

Innovation You Can Depend On™

▪ 您可信赖的创新 ▪ L'innovation

Sur Laquelle Vous Pouvez Compter

▪ 期待に答える技術革新 ▪

Innovación En La Que Usted Puede

Confiar ▪ 신뢰할 수 있는 혁신

▪ Inovação Que Você Pode Confiar

▪ नवयुक्ति जिस पर आप निर्भर कर सकें ▪

One World. One Mission.

Technical Excellence.



Technologies for Greenhouse Gas Emissions Control

Dr. John C. Wall

**Vice President - Chief Technical Officer
Cummins Inc.**

EPA MSTRS

October 6, 2011

Innovation You Can Depend On™

Who we are...

Diversified Global Power Leader

- Four Complementary Businesses



Engines



Power
Generation



Components



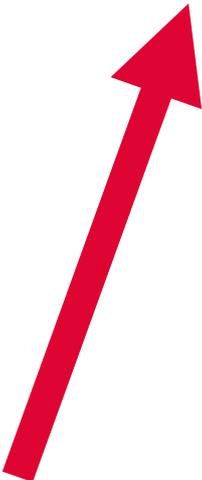
Distribution

Innovation You Can Depend On™

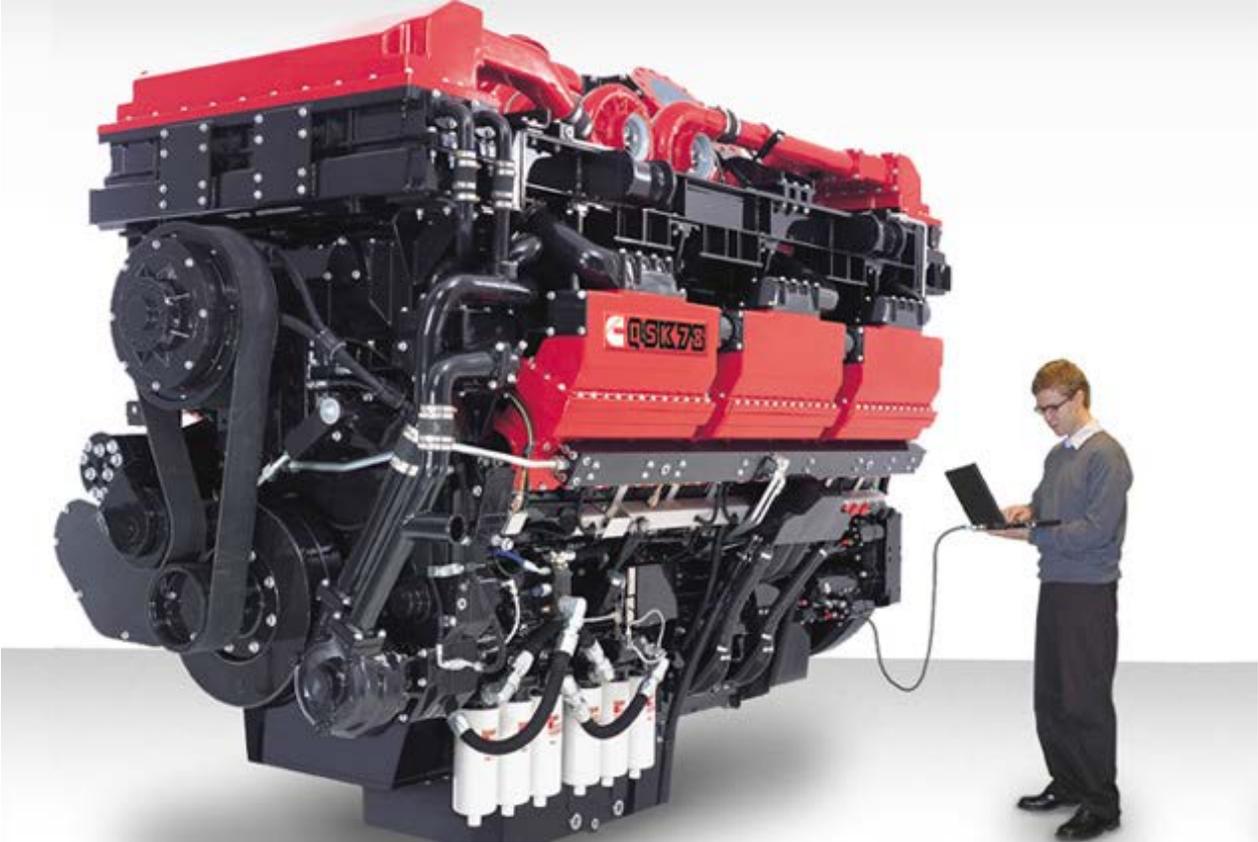
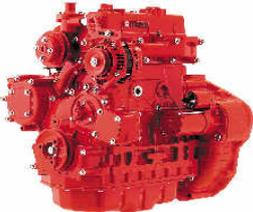


Cummins Engines 109 to 3,500 HP

3,500HP



109 HP



Innovation You Can Depend On™

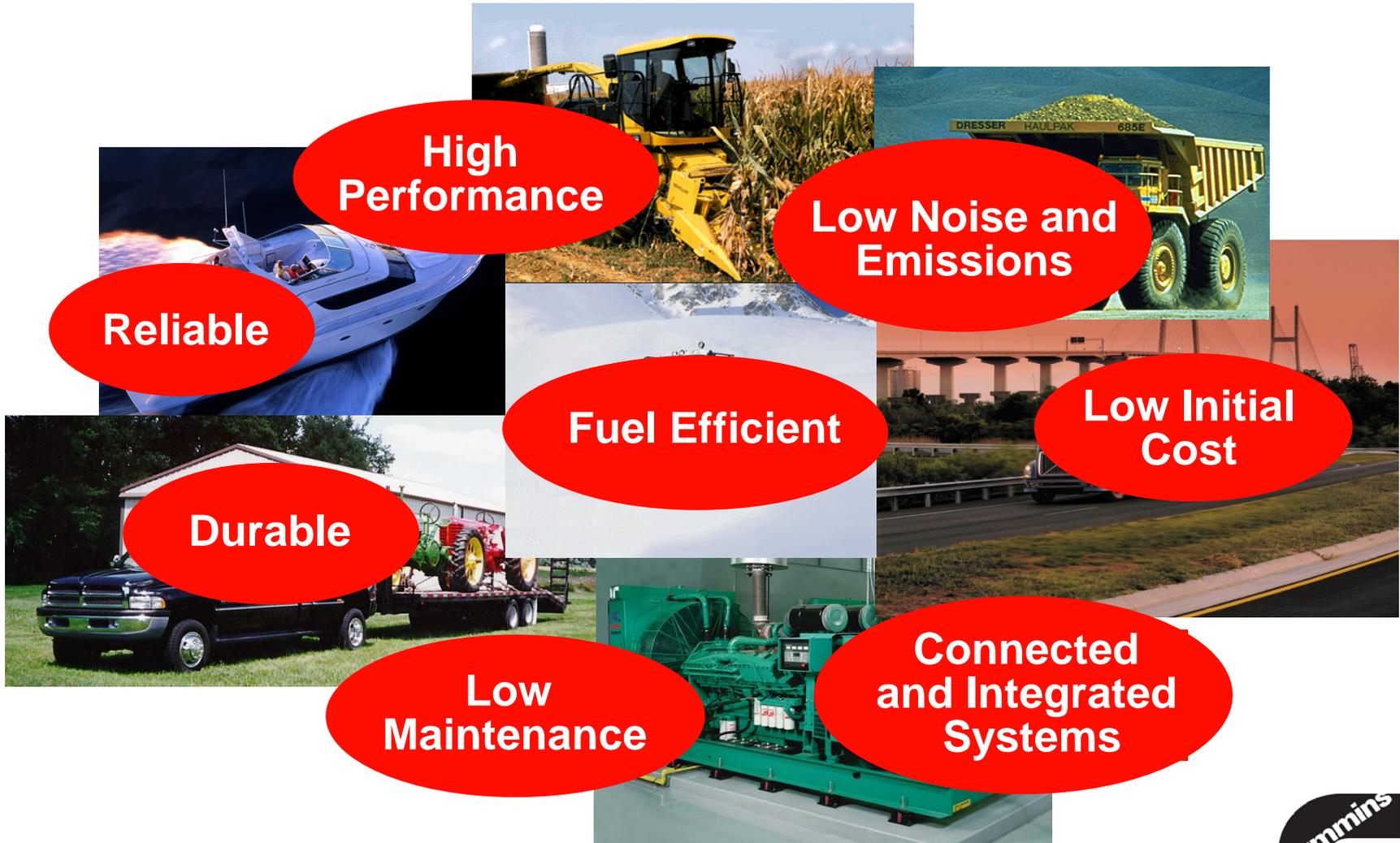


Cummins Approach to Technology Development for Low Emissions

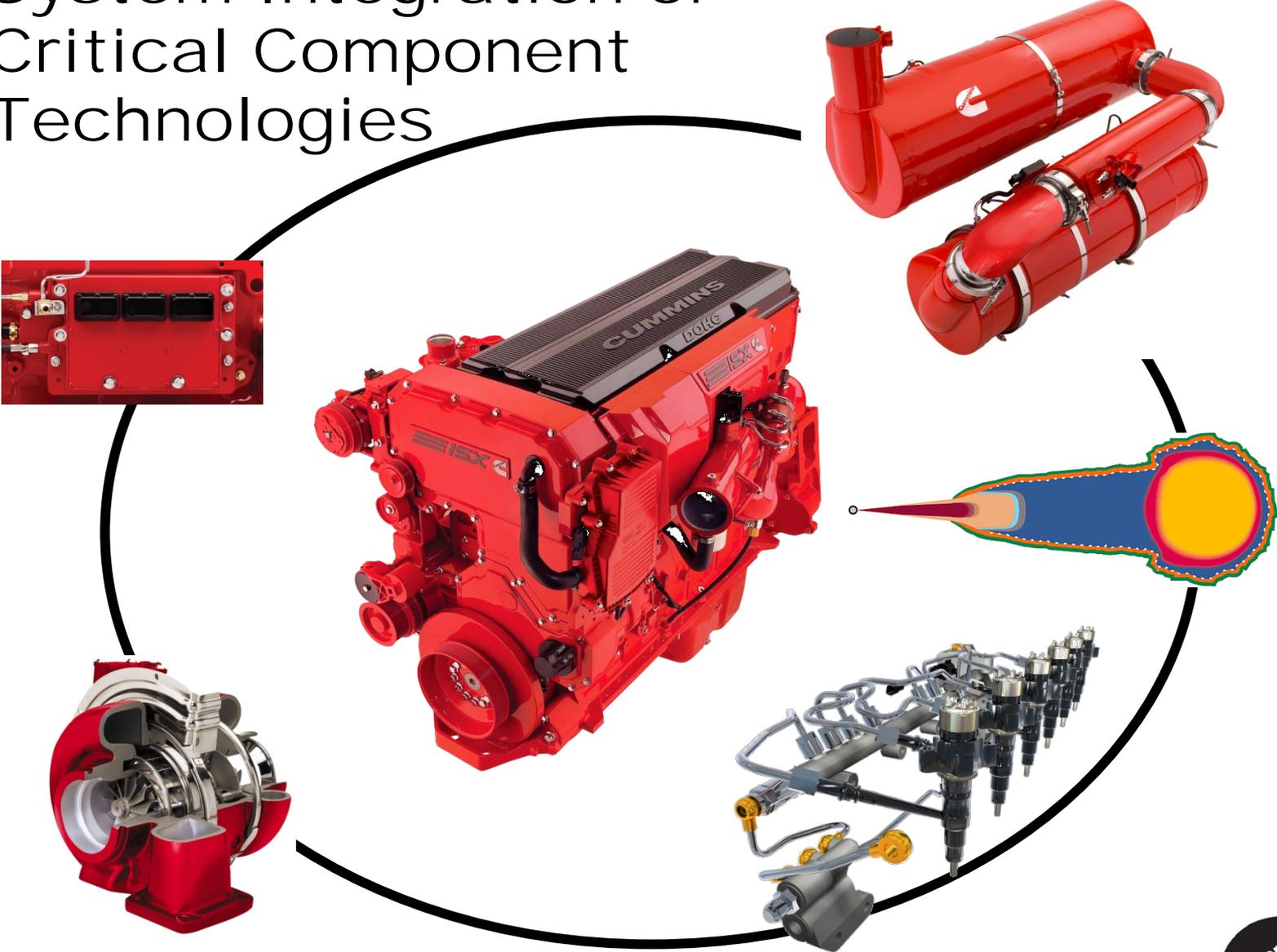
- **Customer + Environmental Value**
 - **“The Right Technology Matters”**
- **System Integration**
 - **Broad Technology Portfolio**
 - **Long Term View**



The Right Technology Matters



System Integration of Critical Component Technologies



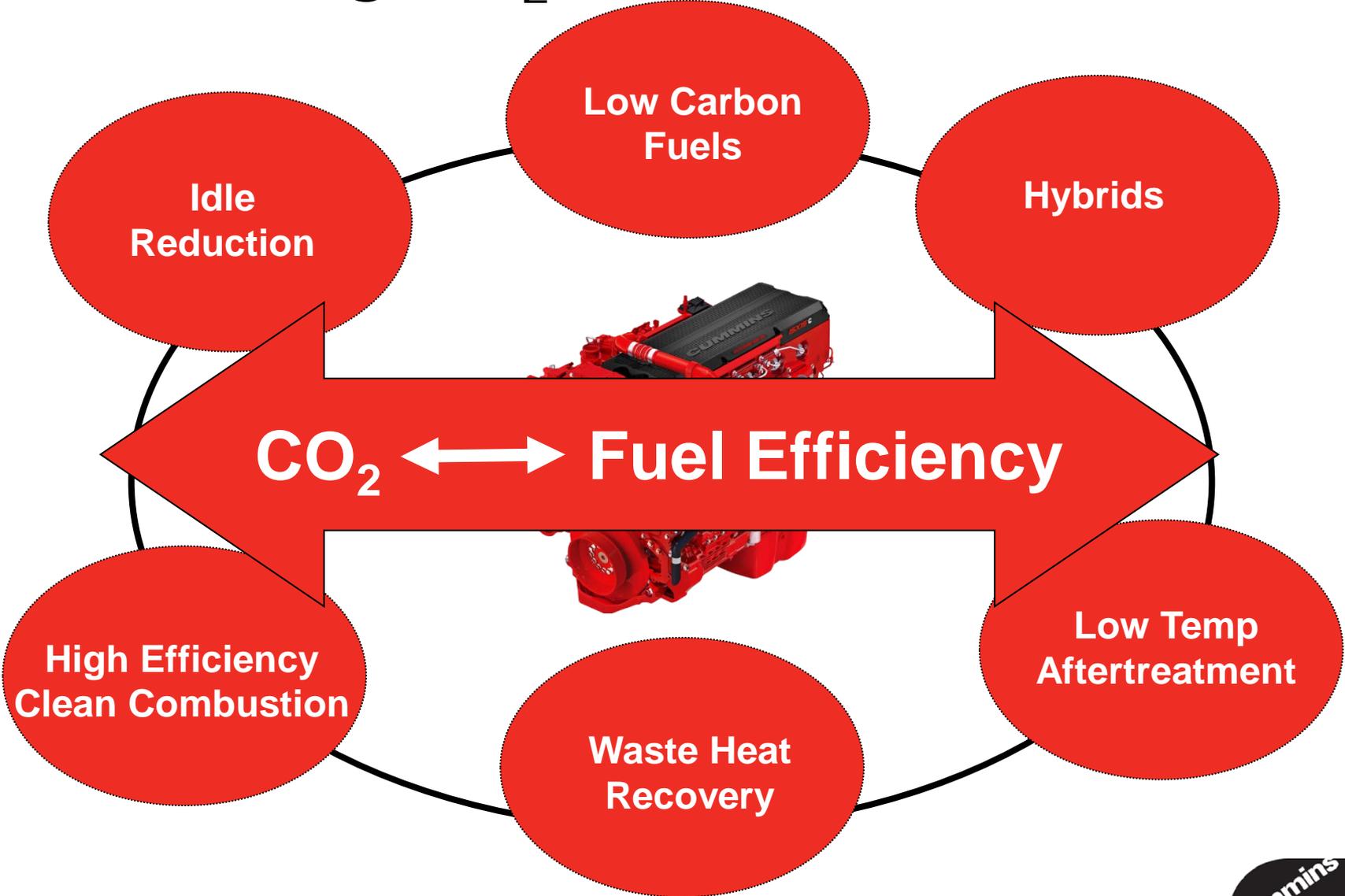
The Right Technology Matters

- **Broad technology portfolio**
- **Align technology with customer application for best value while meeting emissions requirements**

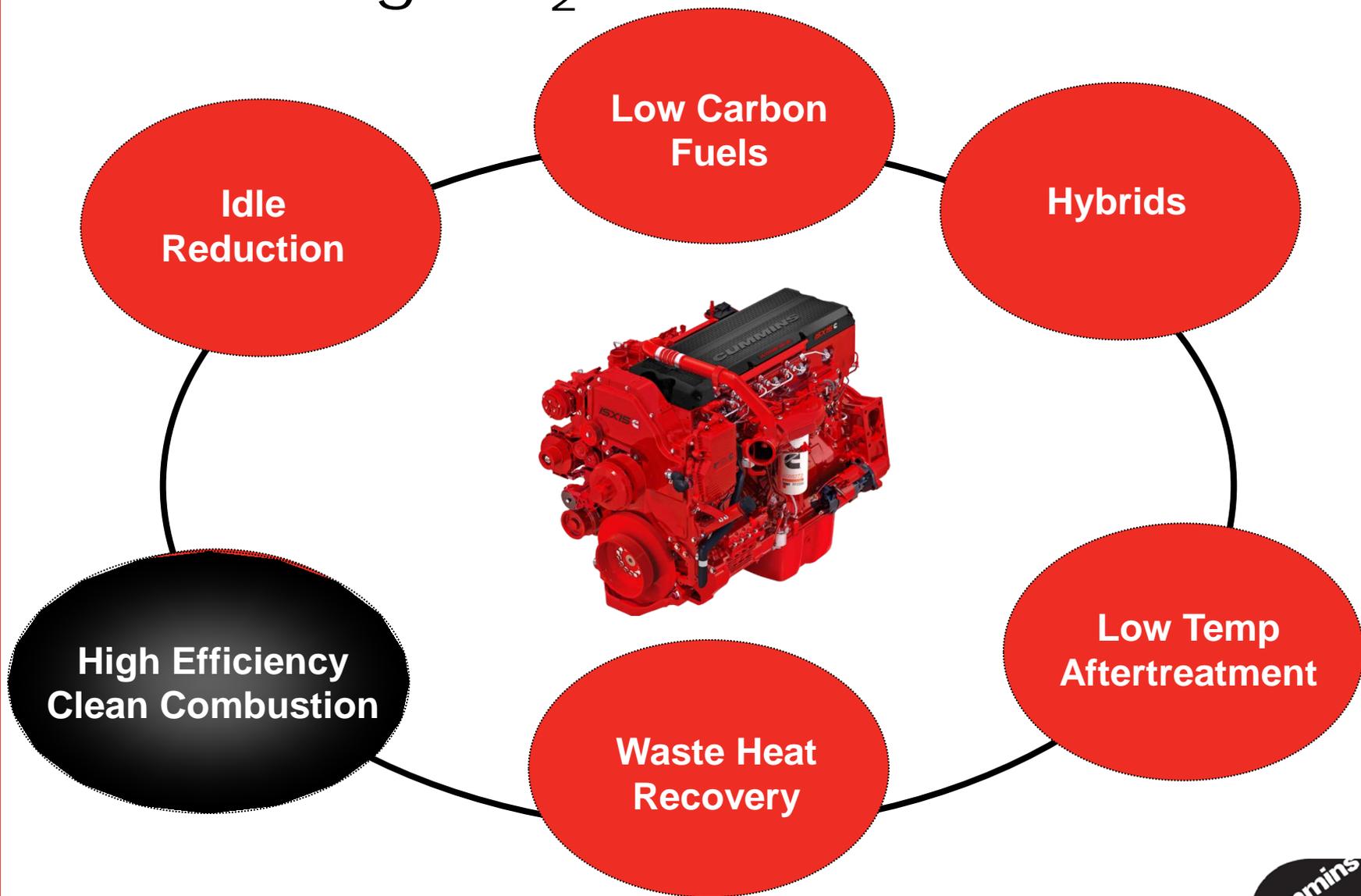
Application	First Date	In-Cylinder Only	Cooled EGR/VGT	NOx Adsorber	SCR	PM Aftertreatment
Tier 3 / EU Stage IIIA	2005	●				
EPA Tier 2 > 751 hp	2006	●				
Euro 4 On-Highway	2006				●	
EPA 07 On-Highway	2007		●			●
EPA 07/10 Pickup Truck	2007		●	●		●
Euro 5 On-Highway	2009				●	
EPA 10 On-Highway	2010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



Reducing CO₂

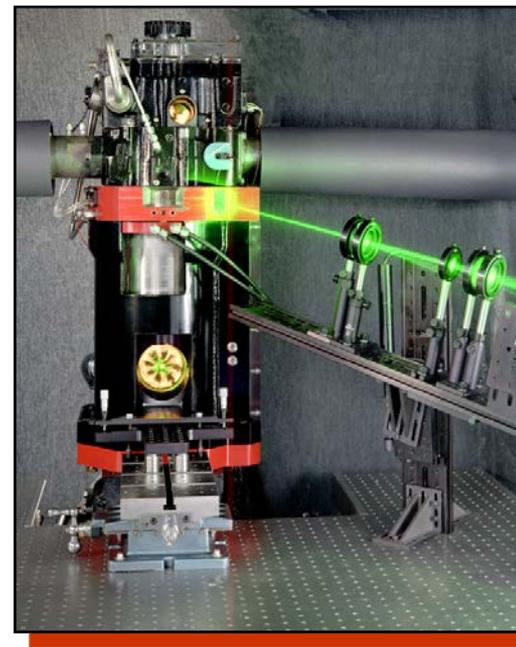
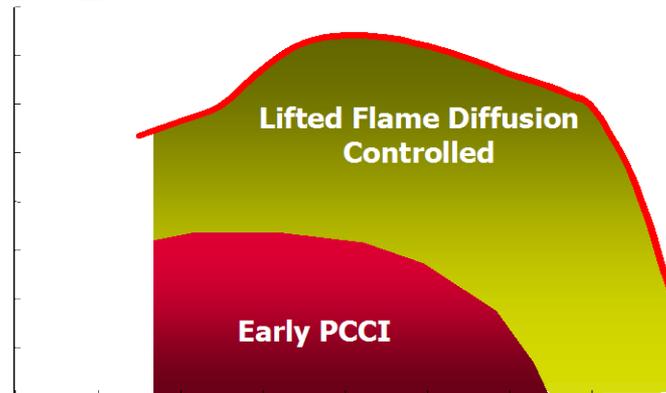
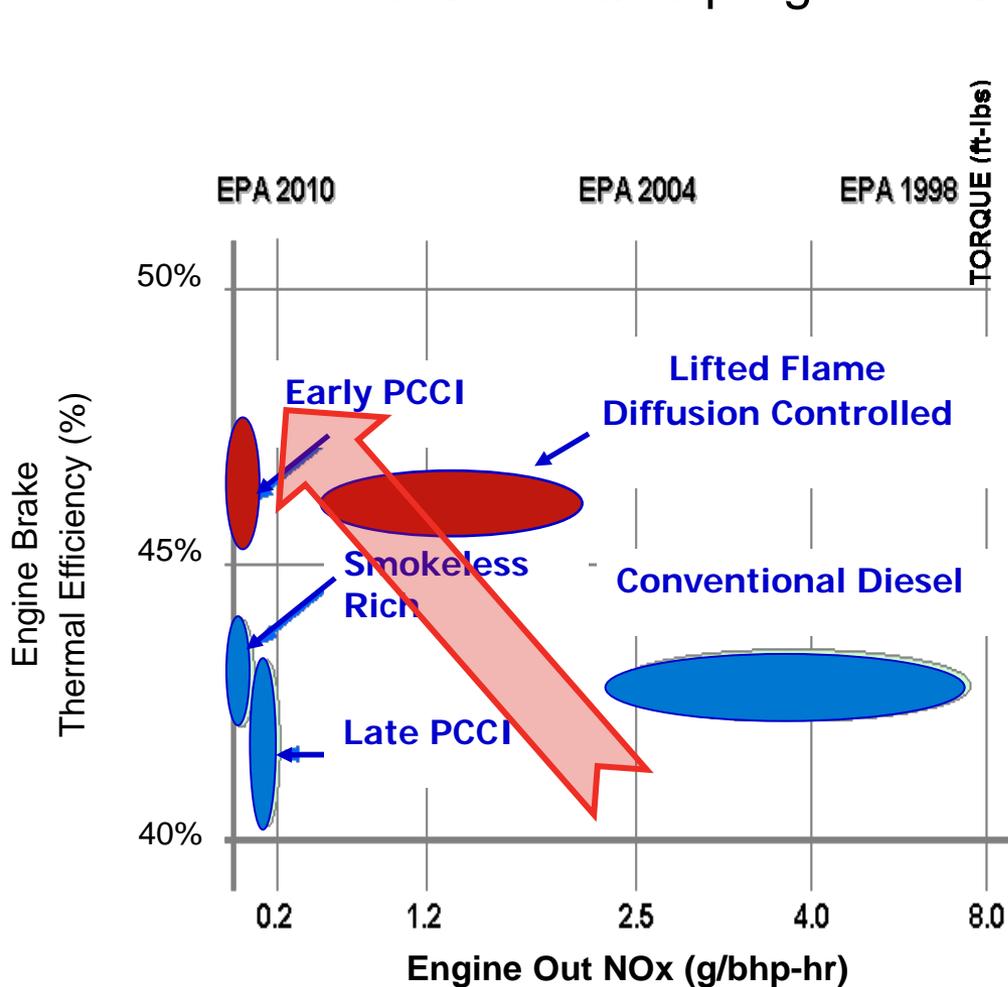


Reducing CO₂



High Efficiency Clean Combustion

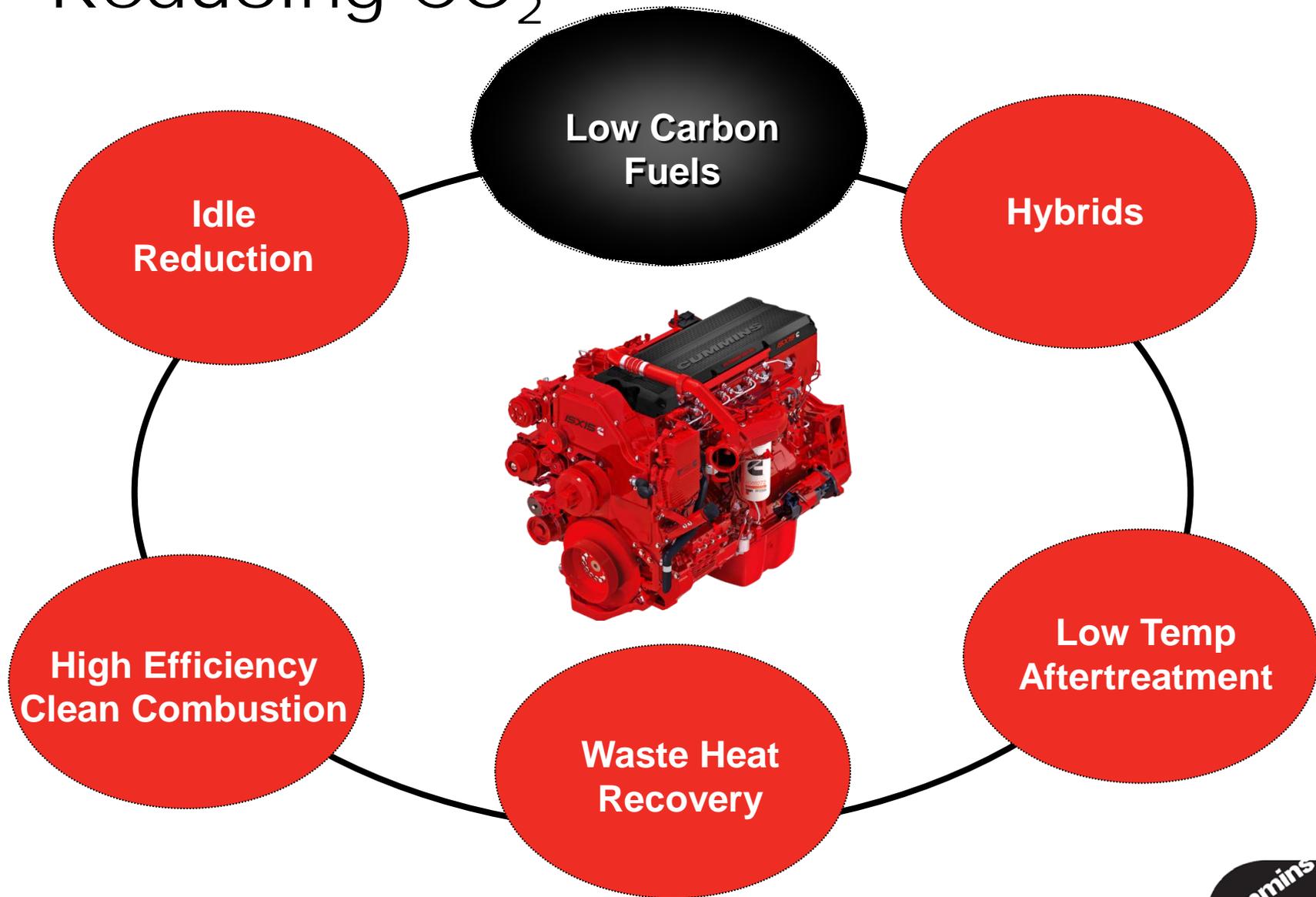
Collaborative program with DoE



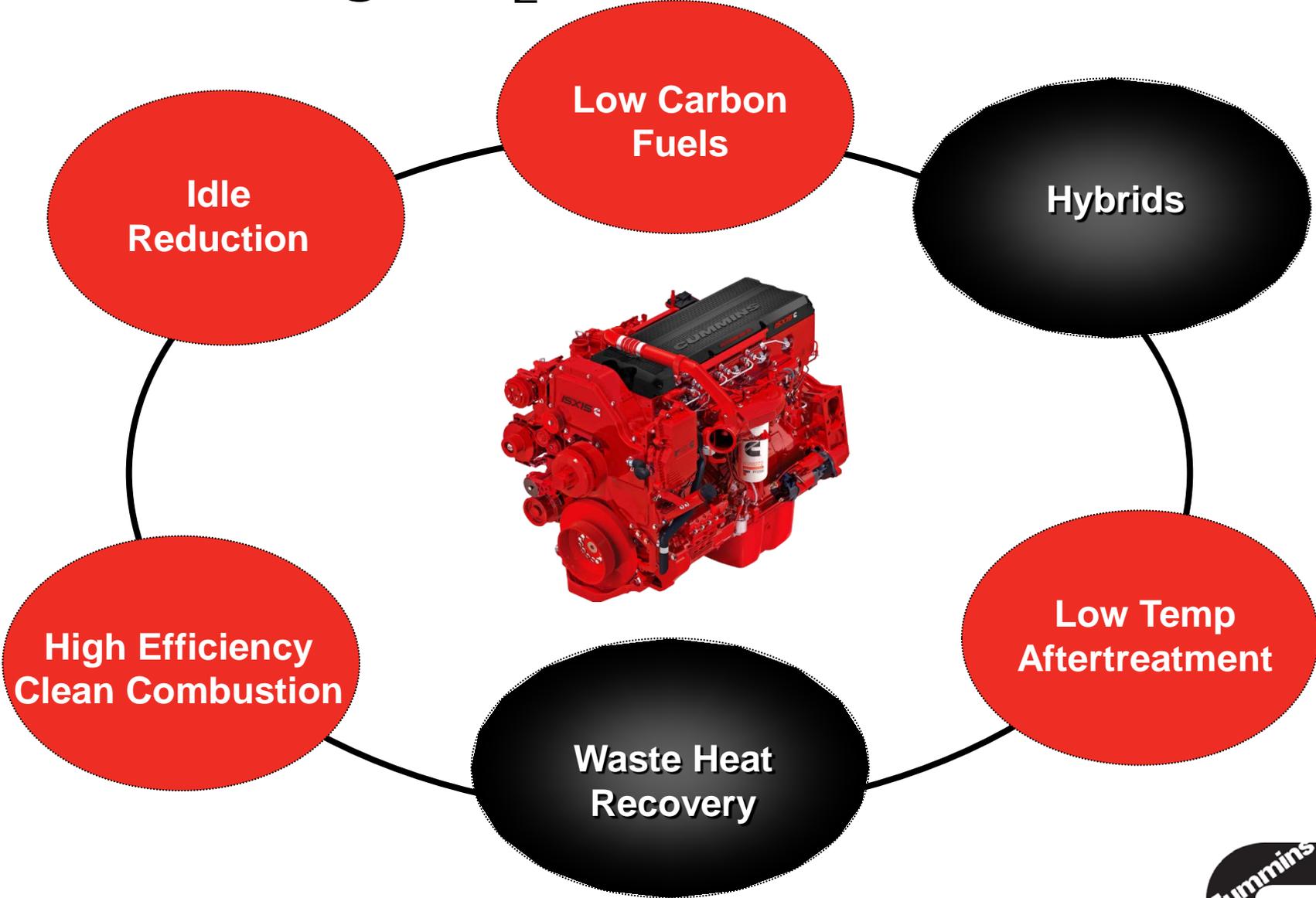
Innovation You Can Depend On™



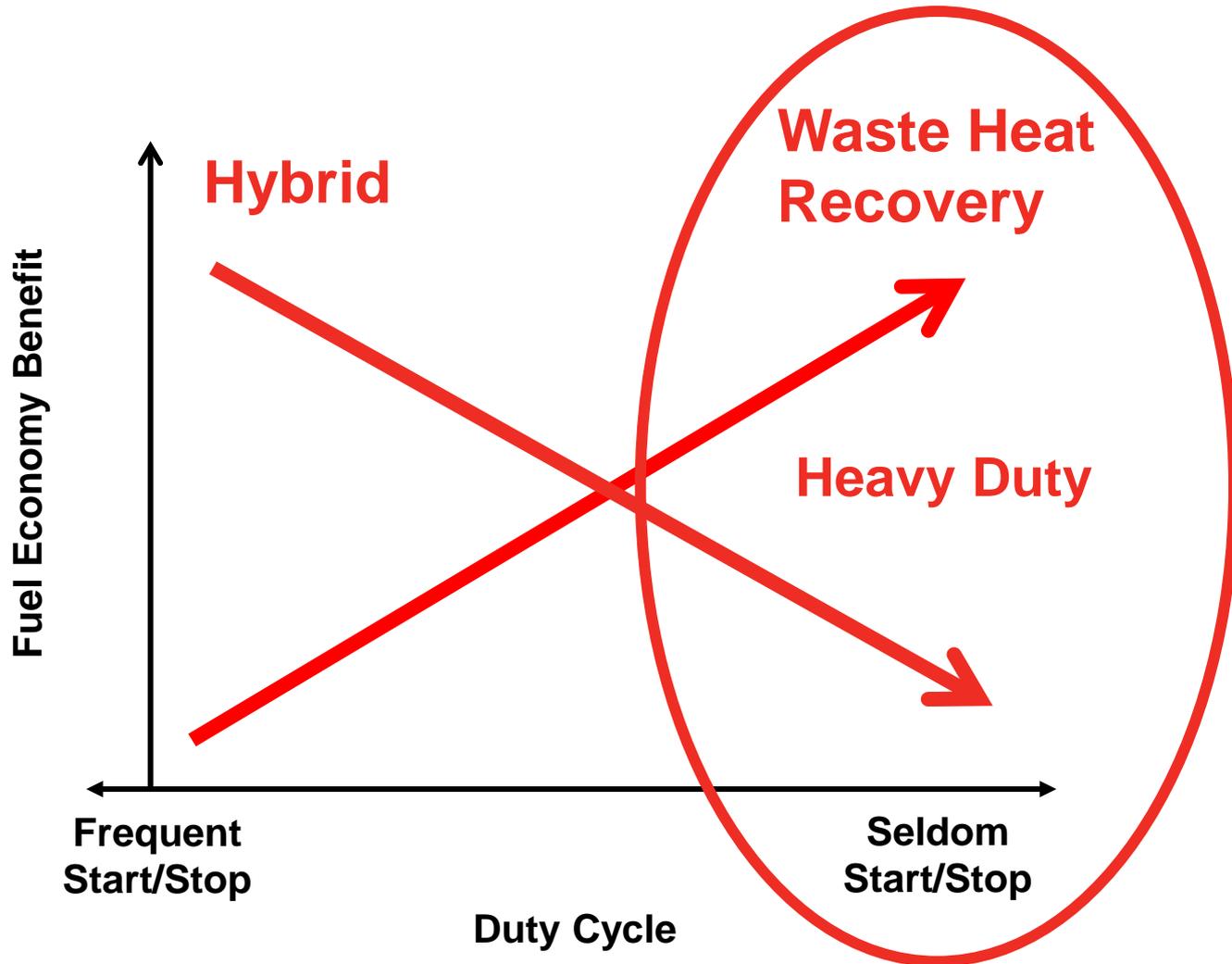
Reducing CO₂



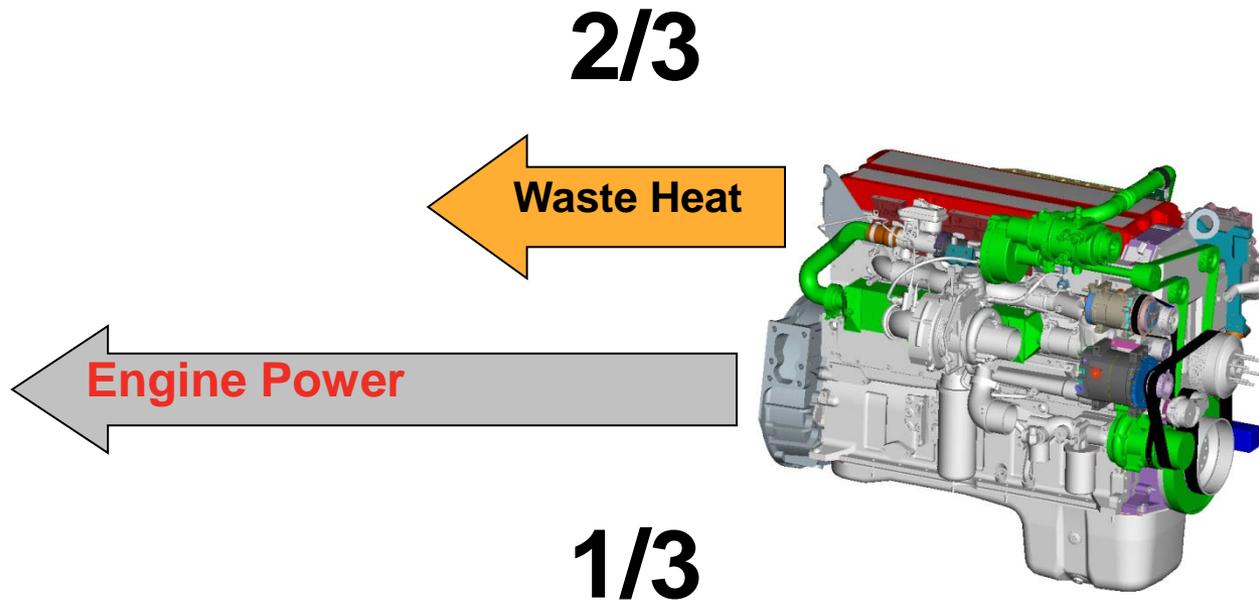
Reducing CO₂



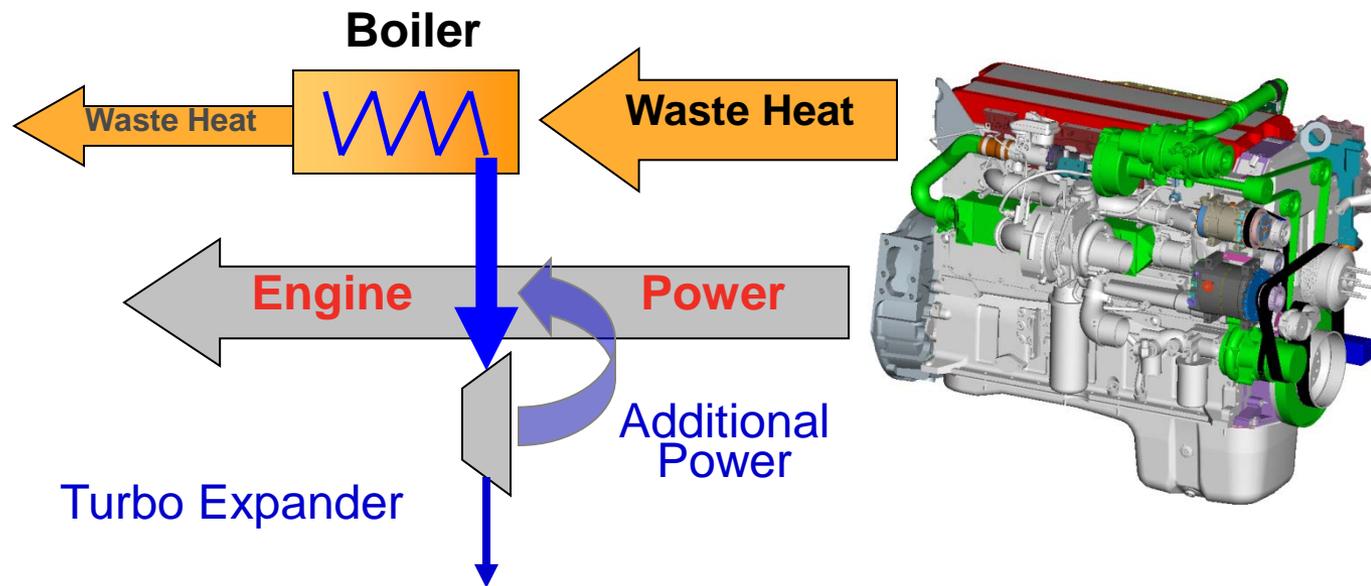
Waste Heat Recovery vs. Hybrid



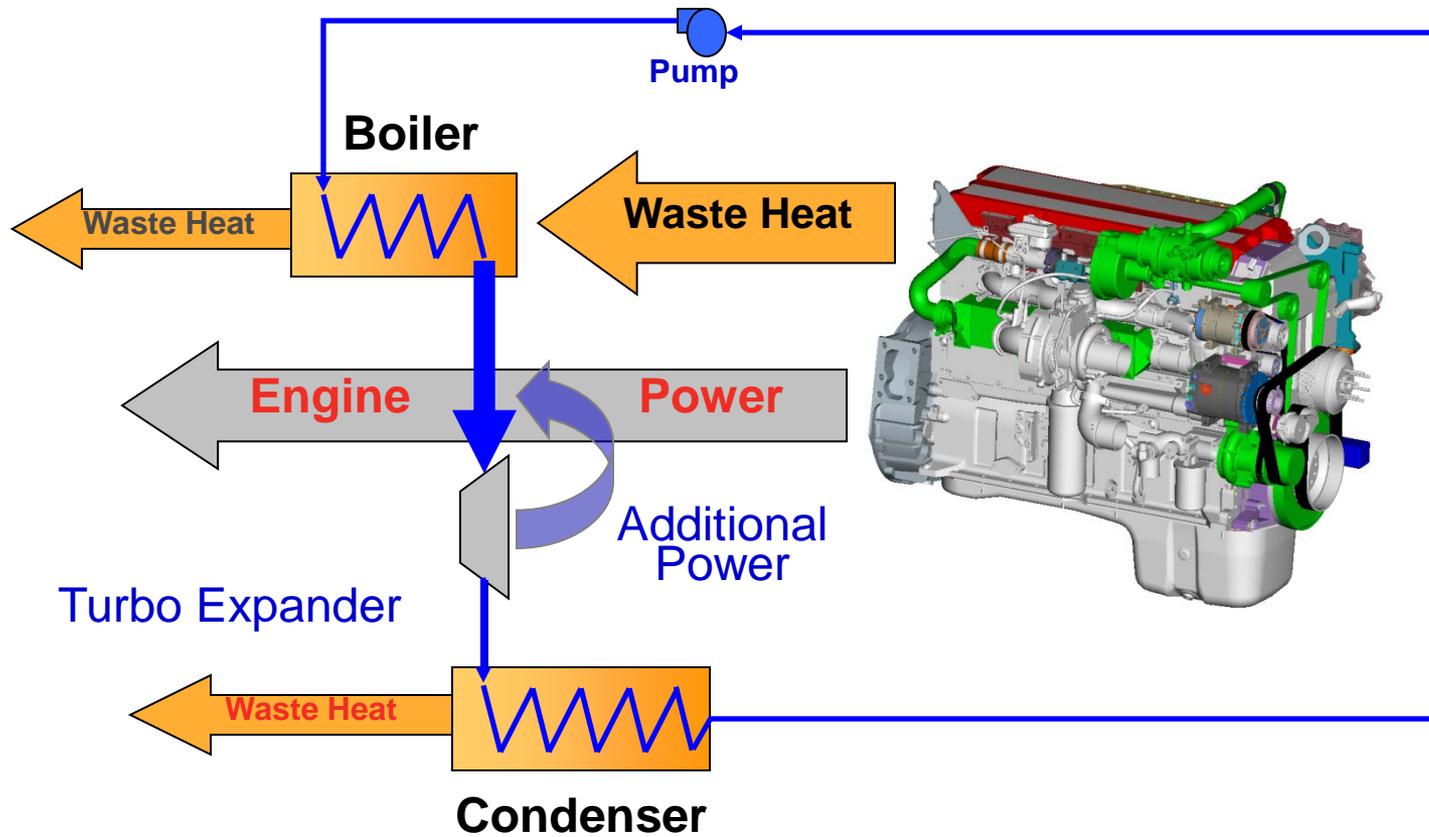
Base Engine



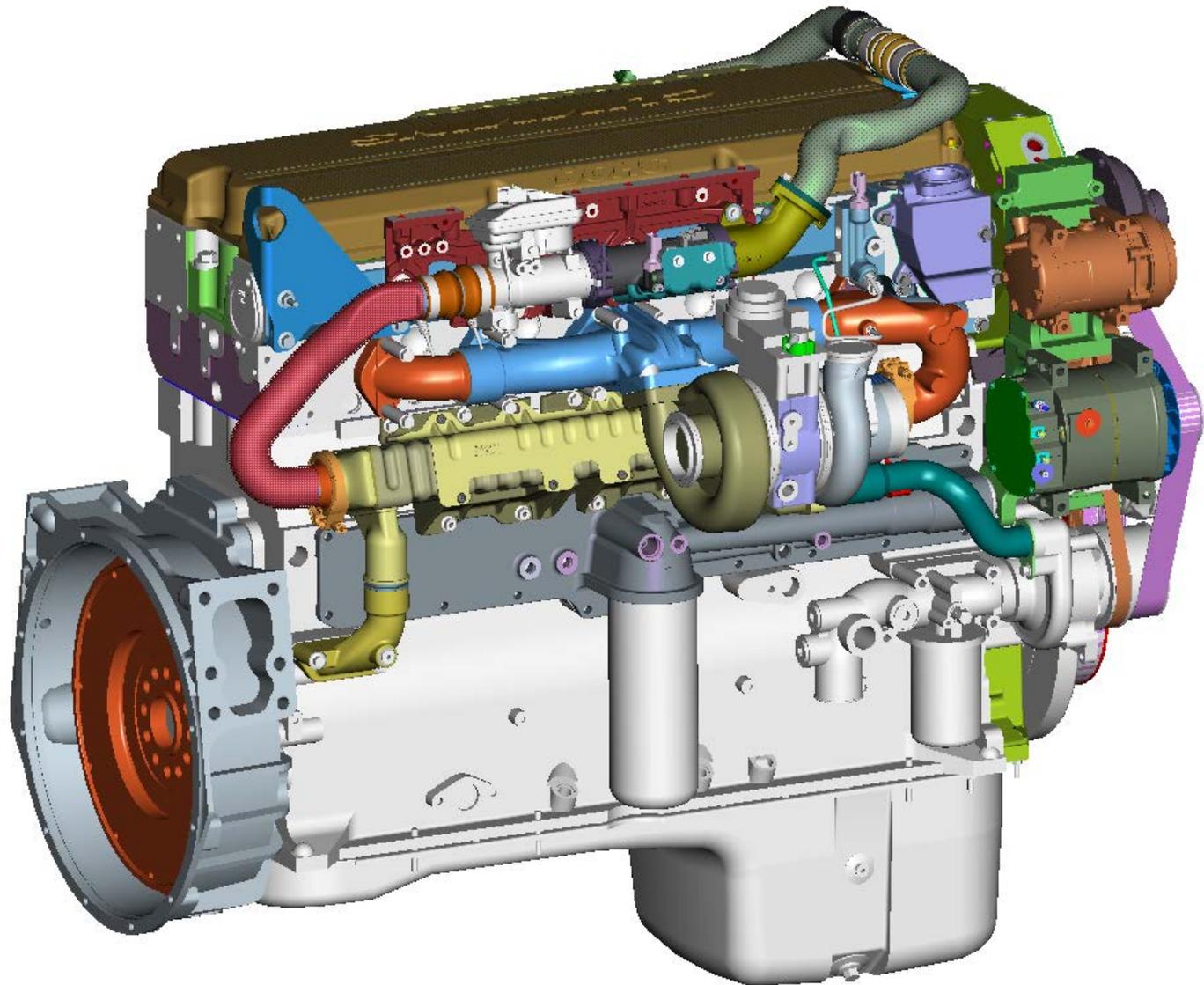
Waste Heat Recovery



Waste Heat Recovery



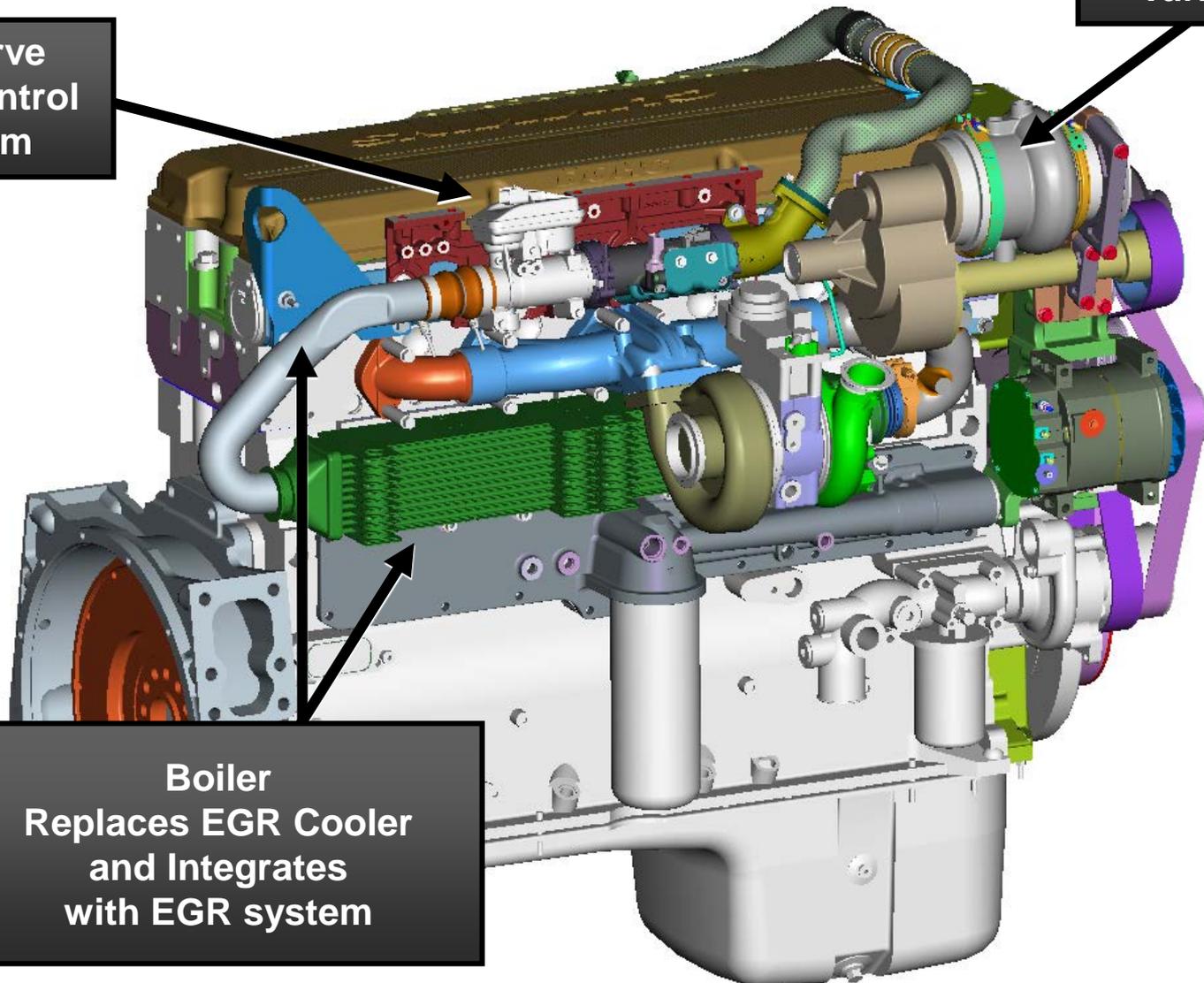
ISX Engine with EGR



ISX Engine with WHR

WHR
Power
Turbine

Preserve
EGR Control
System

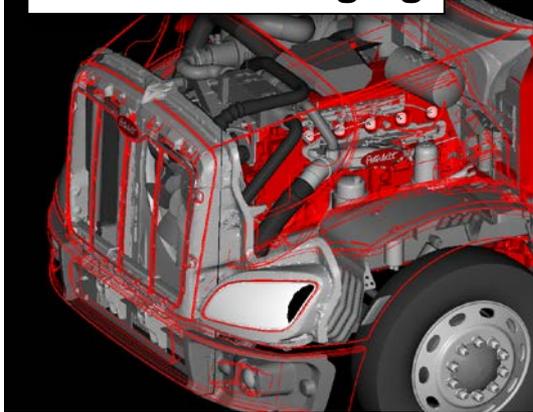


Boiler
Replaces EGR Cooler
and Integrates
with EGR system

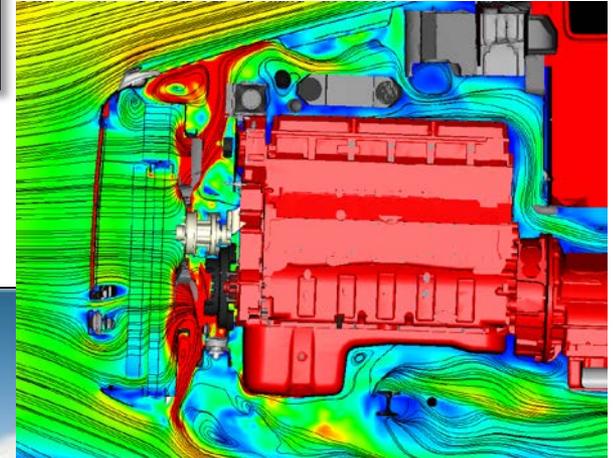


Vehicle Integration and Testing of the Cummins Waste Heat Recovery System – DoE SuperTruck

Vehicle Packaging



Under Hood
Air Flow

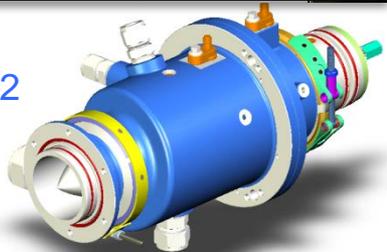


Peterbilt Model 587



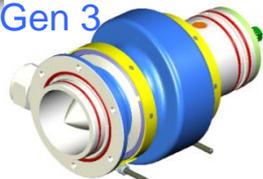
Reduce Size and Cost
of Components

Gen 2

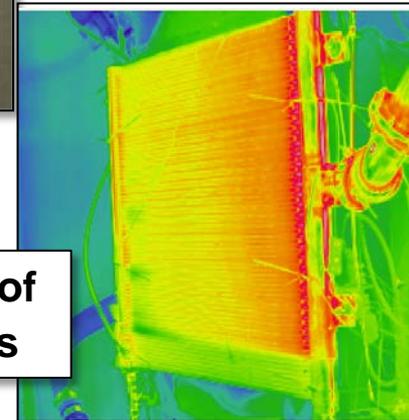


Turbine
Expander

Gen 3



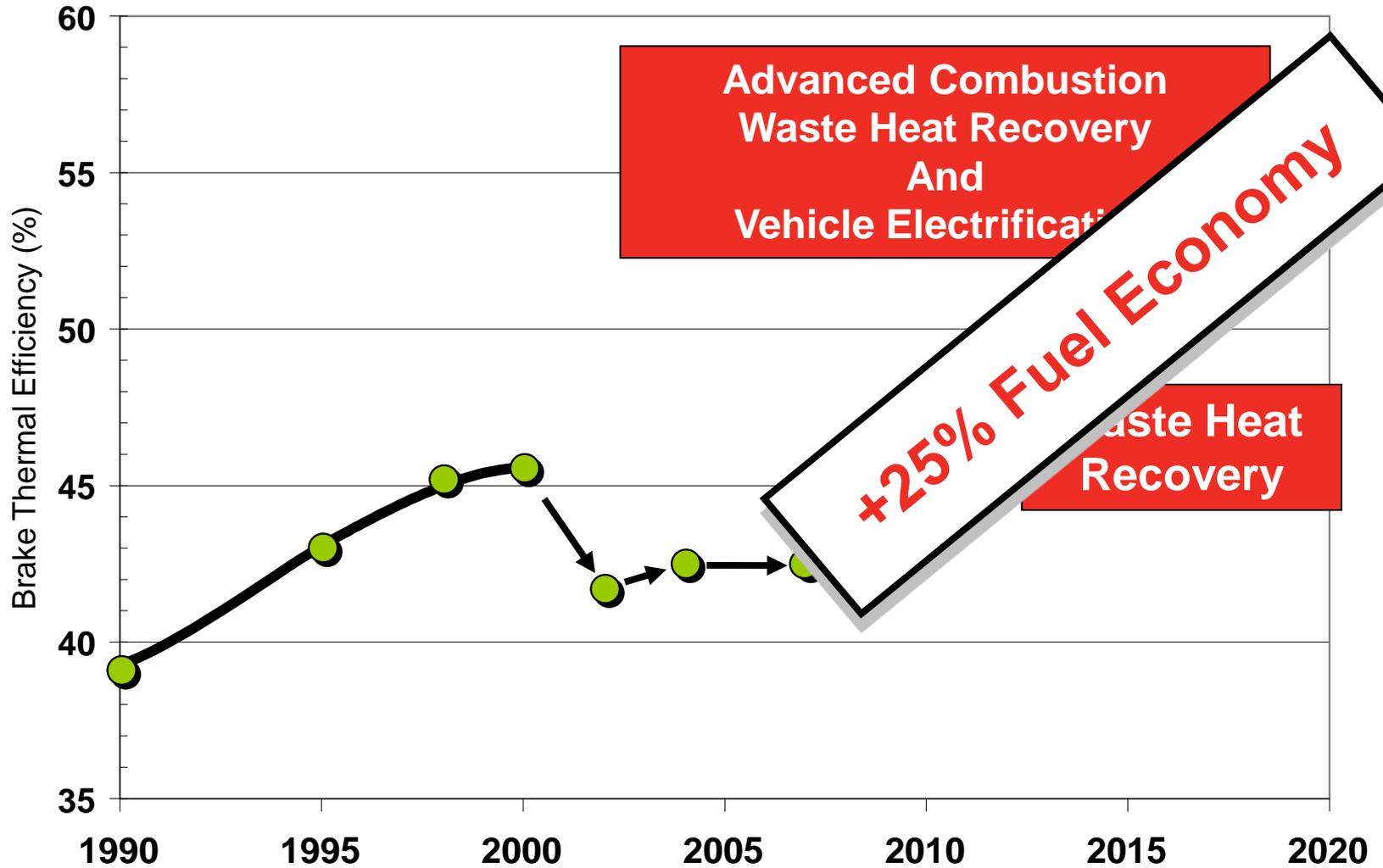
Transient Controls



Thermal Imaging of
Heat Exchangers



Heavy Duty Engine Efficiency



Innovation You Can Depend On™

- 您可信赖的创新 ■ L'innovation
Sur Laquelle Vous Pouvez Compter
- 期待に答える技術革新 ■
Innovación En La Que Usted Puede
Confiar ■ 신뢰할 수 있는 혁신
- Inovação Que Você Pode Confiar
- नवयुक्ति जिस पर आप निर्भर कर सकें ■

**One World. One Mission.
Technical Excellence.**

