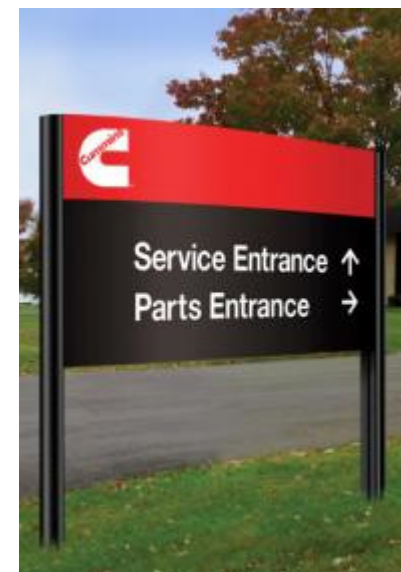


Emerging Engine Technologies for Heavy Duty Vehicle Fuel Efficiency



*ACEEE - ICCT Workshop
July 22, 2014*

Gary Salemmme
Director – Advanced Engineering Systems Integration
Cummins Inc.

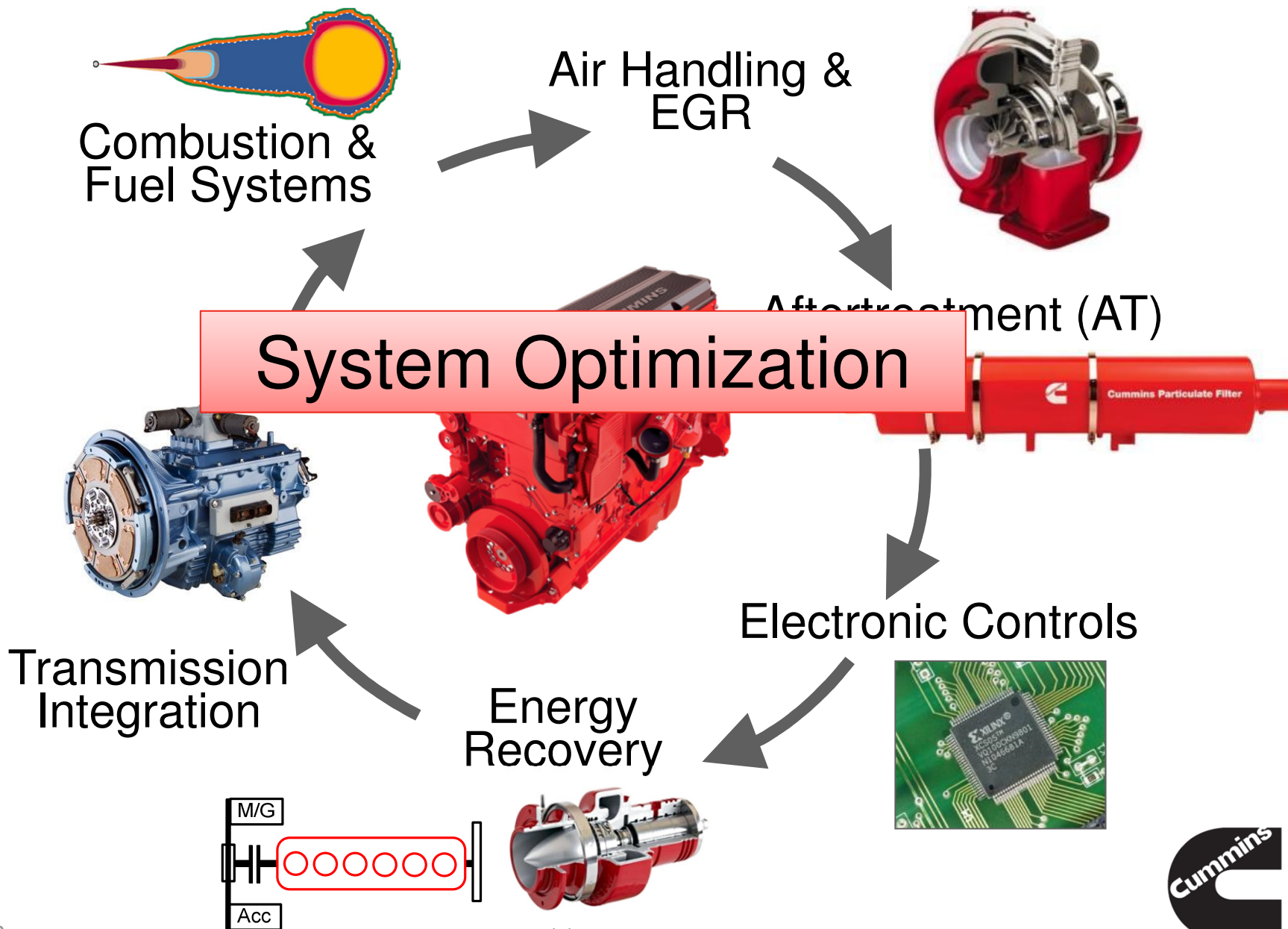


Topics

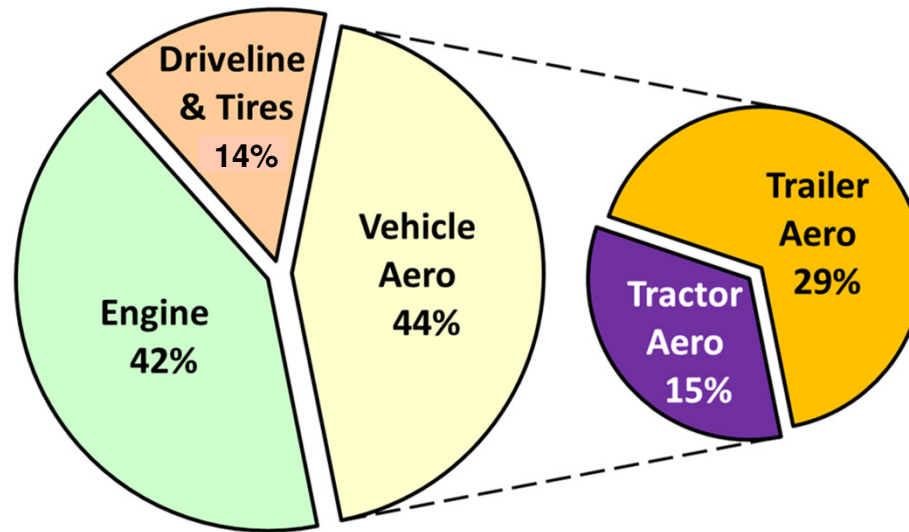
- Engine Technology Potential
- Example Future Technologies



Subsystem Technology Palette



SuperTruck Technology Contributions



Technologies for 50% Engine Thermal Efficiency

Combustion & Air Handling

- Piston bowl size and shape
- Injector specification
- Calibration optimization
- Turbocharger efficiency
- Aftertreatment optimization

Parasitic reductions

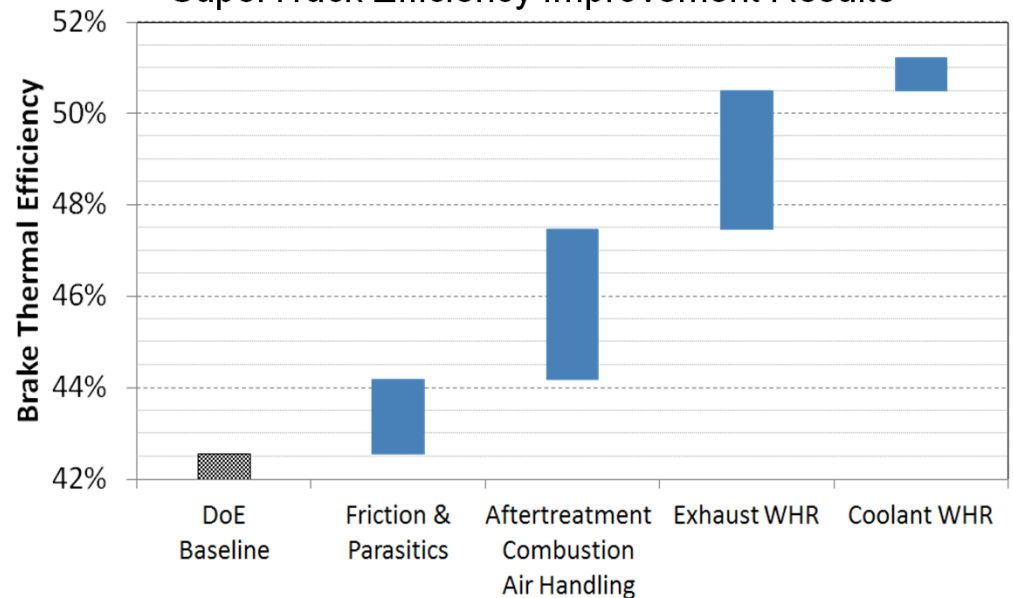
- Shaft seal
- Variable flow lube pump and viscosity
- Geartrain
- Cylinder kit friction
- Cooling and fuel pump power



WHR system

- EGR, exhaust, recuperator
- Turbine expander
- Low GWP refrigerant

SuperTruck Efficiency Improvement Results

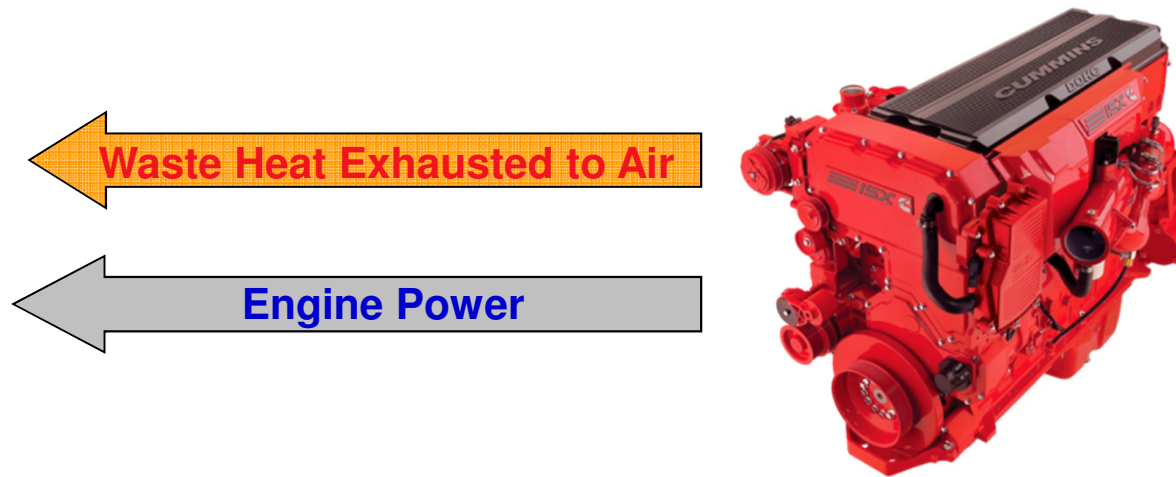


2020 – 2030 CO₂ Reduction Potential

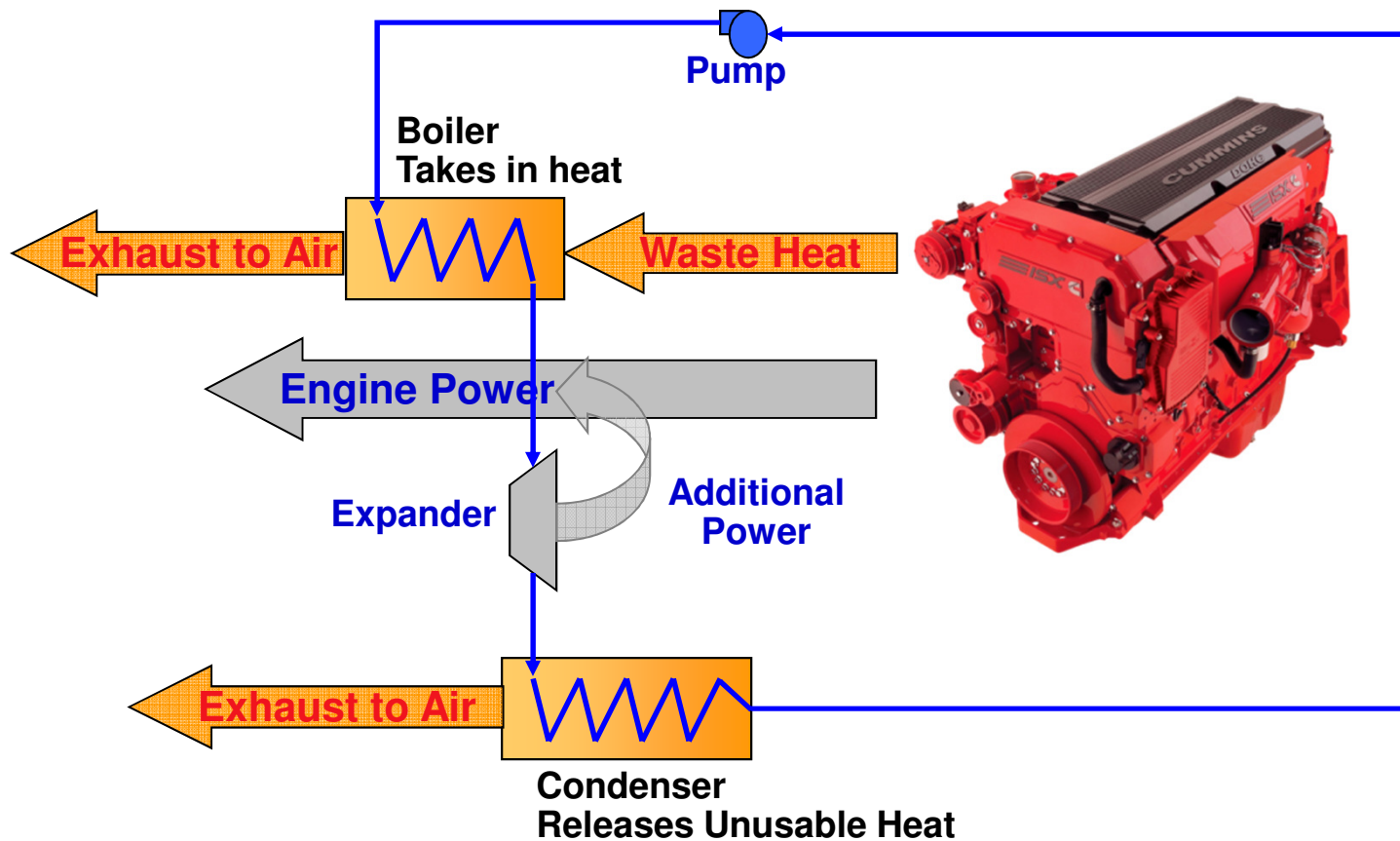
	Potential % Improvement vs. 2017 Standards (On the Certification Cycle)	
	Heavy Heavy-Duty Tractor	Key Technologies
Engine	9 - 15	Advanced Combustion Strategies Turbocharger and EGR Air Handling Friction and Parasitic Reductions Increased Peak Cylinder Pressure High Efficiency Aftertreatment Heat Transfer Management Downspeeding Waste Heat Recovery (WHR)
Engine and Powertrain Integration*	3 - 5	Shift Optimization Cycle Efficiency Management Hybrid

* Not realized on the engine certification cycle

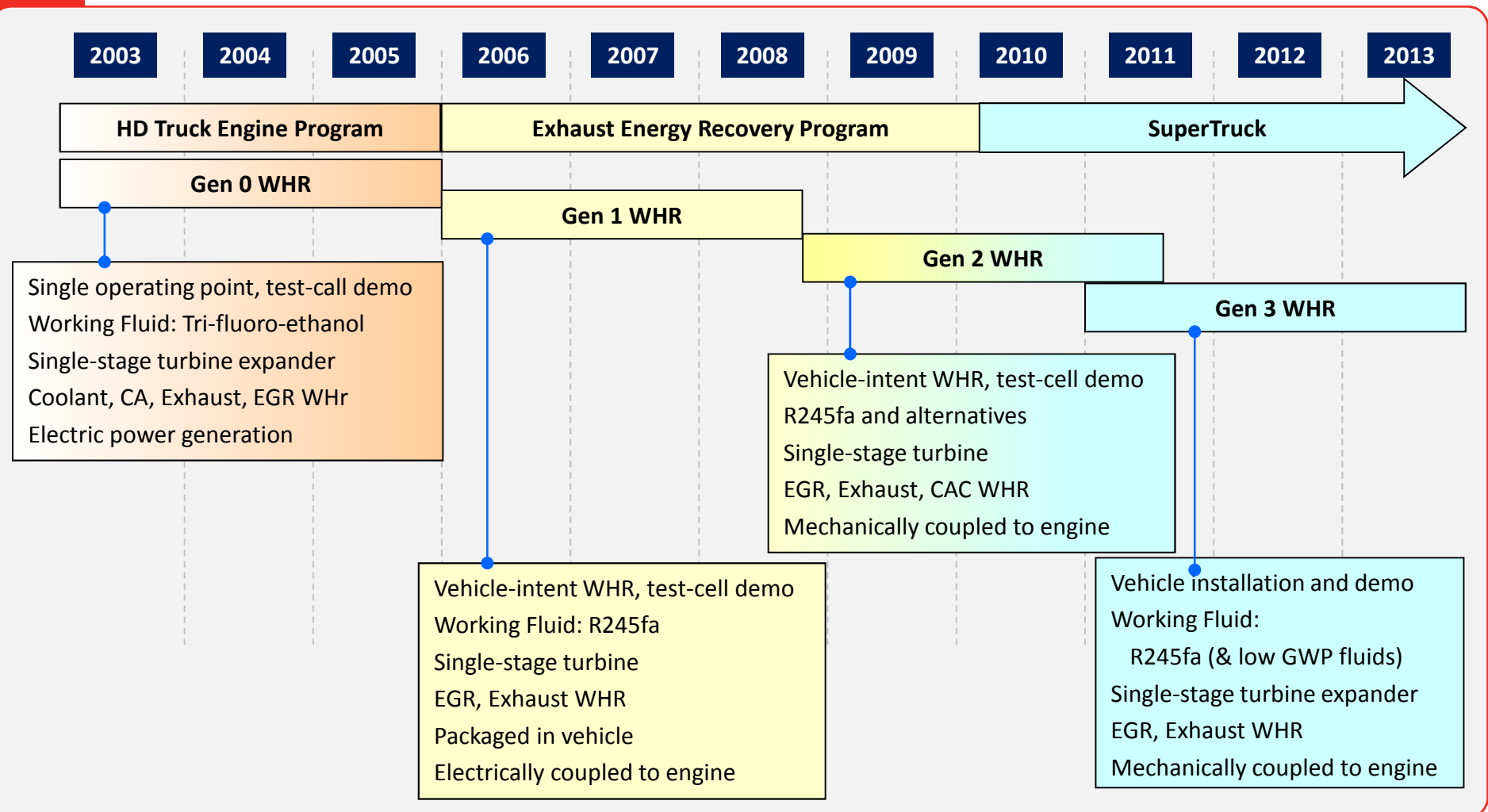
Waste Heat Recovery Technology



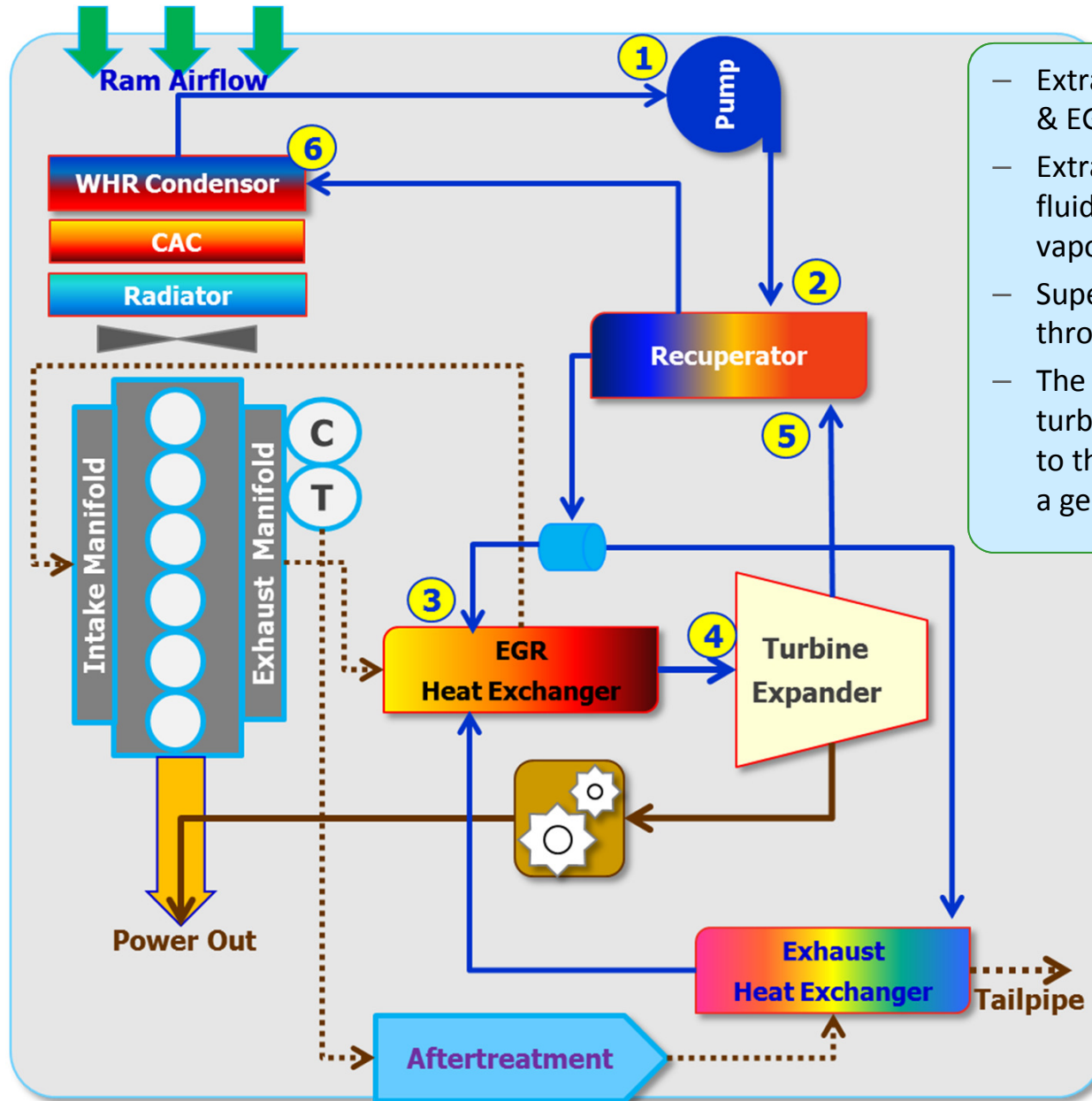
Waste Heat Recovery Technology



History of Automotive WHR Development at CMI



SuperTruck WHR System Overview



- Extraction of energy from Exhaust & EGR stream
- Extracted energy heats working fluid to a "dry" superheated vapor.
- Superheated vapor expands through a Turbine Expander.
- The resulting power to the turbine output shaft is put back to the engine crankshaft through a gearbox.

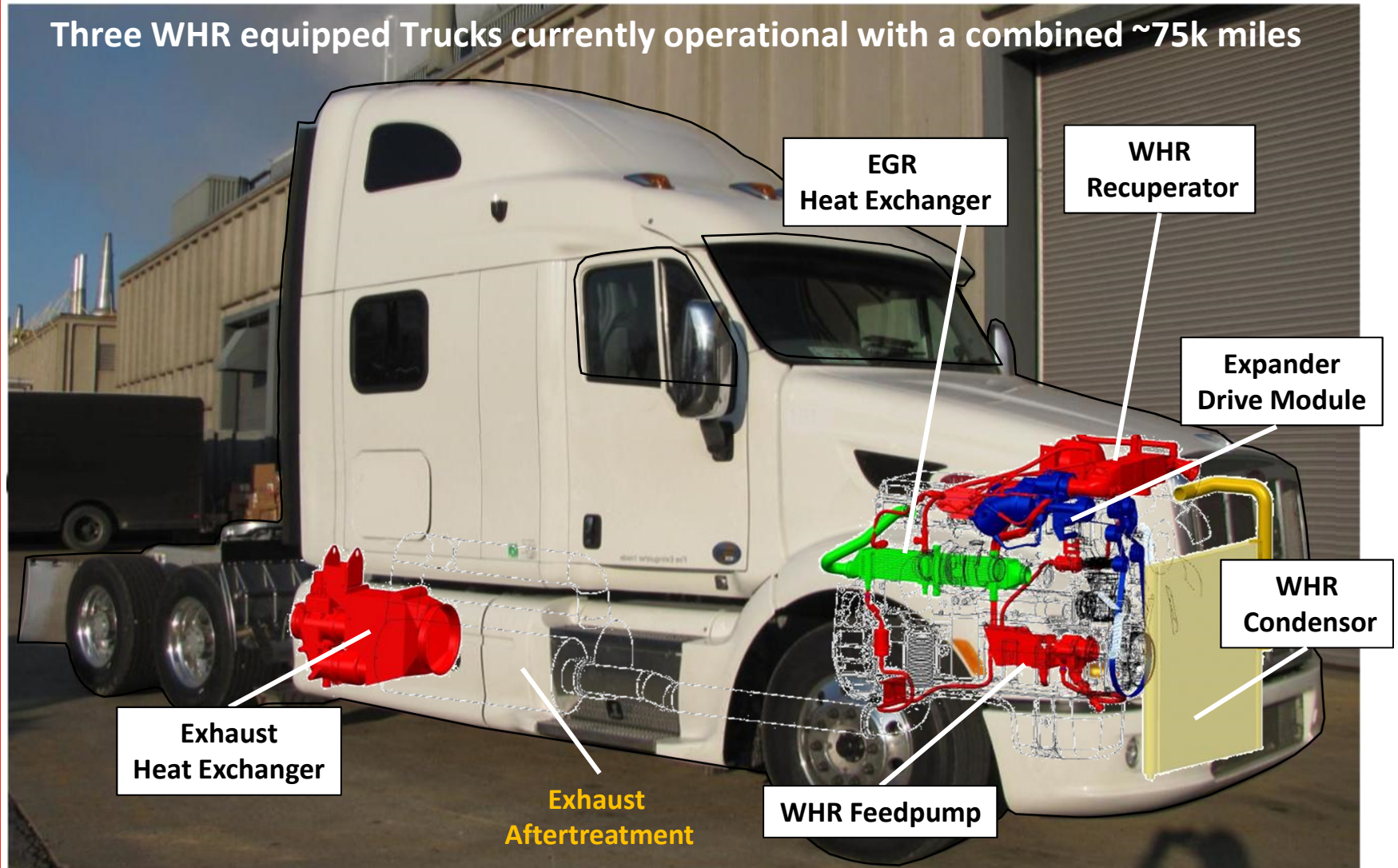
WHR FAQ

- What about vehicle impact?
- What about regional haul?



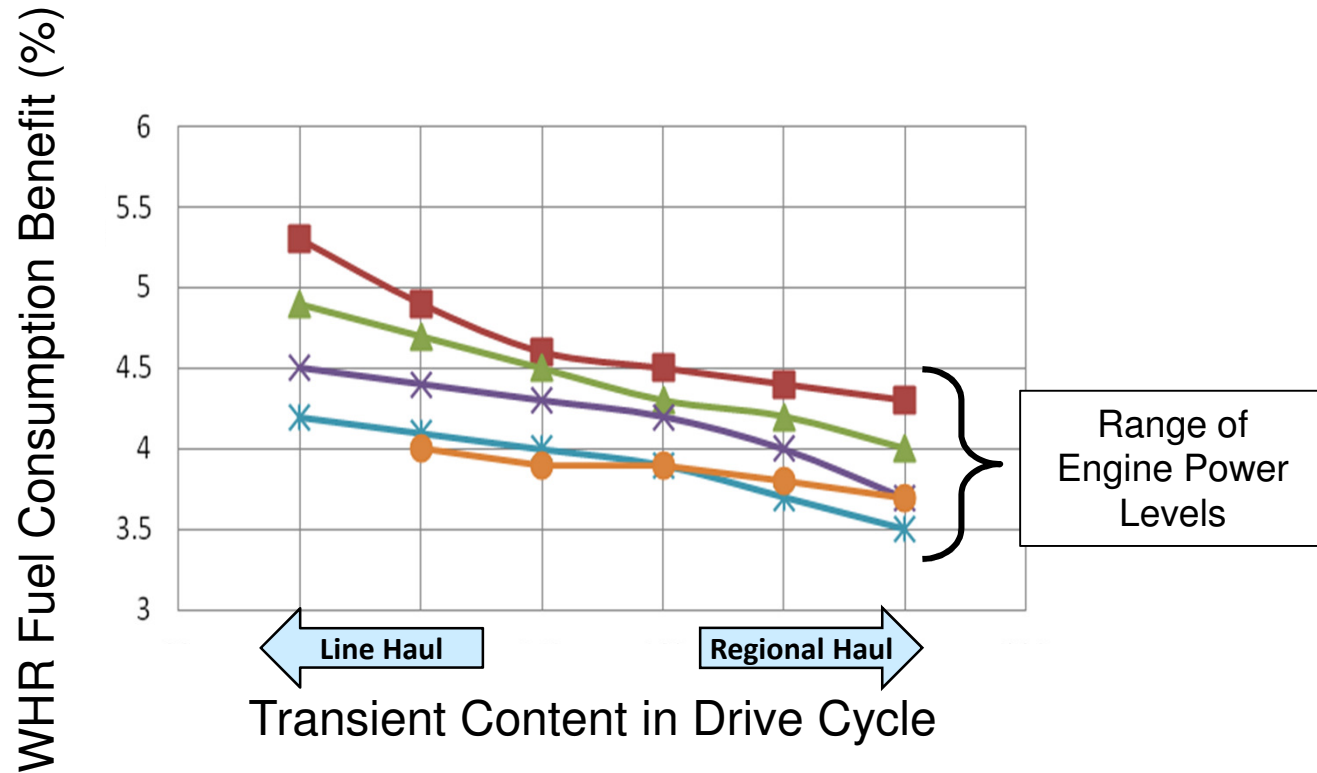
WHR Truck Experience

Three WHR equipped Trucks currently operational with a combined ~75k miles

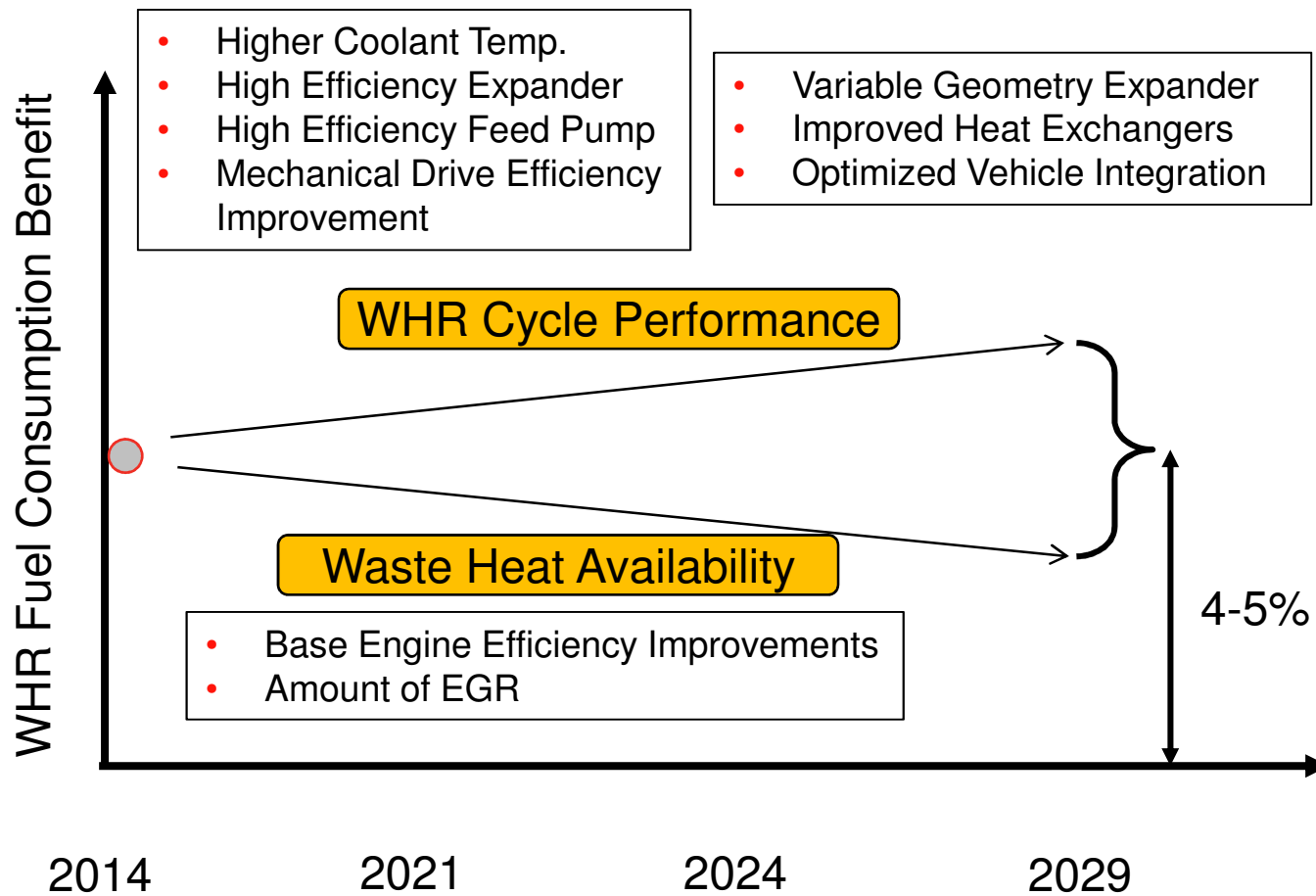


WHR Cycle Sensitivity

WHR Provides Benefit Across Power and Cycle Ranges



WHR Future

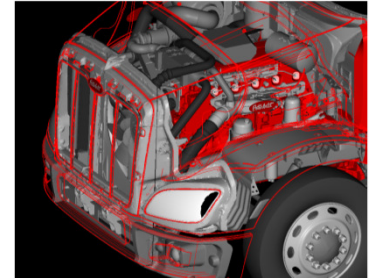


Engine Connection to Other Technologies

Hybrid and
Stop-Start



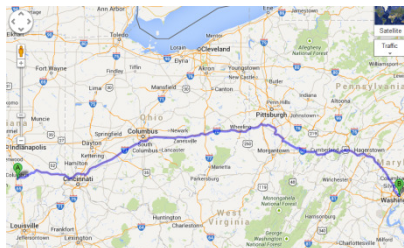
Vehicle
Integration



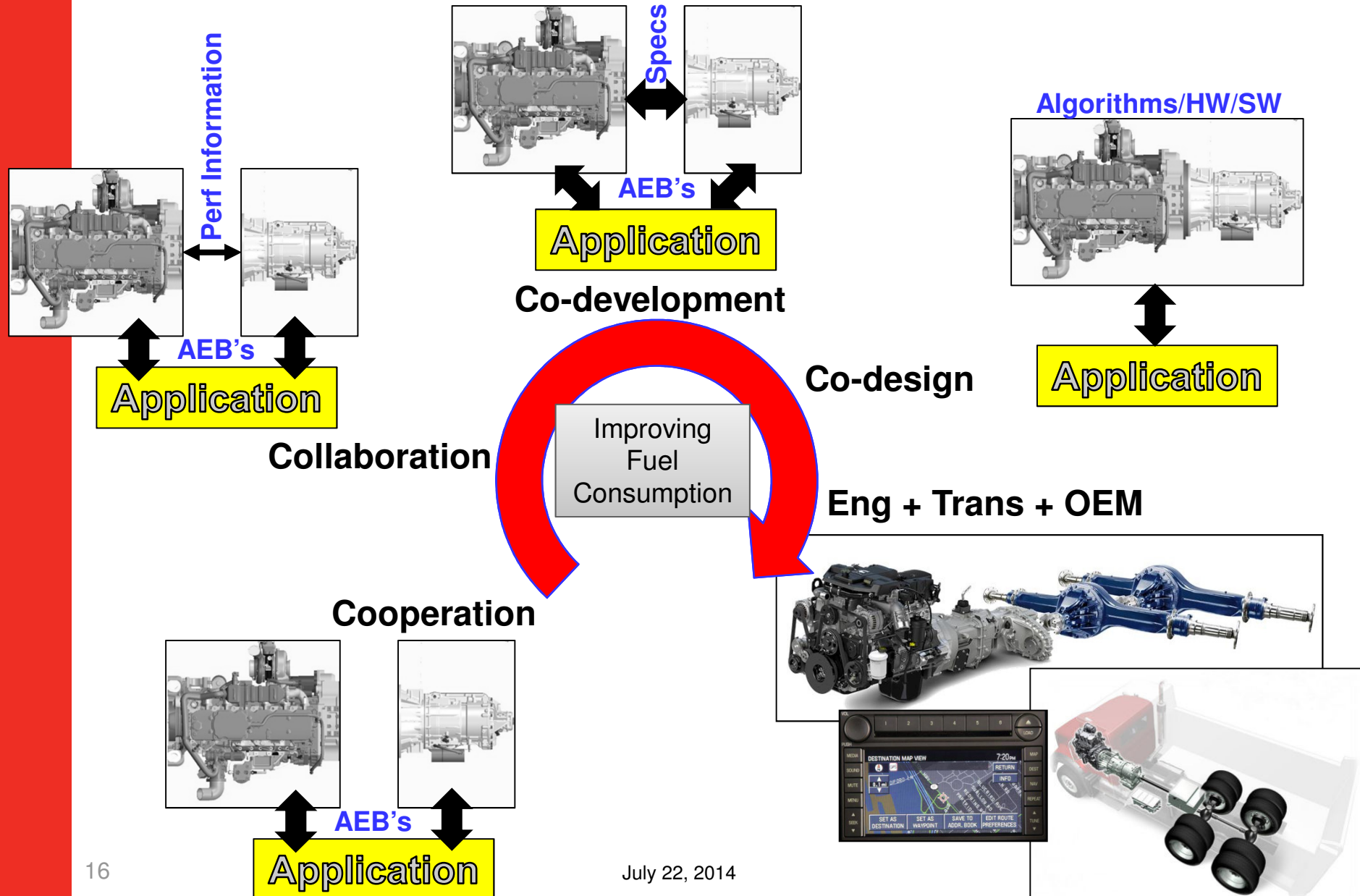
Transmission
Integration



Connectivity and
Telematics



Engine Transmission Integration



Engine Technology Summary

- Engine technology can provide significant improvement in fuel consumption and CO₂ emissions
- System optimization is important
- Waste Heat Recovery technology is progressing
- Optimized powertrain integration will provide significant fuel consumption improvement

