Opportunity Assessment
Clean Diesels in the North American
Light Duty Market

13th DEER Conference
US Department of Energy

August 14, 2007
Martec has completed a comprehensive analysis of the opportunity for clean diesels in the North American light duty market.

Created in partnership with HART Energy Consulting, the study synthesizes the voice of each stakeholder group on critical issues:

- Consumer perceptions and consideration for LDD vs. HEV powertrains
- Urea SCR service intervals and compliance
- Residual value performance
- Variable cost comparison of LDD vs. full HEV by segment
- Fit with national energy and CO2 policy development
- Demand forecast
Agenda

① Performance: it’s all about torque

② Consumer awareness and impressions

③ Voice of dealers, Wall Street and the automotive media

④ Public policy impact

⑤ Forecast and conclusions
US consumer demand for torque has been climbing at a 2.6% annual rate.

US Fleet Torque and Hp Development – Fleet

- **Torque**: +2.6% annual rate
- **Horsepower**: +3.1% annual rate

**Source**: Martec analysis
5.3M premium engine buyers drive > $7.5B in incremental industry revenue and sacrifice fuel economy.

2006 US Fleet Torque vs. Fuel Efficiency

Optional Engine Metrics
- +66 lb-ft torque performance
- ~ $22/lb-ft dealer invoice price
- Sacrificed ~3 mpg fuel efficiency

Source: Martec analysis
Even at escalating fuel prices, a significant share of consumers want to maintain engine performance and vehicle attributes.

Rank as No. 1 Purchase Decision Factor at Increasing Fuel Prices

- Fuel Economy
- Vehicle Size
- Engine Performance

CA Wave 5

Pump Price

$2.70 $3.20 $3.70 $4.20 $4.70
There has been a significant increase in consumer familiarity with Clean Diesel.
But consumer perceptions are not yet aligned with state-of-the-art diesel positioning.

New Vehicle Consumers

CA Wave 5

<table>
<thead>
<tr>
<th>Fuel Economy</th>
<th>Acceleration from a standing start</th>
<th>Innovation/New technology</th>
<th>Environmentally Friendly</th>
<th>Low cost to operate</th>
<th>Exhaust odor</th>
<th>Reliability</th>
<th>Driving distance between refills</th>
<th>Noise/vibration during driving</th>
<th>Highway passing performance</th>
<th>Holds value (resale)</th>
<th>Towing performance &amp; capacity</th>
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<td>Gasoline</td>
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Poor 2.0 3.0 4.0 5.0

Excellent
These perceptions are not deeply held.

**After Education: Percent Selecting Clean Diesel**

- **CA**
- **49 State**

<table>
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<tr>
<th>Month</th>
<th>CA</th>
<th>49 State</th>
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<td>Apr '05</td>
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<td>Feb '07</td>
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Urea SCR compliance is not a deal breaker.

2-part Urea SCR Question

**Part 1:**
On-board reservoir with oil change interval range

- No Impact: 47%
- Slight Impact: 51%
- Would not consider: 3%

**Part 2:**
In-use compliance warnings with no-restart countdown

- No Impact: 47%
- Slight Impact: 48%
- Would not consider: 5%
European badge dealers have the most favorable impressions of diesel engines.
Most dealers see performance as the lead diesel attribute.

Large Sedans & CUV: Superior Powertrain by Attribute (Diesel)

- 0-40 km/h (25 mph) acceleration
- 0-100 km/h (62 mph) acceleration
- 80-120 km/h (50-75 mph) acceleration
- Fun-to-drive
- NVH characteristics
- Residual value at high mileage
- Real-world fuel consumption closest to EPA sticker promise

- Performance lead attribute; efficiency secondary
- Efficiency lead attribute; performance secondary
- Best balance of performance & fuel efficiency attributes
The Prius depreciates at a faster rate than Jetta GLS TDI ... during a period of higher diesel fuel prices.

Residual Value

Prius vs. Jetta Diesel

Source: Manheim Auctions
Diesels pay the owner back with superior residual value retention over standard engines.

**Vehicle Residual Value: Points Over/Under Standard Powertrain at High Mileage**

- **Prius HEV**: -2%
- **Jetta TDI**: 25%
- **RAM 2500 Cummins**: 17%
- **F250 Powerstroke**: 15%
- **Silverado Duramax**: 4%

Drivers want ‘em

Cars at 100K miles; trucks at 150K miles

Source: Manheim Auctions
Wall Street is bullish on light duty diesel.

How would you characterize your overall impression of diesel engine technology/diesel-powered vehicles today?

- Positive: 86%
- Neutral: 14%

No respondents answered “Negative”

How would you characterize your overall impression of hybrid gasoline powertrains/vehicles today?

- Positive: 40%
- Neutral: 50%
- Negative: 10%

Wall Street
Wall Street sees consumer education and capital as the biggest threats to the LDD business case.

Light Duty Diesel Business Case: Identification of Barriers

- Pump price of diesel fuel relative to regular unleaded gasoline: 69% Green, 28% Yellow, 3% Red
- Availability of diesel fuel at off-interstate retailers: 28% Green, 58% Yellow, 14% Red
- Consumer awareness/education on clean diesel benefits: 7% Green, 41% Yellow, 52% Red
- Fit with national energy policy development: 52% Green, 45% Yellow, 3% Red
- Fit with national CO₂ policy development: 48% Green, 52% Yellow
- Gasoline HEVs as a competitive alternative technology: 38% Green, 45% Yellow, 17% Red
- Capital availability to convert a significant share of North America powertrain production to clean diesel: 10% Green, 55% Yellow, 35% Red

Legend:
- Green: Not a barrier to LDD business case
- Yellow: In transition, but moving toward green status (not a barrier)
- Red: At this time, appears unfavorable to LDD business case
The California Energy Commission finds diesel fuel is significantly advantaged on well-to-tank emissions and energy efficiency.

Source: California Energy Commission, June 2007
HDPU diesels produced from 1994-2006 will save the US 18B gallons of fuel over their useful lives.

Based on 1994-2006 HDPU vehicle sales. Assumes diesels did not exist and were replaced by standard (71%) and optional gas engines (29%), US EPA Mobil 6 VMT and 15 year useful life. Martec analysis of real world fuel economy for all engines in this segment.

Source: Martec analysis
How important is an 18B gallon savings?

**Energy Security**

- 914MM barrels of crude
- 20 months Venezuelan imports
- Enough gasoline to support California’s demand for 425 days
- More than $36B in economic savings to vehicle owners
1 new light duty diesel pickup truck will save the nation more fuel than 3 midsize hybrids.

Light Duty Diesel Pickup vs. Midsize Hybrid – Gallons Saved

Source: Martec analysis
Both the industry and automotive media forecast light duty diesel penetration significantly higher than EIA.

Energy Information Administration Long Range Forecast vs. Industry and Media - Fleet

Share of Light Duty Vehicle Sales


Industry Forecast

Media Forecast

EIA

Both consumers and the nation win with diesel.

Summary

1. Diesel-powered vehicles deliver the kind of performance US consumers want ... and pay a premium to acquire.

   *Diesels pay the consumer back through:*
   - Exceptional real-world fuel economy and range
   - High residual values

2. Consumer education is the biggest gap identified across all voice modules included in the study.

3. Light duty diesels are positioned to make major contributions to the nation’s fuel consumption and CO2 emissions reduction objectives.

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*The complete study is available by subscription from Martec or HART Energy Consulting.*

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