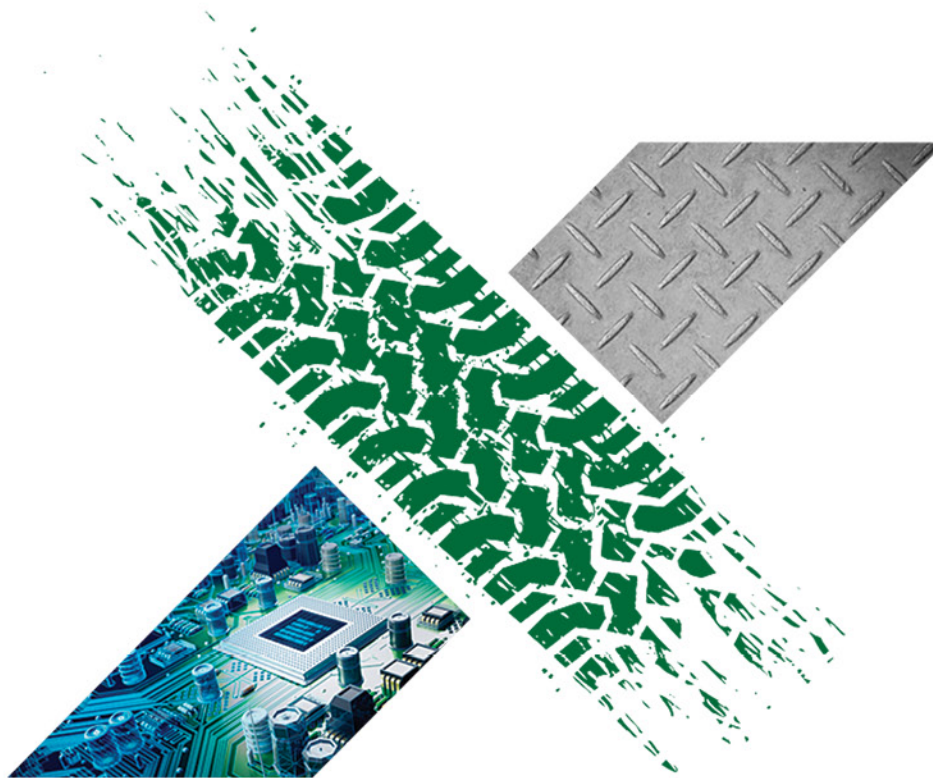




# Trucking Efficiency: Lightweighting

An effort of the Carbon War Room and the North American Council for Freight Efficiency





# FLEET TECHNOLOGY EXPO

AUGUST 24-26, 2015 | LONG BEACH CONVENTION CENTER, LONG BEACH, CA

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**FLEET**

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Fleet Financials  
EXECUTIVE FLEET MANAGEMENT

GOVERNMENT FLEET  
FOR THE PUBLIC SECTOR

GREEN FLEET

HDT  
HEAVY DUTY TRUCKS

WORK TRUCK

fleet technology  
**expo**  
FOR SMART &  
EFFICIENT FLEETS



Mike Roeth, Executive Director NACFE & CWR  
Andrew Halonen, NACFE & Mayflower Consulting

- Trucking Efficiency
- Fleet Fuel Study
- Technologies
- Lightweighting
- Questions



# Trucking Efficiency

Dedicated to doubling the efficiency of North American goods movement

We pursue this goal in two ways:

1. By improving the quality of information flow and
2. By highlighting successful adoption of technologies



[www.nacfe.org](http://www.nacfe.org)



[www.truckingefficiency.org](http://www.truckingefficiency.org)

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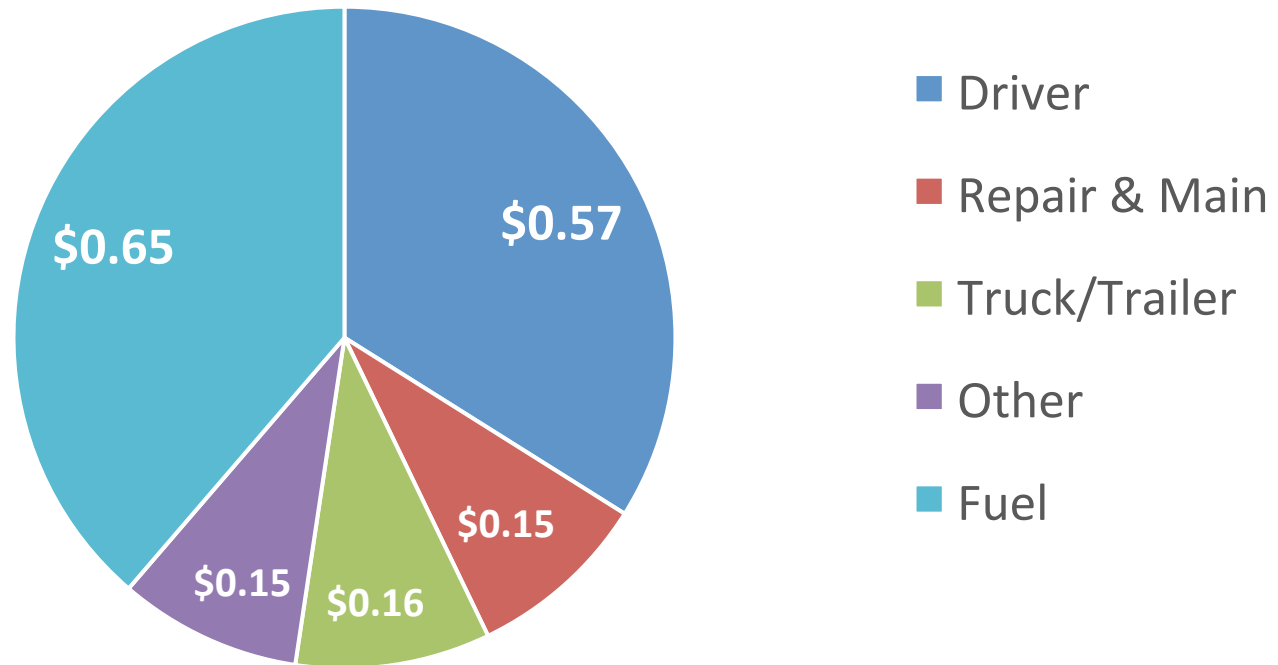
**GREEN FLEET**

**HDT**

**WORK TRUCK**

# Fuel Cost

## Tractor Trailer Cost/Mile



Source: 2013 ATRI

\$75,000/year 1% savings = \$750 year/truck

# Annual Fleet Fuel Study



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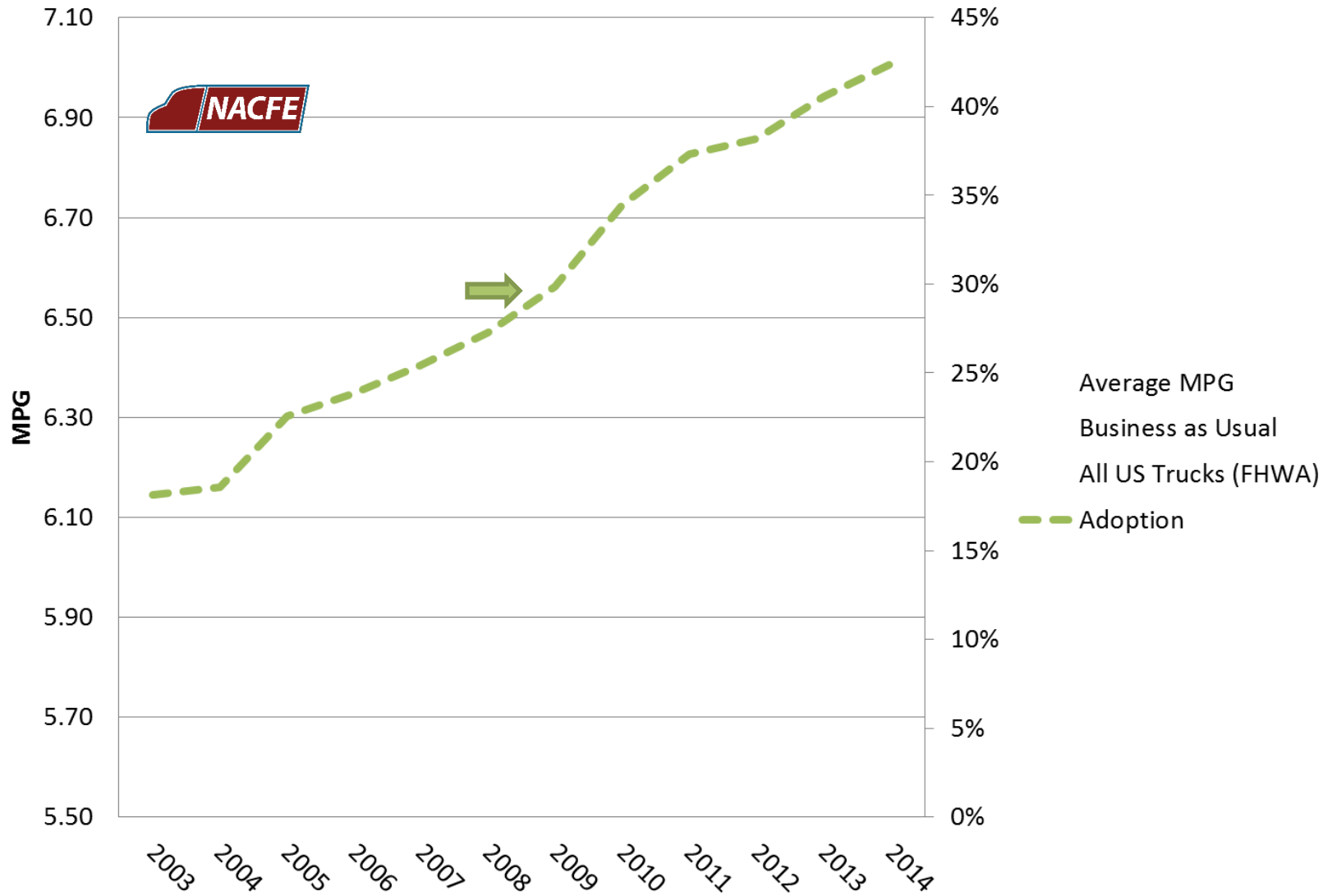


# Fuel Economy Technologies

- Which ones are most popular on new trucks?
- Did they keep buying them?
- Are they delivering fuel savings?

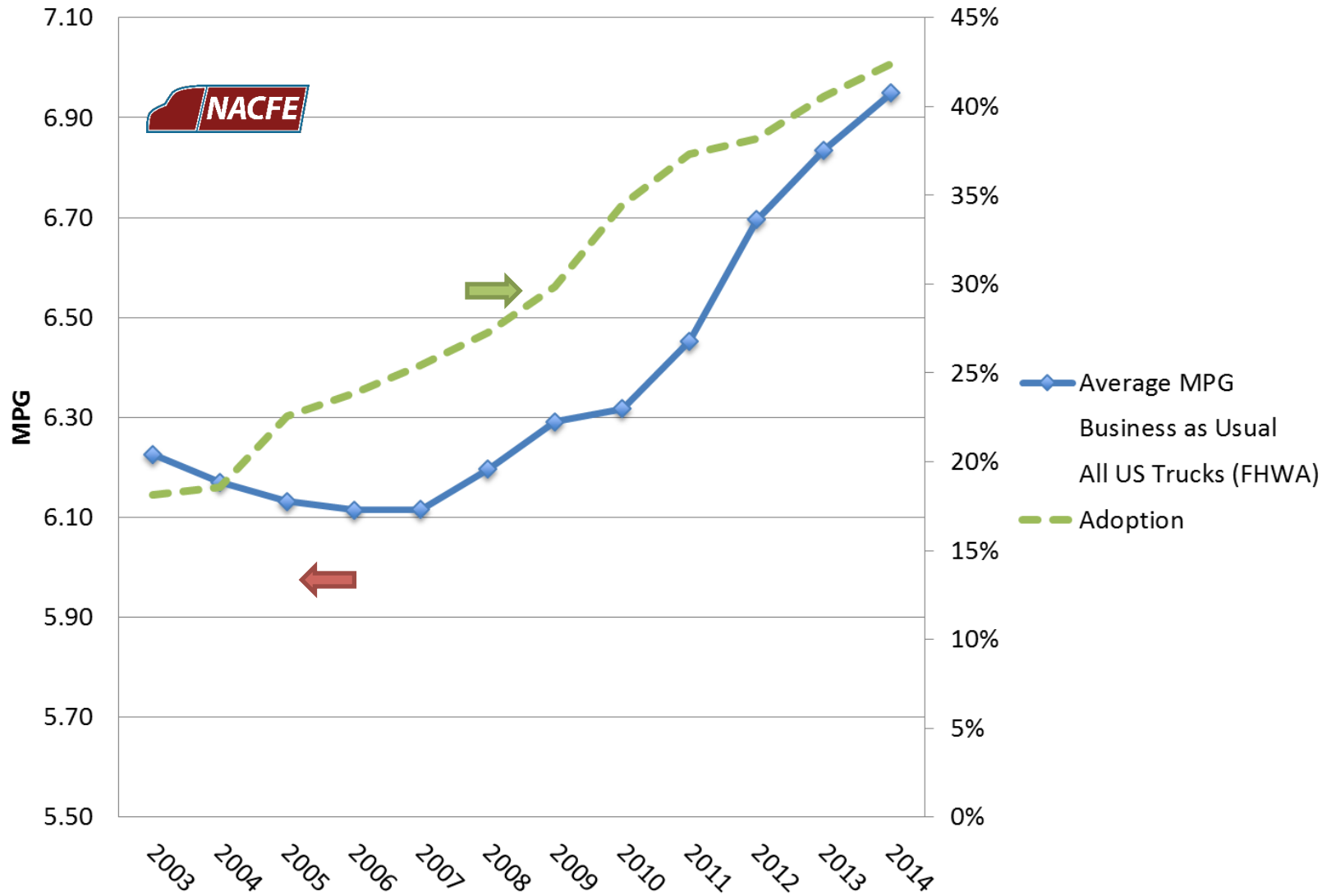


# IFTA MPG and Adoption Percent Over Time

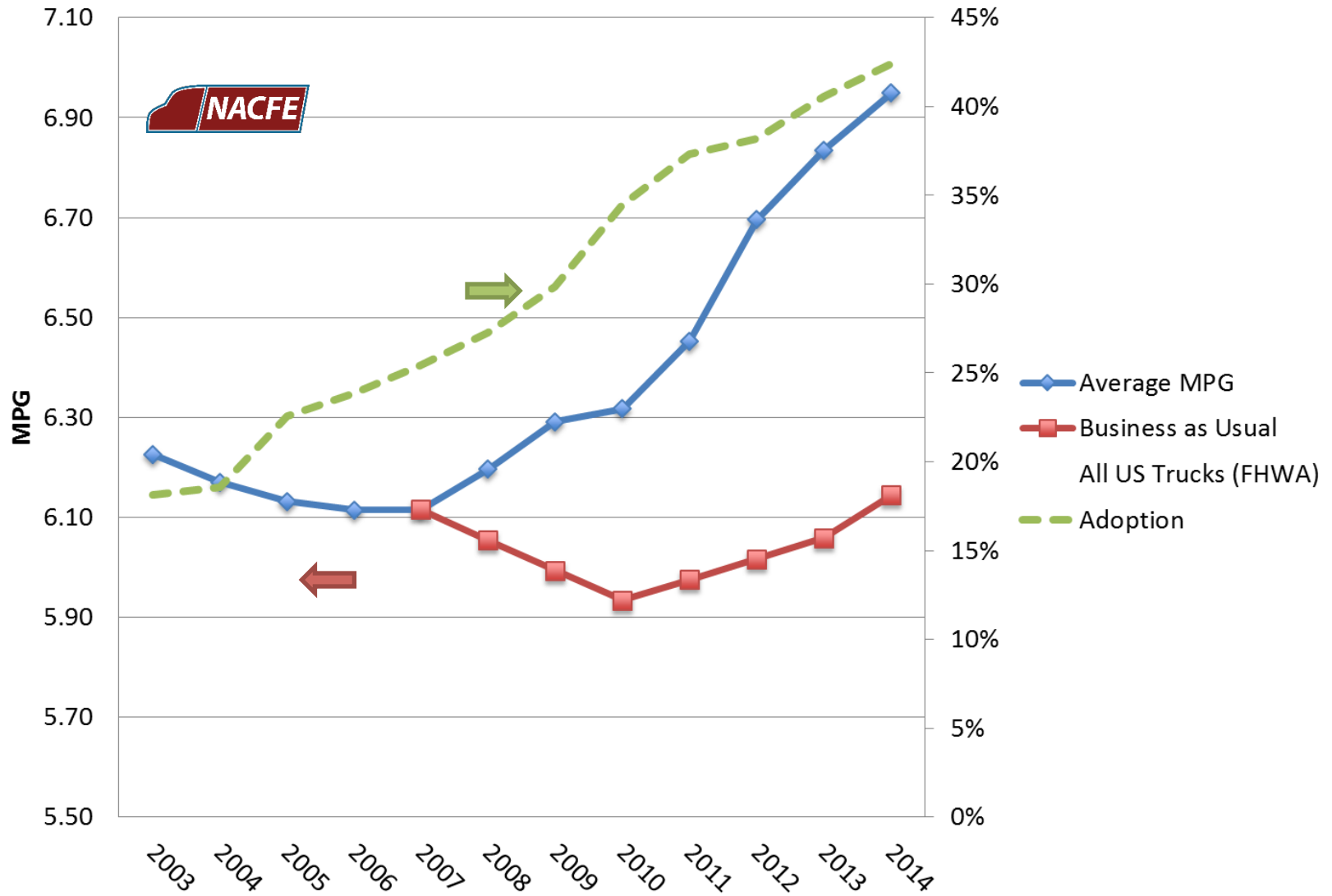




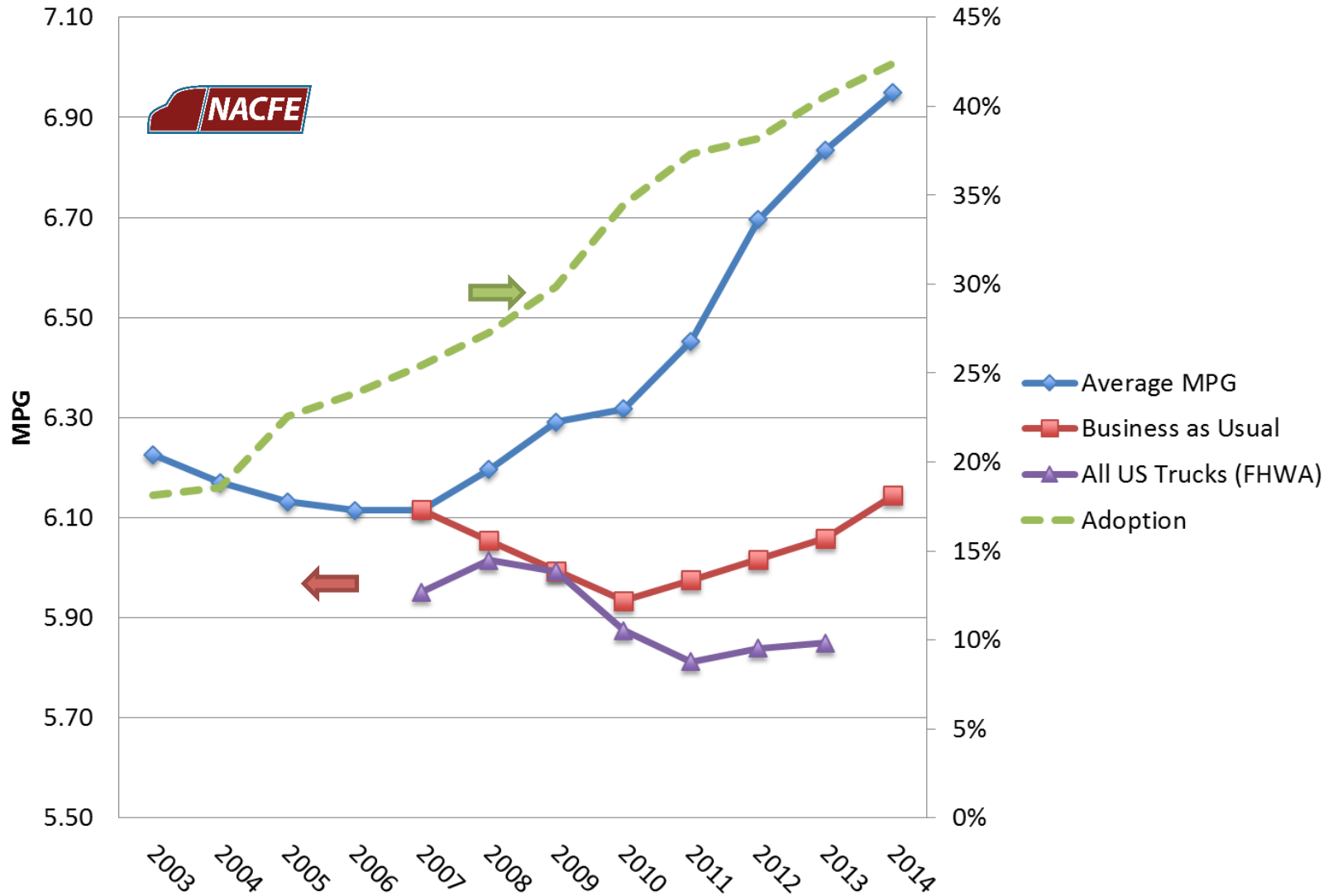
# IFTA MPG and Adoption Percent Over Time



# IFTA MPG and Adoption Percent Over Time

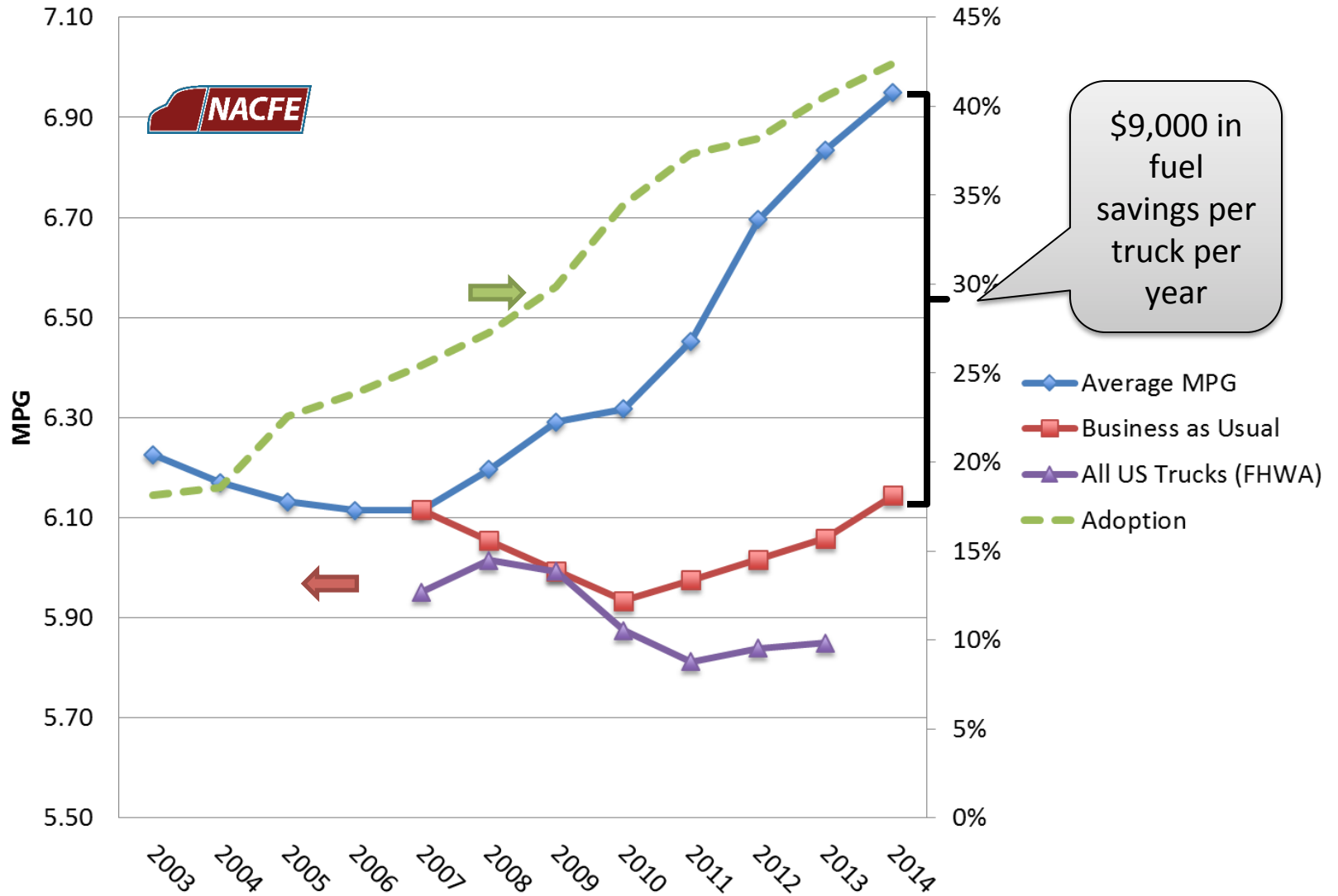


# IFTA MPG and Adoption Percent Over Time





# IFTA MPG and Adoption Percent Over Time



# Trucking Efficiency

## Save Fuel

- Confidence Reports
- Decision-Making Tools
- Workshops
- Tech Guide at [www.truckingefficiency.org](http://www.truckingefficiency.org)
- Thought Leadership
- Industry Events
- Collaboration

## Comprehensive, unbiased technology reviews



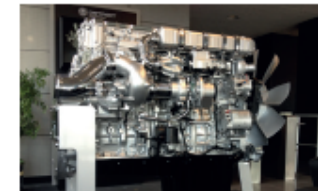
Tire Pressure Systems



6x2 Axles



Idle Reduction



Engine Parameters



Automated  
Transmissions

### In Progress

- Tires
- Downspeeding

### Upcoming

- Light-weighting
- Maintenance
- Driver Coaching
- Aerodynamics

# Study Released Today

Home | Technologies | Operational Practices | Lightweighting

TECHNOLOGIES HOW THIS WORKS NEWS & EVENTS ABOUT US

## LIGHTWEIGHTING

### EXECUTIVE SUMMARY

Emissions regulations combined with fuel economy features and driver amenities on today's commercial vehicles have added 1,000 lbs. to the typical Class 8 truck. Certain fleets like bulk haulers value weight savings more than other segments of the market.

To understand the true benefits of reducing vehicle weight fleets should look beyond fuel economy improvement to freight efficiency gains—the ability to use fewer trucks to carry the same amount of payload.

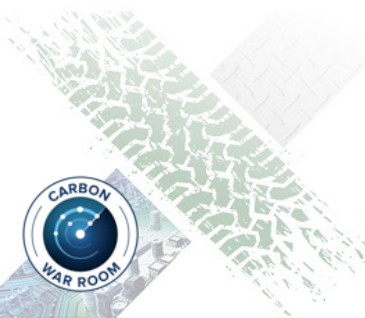
Fleets can save 2,000 lbs. by investing to a limited degree in lightweighting and as much as 4000 lbs. with an aggressive investment. Lightweighting can take place in various areas of the tractor and trailer including the powertrain, axle suspensions, wheel ends, drive shaft, frame, fifth wheel, end more.

EXECUTIVE SUMMARY	EXPLORE REPORT
<a href="#">Lightweighting: Executive Summary</a>	<a href="#">Confidence Report: Lightweighting</a>

### BENEFITS & CHALLENGES

BENEFITS	CHALLENGES
<a href="#">Fuel Savings</a>	<a href="#">Upfront Costs</a>
<a href="#">Increased Freight Efficiency</a>	<a href="#">Negative Impacts On Resale Value</a>
<a href="#">Driver Retention</a>	<a href="#">Higher Maintenance Costs</a>
<a href="#">Additional Fuel Efficiency Technology</a>	<a href="#">Difficulty Calculating the True Value Offered</a>

### VIDEO



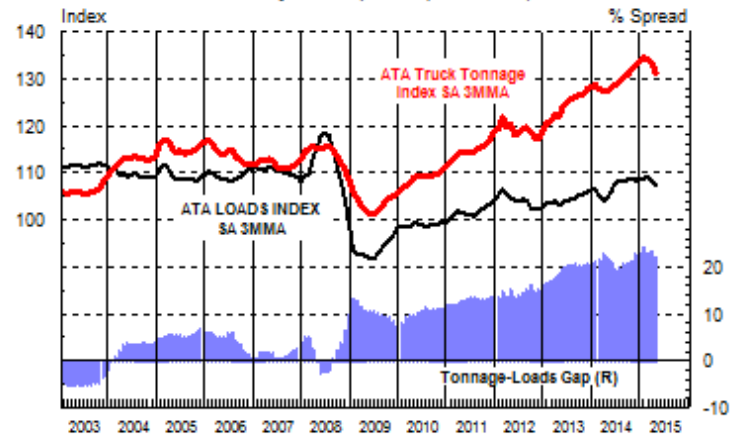


# Why Lightweighting?

- Fuel vs. Freight Efficiency
- Real work accomplished
  - MPG
  - Ton-miles or Cube-miles per gallon

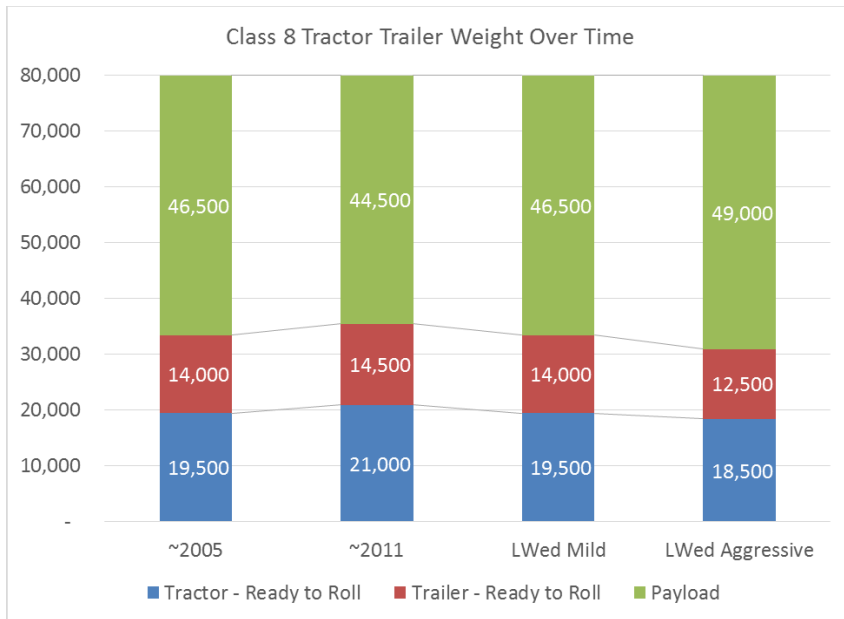
ATA Truck Tonnage Index  
& ATA Truck Loads Index

January '03 - April '15 (2000=100)



Source: American Trucking Associations, JCT Research Co., LLC; Copyright 2015

# Weight over Time



- Tractors, and to some extent Trailers, have gotten heavier
  - Emissions
  - Driver Amenities
  - Fuel Economy Features
- Actions
  - Mild Lightweighting
  - Aggressive Lightweighting

# Why Lightweighting?

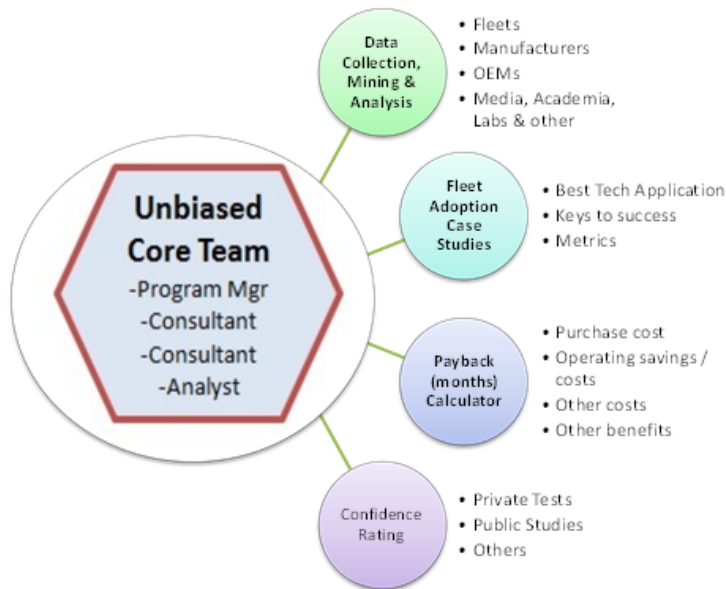
- Three “Categories”
- Industry Trends
  - Tractors and Trailers have gotten heavier
  - Denser Freight
  - More Pallets/Trailer
- Shippers asking for more Payload





# Study Methodology

- Common Approach



- Team

- Andrew Halonen
- Rob Swim
- Mike Roeth
- NACFE Technology Advisory Committee

- Sponsors

- Silver - Aluminum Association
- Bronze – Great Dane, Hendrickson, Jost and Webb Wheel

# Benefits and Challenges

## Benefits & Enablers

- Regulations
- Increased Freight Efficiency
- Improved Fuel Economy
- Sustainability Goals
- Additional FE Technologies

## Challenges & Consequences

- Upfront Cost
- Residual Value
- Maintenance Costs
- Redundant Product Testing
- Driver Retention
- Ability to take Advantage
- Over-spec

# Fuel Efficiency Technology

Feature	Estimated Weight (lbs.)
Full chassis fairings	360
Trailer skirts	180-250
Tail skirts	120-175
APU (Federal law allows 400 lb. exemption for this weight)	400-500
AMT	150-500
<b>TOTAL WEIGHT ADDED FOR FUEL ECONOMY</b>	<b>1,210 lbs.</b>

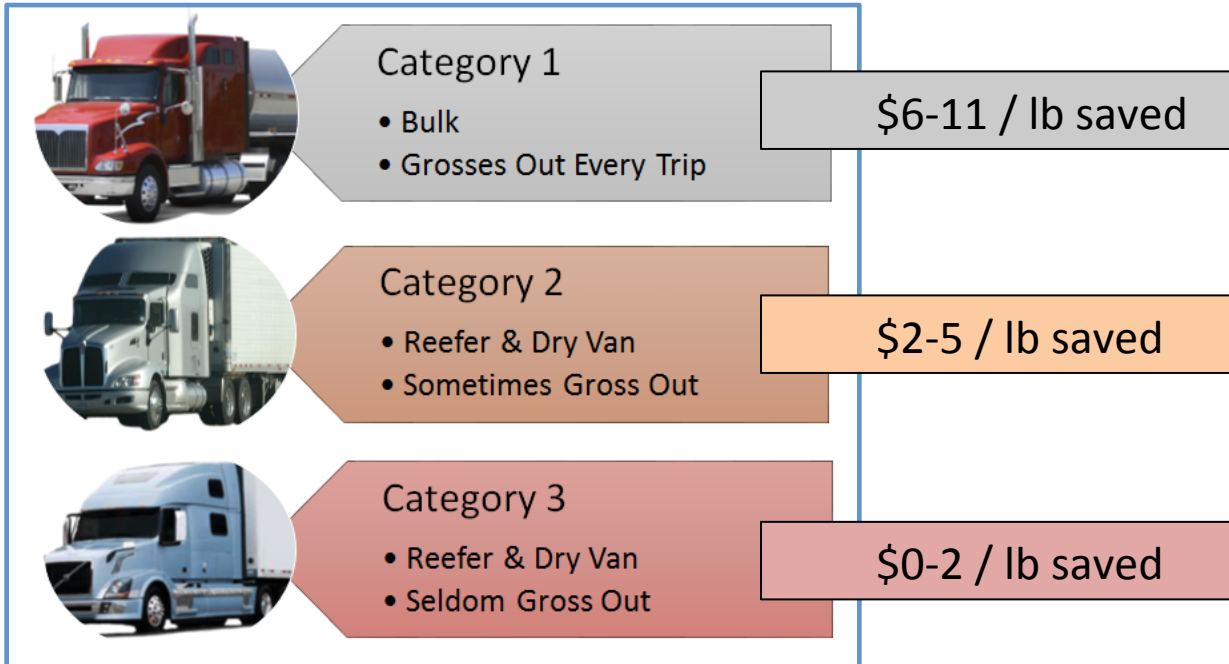
+ Compressed natural gas (CNG) 1500-2000 lbs

Measurable fuel savings, at the expense of weight.



# Lightweighting

Value in Dollars per Pound



## Weight Reduction Methods

- Material Conversion
- Design Integration
- Right-Sizing

# Material Conversion

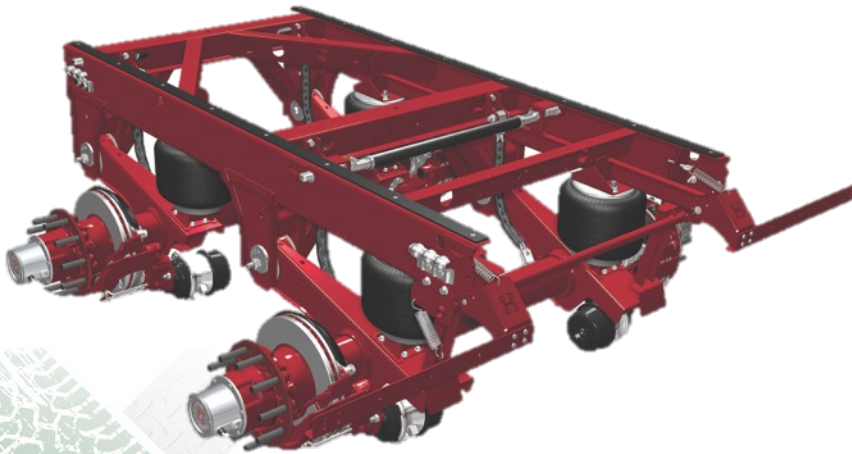
Product	Baseline	Conversion	Weight Savings per Tractor
<b>BRAKE DRUM</b> 	Iron	Steel shell with iron liner	168 lbs
<b>WHEEL</b> 	Steel	Aluminum	307 lbs
<b>FRAME RAILS</b> 	Steel	High Strength Steel	200 – 300 lbs
<b>LEAF SPRINGS</b> 	Steel	Composite	125 lbs per Trailer

# Design Integration



## Wide Base Wheels

Weight Savings 400 lbs / tractor  
308 lbs / trailer



## Trailer Slider Box

Optimized steel design  
Weight savings 100 lbs  
Lower cost

# Right-Sizing Fuel Tanks



Hours of Service (HOS) = 11    Average fuel economy = 6 mpg    Average speed = 55 mph  
 $11 \text{ hours} * 55 \text{ mph} / 6 \text{ mpg} = 101 \text{ gallons}$

@ 7 lbs / gal diesel, an extra 50 gal = 350 lbs    → Equivalent to weight of trailer skirts or AMT



# Available Options

Weight Reduction Options for Class 8 Tractor		
Item	Specification	Weight Savings (lbs)
Cab Configuration	Day cab vs. short sleeper	700-1000
Sleeper	Small (50-58") vs. large (75-80")	350-600
	Mid roof vs. high roof	200
Cab	Aluminum vs. steel	200
Roof fairing	SMC to molded plastic	25
Engine	13 liter vs. 15 liter	300-500
	11 liter vs. 13 liter	390
Fuel tank	Single 100 vs. twin 100s w/brackets	225
Fuel weight	Less 100 gal	700
Diesel Exhaust Fluid	23 to 16 gal tank, hardware & fluid	100
Batteries	Aluminum vs. steel battery box	42
	Less one battery	60
Exhaust	Horizontal vs. vertical single stack	150
Transmission	Manual vs. AMT	150-500
Clutch cover	Aluminum vs. steel housing	53-85
Driveshaft	Aluminum vs. steel	100
Front axle	Fabricated vs. solid I-beam	118
	Airspring front suspension	88
Rear axle & suspension	6x2 vs. 6x4	300-400
	Aluminum rear axle carrier	85
	Lightest tandem suspension	305
Seat	Omit passenger seat	35
Frame	Aluminum vs. steel crossmembers	85
	Aluminum frame	500
5 <sup>th</sup> wheel	Fixed vs. air slide	158
	Aluminum top plate	100
Wheels	Aluminum vs. steel front wheels	70
	Aluminum vs. steel rear wheels	280
Wheel & tire	Wide-base vs. duals (aluminum vs. aluminum)	408
	Wide-base vs. duals (aluminum vs. steel)	520
Hubs	Aluminum vs. steel hubs all axles	154
Brakes	Steel shell vs. S cam drum, front	28
	Steel shell vs. S cam drum, rear	92
	Steel shell vs. standard drum	112
Air tank	Polished aluminum vs. steel air tank	28
Bumper	1 piece aluminum bumper vs. aero bumper	31
Headlights	Halogen vs. standard headlights	13

Weight Reduction Options for Trailer		
Item	Specification	Weight Savings (lbs)
Flooring	Wood composite vs. hardwood	360
	Aluminum vs. wood (lower rating)	375
Cross members	Aluminum vs. steel	250
Axle	6" diameter vs. 5" diameter	36
Brakes	Air disc & aluminum hub	125
	Light iron vs. standard iron	48
	Steel shell vs. standard iron	88
Hubs	ADI vs. Aluminum	4
Wheels	Aluminum vs. steel	272
Wheel & tire	Wide-base vs. duals (aluminum vs. aluminum)	308
Landing gear	High strength steel	25
	Aluminum	50
Doors	Light design	60
	3 rod locks vs. 4 rod locks	20-30
Roof bows	Aluminum vs. steel	100
Wall post beams	Aluminum vs. steel	270
Rear door surround	Aluminum vs. steel	150
Slider box	Aluminum vs. steel	150
Structure for suspension assembly	Aluminum vs. steel	280
Upper coupler assembly	Aluminum vs. steel	430
Four leaf springs	Composite vs. steel	145

- Many options, yet low take rate.
- As volumes increase, price comes down.

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# Cost of Lightweighting

## LIGHTWEIGHTING PRICE CATEGORIES

LIGHTWEIGHTING TECHNOLOGIES AVAILABLE TODAY CAN BE ROUGHLY SPLIT INTO THREE PRICE CATEGORIES: NO COST, SOME COST, AND MORE COST. THIS REPORT BREAKS DOWN THOSE CATEGORIES AS FOLLOWS:

TRACTOR			TRAILER		
NO COST (Right-Sizing)	SOME COST	MORE COST	NO COST (Right-Sizing)	SOME COST	MORE COST
Shorter cab	Aluminum hubs	Aluminum wheels	Large diameter axle	Wood composite floor	Aluminum floor
Smaller engine	Light brake drums	Aluminum fifth wheel	Duals to wide-base wheels	Aluminum hubs	Aluminum wheels
Horizontal exhaust	Light cross members	6x4 to 6x2	ADI hubs	Light brake drums	Aluminum structure
Smaller fuel tank	Aluminum air tank	Aluminum frame		Light cross members	Composite brake drums
Less fuel	Aluminum battery box	Composite brake drums		Roof bows	Carbon fiber
Less diesel exhaust fluid	Aluminum carrier housing	Carbon fiber		Wall beams	
Fewer batteries	Molded plastic fairings			Door surround	
Remove passenger seat	Aluminum cab			Light landing gear	
AMT to manual	Clutch cover				
Duals to wide-base wheels					
Sliding to fixed fifth wheel					

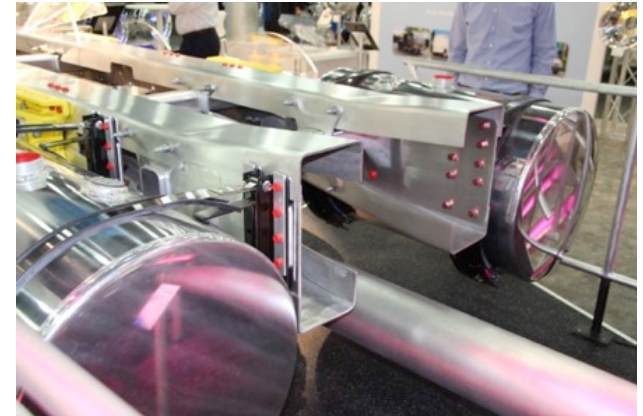
# Fleet Lightweighting Packages

Suggested Technology Packages		
<b>Mild Lightweighting</b> ~2,000 pounds of savings	Tractors	<ul style="list-style-type: none"> <li>• Smaller fuel tanks</li> <li>• Wide-base tires &amp; wheels</li> <li>• Horizontal exhaust</li> <li>• Select others</li> </ul>
	Trailers	<ul style="list-style-type: none"> <li>• Aluminum and other lightweight components</li> </ul>
<b>Aggressive Lightweighting</b> ~4,000 pounds of savings	Tractors	<ul style="list-style-type: none"> <li>• All of the above “mild” technologies, plus:                             <ul style="list-style-type: none"> <li>○ Smaller engine</li> <li>○ Shorter sleeper</li> <li>○ Aluminum components</li> <li>○ Select others</li> </ul> </li> </ul>
	Trailers	<ul style="list-style-type: none"> <li>• All of the above “mild” technologies, plus:                             <ul style="list-style-type: none"> <li>○ Wide-base tires &amp; wheels</li> <li>○ Select others</li> </ul> </li> </ul>

- Right-sizing is free, or even a cost reduction
- Aluminum is approx. \$6 / lb
- Fifth wheel is \$10 / lb
- Carbon fiber ~ \$20 / lb

# Future Innovations

- Materials
- Design
- Improve quality of current offering to increase take rate





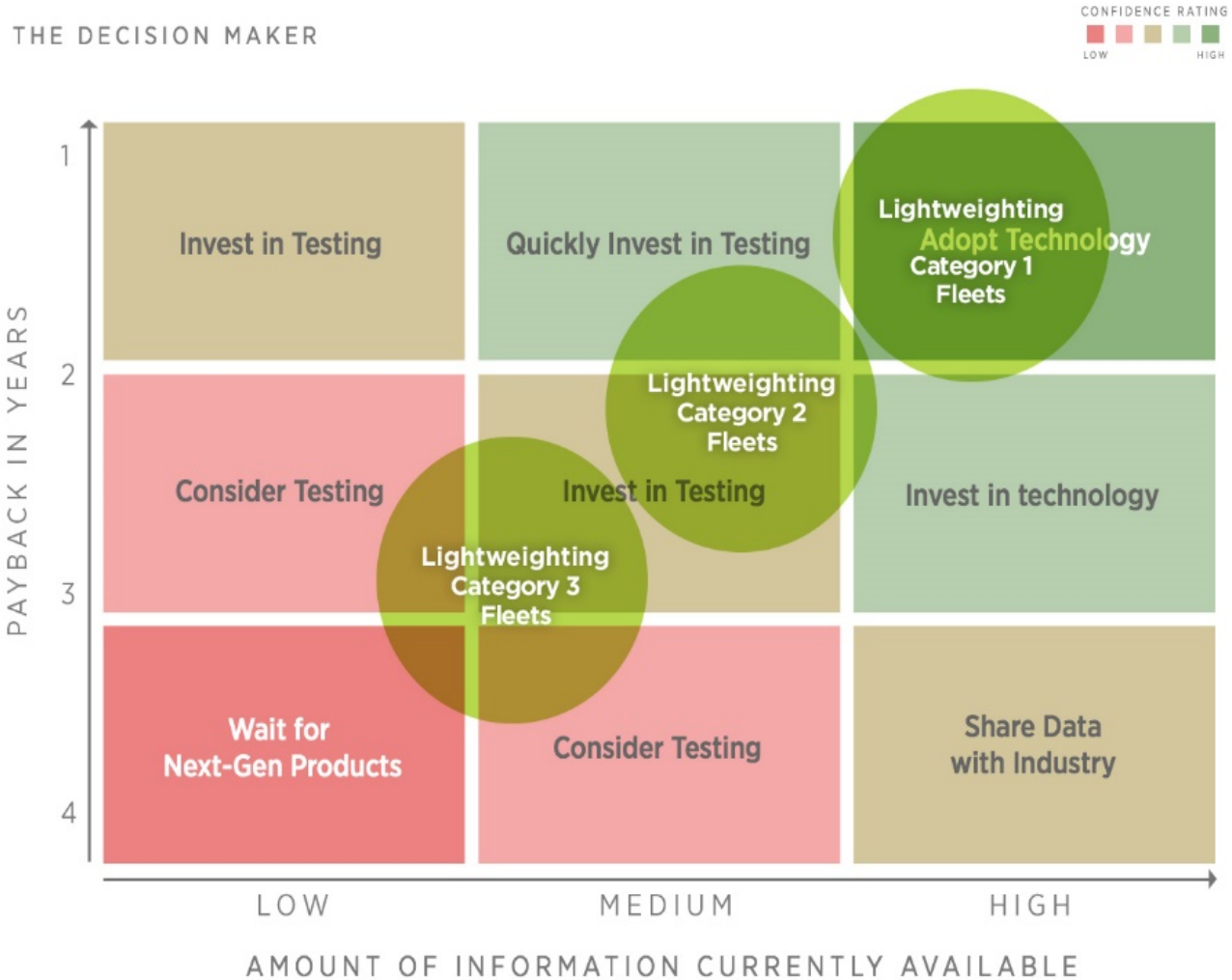
# Study Findings

- Findings
  - Heavier equipment
  - Denser freight
  - Fleets hesitant to LW
  - Industry trends indicate need for LWing will increase
  - Fuel economy and freight efficiency
  - Opportunities exist, and more coming
- Recommendations
  - Category 2 and 3 fleets should begin to explore LWing (lightweighting).
  - Supply chain collaboration can bring down costs and shorten lead time.
  - Fuel efficiency depends on lightweighting due to other technologies

# Study Recommendations

- Trade associations can assist with training & best practices on integration & maintenance.
- Will the F-150 aluminum body build confidence in durability & corrosion protection?
- Educate the resale market on freight & fuel efficiency.
- Fleets create pull. Make your lightweighting needs known and the innovators will respond.

# Study Findings



# Thank you.

[www.truckingefficiency.org](http://www.truckingefficiency.org)

[www.nacfe.org](http://www.nacfe.org)

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and suggestions, contact  
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