Aerodynamics and Fuel Efficiency

John Woodrooffe

University of Michigan Emeritus

Presentation to

IRTENZ

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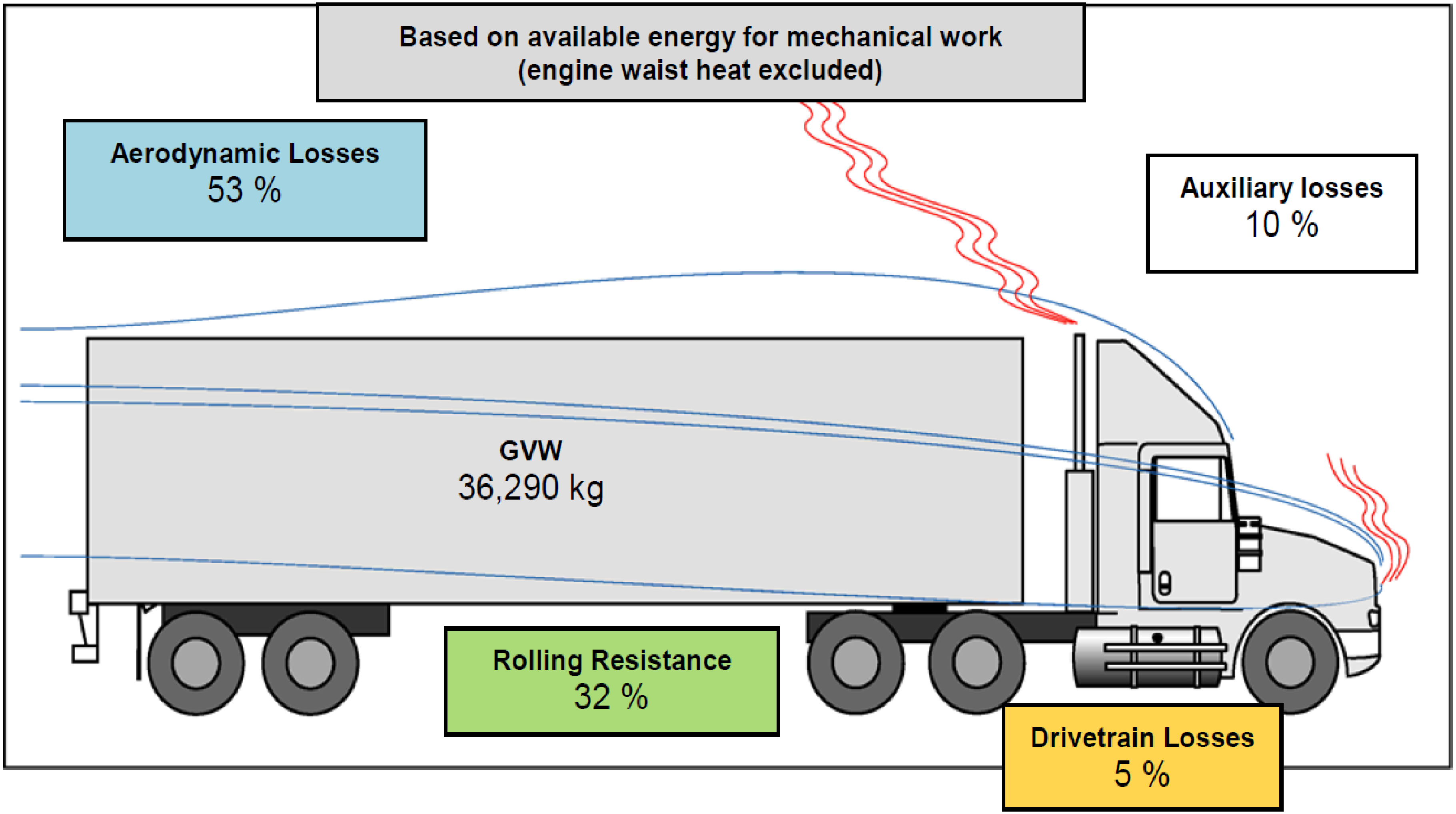


Based on available energy for mechanical work
(engine waist heat excluded)
Aerodynamic Losses
53 %
Auxiliary losses
10 %
GVW
36,290 kg
Rolling Resistance
32 %
Drivetrain Losses
5 %

Aerodynamic power loss

$$P_d = \frac{1}{2} * \rho * C_D * A * V^3$$

P_d Power required to overcome aerodynamic drag

C_D Aerodynamic drag coefficient

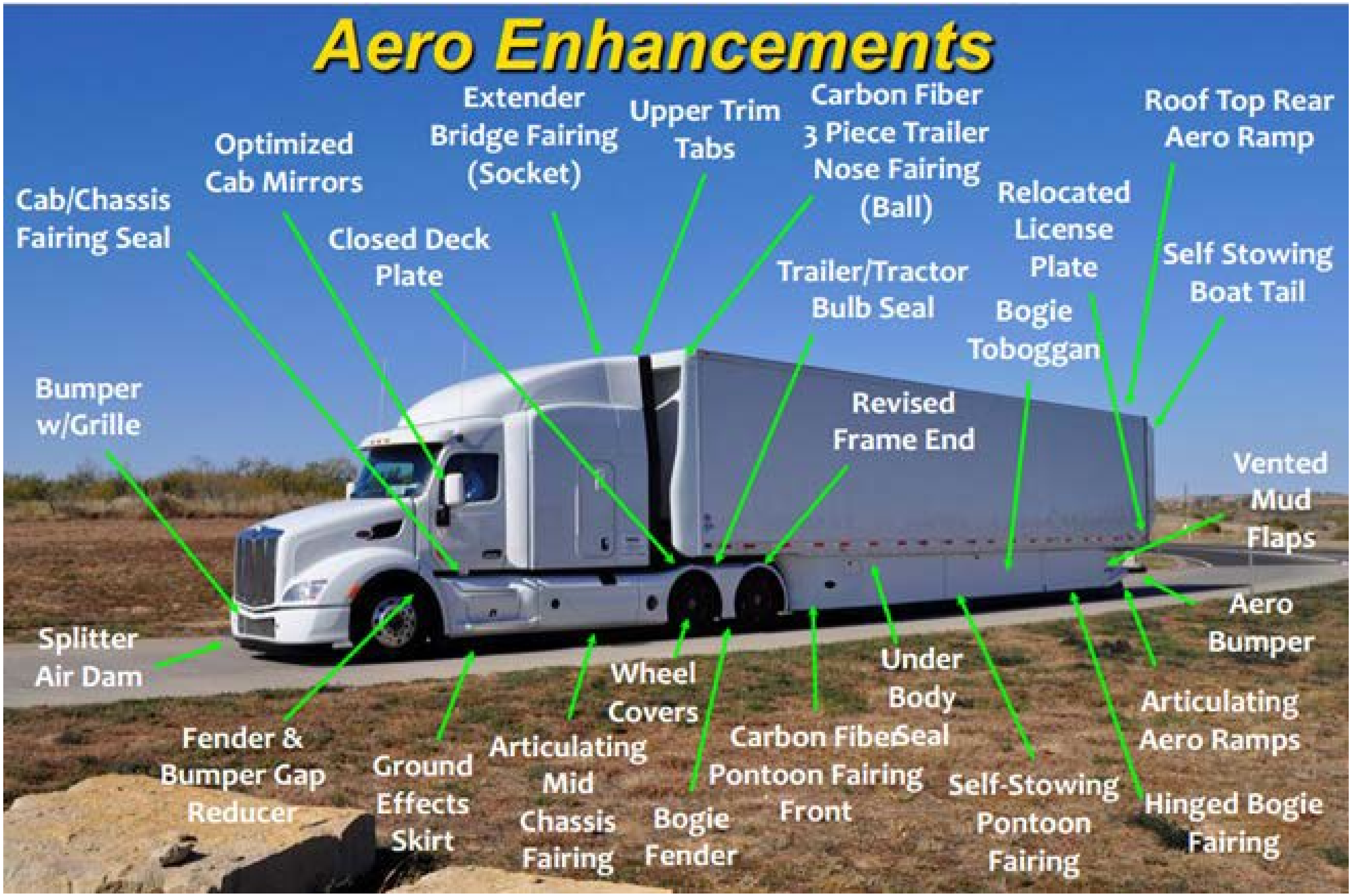
A Projected frontal area of the vehicle

V Velocity of the vehicle

ρ Air density

Key variables for aerodynamic efficiency

- Velocity – most powerful parameter – power requirement (fuel consumption) varies as the cube of velocity
- Aerodynamic drag coefficient represents the slipperiness of the vehicle
- Projected area is effectively governed by vehicle dimensional regulations – the lower and narrower the vehicle the better
- Carriers have the ability optimize aerodynamic loss through speed control.

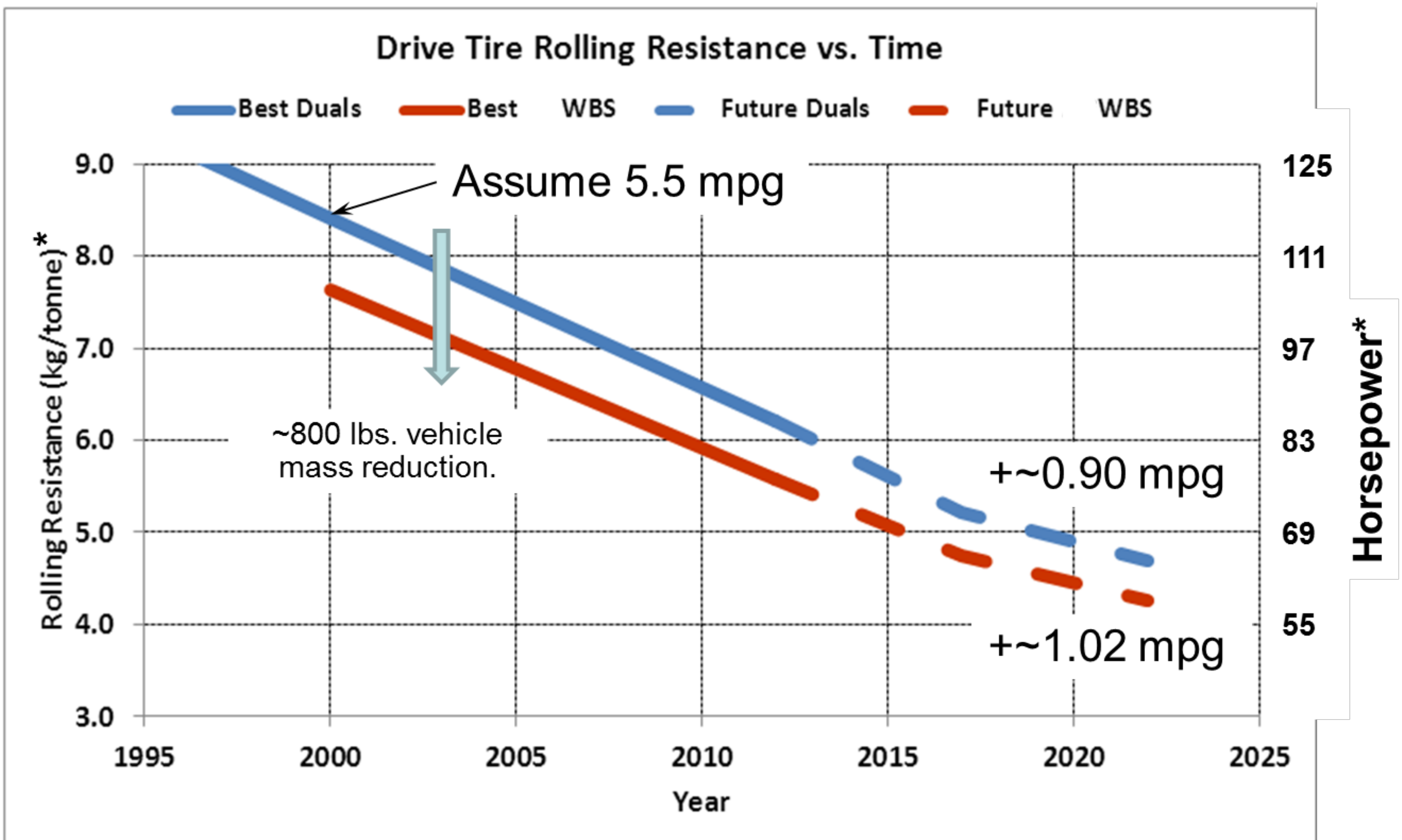

Aero Enhancements
Extender Bridge Fairing (Socket)
Upper Trim Tabs
Carbon Fiber 3 Piece Trailer Nose Fairing (Ball)
Roof Top Rear Aero Ramp
Optimized Cab Mirrors
Cab/Chassis Fairing Seal
Closed Deck Plate
Relocated License Plate
Trailer/Tractor Bulb Seal
Self Stowing Boat Tail
Bogie Toboggan
Bumper w/Grille
Revised Frame End
Vented Mud Flaps
Aero Bumper
Splitter Air Dam
Under Body Seal
Wheel Covers
Articulating Aero Ramps
Fender & Bumper Gap Reducer
Ground Effects Skirt
Articulating Mid Chassis Fairing
Carbon Fiber Pontoon Fairing Front
Self-Stowing Pontoon Fairing
Hinged Bogie Fairing
Bogie Fender


FREIGHTLINER
FREIGHTLINER
SUPERTRUCK

Boat tails reduce the area of negative pressure at the rear of the vehicle which reduces drag force

Tyre rolling resistance

- Effort to reduce tyre rolling resistance have been ongoing for decades
- Rubber compound chemistry, carcass and tread design are primary design factors influencing rolling resistance
- Tyre choice and inflation pressure are key management/operational factors influencing rolling resistance.

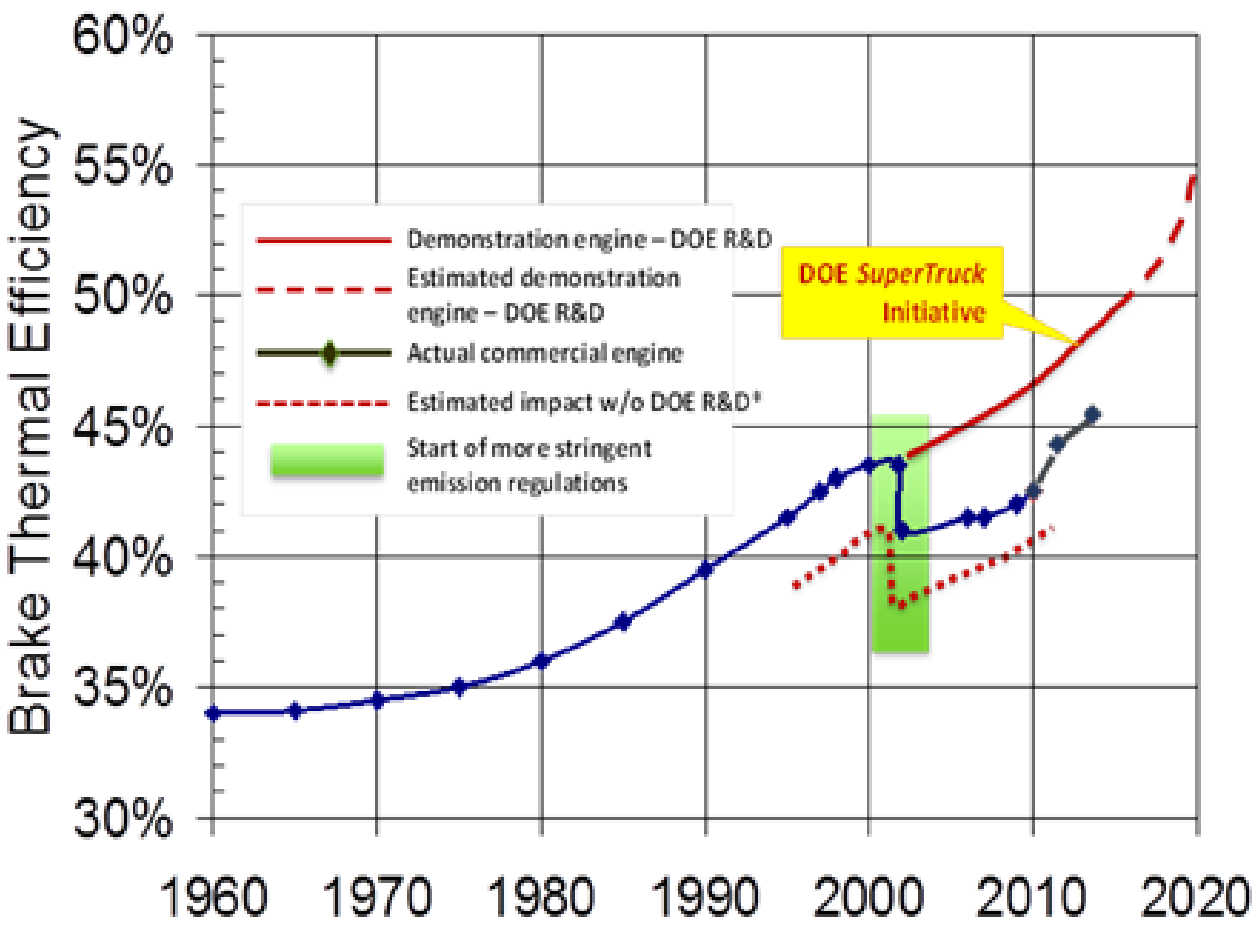


Drive Tire Rolling Resistance vs. Time
Best Duals
Best WBS
Future Duals
Future WBS
Assume 5.5 mpg
~800 lbs. vehicle
mass reduction.
+~0.90 mpg
+~1.02 mpg
Rolling Resistance (kg/tonne)*
9.0
8.0
7.0
6.0
5.0
4.0
3.0
1995
2000
2005
2010
2015
2020
2025
Year
125
111
97
83
69
55
Horsepower*

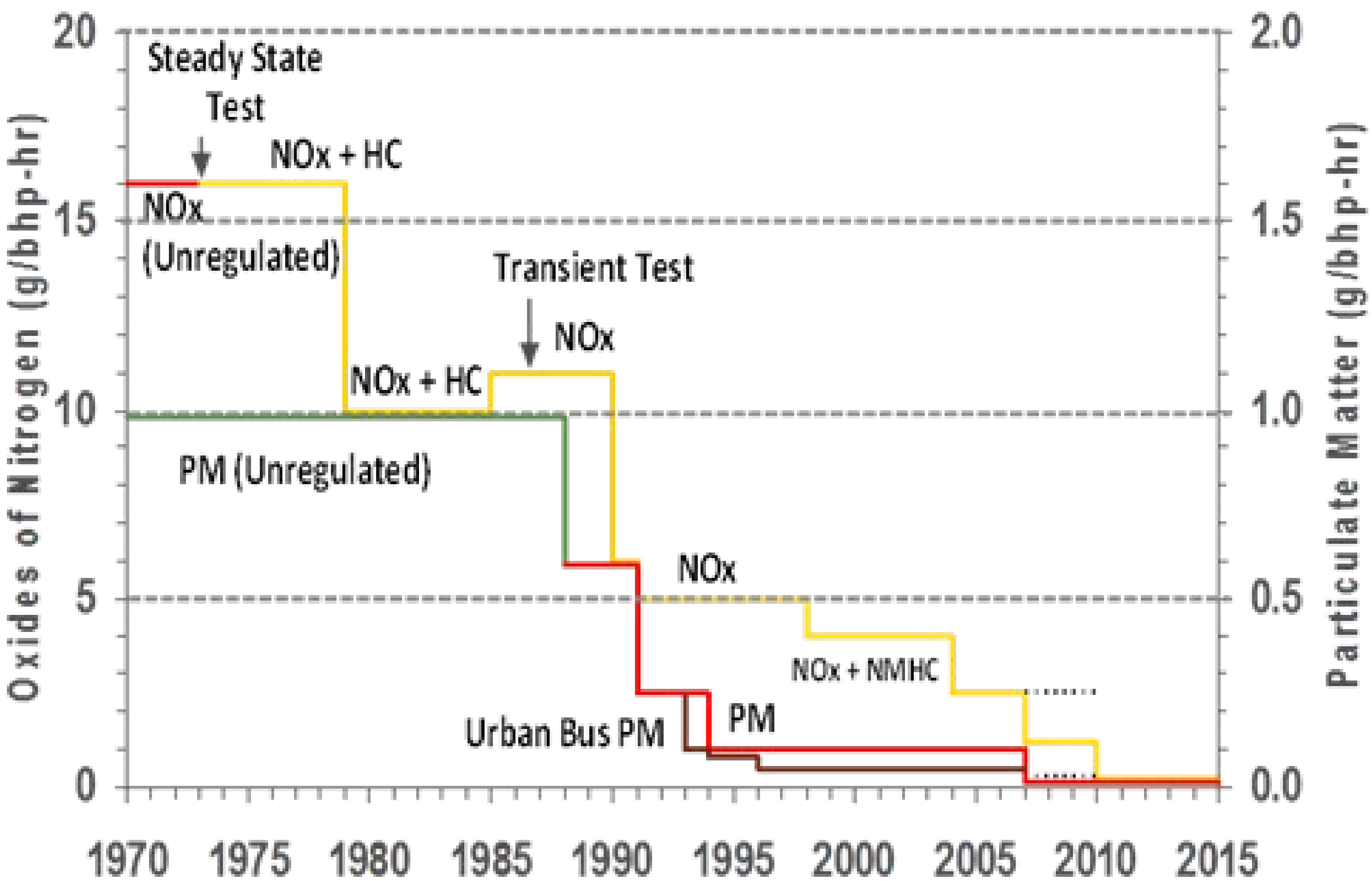
Engine Efficiency

- Modern truck engine thermal efficiency is approximately 42 percent, i.e. only 42 percent of the fuel is converted to mechanical work
- 1960 through 2003 thermal efficiency has increased by approximately 40 percent
- Emissions control has complicated engine design
- 2003, a typical heavy-duty truck engine cost approximately $US 9,000 - today it costs approximately $US 30,00

Heavy-duty diesel engine thermal efficiency trend



Heavy-duty diesel engine emissions trend



Kinetic energy management

$$kenetic\ energy = \frac{1}{2}\,mv^2$$

44 tonne truck (about 30 cars)

100 km/h = 17.0 mega joules

50 km/h = 4.2 mega joules

Speed change from 50 to 100 km/h consume 4 times more energy than from 0 to 50 km/h

US Class 8 truck fuel bill $US50,000 (72,000 liters)/yr

Kinetic Energy Management

- Vehicle speed is an option for energy management
- Increasing seed prior to short hill climbs to reduce spikey engine power demands can improved fuel efficiency.
- Reducing speed at the crest of a hill and accepting some overspeed at the bottom conserves energy
- Such speed management strategies will be at odds with speed monitoring technology if limits are exceeded – what can be done about this?

Conclusions

- Several strategies are available for truck energy conservation
- The truck owner and operator have significant control over energy conservation and fuel economy through equipment choice and operation strategies
- Technology improvement is entering the “hard yards” phase as much of the low hanging fruit has been picked

Thank You

John Woodrooffe
Principal, Woodrooffe Dynamics LLC
Phone: (613) 513-8886 | **Email:** jhfw@woodrooffe.com