integrate the complete Tier 4 system from air-intake to exhaust



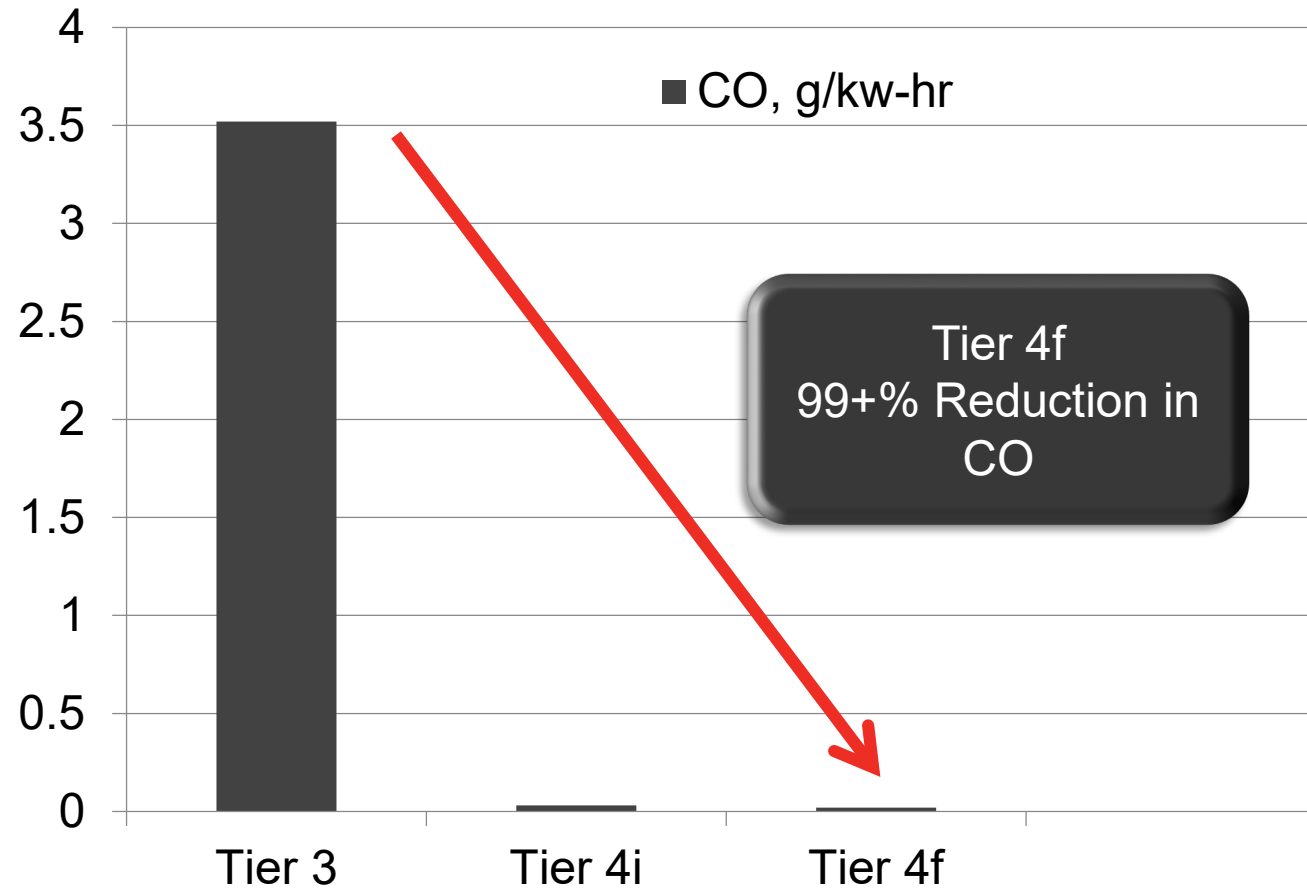
The Right Technology Matters

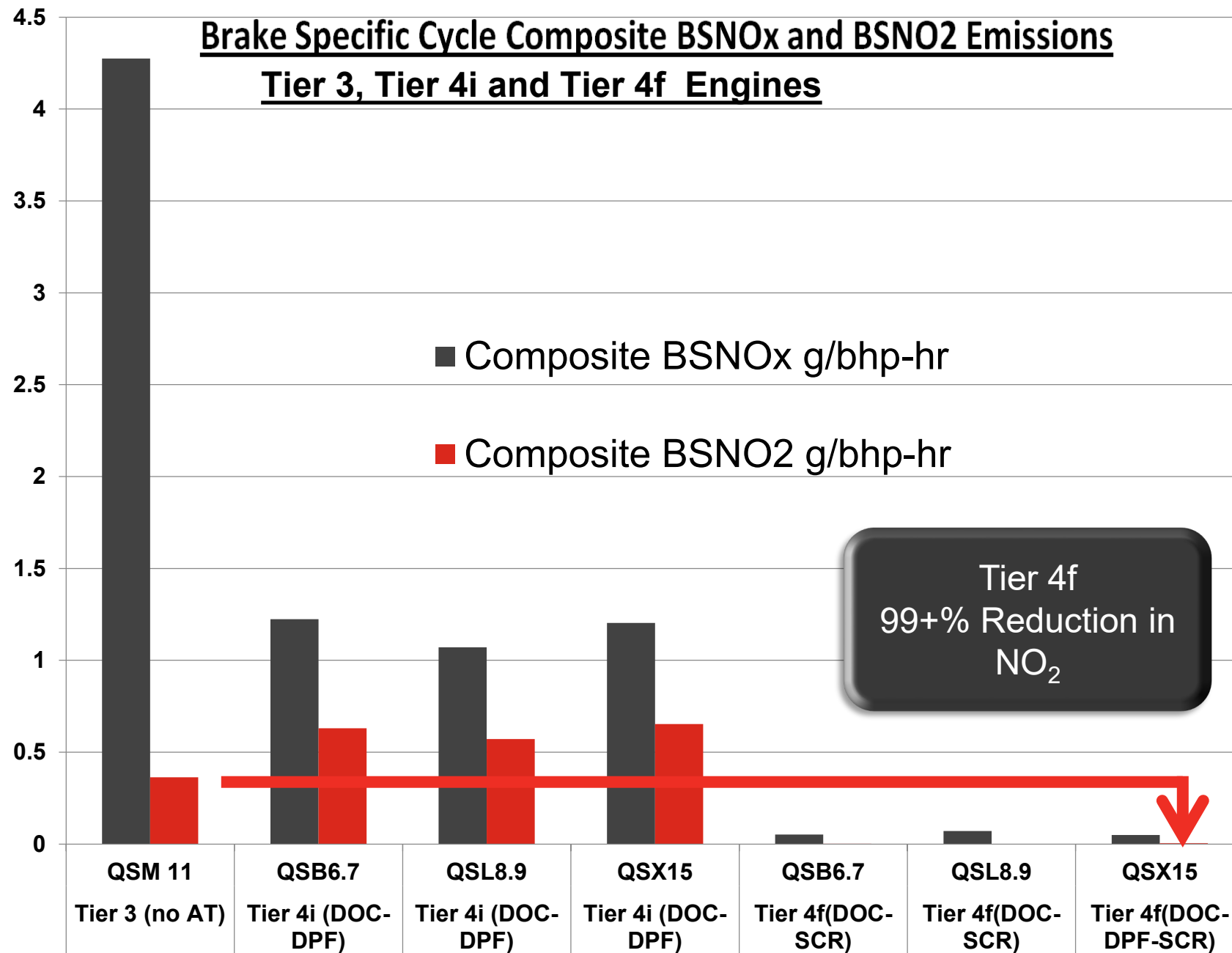


- Fit technology to market application

Application		First Date	In-Cylinder Only	Cooled EGR/VGT	NOx Adsorber	SCR	PM Aftertreatment
Tier 3 / EU Stage IIIA		2005	●				
EPA Tier 2 > 751 hp		2006	●				
Euro 4 On-Highway		2006				●	
EPA 07 On-Highway		2007		●			●
EPA 07/10 Pickup Truck		2007		●	●		●
Euro 5 On-Highway		2009				●	
EPA 10 On-Highway		2010		●		●	●
Tier 4 Interim / Stage IIIB	174-751 hp	2011		●			●
	75-173 hp	2012		●			●
Tier 4 Final / Stage IV	174-751 hp	2014		●		●	
	75-173 hp	2015		●		●	
Stage V		2019				●	●
Tier 4 Final		2020				●	●

Carbon Monoxide Emissions





Characteristics of New vs. Old Diesel PM

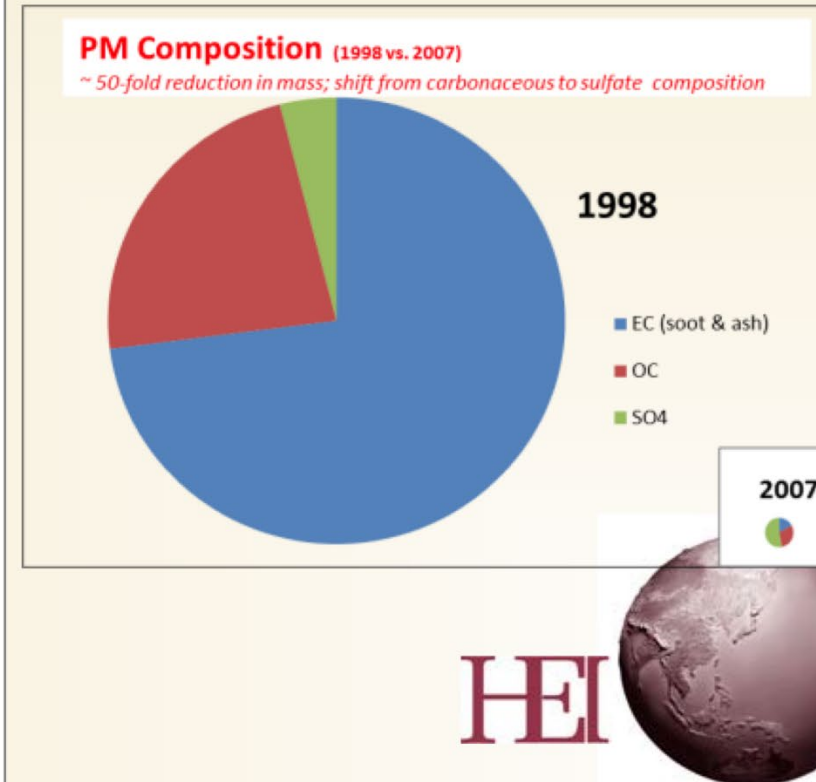
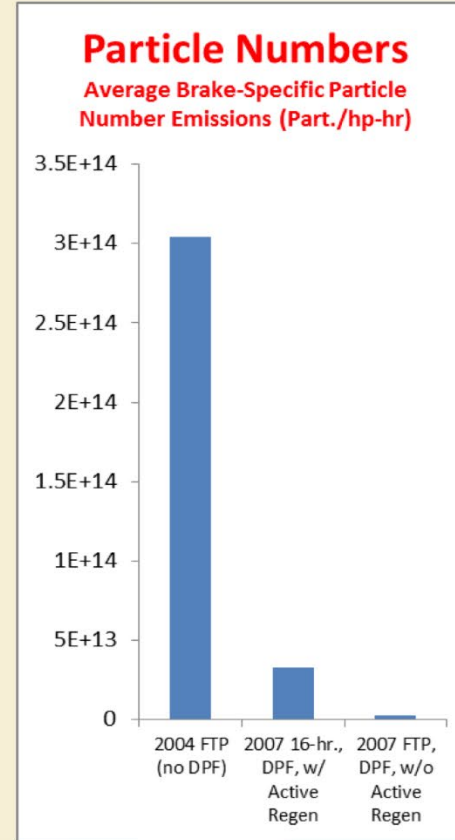
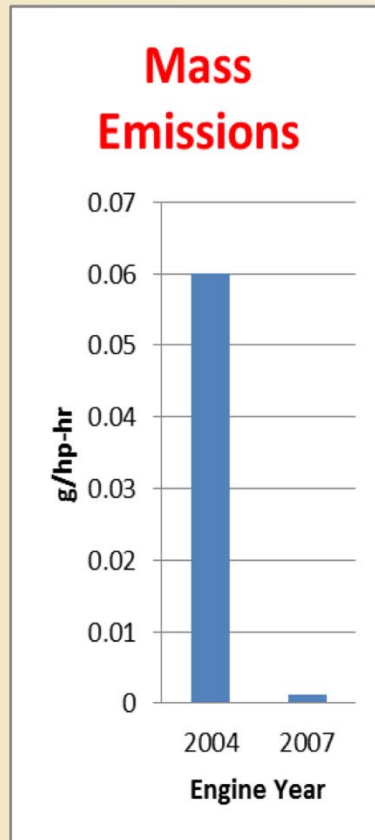
HEI ACES Results Compared to earlier Testing:

Dramatic Reductions

98% reduction in mass

90% - 99% reduction in Ultrafine Particles

Substantial reduction in carbon particles

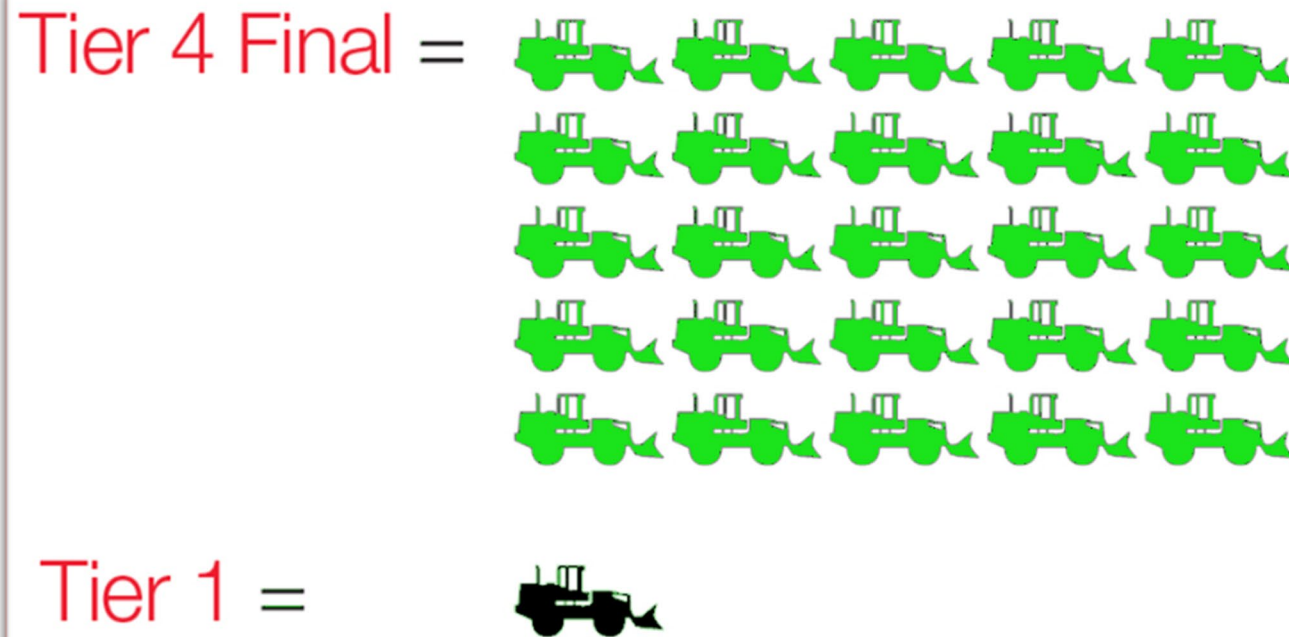


(Khale, Air & Waste Manag. Asso., 2011)

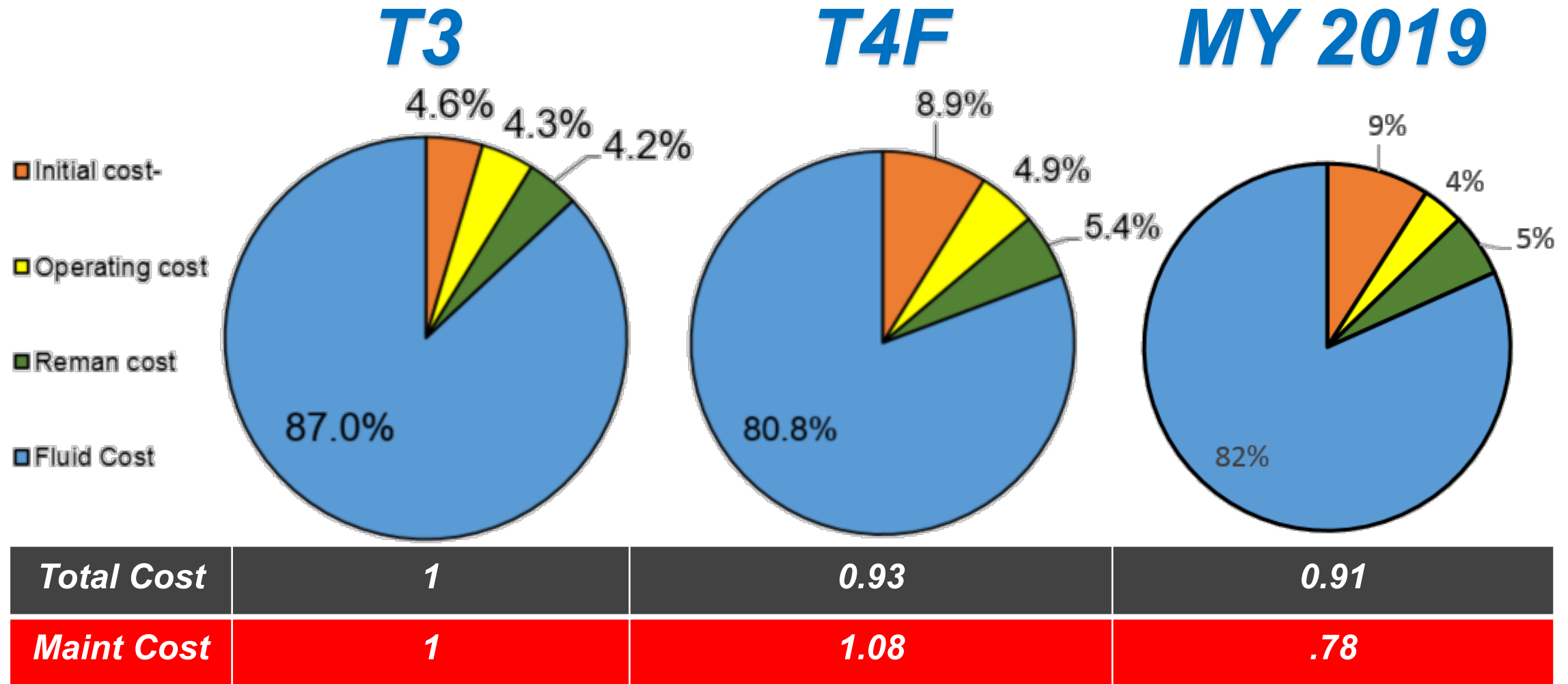
(Courtesy of HEI Report, 2015)

Meeting 'Near-Zero' Emissions

Emissions from 25 Tier 4 Final machines
equivalent to just one Tier 1 machine!



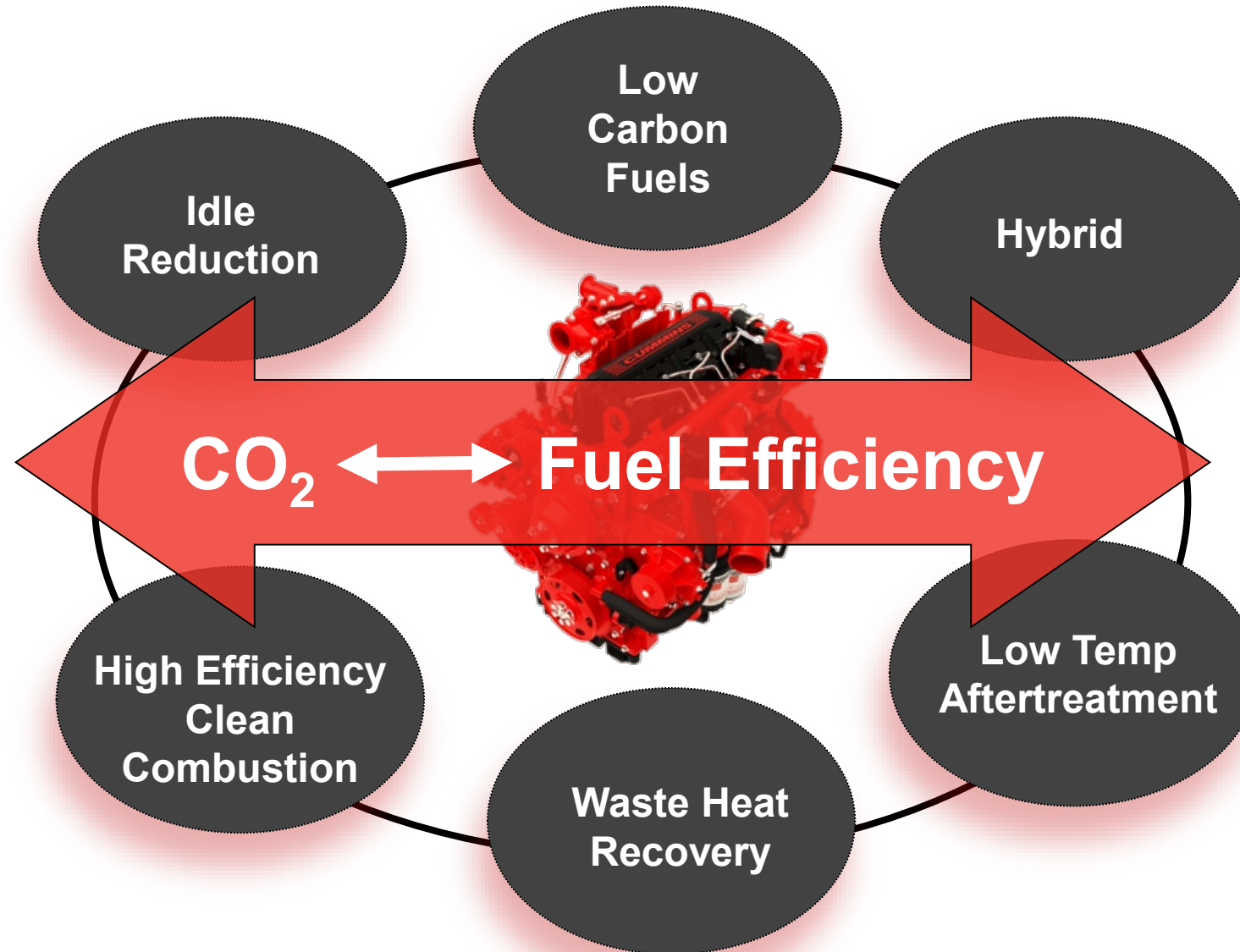
Operating TCO Comparison: 6.7L



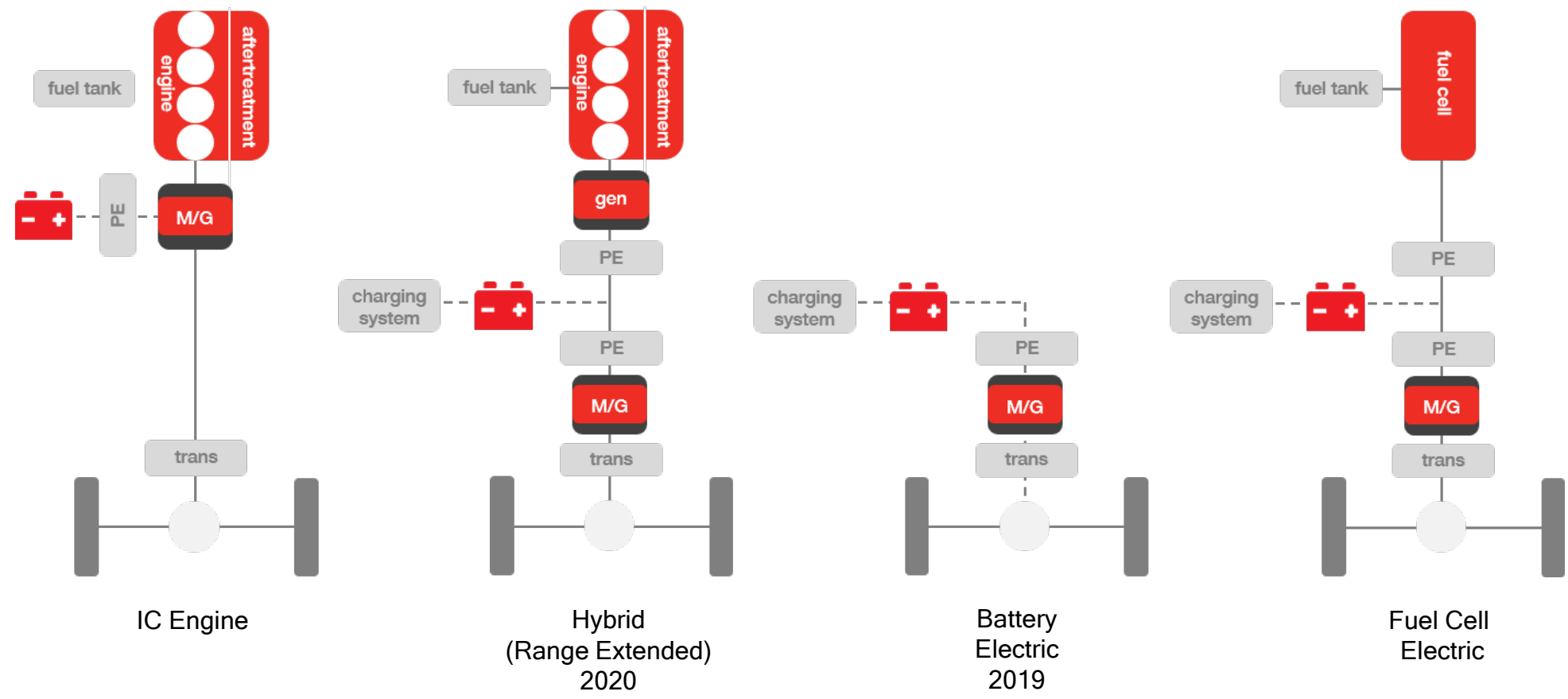
**TCO savings realized with newer products is highly duty cycle dependent.*

**Regional diesel & DEF pricing have direct affects on the above.*

Reducing CO₂



POWERTRAIN OF CHOICE



Alternate Energy

electrification • natural gas •
gasoline • others

Super Power Solution

Intelligent Data Systems

connected systems •
controls • intelligent
transportation

Powertrain Integration

transmission • axles • brakes

Super Engine System

» Cummins is committed to being a diverse powertrain supplier across our regions and markets.

» We are in a period of transformative change within the industry. With change comes opportunity.

The future includes:

» Internal combustion powertrain fueled by conventional and non-conventional fuels.

Electric powertrain as pure EV, range extended EV and hybrid.

Connected solutions to drive the demands of digital business.

energy diversity is **KEY**



Q+A

