Opportunities to Improve Vehicle Efficiencies

Aerodynamics, engine technology, tires, vehicle automation and the connected vehicle

John Woodrooffe

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IRTENZ

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Trucks and Transportation

- The U.S. public road system road length is roughly 30 times that of rail roads
- Trucks transport 6.5 times as much freight by weight and 30 times more by value than railroads
- Compared to all other modes combined, (rail + water + air + pipelines) trucks transport approximately twice the amount of freight by weight and approximately 1.8 times the amount of freight by value.
- Weight distance - rail 39.5%, truck 28.6%, pipeline 19.6%, water 12.0%, air 0.3%.

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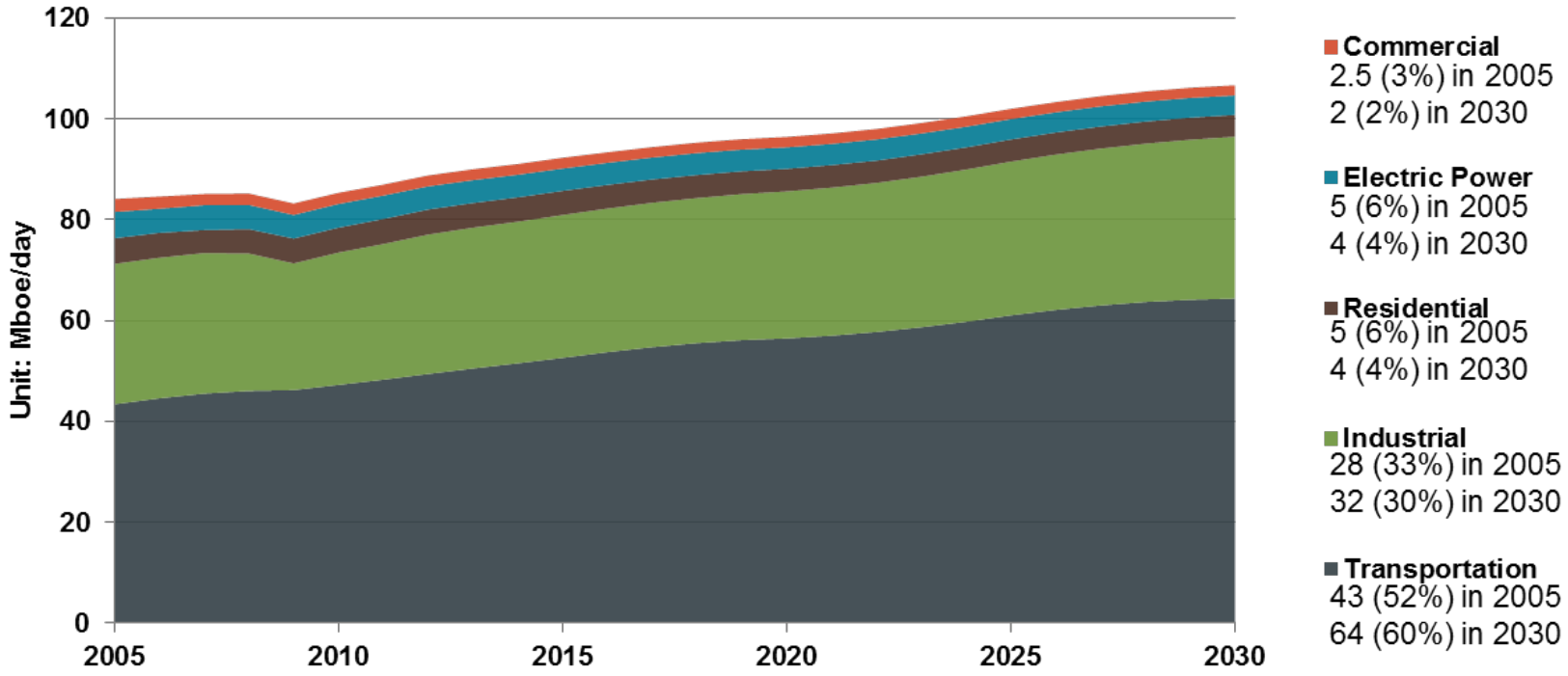
Consumption of liquid fuels by sector



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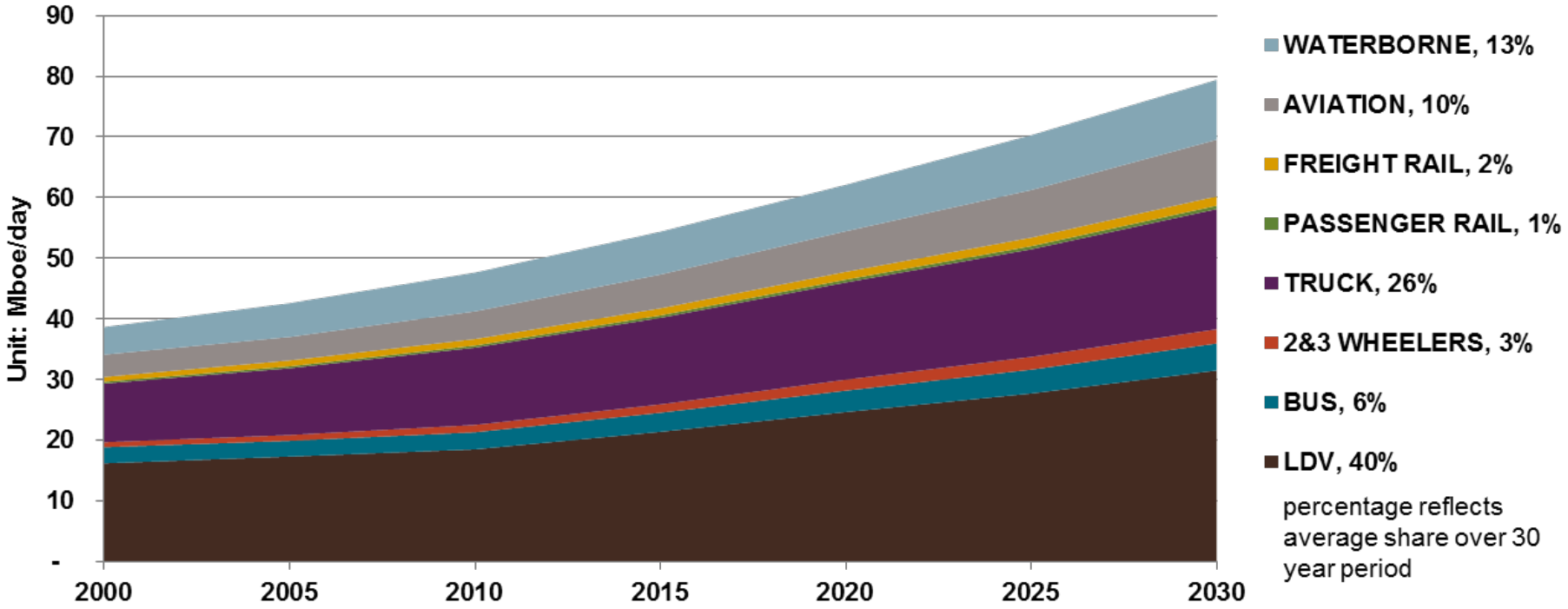
Share of energy consumption by transportation mode



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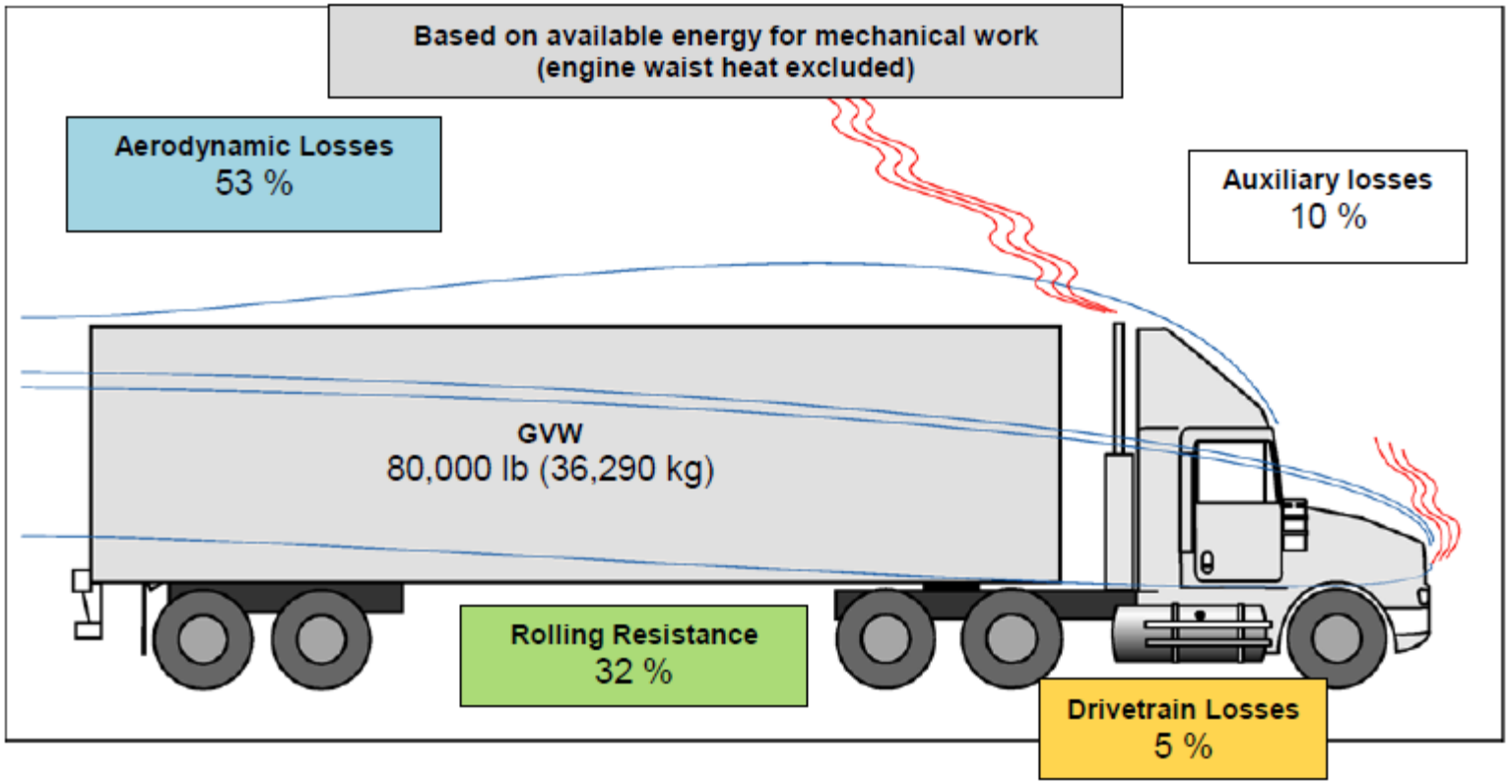
Approximate distribution of resistance loss for a tractor semitrailer on level road at 105 km/h.



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Tires

- New generation wide-base single tires were introduced in 2000
- Require approximately 30 percent less inflation pressure, resulting in a lower more uniform tire contact patch pressure distribution, which reduces pavement wear.
- Provide clear benefits in rolling resistance
- Significant tare weight savings

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Rolling Resistance

- Wide-base single tires replacing dual tires can be expected to reduce tire and rim weight by 20 percent compared to dual tires and provide about 5 percent improvement in freight efficiency through lower rolling resistance and lighter tire and rim weight.

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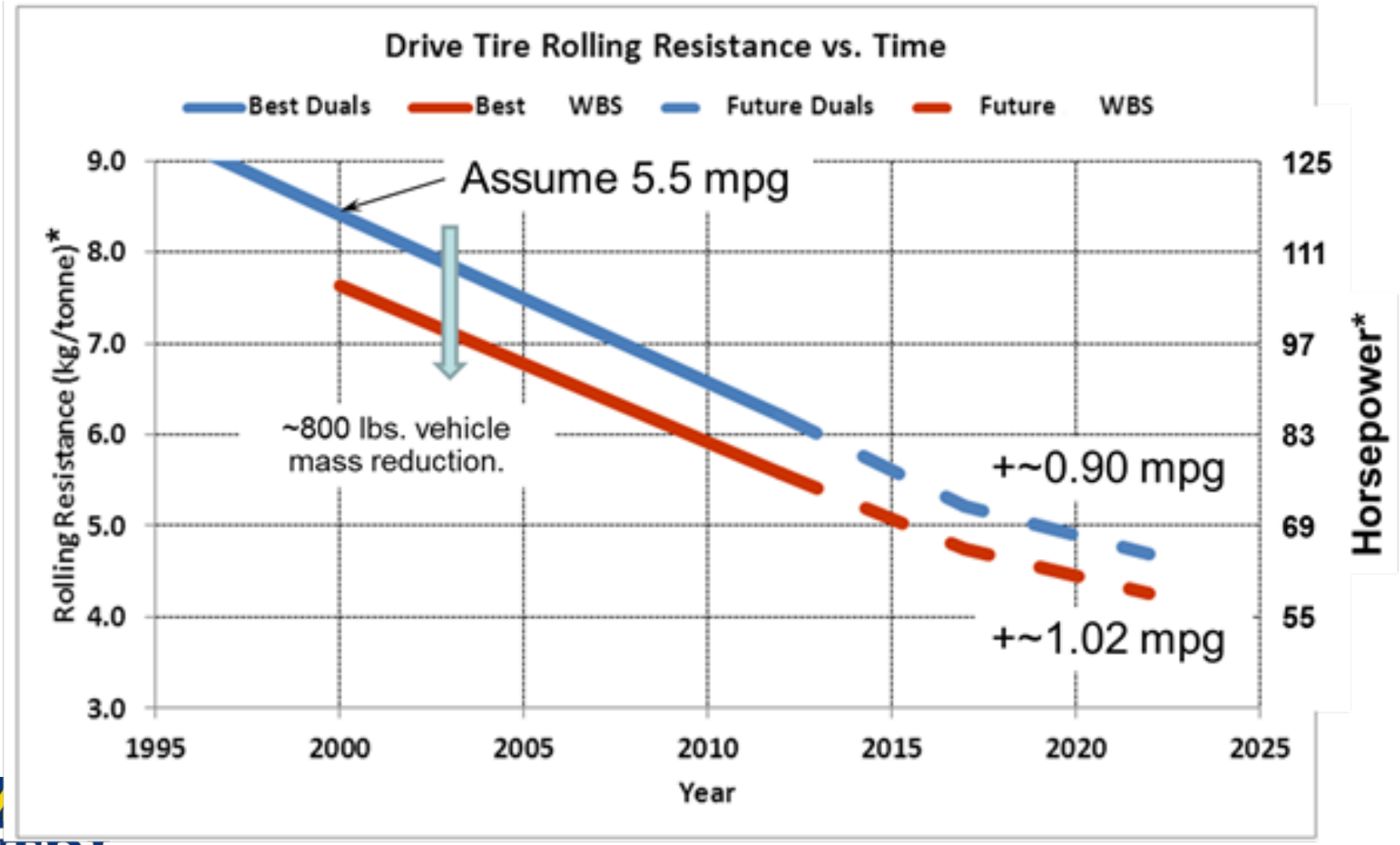
Rolling resistance of new truck drive axle tires over time



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Aerodynamics

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

Pd - is the power required to overcome aerodynamic drag
CD - is the aerodynamic drag coefficient
A - is the projected frontal area of the vehicle
V - is the velocity of the vehicle
ρ - is the air density

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Aerodynamic side skirts and boat tails used to reduce aerodynamic drag

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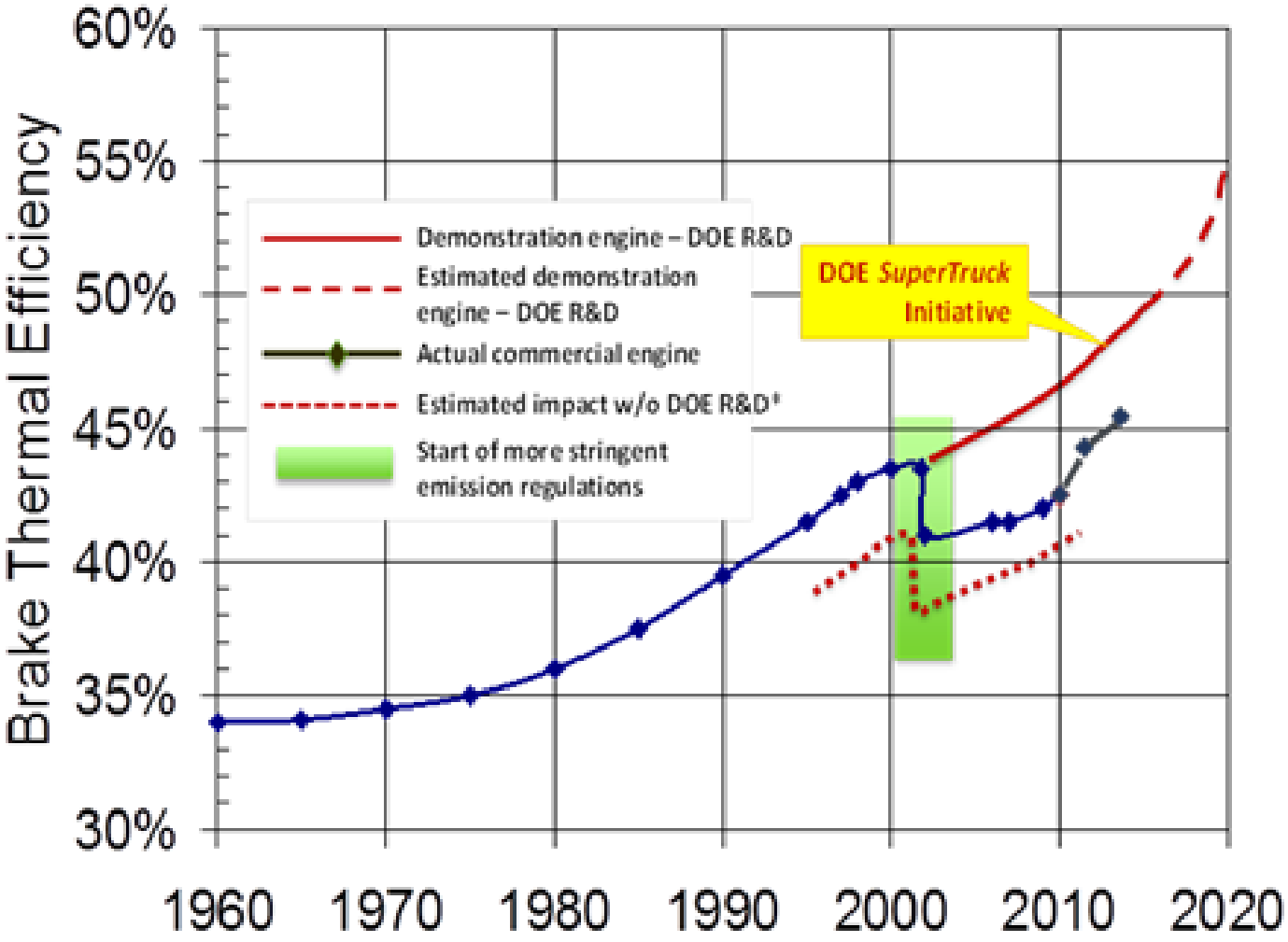
Engine Efficiency



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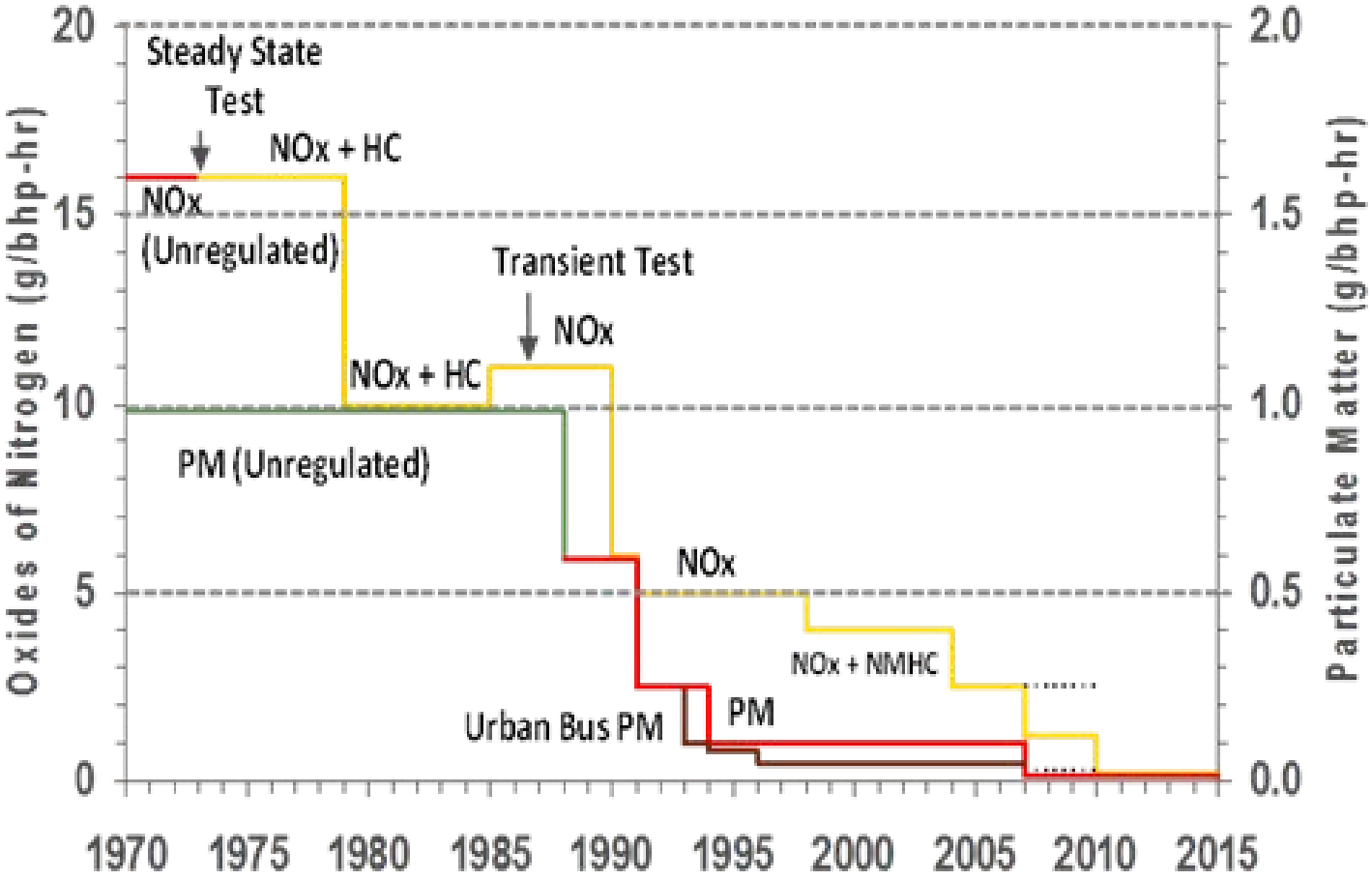
Historical trend in emissions from heavy-duty diesel engines



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Size and Weight

- Ensures vehicle compatibility with the roads and bridges
- We recognize these limits also influence vehicle productivity, safety, fuel use, emissions and economic efficiency
- A politically contentious issue where fear tends to smother rational debate.
- Emotion trumps all – it is in our DNA

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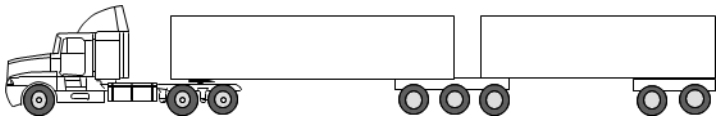
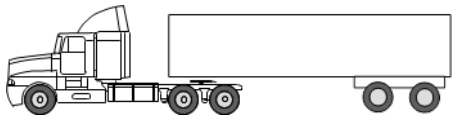
Productivity Comparison



Canadian B-train



US Tractor semitrailer

Country & Vehicle	GVW	Number of axles	Payload	Productivity Advantage
Canada 8-axle B-Train	62,500 kg	8	42,200 kg	Factor of 2
US Tractor semi	36,300 kg	5	20,900 kg	-

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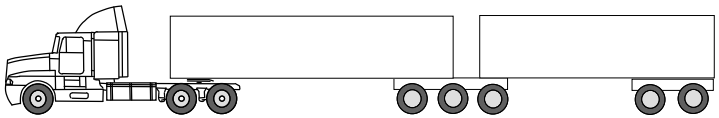
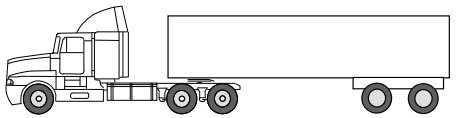
Fuel and GHG Comparison
unrestricted access vehicles



Canadian B-train



US Tractor semitrailer

Country & Vehicle	Cargo unit Fuel (liter/tonne-km)	Cargo unit CO_2 (g CO_2/tonne-km)	Fuel and GHG Advantage per unit cargo
Canada B-Train	0.037	98.79	68%
US Tractor semi	0.063	165.9	-

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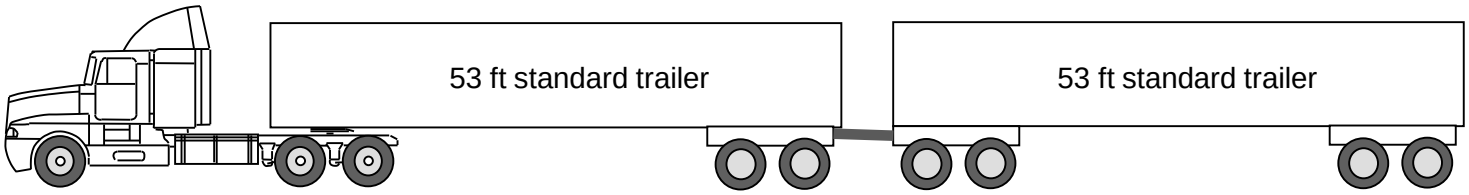
Long vehicle combinations

Significant fuel and emissions savings



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Fuel Use and Emissions

Estimated Potential Realistic Improvement in Fuel Efficiency and CO2 Emission Reduction

Aspect	Realistic Gain in Fuel efficiency CO2 Reduction	Level of technical challenge	Technical timeframe and comments
Tires	13%	Moderate	Much of this benefit currently available – remaining benefit expected 5 – 10 years
Aerodynamics	10%	Easy	Much of this benefit currently available – development ongoing
Engine	16%	Difficult	Very challenging and costly to achieve – 15 – 20 years, would likely require regulation
Size & Weight Regulation	10% - 20%	Easy	Not limited by technology or development time. Requires policy change only. Politically sensitive.

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10% Reduction in Truck VMT

Benefit study variable	Injury severity	Reductions assuming 10%reduction in exposure	Estimated annual benefits ($US Billion)
Estimated safety benefits attributed to a 10% reduction in truck travel distance	no apparent injury	21562	0.20
	possible injury	2,929	0.44
	evident injury	2,724	0.68
	disabling injury	1,453	0.87
	Killed	330	2.54
	Total safety cost saving attributed to 10% reduction in exposure		**4.73**
Estimated fuel and emissions benefits attributed to a 10% reduction in truck travel distance	Category	Quantity saved	Annual cost saving ($US Billion)
	Diesel fuel reduction	10.6 billion liters	10.60
	CO2 reduction	28.3 Million metric tons CO2	0.680
Combined benefits	**Total estimated annual savings**		**16.01**

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Conclusion

- Aerodynamics improvements particularly on trailers is the source of most new benefit.
- Traveling at reduced highway speed has significant aerodynamic benefit with little cost.
- Diesel engine thermal efficiency appears to be reaching a limit – now at 42% future 50%.
- Tires are also approaching a limit for rolling resistance reduction.
- Size and weight depends on the capacity of the infrastructure.

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Thank You!

John Woodrooffe
jhfw@umich.edu
(734) 276-5550

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