Why Light Duty Diesels Make Sense in the North American Market

12th DEER Conference
US Department of Energy

August 22, 2006

MARTEC®

Agenda

① **Performance: it's all about torque**

② **The diesel value proposition in the US**

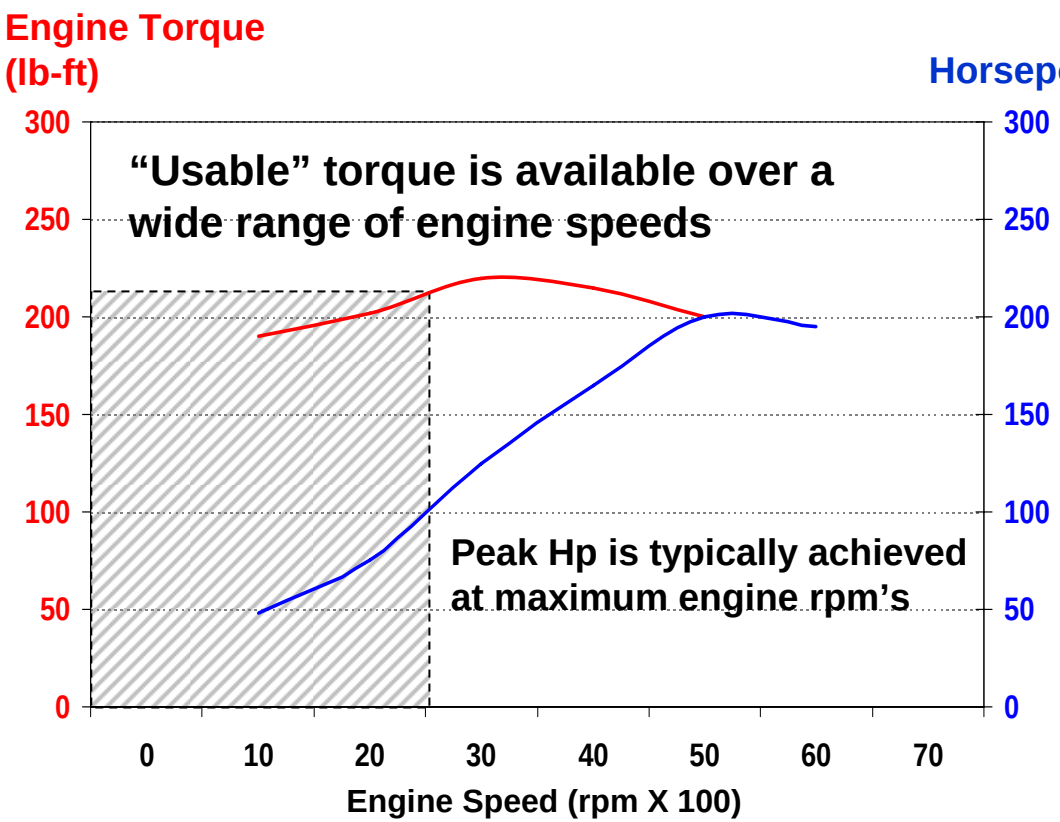
③ **50-state emissionized diesel cost assessment**

④ **Summary and conclusions**

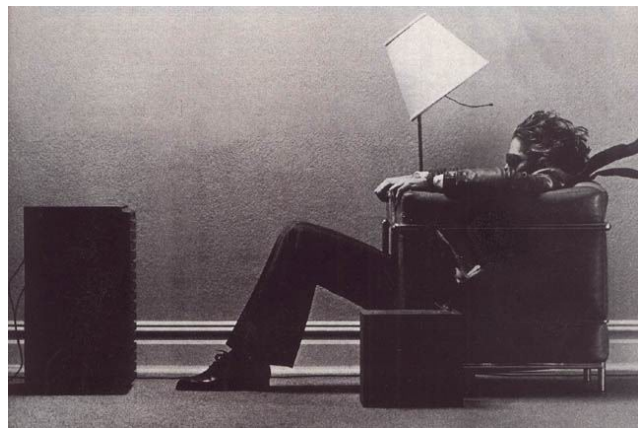
MARTEC®

US consumers have been trained to think about HP, but torque makes a vehicle fun-to-drive.

Torque and Hp Output Curves – Typical US Gasoline V6



Torque . . . .

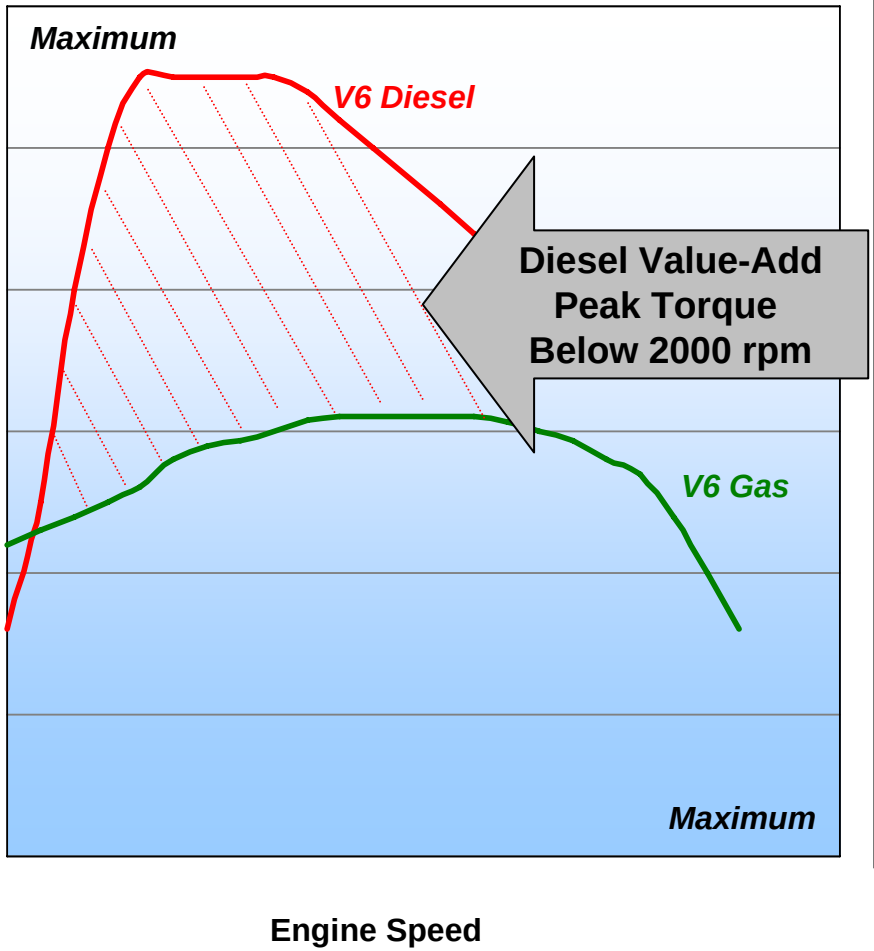


The force that presses you into the seat when you accelerate

MARTEC®

Modern diesels deliver more torque at lower engine speeds . . . where we drive.

Illustrative V6 Torque Curves



The Benefits of Low End Torque

Better acceleration
- City driving
- Highway passing

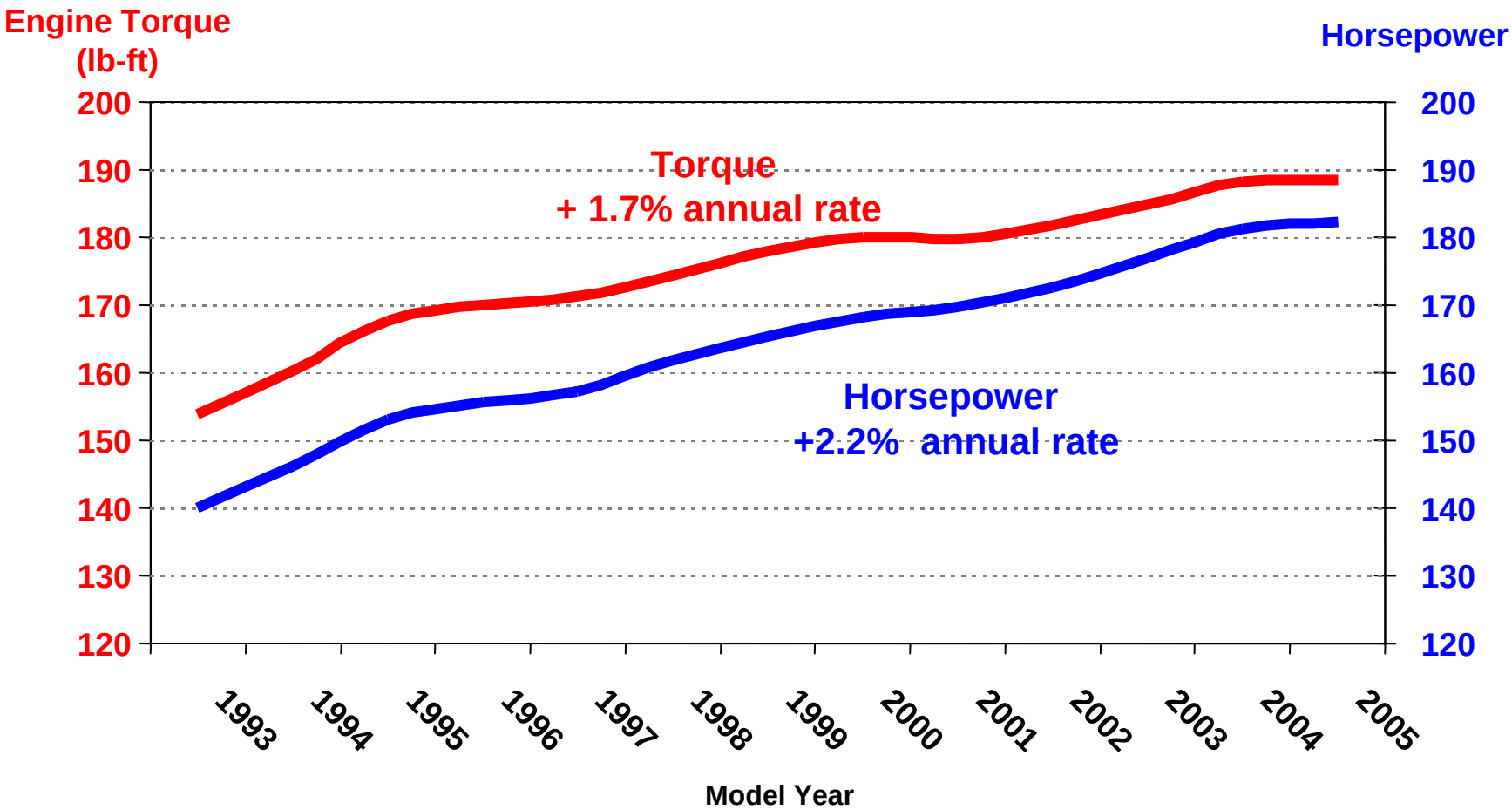
Better towing performance
- For trucks and SUVs

New transmissions compliment diesel engines
- 6+ speed automatics
- Enable diesels to stay in peak torque and fuel efficiency zone

MARTEC®

In the US car fleet, consumer demand for torque has increased at nearly 2% per yr.

US Fleet Torque and Hp Development - Cars

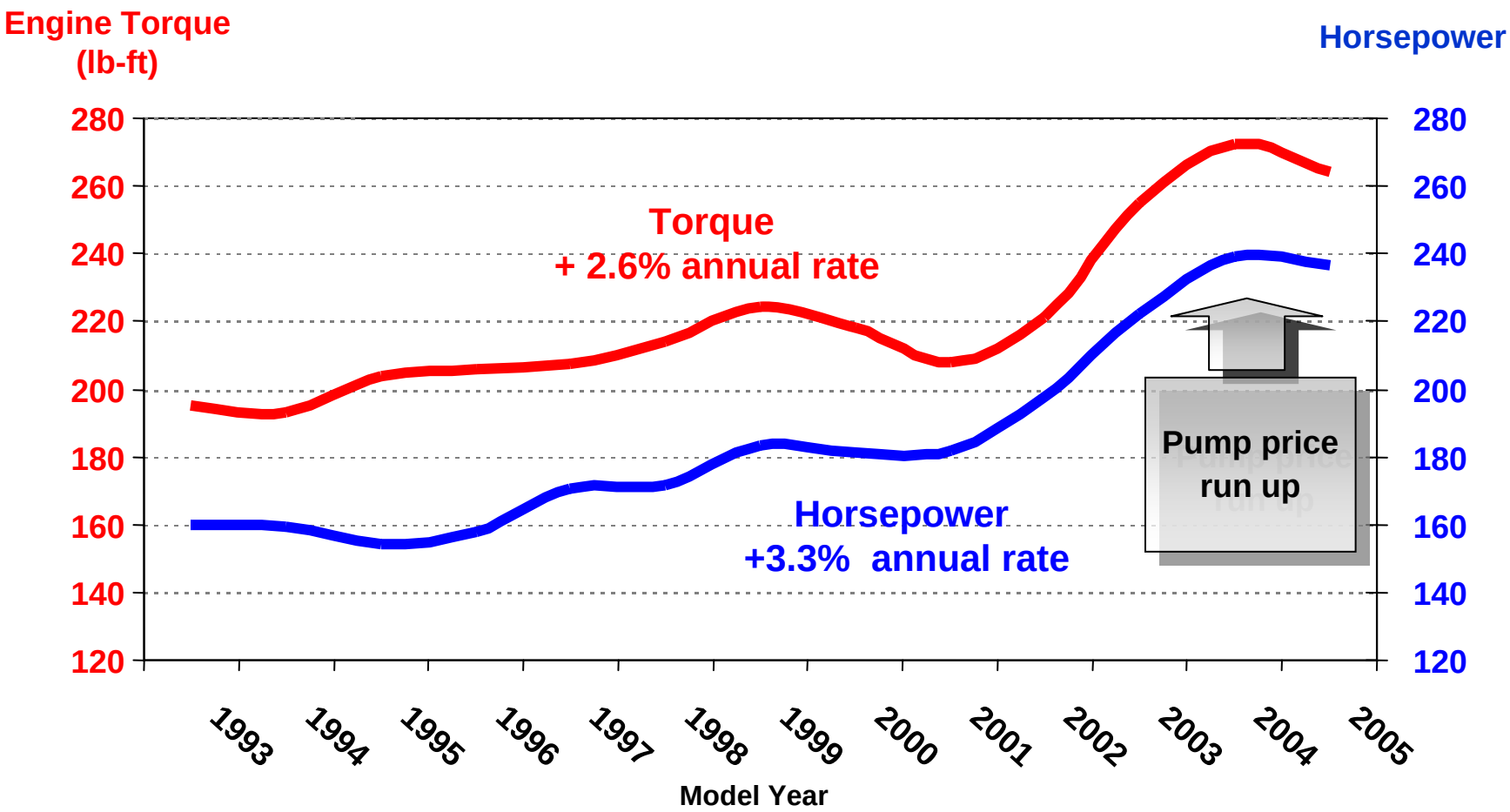


Source: Martec analysis

MARTEC®

In the light truck fleet, consumer demand for torque has been increasing at more than 2.5%.

US Fleet Torque and Hp Development – Light Trucks

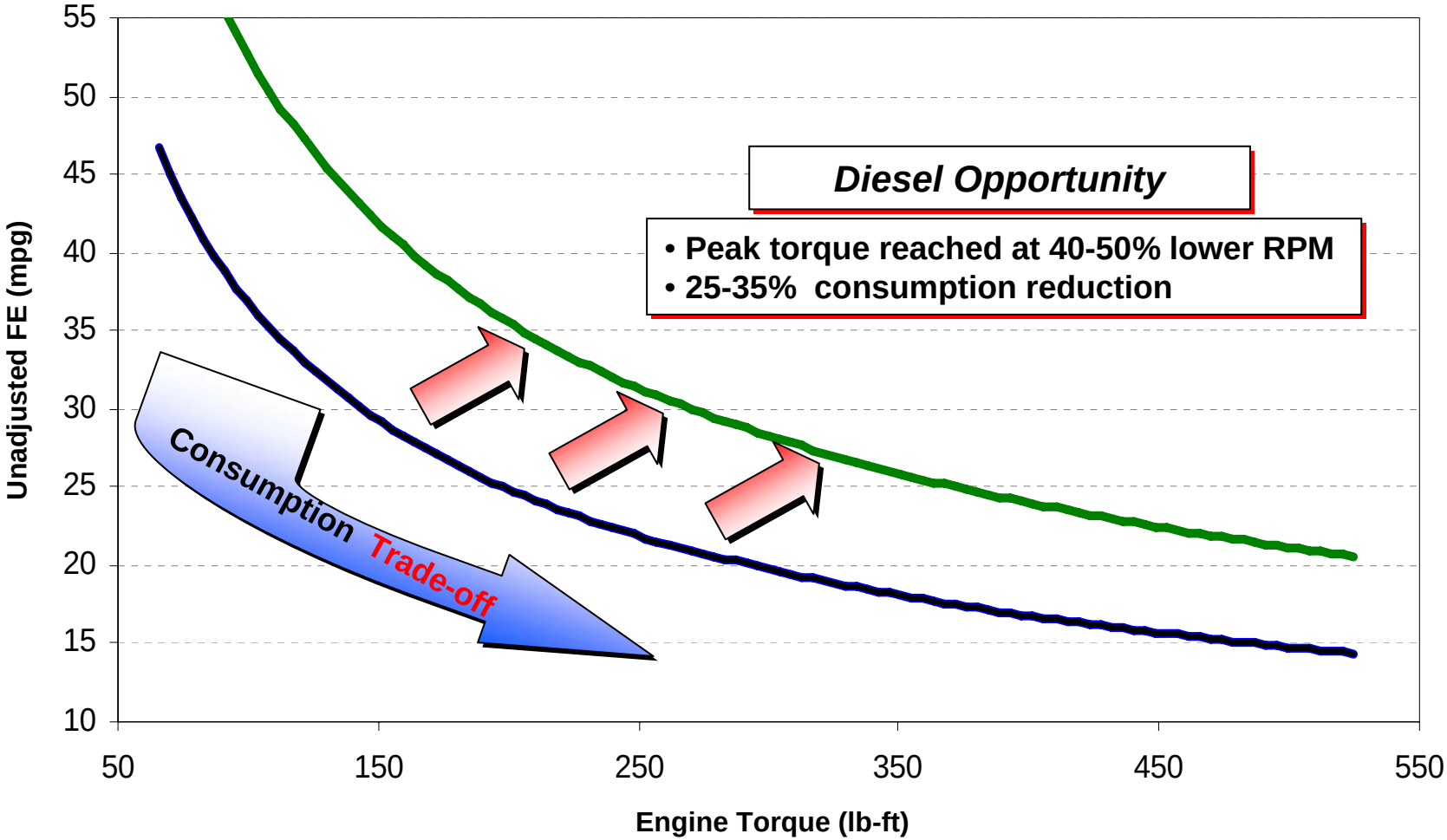


Source: Martec analysis

MARTEC

A significant number of consumers pay a premium for even more performance over the standard engine . . . and sacrifice fuel efficiency.

US Gas Engine Torque vs. FE Curve

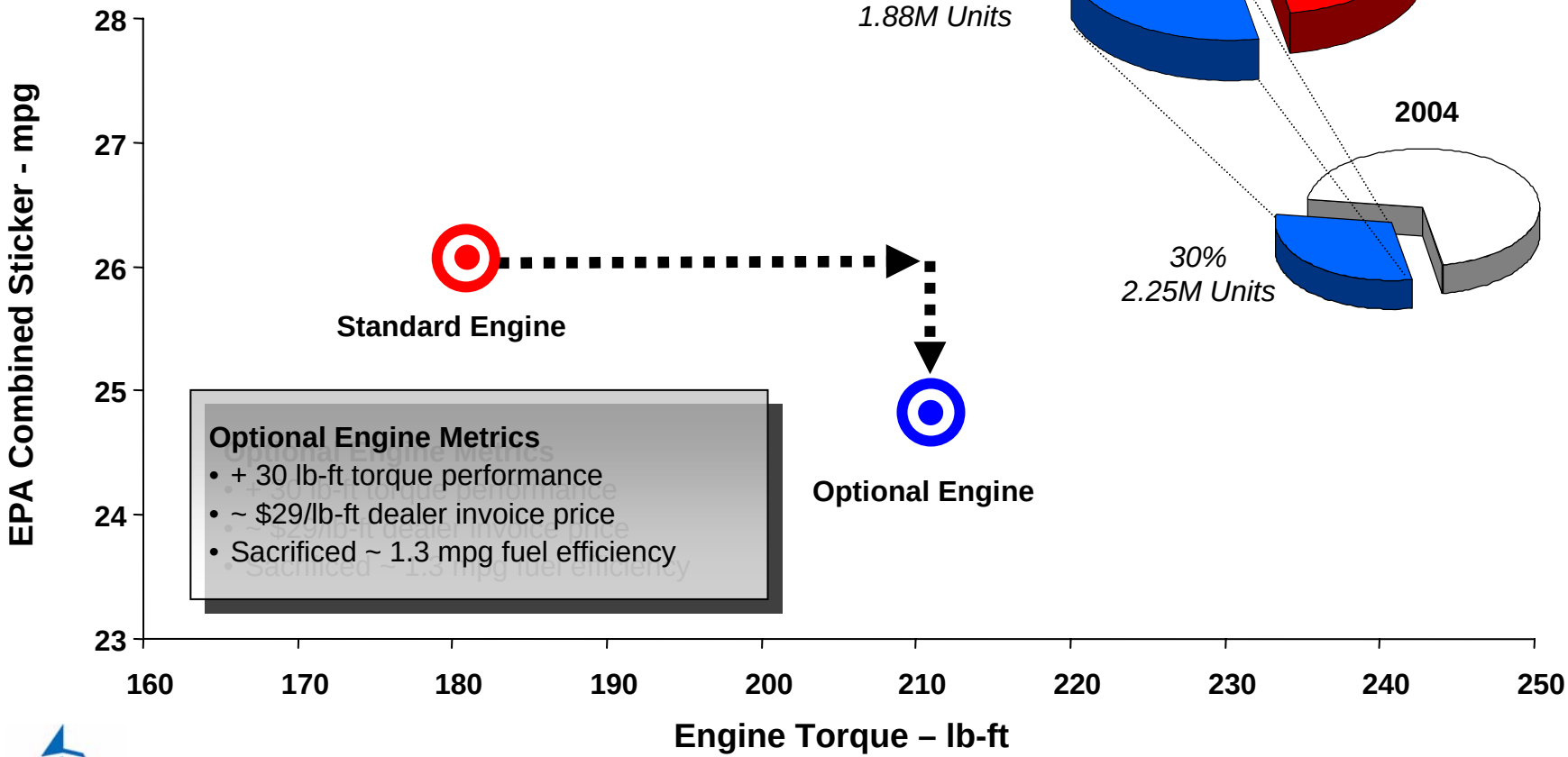


Source: Martec analysis

MARTEC®

Nearly 2M US car buyers paid an optional premium for engine performance in 2005.

2005 US Fleet Torque vs. Fuel Efficiency – Cars

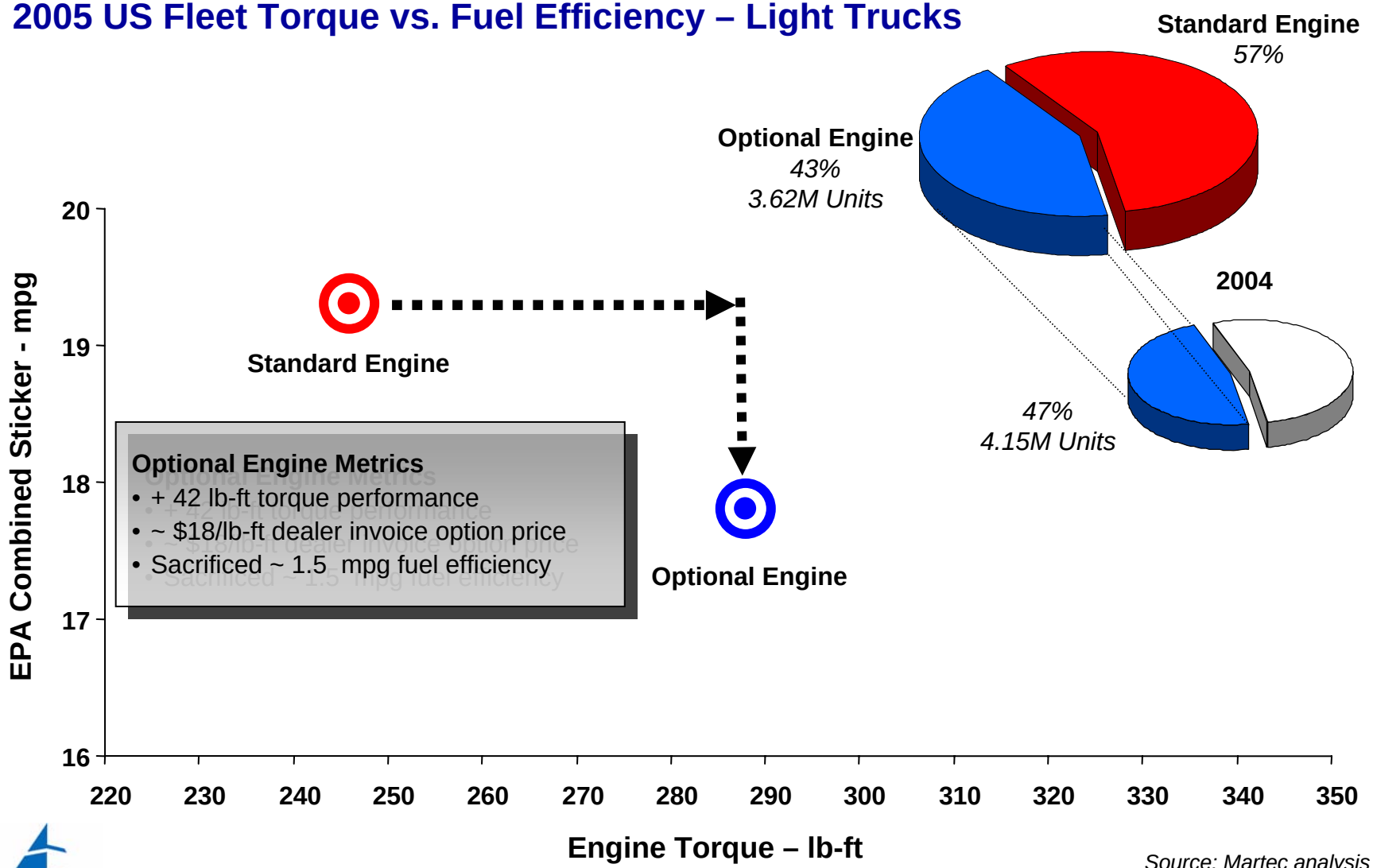


Source: Martec analysis

MARTEC

In the light truck market, more than 3.5M buyers paid a premium for additional performance.

2005 US Fleet Torque vs. Fuel Efficiency – Light Trucks

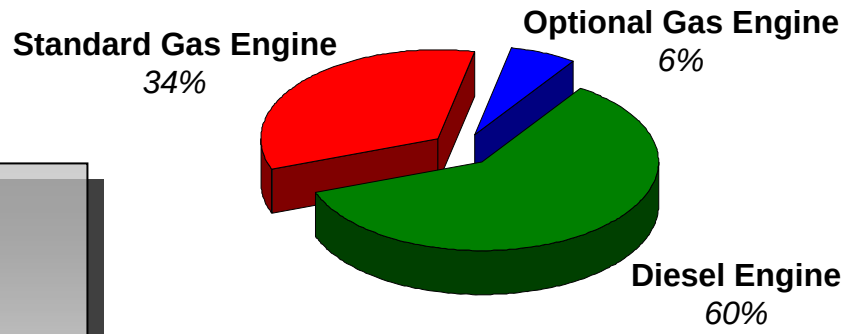


Source: Martec analysis

MARTEC

Diesels now dominate the US heavy-duty pickup truck market.

US Fleet Torque vs. Fuel Efficiency HD Pickup



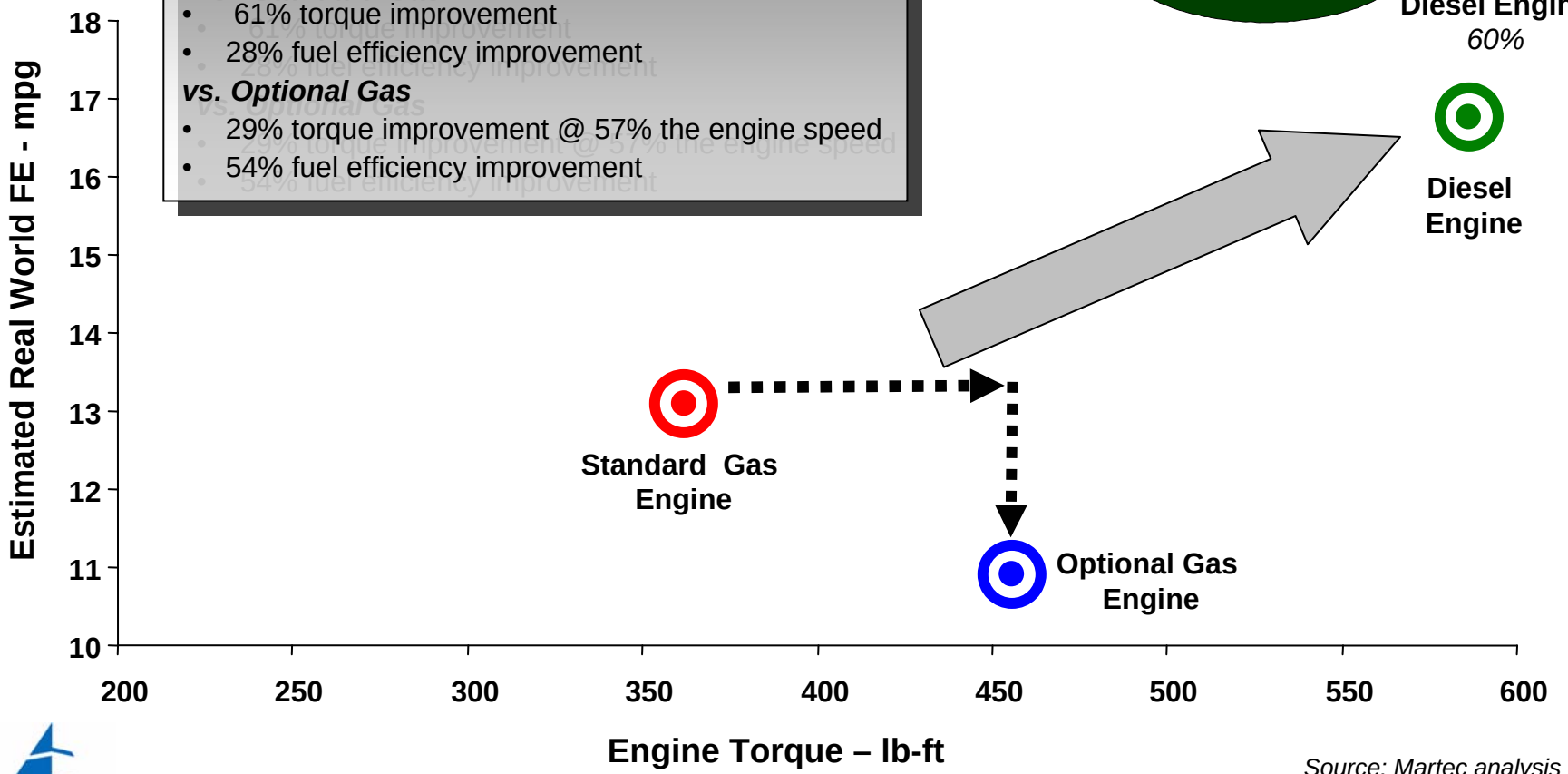
Diesel Value Proposition

vs. Standard Gas

- 61% torque improvement
- 28% fuel efficiency improvement

vs. Optional Gas

- 29% torque improvement @ 57% the engine speed
- 54% fuel efficiency improvement

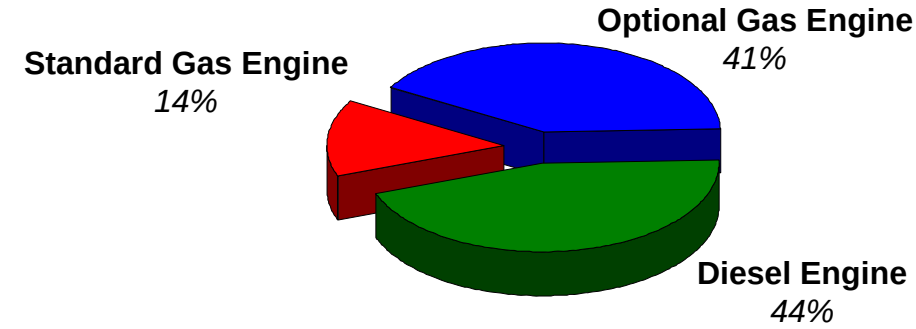


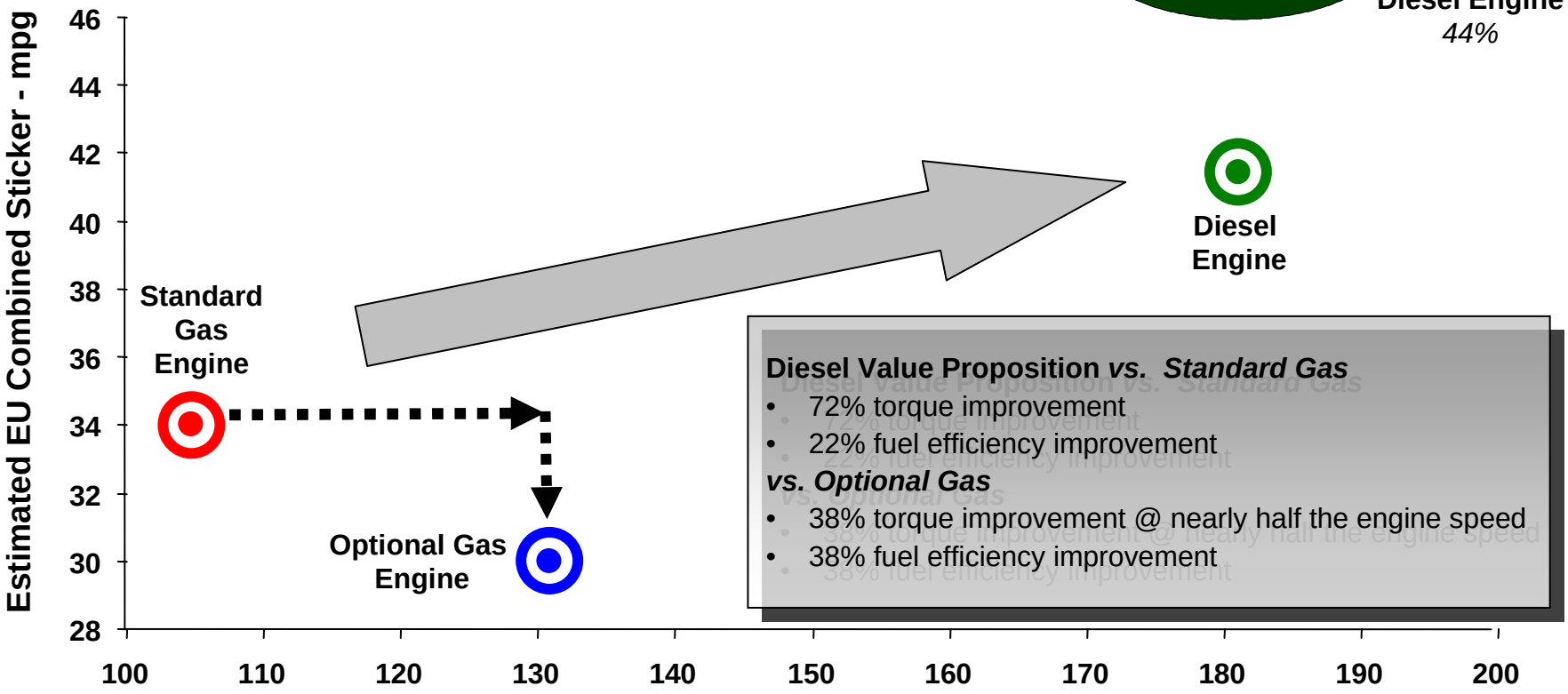
Source: Martec analysis

MARTEC

Diesels are the optional performance engine of choice in Europe.

EU Fleet Torque vs. Fuel Efficiency





Diesel Value Proposition *vs.* *Standard Gas*
- 72% torque improvement
- 22% fuel efficiency improvement

vs. Optional Gas
- 38% torque improvement @ nearly half the engine speed
- 38% fuel efficiency improvement

Source: Martec analysis

MARTEC

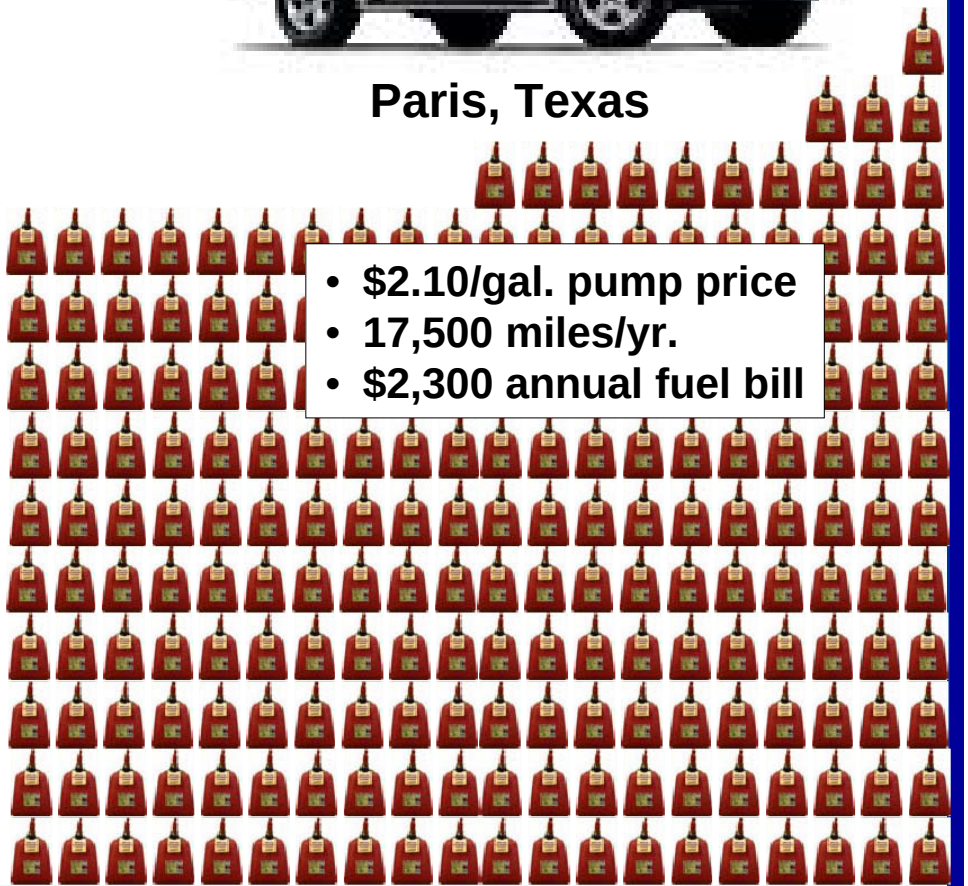
“Europe is different because fuel is so much more expensive.”

Paris, France

- $4.88/ gal. pump price
- 7,500 miles/yr.
- $900 annual fuel bill

Paris, Texas

- $2.10/gal. pump price
- 17,500 miles/yr.
- $2,300 annual fuel bill



MARTEC

Source: Martec analysis

Agenda

① Performance: it's all about torque

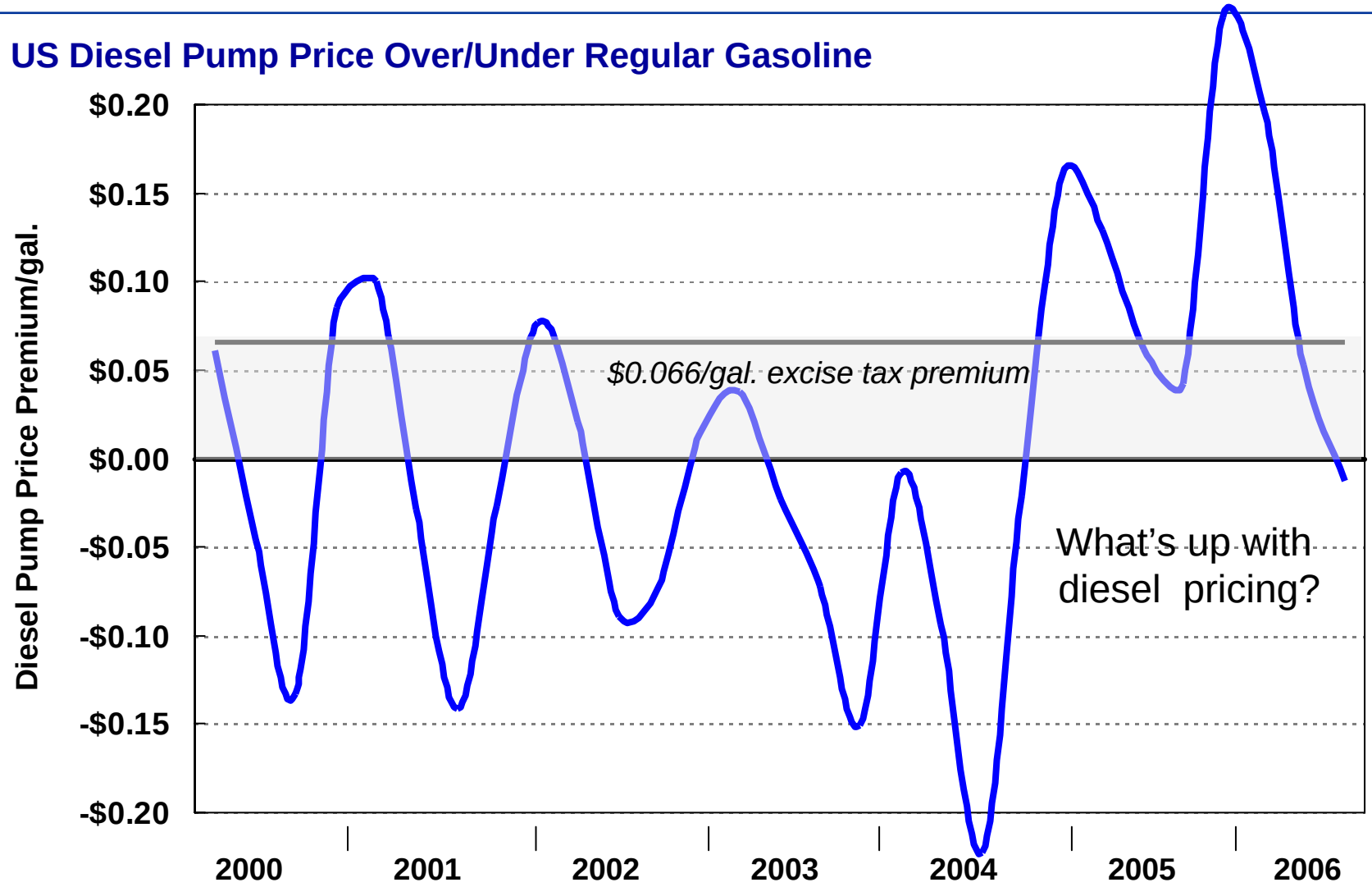
② The diesel value proposition in the US

③ 50-state emissionized diesel cost assessment

④ Summary and conclusions

MARTEC®

Unlike most of Western Europe, diesel fuel is taxed more heavily than gasoline in the US.

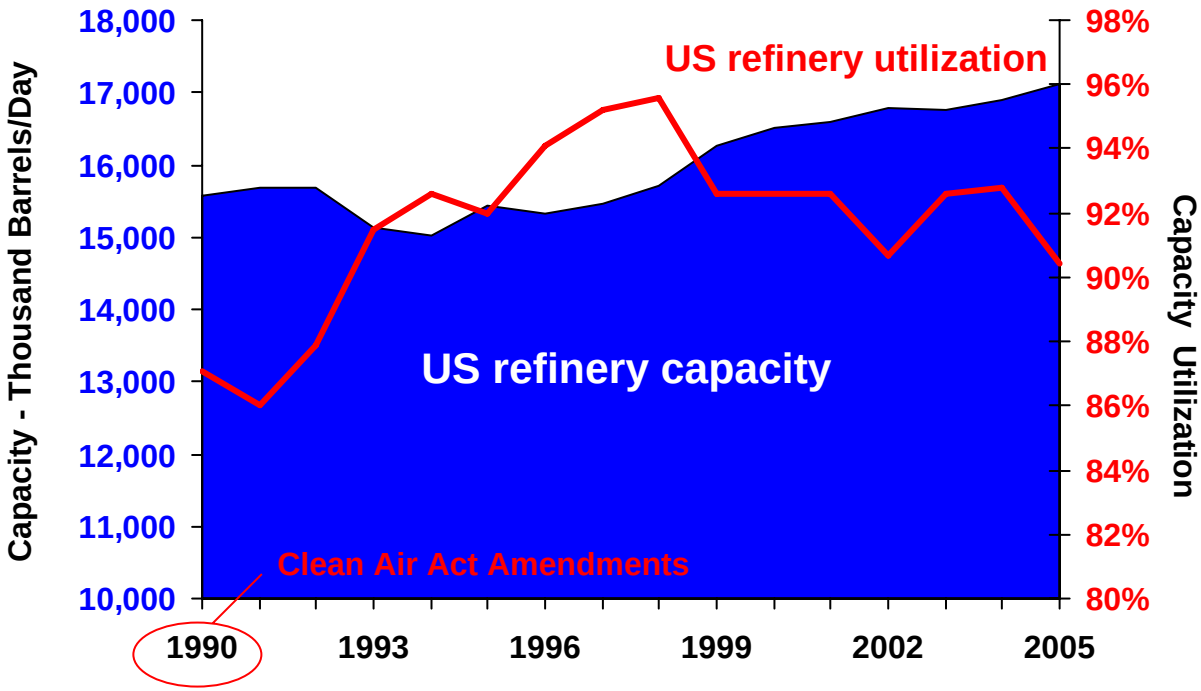


Source: EIA

MARTEC

US fuel refining capacity increases have crept along at <0.7% annual rate since 1990.

US Refinery Capacity and Utilization



Capacity utilization has consistently exceeded 90% since 1993

US demand for fuel has increased at a much faster rate since 1995:

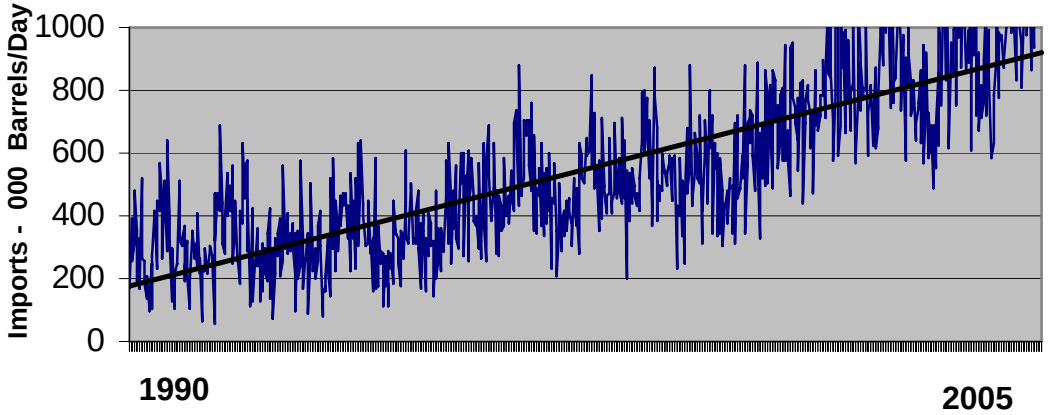
- **Gasoline demand has increased at 1.7% annual rate . . . .**
- ***With distillate demand increasing at 2.1%***

Source: EIA

MARTEC

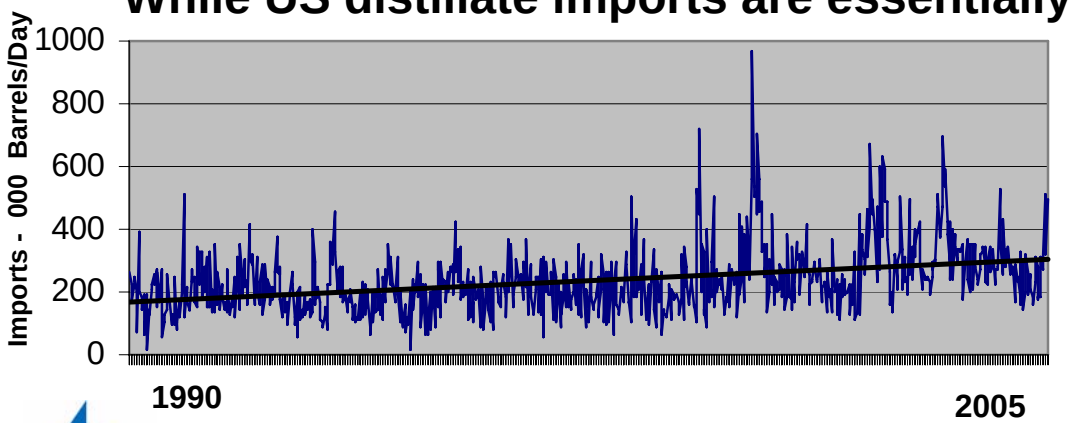
Europe is exporting excess gasoline to the US, helping to depress pricing relative to diesel.

US gasoline imports have risen dramatically: > 5.5% CAGR



Half of the increased US demand met by imports
- ***60% from Europe***

While US distillate imports are essentially flat



EIA 2007 Forecast:

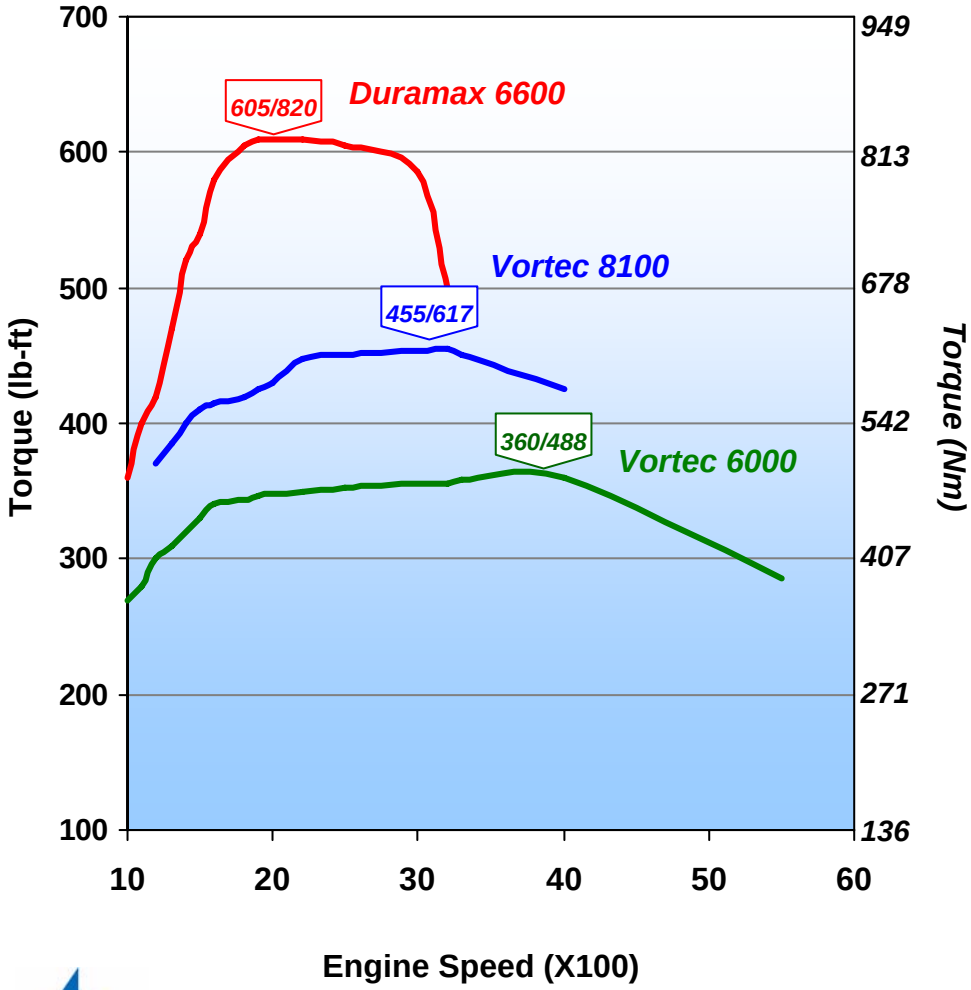
$0.07 premium for diesel…most of which is tax delta

Source: EIA

MARTEC

The HD pickup customer buys the diesel for low-end torque; fuel efficiency is a bonus.

Example HD Pickup Torque Curves



HD Pickup Truck Market Sales Weighted Metrics

Base V8 OHV/SOHC gas engine

- 364 lb-ft/494 Nm @ 4012 rpm
- Real world FE combined: 13.1 mpg

Optional diesel engine

- 587 lb-ft/796 Nm @1849 rpm
- Real world FE combined: 16.8 mpg
- Option price (with auto trans): $6603

Optional V8/V10 gas engine

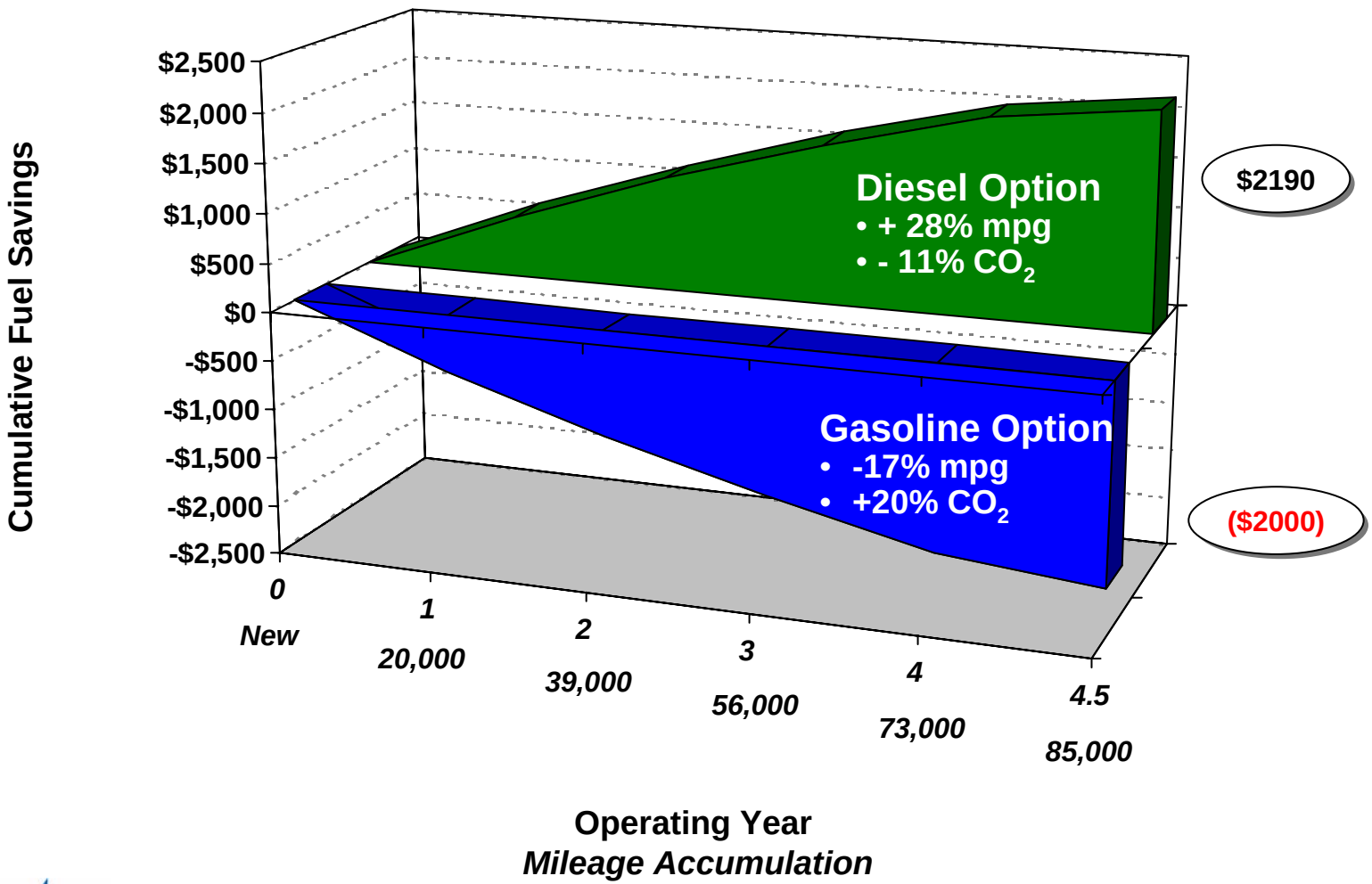
- 456 lb-ft/619 Nm @ 3232 rpm
- Real world FE combined: 10.9 mpg
- Option price (with auto trans): $2250

Source: Company websites

MARTEC

After 4.5 years, the average diesel owner has saved nearly $4200 in fuel vs. the alternative high torque option.

HD Pickup Trucks – Optional Engine Fuel Savings vs. Base Engine (NPV- 3 yr. Fuel)

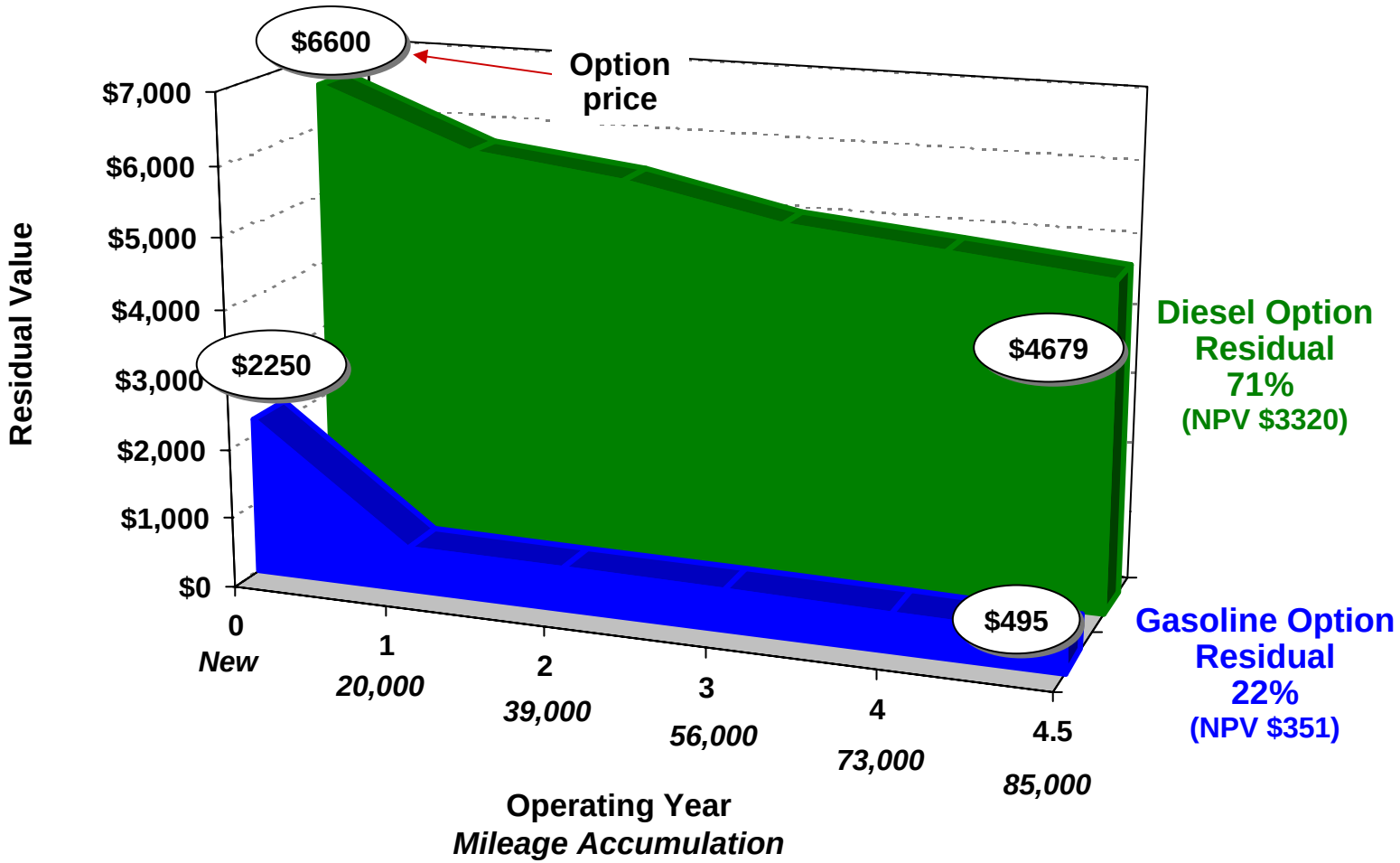


Source: Martec analysis

MARTEC

The diesel customer recovers a $4700 trade-in premium after 4.5 years.

HD Pickup Trucks – Optional Engine Residual Value (NPV)

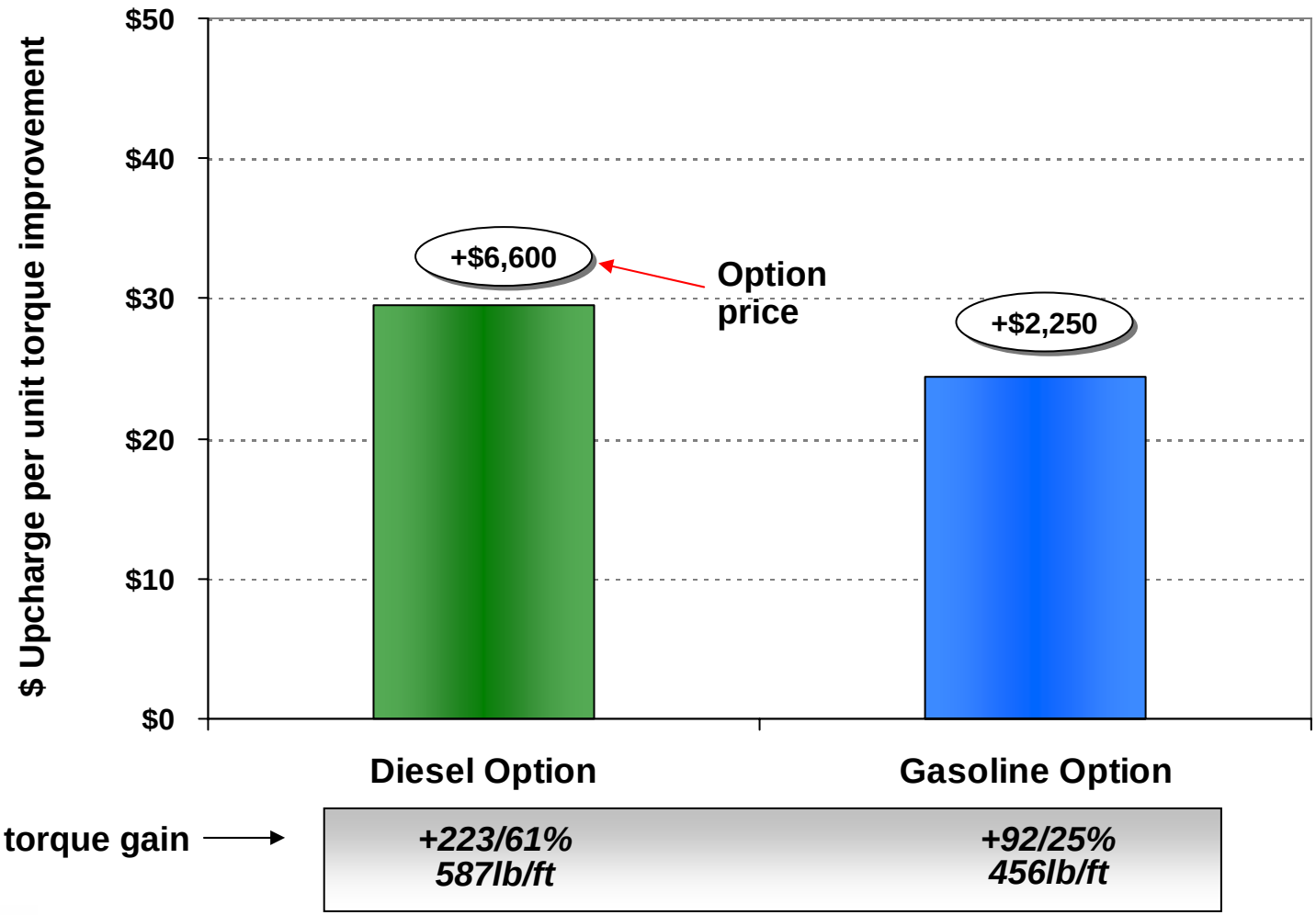


Source: Martec analysis

MARTEC

The diesel customer is paying a 20% premium per unit of torque improvement vs. optional gas. . . but diesel pays you back.

HD Pickup Trucks – $/Unit of Torque Improvement (NPV)

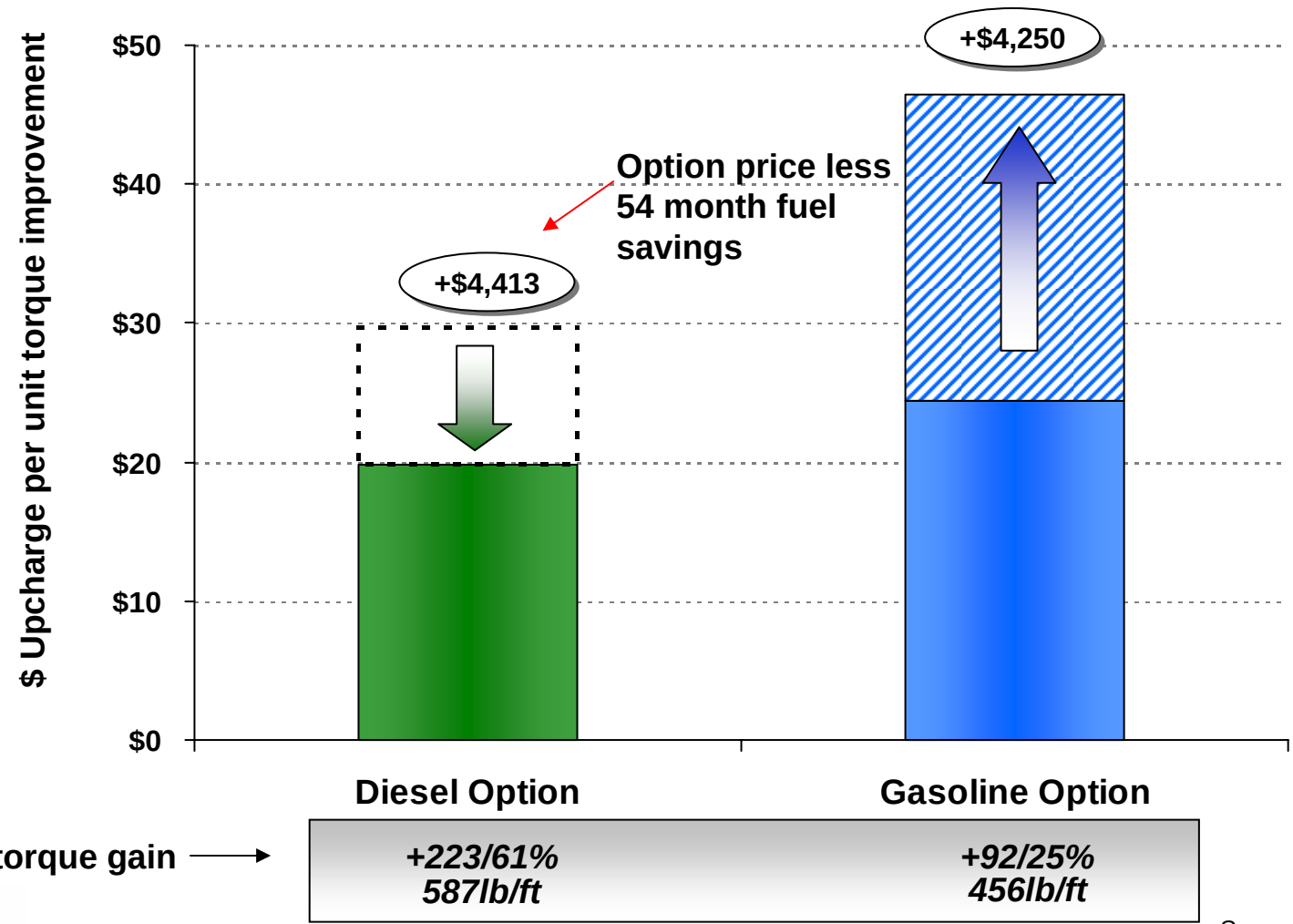


Source: Martec analysis

MARTEC

After 4.5 years, fuel savings have reduced the effective diesel option price by one-third.

HD Pickup Trucks – $/Unit of Torque Improvement (NPV 3-yr. Fuel)

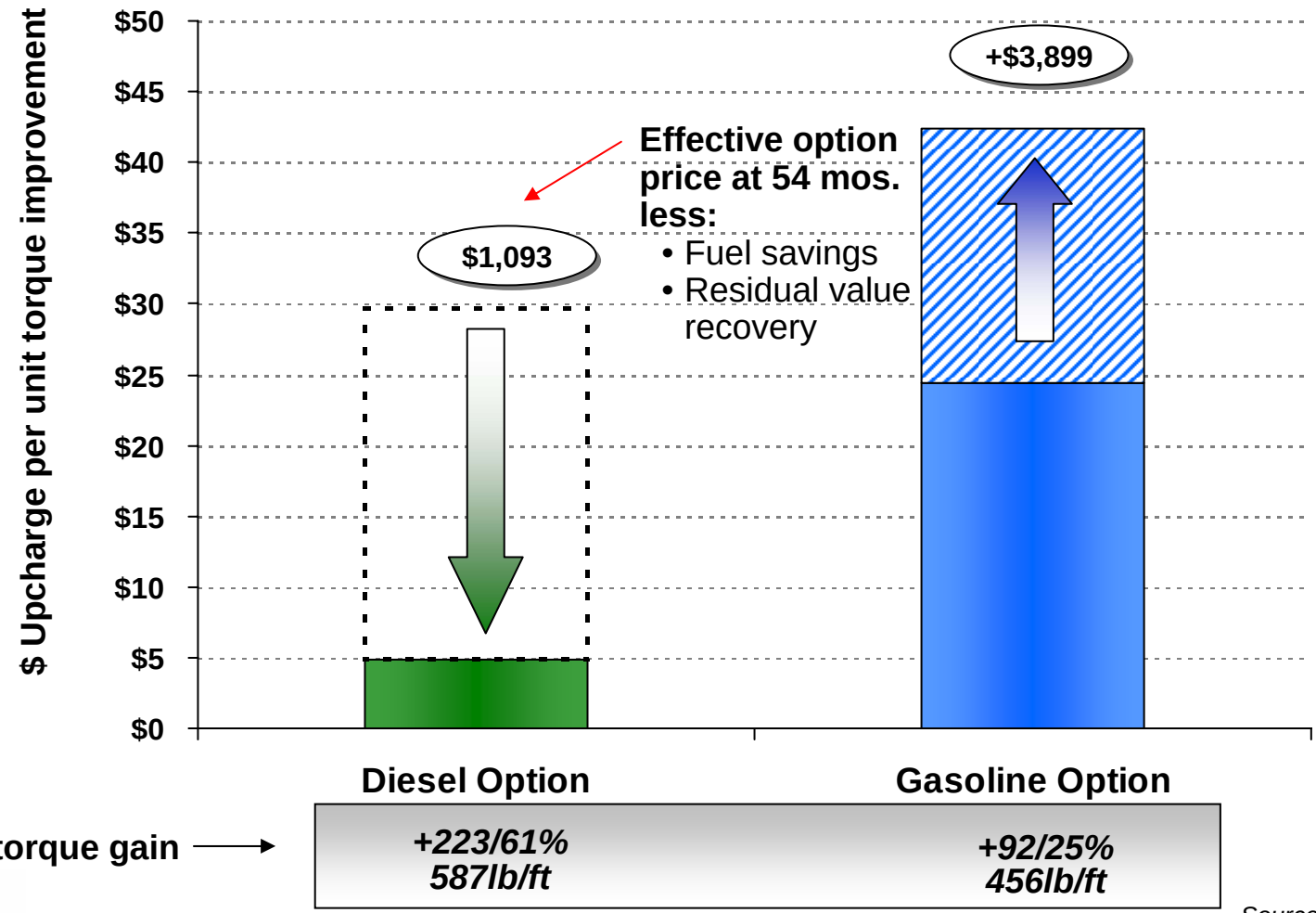


Source: Martec analysis

MARTEC

At trade-in, the effective cost of 4.5 years of premium performance is about $1,100.

HD Pickup Trucks – $/Unit of Torque Improvement (NPV 3-yr. Fuel)

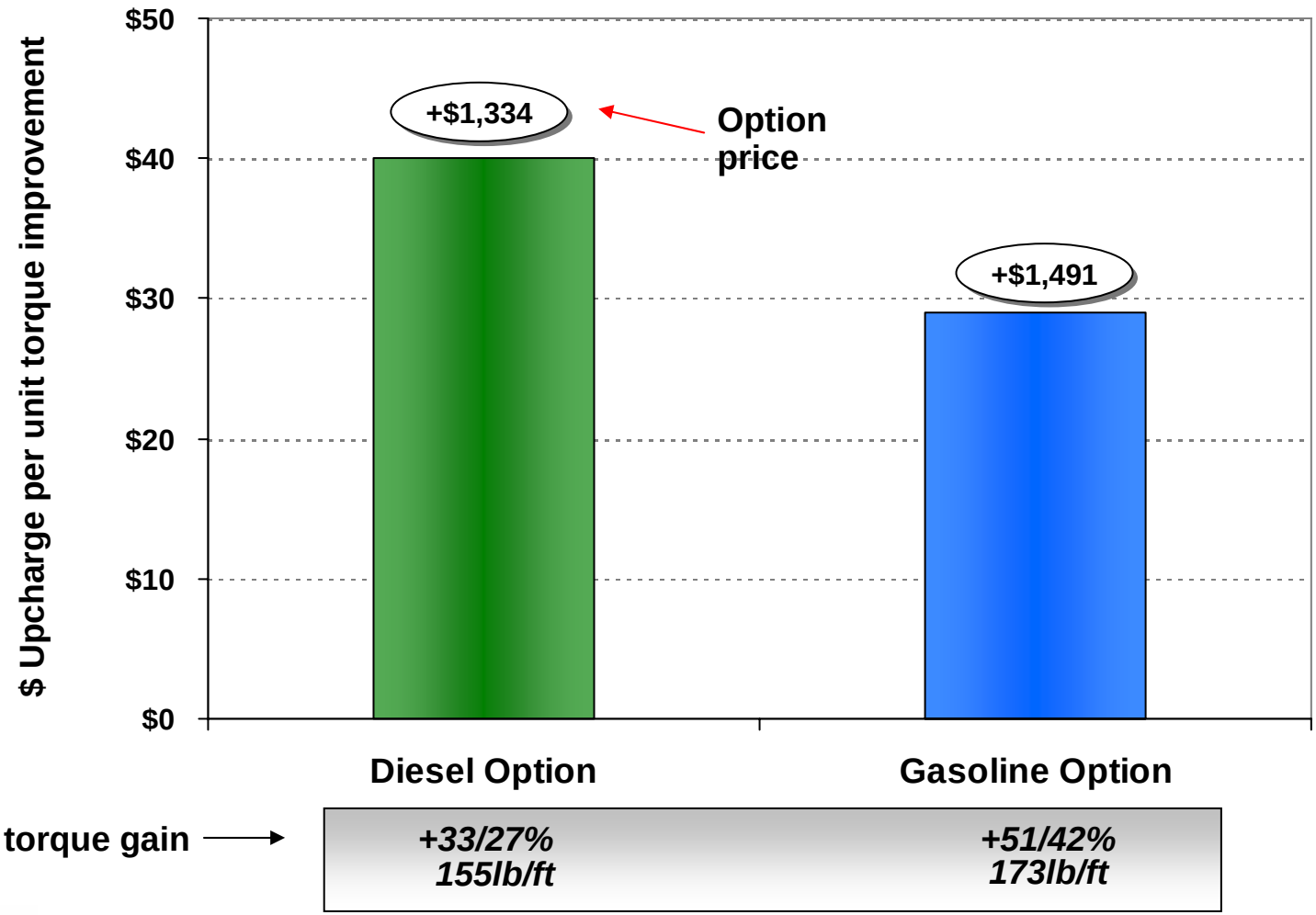


Source: Martec analysis

MARTEC

The Jetta diesel customer is paying a 38% premium per unit of torque improvement vs. optional gas. . . but diesel pays you back.

VW Jetta – $/Unit of Torque Improvement (NPV)

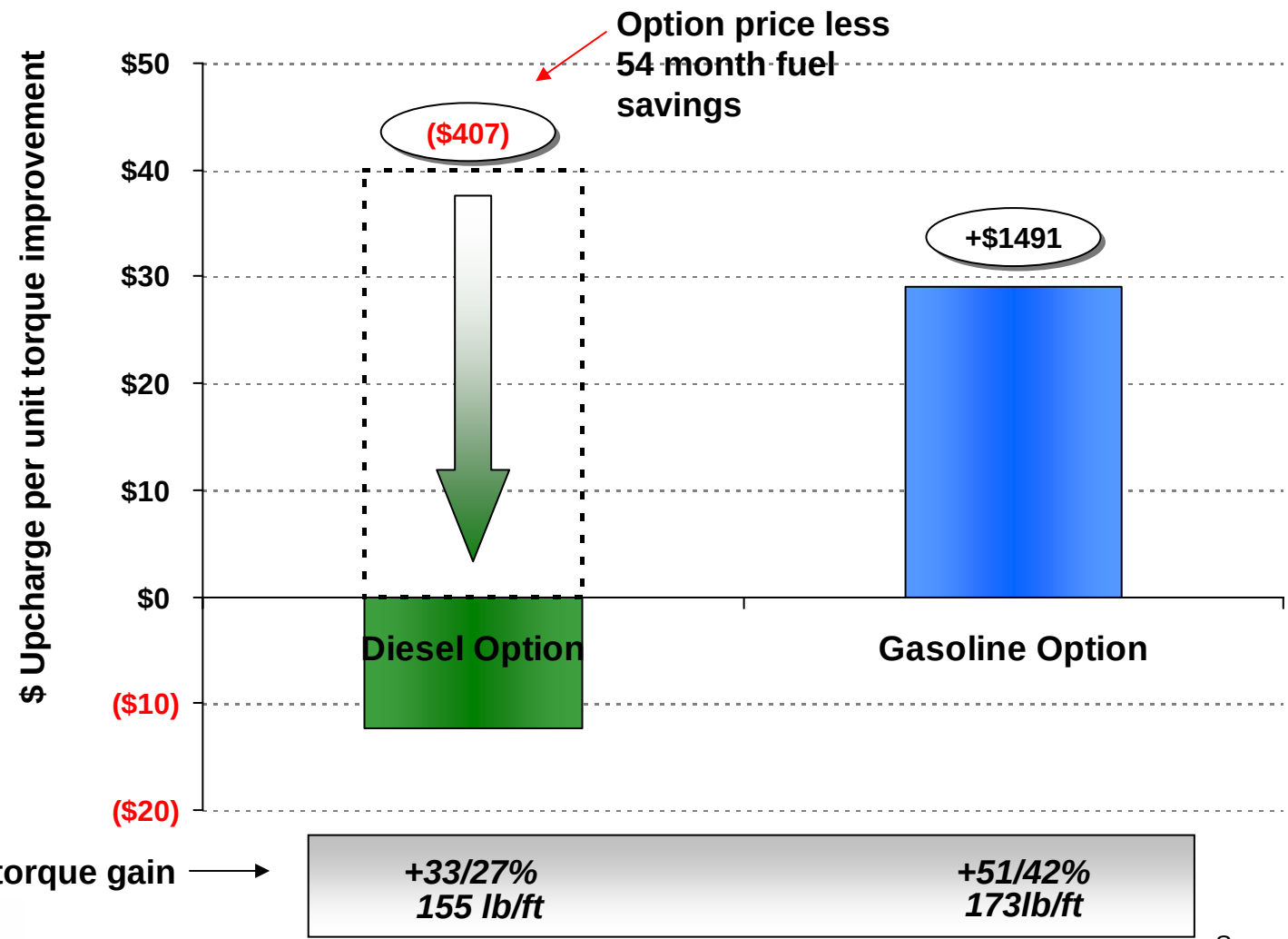


Source: Martec analysis

MARTEC

After 4.5 years, fuel savings have recovered the total Jetta diesel option price.

VW Jetta – $/Unit of Torque Improvement (NPV 3-yr. Fuel)

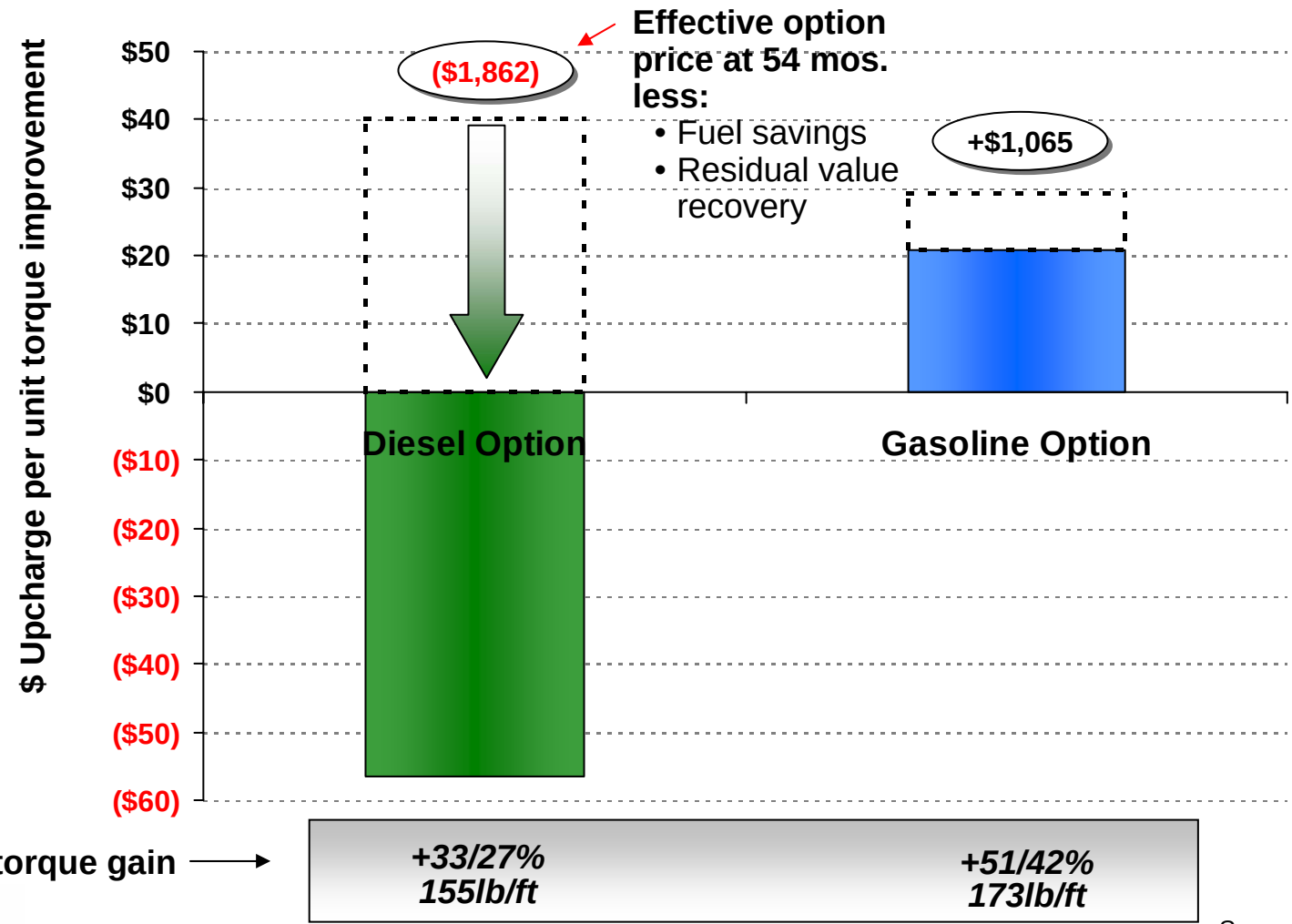


Source: Martec analysis

MARTEC

At trade-in, the effective cost of 4.5 years of premium performance is about ($1,850).

VW Jetta – $/Unit of Torque Improvement (NPV 3-yr. Fuel)

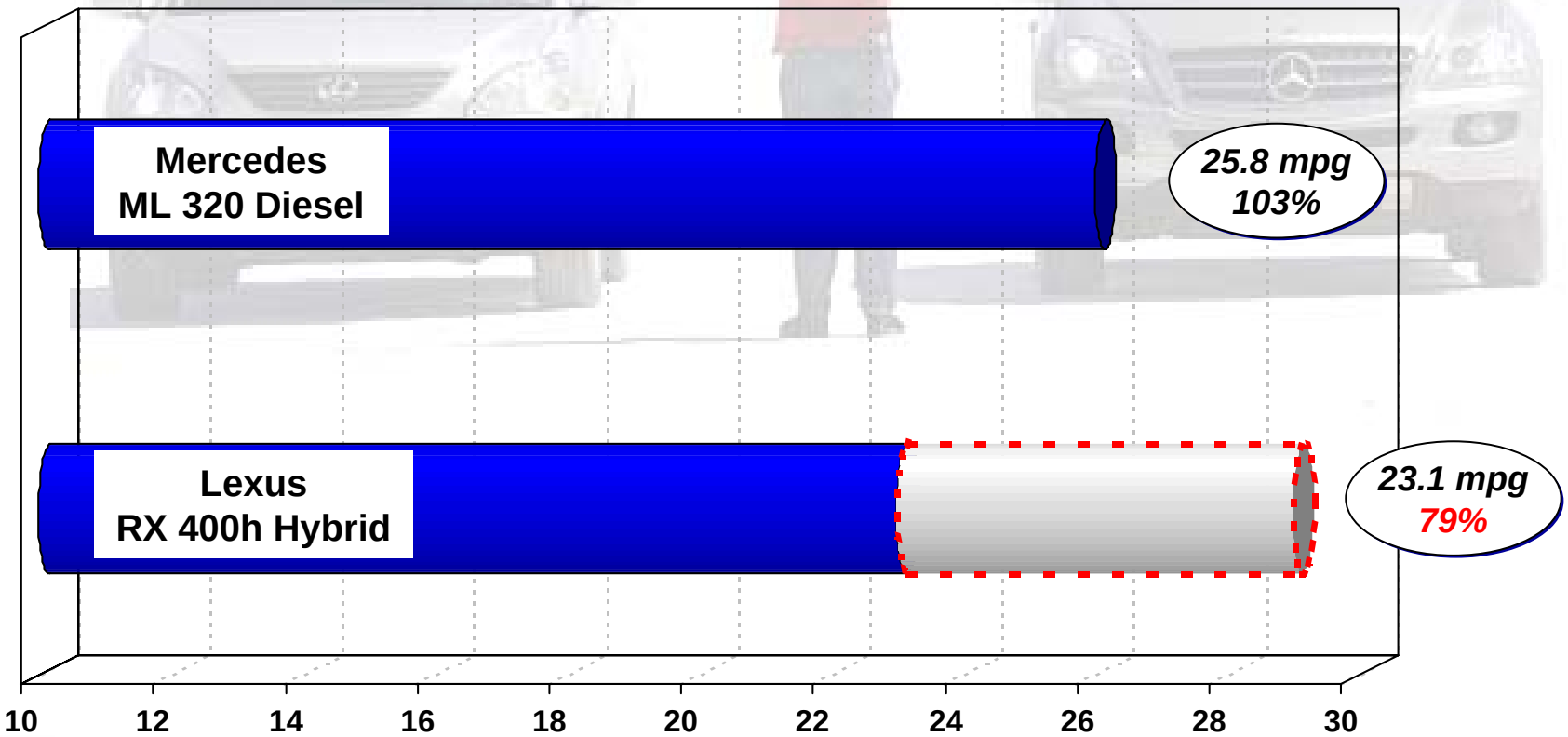


Source: Martec analysis

MARTEC

In a coast-to-coast test by Autobild magazine, a diesel SUV delivered on its fuel efficiency promise. The hybrid fell short.

The HEV Loophole: Real World Efficiency Falls Short of Promise



Source: Autobild.de

MARTEC

Agenda

① Performance: it's all about torque

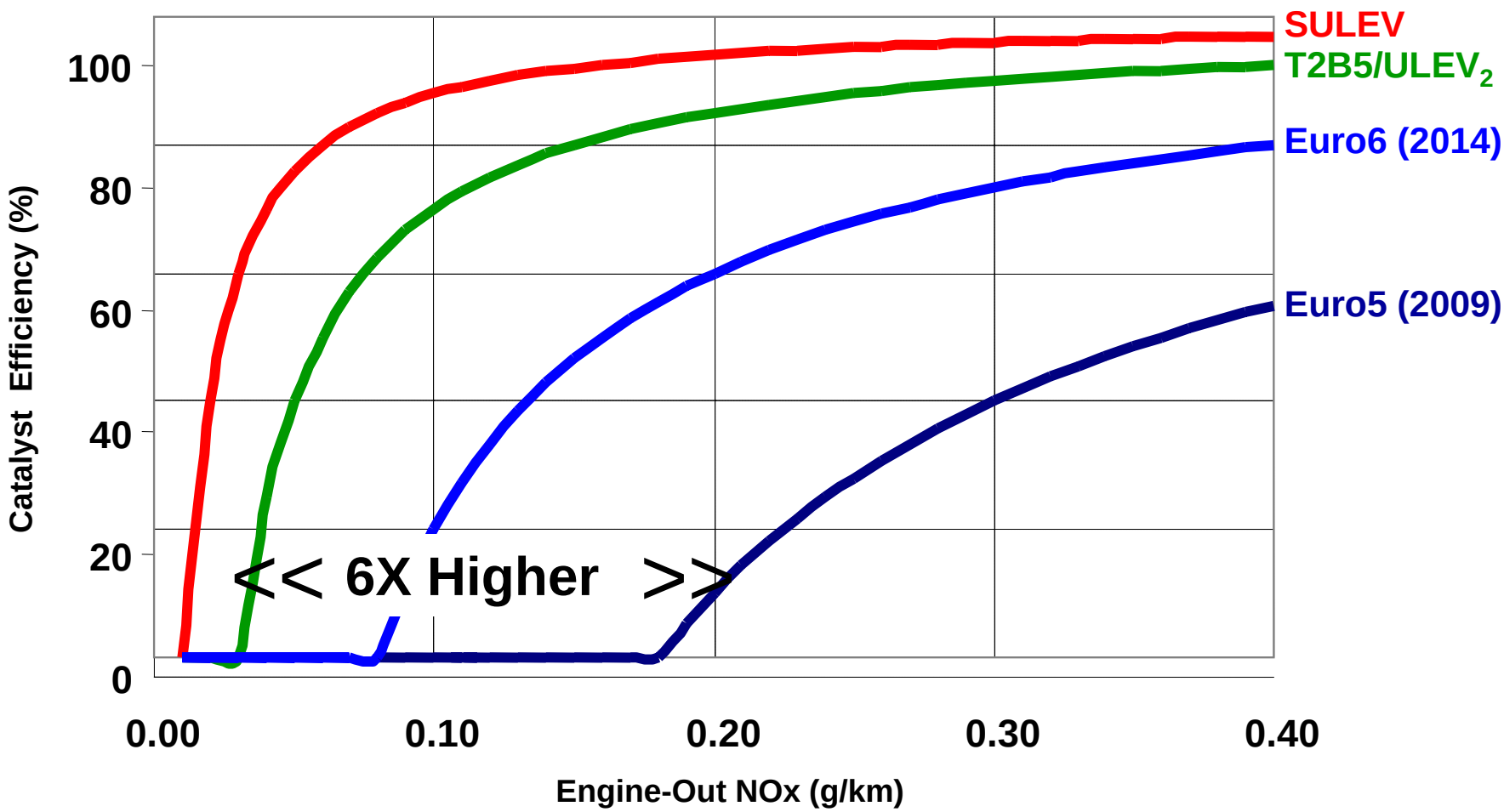
② The diesel value proposition in the US

③ 50-state emissionized diesel variable cost assessment

④ Summary and conclusions

MARTEC®

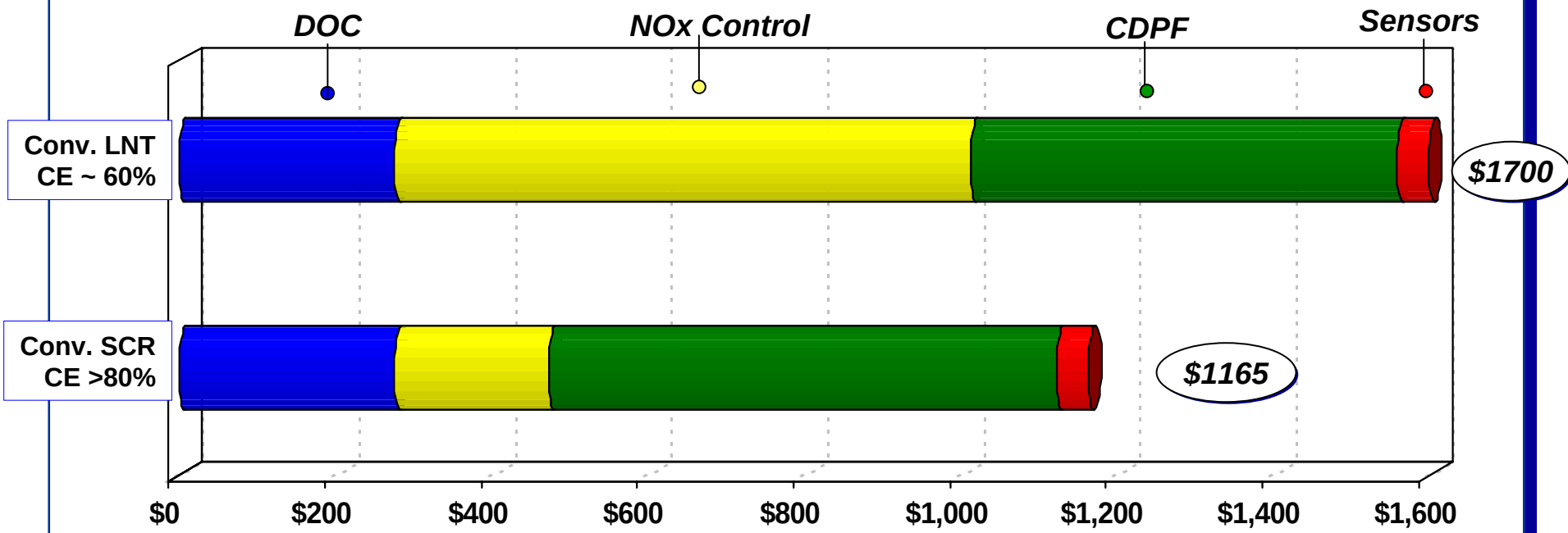
High efficiency NOx aftertreatment will be required to create a 50-state light duty diesel market.



MARTEC

Aftertreatment technology has entered the cost optimization phase of development.

4.5L DOHC V6 Diesel – 2010 Scenario



5.0L OHV V8 bin 5 gasoline aftertreatment and evap system baseline: $285

Net aftertreatment costs

- SCR ~ $880
- LNT ~ $1415
- With potential for significant reductions through advanced “pre-mix” combustion system development

MARTEC

Source: Martec analysis

Engine architecture drives a range of on-engine diesel costs.

Construction of Dieselization Costs vs. V8 OHV 2V Baseline

V8 OHV 2V Baseline

Potential Diesel Architecture →	Cost Delta vs. V8 OHV 2V		
	L6 DOHC 4V	V6 DOHC 4V	V8 DOHC 4V
Downsizing credit	($300)[1]	**$100[1]**	$600[1]
Diesel Content • VGT turbo and accessories • Advanced diesel FI system • Injectors, HP pump, rail (s) and diesel ECM • Minor mechanical upgrades	$1100	**$1200**	$1300
Net on-engine variable cost delta	$800	**$1300**	$1900
Net variable cost increase with SCR aftertreatment	$1,700	**$2,200**	$2,800

1 Assumes conversion from Fe to Al block

Only variable costs captured.

MARTEC®

A potential US full size pickup truck diesel value proposition:

Key Assumptions	Metric
Diesel option price – 4.5L DOHC V6	$4,000
Performance increased 30% vs. class average	432 lb-ft torque
Fuel consumption reduced 30%	19 mpg
VMT over 4.5 years	79,000
Residual value on option = to European typical	64%

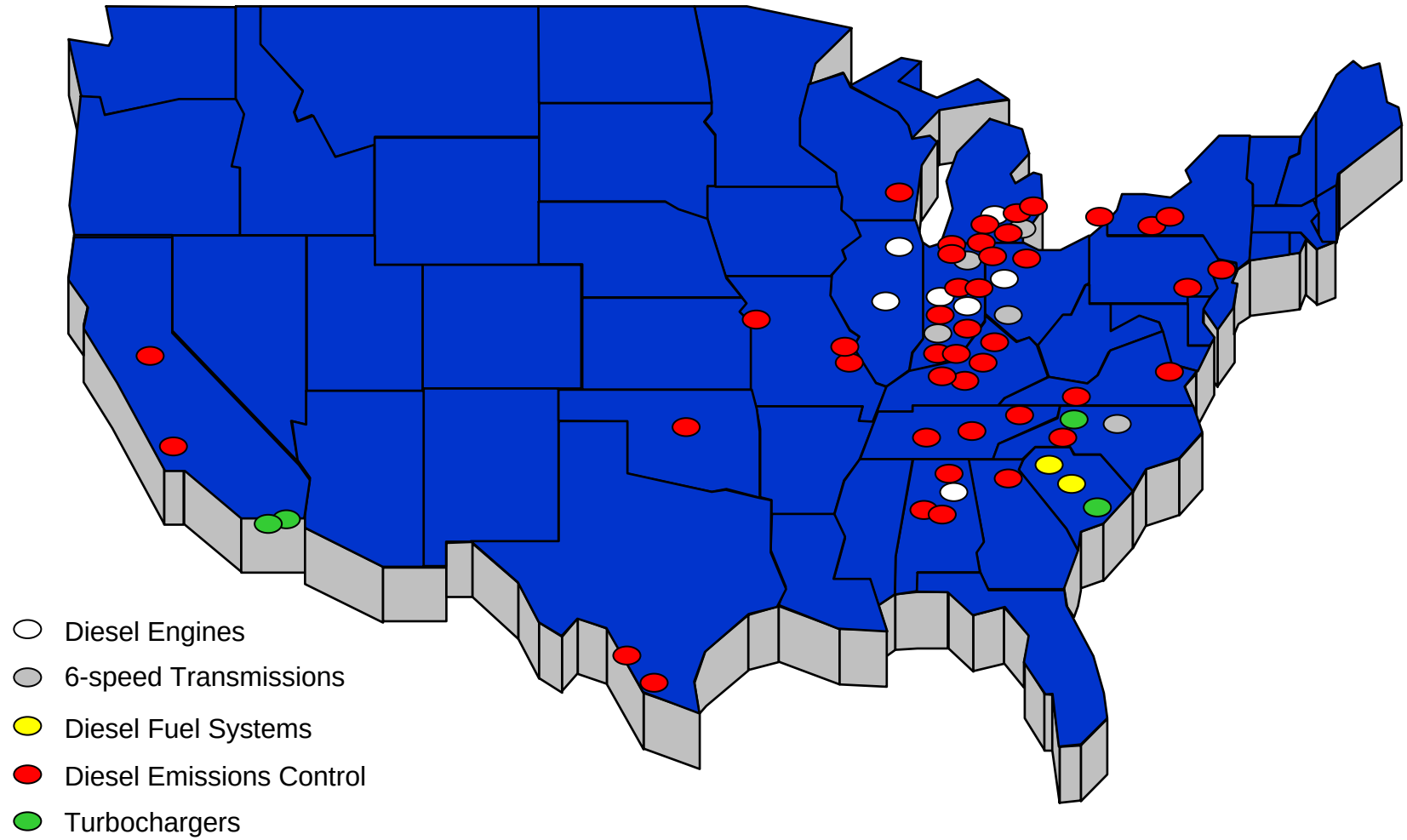
Customer Value Proposition	Metric
Option cost/lb-ft performance +	$40
Fuel savings – NPV @ 3-year US avg.	($2,580)
Saved re-fueling stops/month	1.2
Residual value recovery - NPV	$1,820
NPV cost for 4.5 years of premium performance	($400)

Excludes urea costs. At 3% dosing rate ~ $185-250 at $1.5-2.0 per gallon retail.

MARTEC®

Heavy capital investment necessary to support light duty dieselization already exists in the US.

Existing Manufacturing Capital to Support Light Duty Dieselization



Source: Martec analysis

MARTEC®

Agenda

① Performance: it's all about torque

② The diesel value proposition in the US

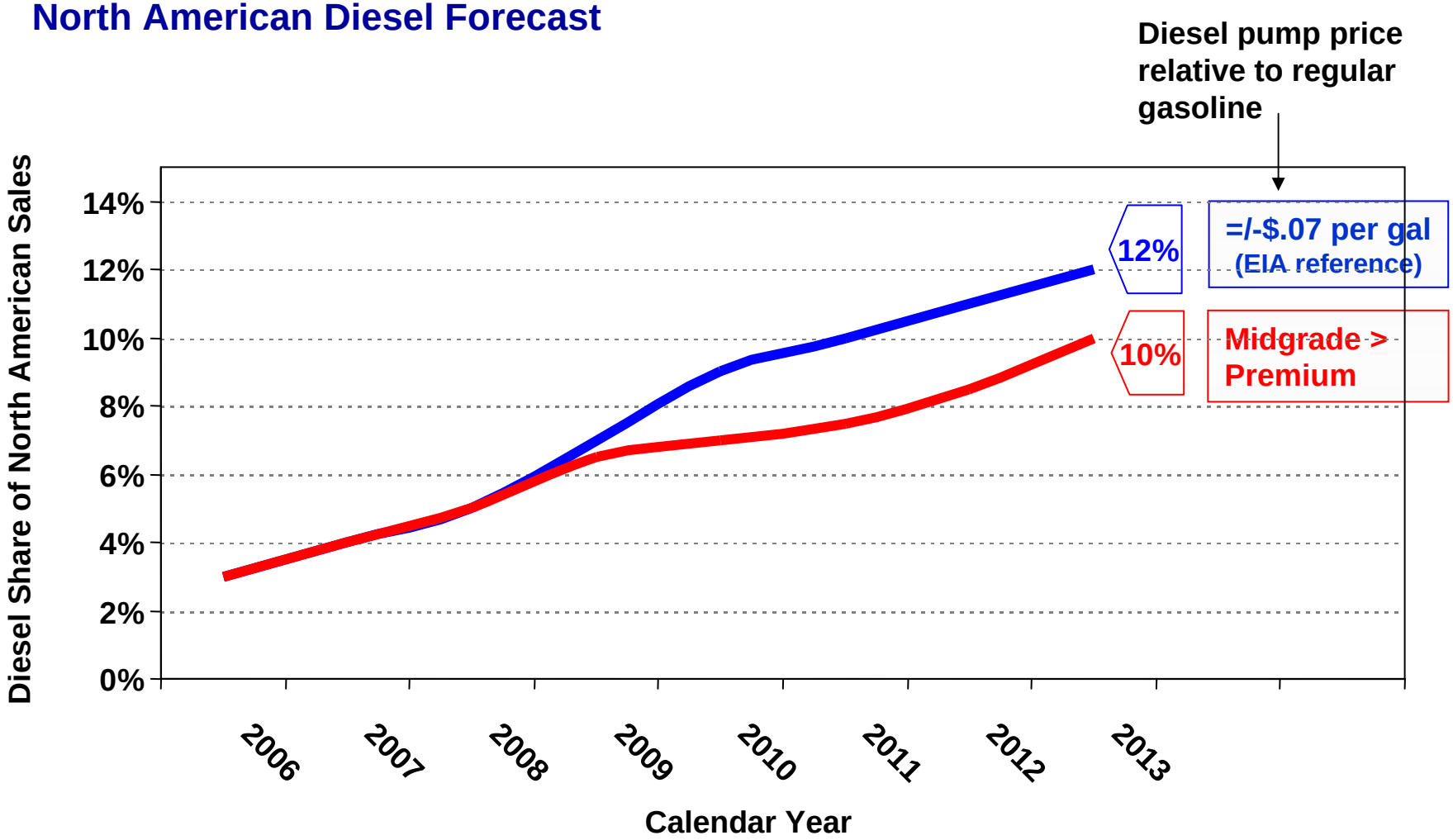
③ 50-state emissionized diesel variable cost assessment

④ Summary and conclusions

MARTEC®

We expect substantial growth in the diesel share of North American demand.

North American Diesel Forecast



Source: Martec analysis

MARTEC

The diesel value proposition, demonstrated in Europe and in the HD pickup segment, will work in the North American light duty market.

Summary

Why light duty diesels make sense in the North American market.

- **Diesel powered vehicles deliver the kind of performance and durability consumers want . . . and pay a premium to acquire**
- **They are economically viable for both manufacturers and consumers**
  - ***Low operating cost and time savings***
  - ***High residual value at trade-in***
  - ***Real-world FE in line with promise***

Diesel Pays You Back

- **50-state emissions levels will be achieved through advanced combustion control and aftertreatment systems**
- **Diesels can deliver near term benefits to the environment and the economy by reducing demand for imported oil**

THE MARTEC GROUP, INC.

MARTEC®