



# Passenger Car Trends and GF-5 / SN / dexos1™ Story

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# Presentation Outline

## Passenger Car Trends

- Market Drivers, Hardware, and Lubricant Responses
- GF-5 / SN / dexos1™ Market Event
- Demand Perspective
- Summary

dexos1 is a registered trademark of the General Motors Corporation

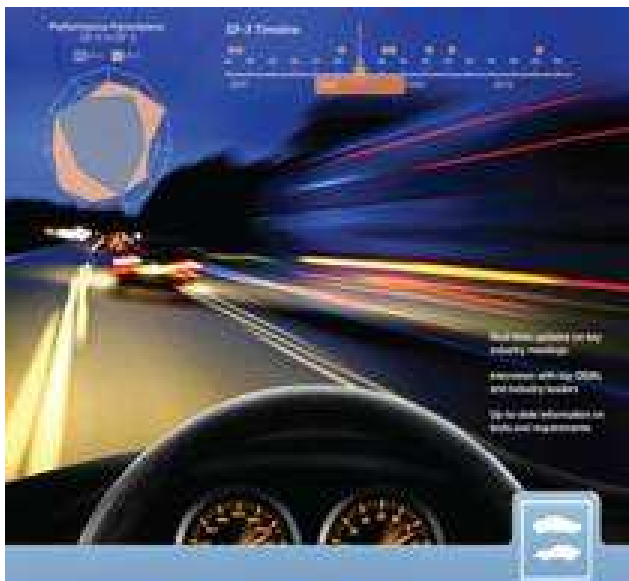


# Passenger Car Trends



## Lubricant Response - OEM Driving Forces

- Fuel economy
- Emissions
- General oil robustness



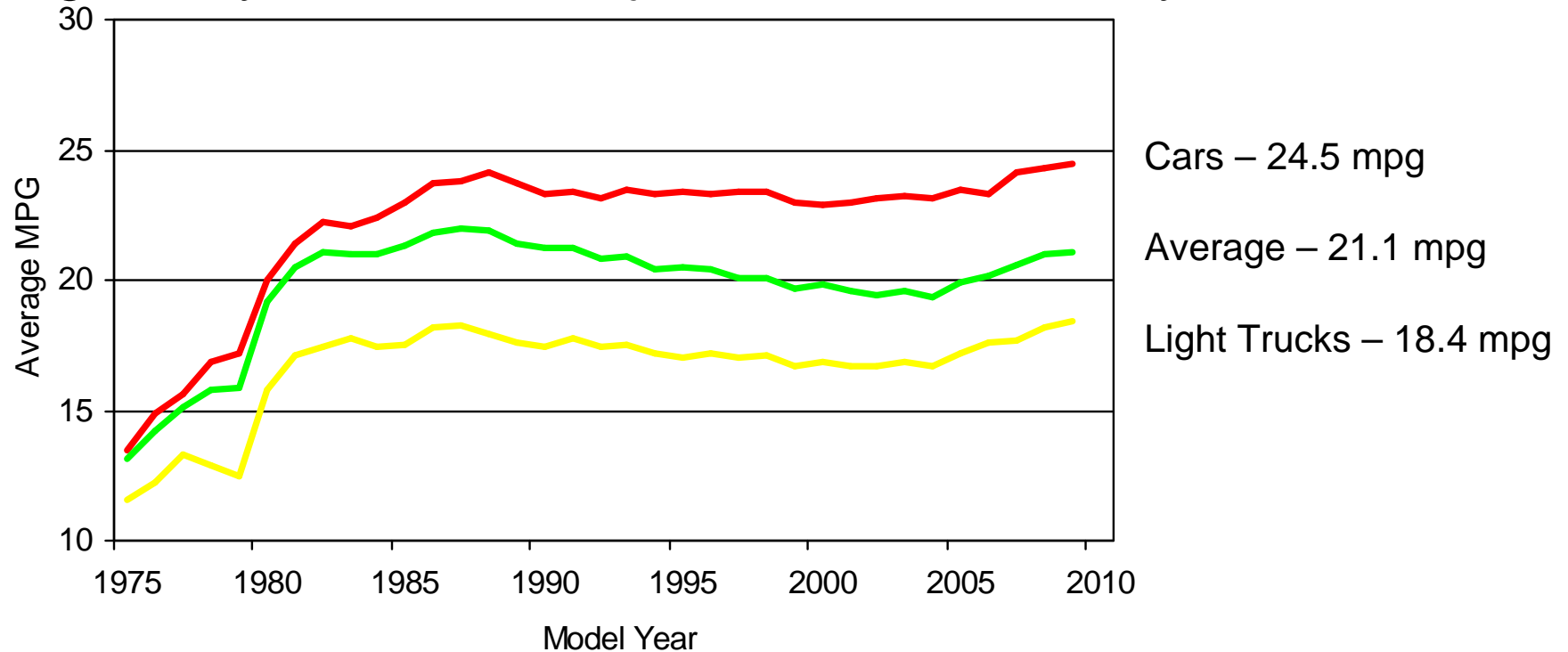
This is what the GF-5 story is all about



[www.GF-5.com](http://www.GF-5.com)

# Market Drivers: Fuel Economy

## Light Duty Vehicles – Adjusted\* Fuel Economy



**Fuel economy was flat for 20 years**

\*Corrected for on-road fuel economy (city/highway) and production mix.  
 Source: EPA Light Duty Automotive Technology and Fuel Economy Trends 2009

# Market Drivers: Fuel Economy

## Proposed CAFE Standards

National Fuel Efficiency Policy: +5% MPG improvement each year  
From 2012 MY to 2016 MY.

MY	Cars mpg	Trucks mpg	Combined mpg
2012	31.9	25.3	28.8
2013	33.3	26.5	30.1
2014	35.3	28.1	31.9
2015	37.1	29.5	33.5
2016	39.3	31.3	35.5

- Assumptions:
  - Vehicle mix
  - Linear progression to 35.5 MPG

## Fuel Economy CAFE Penalty: Example (Cars)



Assume:

- OEM's CAFE is 27.1 mpg (0.4 below the minimum required limit of 27.5 mpg)
- CAFE Penalty would be \$5.50 per 0.1 mpg below 27.5 per vehicle

**Result: an OEM that produced 4.0 million vehicles per year would have a potential penalty of \$88 million**

Calculation:  $4.0 \text{ million} \times \$5.50 \times (27.5 - 27.1) \times 10$

Assume:

- Using a GF-5 oil that provides 0.5% fuel economy improvement
- OEM could improve their CAFE by 0.136 MPG

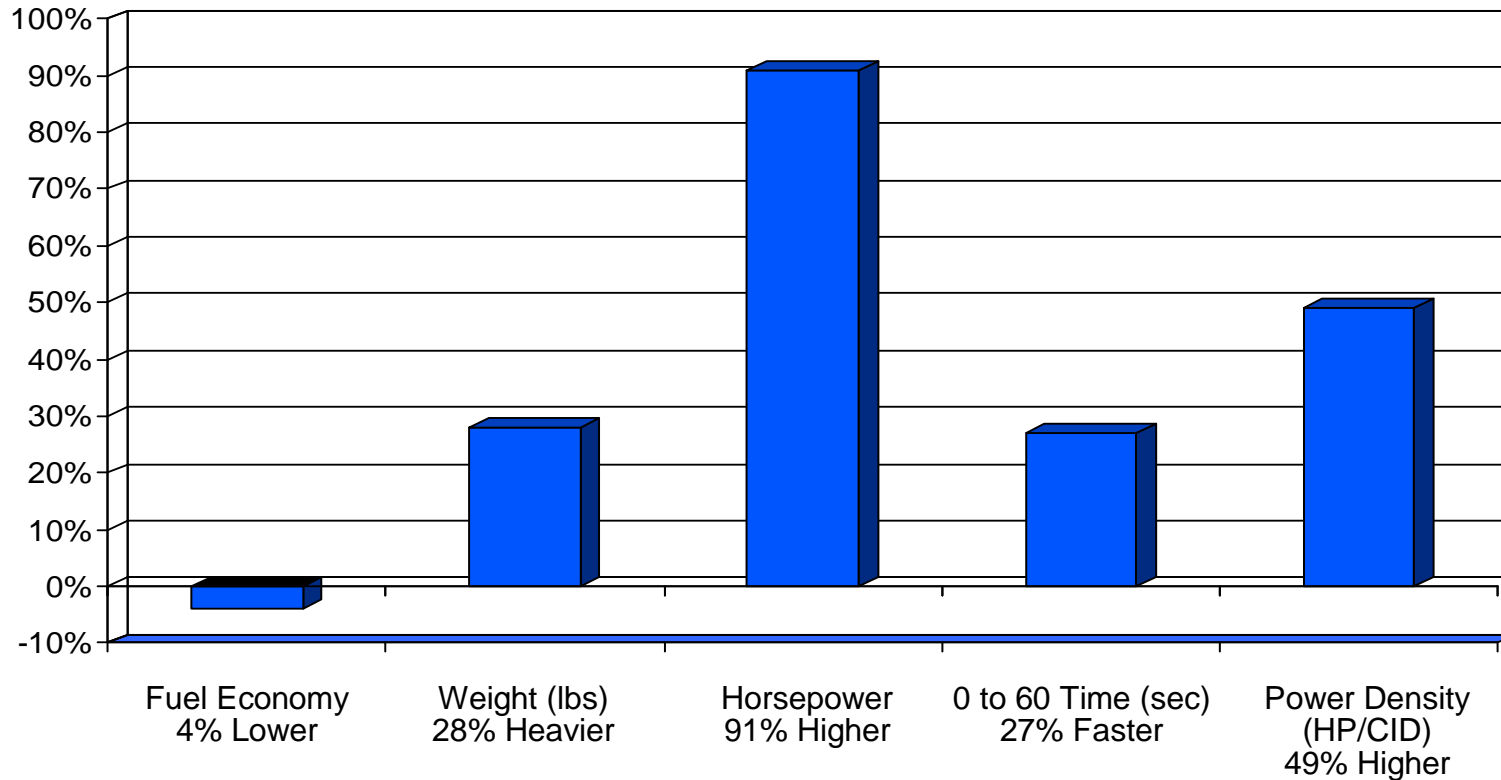
**Result: OEM could realize potential penalty reduction of \$29.9 million**

Calculation:  $(0.5\% \times 27.1 \text{ MPG})$

Trade-Off: Vehicle/Engine Design vs. Fuel Economy



Percent Change from 1987 to 2009 in Average Vehicle Characteristics



**Many of today's family sedans outperform the muscle cars of the 1960s**



2009 Fuel Economy Performance (Light Trucks)



<b>Manufacturer</b>	<b>CAFE (MPG)</b>
Chrysler	<b>22.2</b>
Ford	23.4
General Motors	<b>21.8</b>
Toyota	24.2
Honda	25.5
Nissan	<b>22.5</b>
VW	23.9
Hyundai-Kia	24.9
Fuel Economy Standard	23.1

**Fuel Economy doubled since the mid-1970s as a response to higher gasoline prices and fuel economy standards, however.....it flat lined in the 1990s**

Source: EPA Light Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends 2009 (Appendix L)

## Hardware Response--Next Generation Gasoline Engines

- **Engine and after-treatment devices are still area's for improvement including:**
  - Port-FI to Gasoline Direct Injection
  - Turbocharging (10-20 %)
  - HCCI (homogeneous charge compression ignition 20 – 30 %)
  - Down sizing and variable timing
  - After treatment and in-cylinder emission controls
- **Alternative designs:**
  - Hybrids, EV's, PC Diesels, Fuel Cells, and Hydrogen

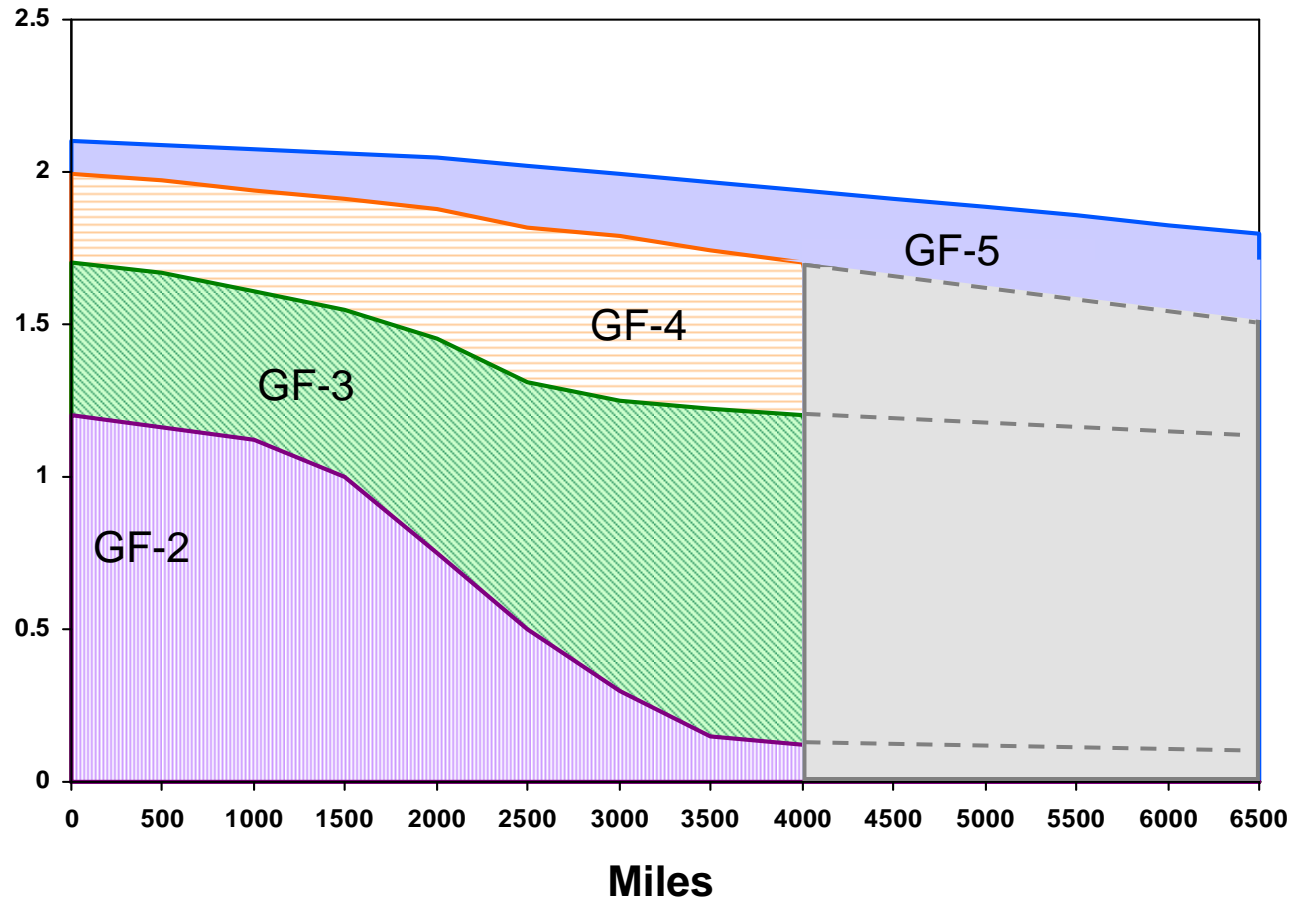


**Gasoline engine wins in NA for the next 20 years!**



Lubricant Response:  
 Fuel Economy Durability Greatly Improves from GF-2 to GF-5

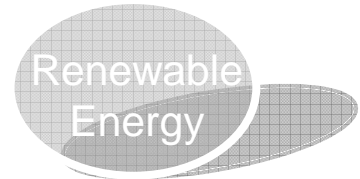
**Fuel Economy Improvement (%)**  
**5W-30**



Note: GF-5 level shown is based on a single data point as information for this specification is still so new.

# Alternative Fuel Use to 2020

Alternative Fuel	Now	2020	Maximum Practical Use
Conventional Diesel	20%	20%	
Conventional Gasoline	77%	70%	
Bio-Diesel	1%	3-4%	5 to 10%
Ethanol Containing Gasoline	2%	5%	10 to 15%
Hydrogen	0%	<1%	
Electricity	0%	<2%	



- Drivers**
- Regulatory on GHG
  - Global treaties
  - Sustainability
  - Promotion of local agriculture
  - Reduced dependence on crude oil

- Sources**
- Bio-ethanol
  - LPG, CNG/LNG
  - Bio-diesel

**Gasoline engine wins in NA for the next 20 years!**

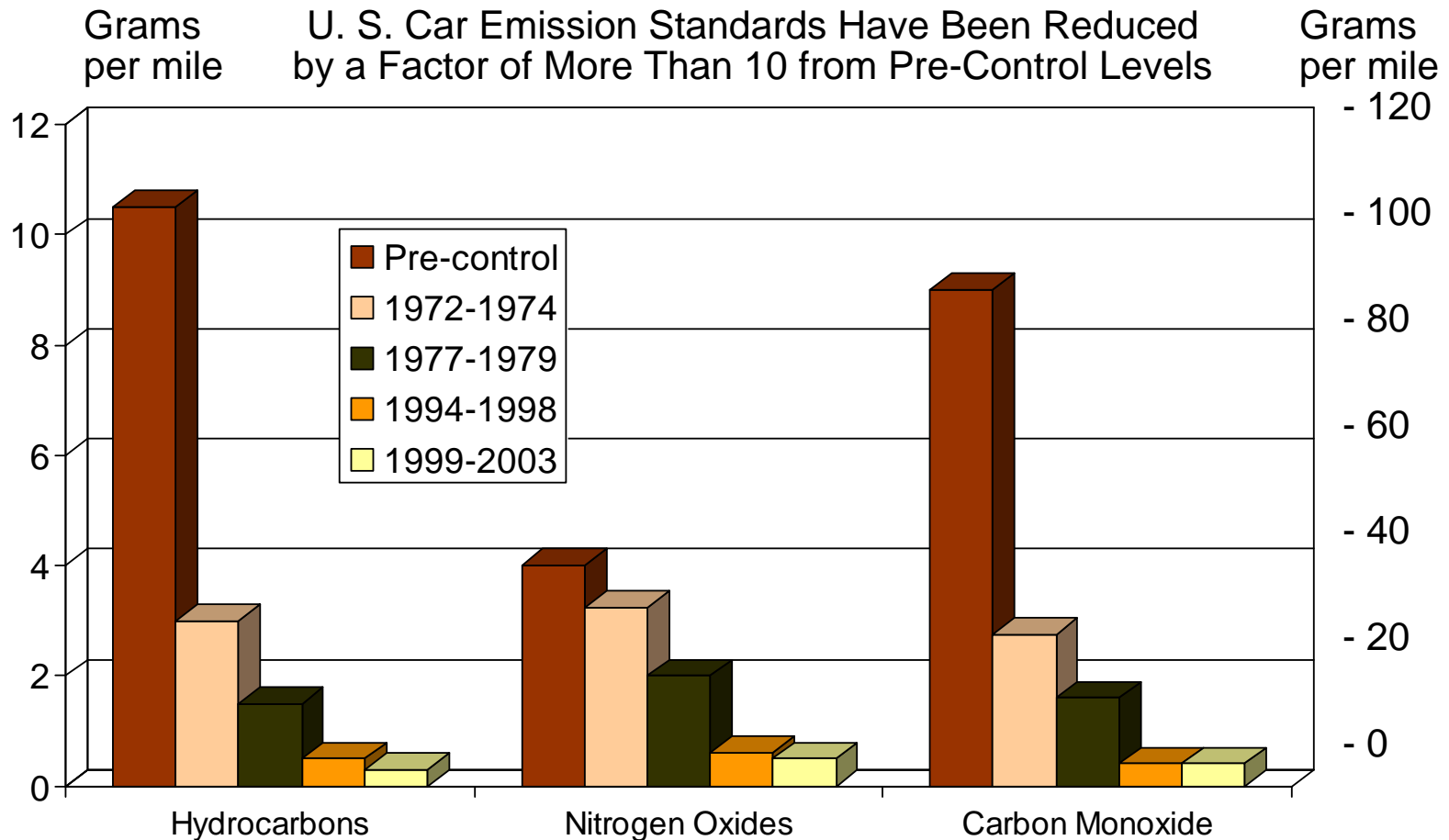
## OEM Driving Forces

- Fuel economy
- Emissions
- General oil robustness



# Emissions

Past progress has been impressive, but New regulations are in place to further reduce emissions



EPA Projected CO<sub>2</sub> and FE Compliance Levels  
Footprint Based



	2012	2013	2014	2015	2016
Passenger Cars (g/mile)	261	253	246	235	224
Light Trucks (g/mile)	352	341	332	317	302
Combined cars and trucks (g/mile)	295	286	276	263	250
Combined cars and trucks (MPG)	31.0	31.1	32.2	33.8	35.5

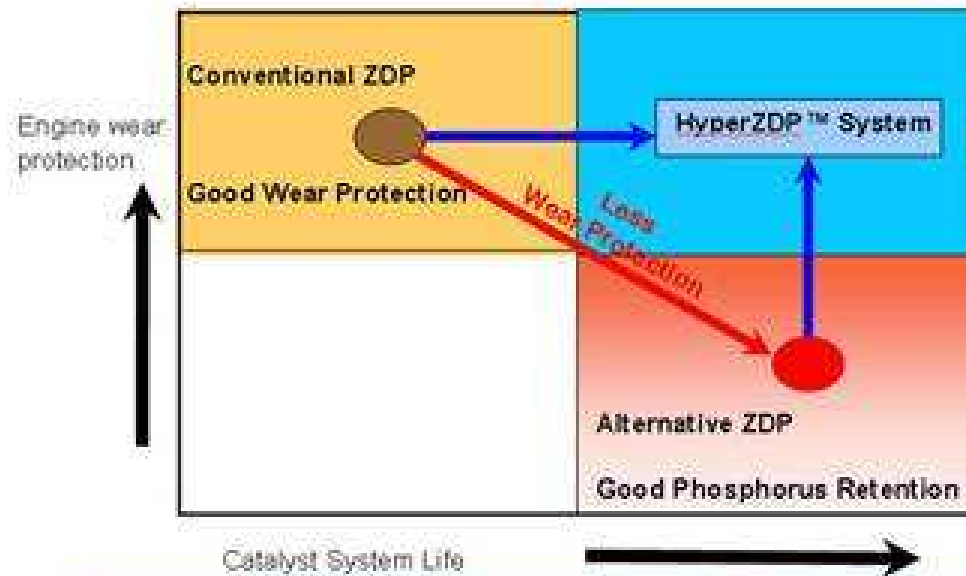
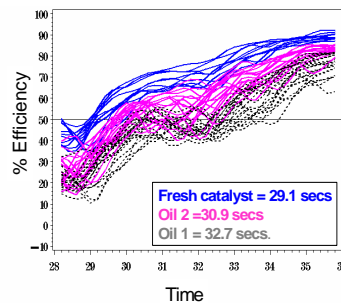
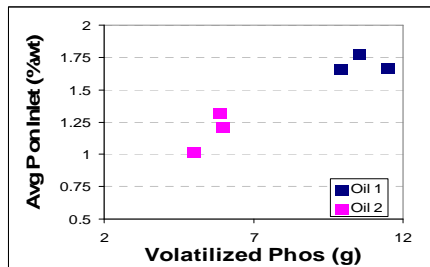
Source: [www.epa.gov](http://www.epa.gov)



# How does all this affect Lubricants?

- These requirements have resulted in the wider use of advanced catalysts in the exhaust systems.
- In the lubricant, the amount and retention of phosphorus is now a key controlled property.
- In the additives, it now means:

## HyperZDP™ System



The HyperZDP™ System optimizes both Engine Wear Protection AND Catalyst System Life.



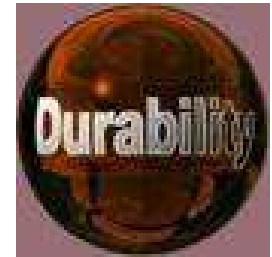
## OEM Driving Forces

- Fuel economy
- Emissions
- General oil robustness



## OEMs need to sell cars...

- The consumer still desires features and benefits across the gamut of options:
  - Performance, Luxury, Size, Price, etc.
  - Meeting Performance while controlling FE, and Emissions along with a variety of hardware adjustments is HIGH Stress to Lubricants
  - Engine Oil Durability is a critically important factor



## General Oil Robustness

Marketed in several performance categories:

- Cleanliness, Wear, Emission System Protection, Oil Drain Interval, Oil Life, FE



Engine oil robustness is met with various additives that are balanced and qualified by a licensed program:



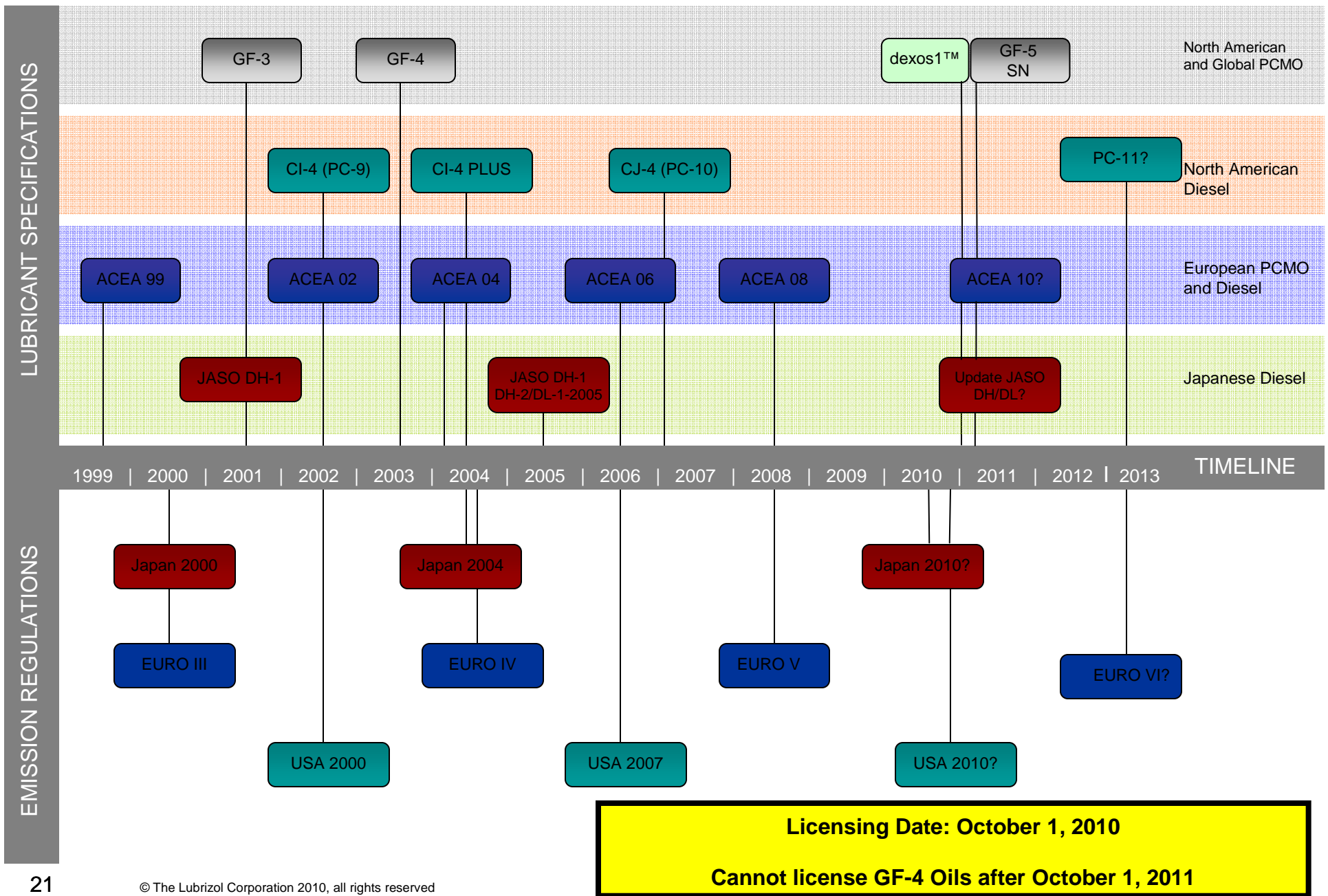
- Detergents for improved piston cleanliness
- Dispersants for preventing engine sludge buildup
- Unique zinc antiwear additives prevent wear and oxidation
- Antioxidants resist a variety of oil degradation processes
- Friction Modifiers enable FE
- Basestocks and Viscosity Modifiers provide overall protection across all types of driving conditions



# GF-5 / SN / dexos1™ Market Event



# Engine Oil Specification Changes



## ILSAC GF-5 Needs Statement



### ***Jan 23, 2008: GF-5 Needs Statement Finalized (and Fulfilled)***

- ILSAC GF-5 must provide improvements relative to ILSAC GF-4 balancing among these three equally important needs
  - ***Fuel economy and fuel economy retention***
  - ***Protection of emission control systems***
  - ***Engine oil robustness***



## API SN, API SN With Resource Conserving

- First allowable license date for both API SN and API SN With Resource Conserving coincides with ILSAC GF-5 first license date of 10/1/2010.
- An example of the API SN and API SN With Resource Conserving Donuts are shown:



**API SN alone does not require the fuel economy, phosphorous retention, emulsion retention or turbocharger testing.** Other requirements for API SN alone depend on the viscosity grade to be licensed.

## API SN, SN With Resource Conserving versus GF-5

- All performance requirements same as GF-5, except:

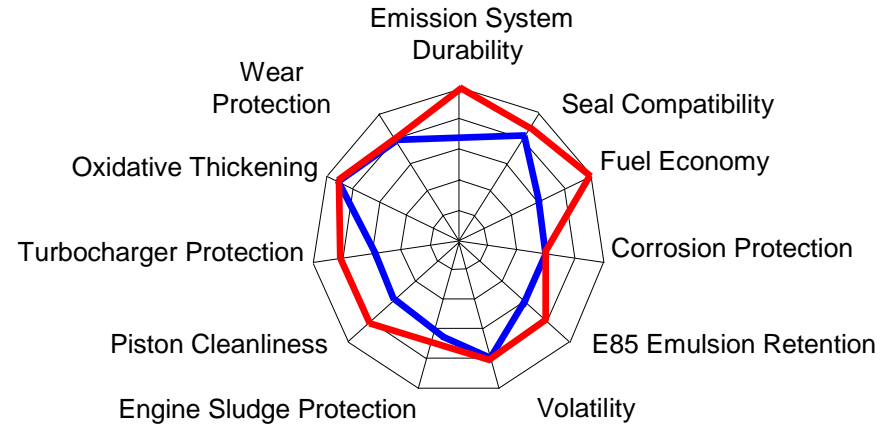
	ILSAC GF-5	API SN		API SN with Resource Conserving
Viscosity Grades	0W, 5W, 10W multigrades	0W-20, 0W-30, 5W-20, 5W-30, 10W-30	Others	0W, 5W, 10W multigrades
Seq. VID	Pass	NR	NR	Pass
Seq. IIIGA or ROBO	Pass (all 0W-XX, 5W-XX, 10W-XX)		NR	Pass
Seq. IIIGB Phosphorus Retention, %	79	NR	NR	79
Phosphorus, % max/min*	0.08 / 0.06		NR / 0.06	0.08 / 0.06
Sulfur, % max*				
0W-20, 0W-30, 5W-20, 5W-30	0.5		NR	0.5
10W-30	0.6		NR	0.6
All other viscosity grades	--		NR	0.6
TEOST MHT*	35		45	35
TEOST 33C	30 (NR for 0W-20)	NR		30 (NR for 0W-20)
Foam	1 min. settling		10 min. settling	1 min. settling
Scanning Brookfield, Gelation Index,	12		NR	12
Emulsion Retention	No Water Separation	NR		No Water Separation
Seals	Per GF-5 Limits			
*Requirements waived for API SN if CH-4, CI-4 or CJ-4 precede the "S" category				






# New Lubricant Specification Required for 2011 MY Vehicles

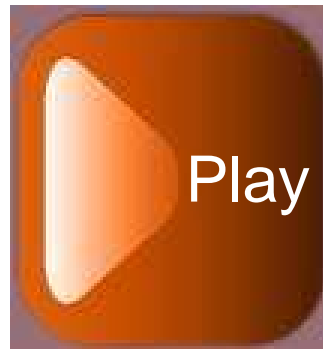
## ILSAC GF-5

- Improved performance
  - Fuel economy
  - Emissions systems durability
- Improved robustness
  - Engine sludge protection
  - Piston cleanliness
  - Seal protection
- Turbo protection
- Flex-fuel (E85) protection
- Will not address passenger car diesel



  	New Friction Modifier, Increased Treatment Levels	HyperZDP™ System to optimize both Engine Wear Protection and Catalyst System Life	Trident™ H-E-I Technology to enable use of ethanol based fuel up to E85	Multi-functional additives to improve piston cleanliness, enhance sludge protection and reduce turbo charger coking,
<b>Fuel Economy</b>	✓			
<b>Emissions</b>	✓	✓	✓	✓
<b>Durability</b>		✓	✓	✓

**GF-5 is a true upgrade that demands a New Level of Performance from engine lubricants**



[From www.GF-5.com](http://www.GF-5.com)

## Videos

- GF-5: A New Era of Performance

## Spider Diagrams

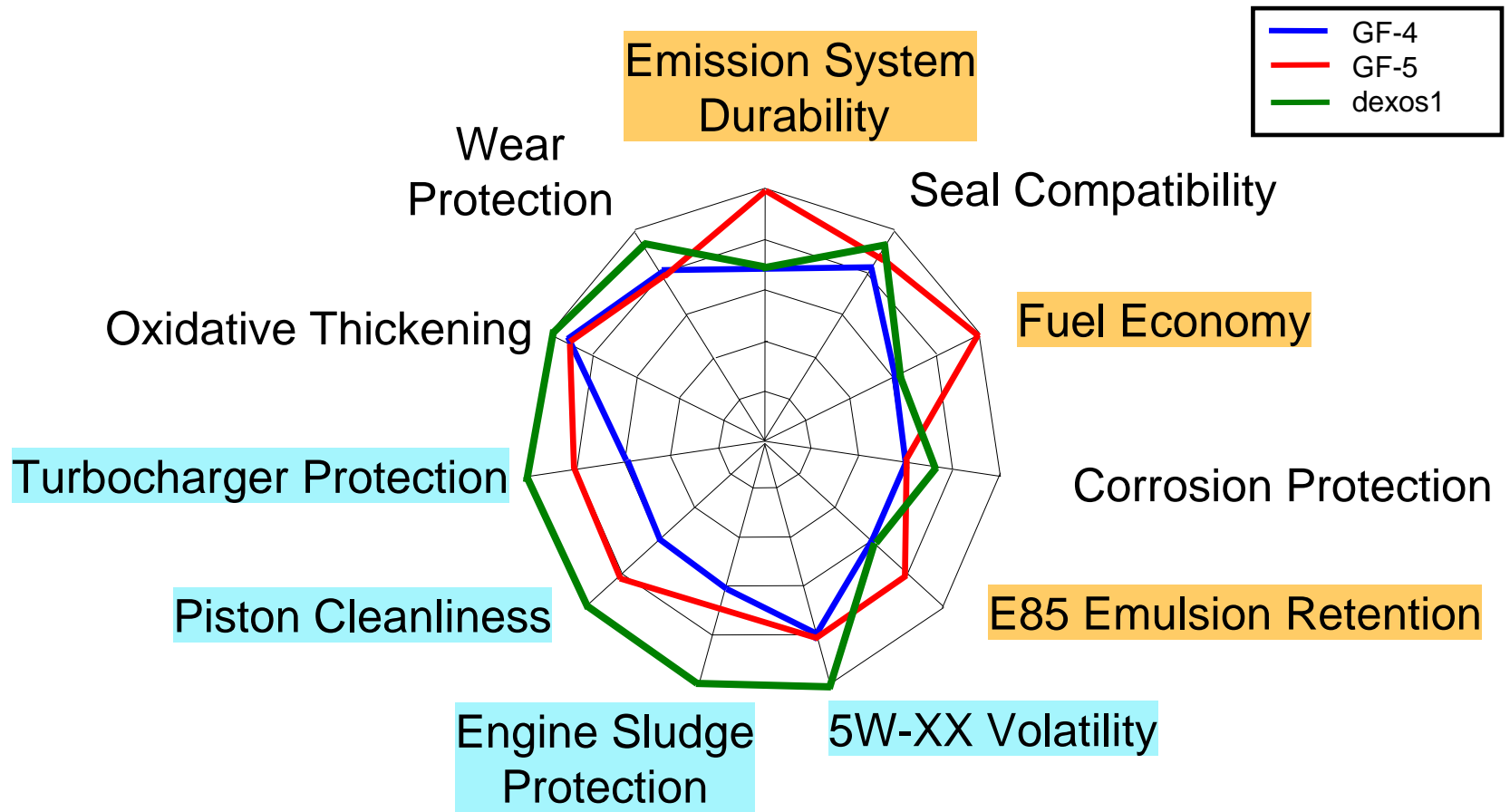


## dexos1™: an GM Spec



- Combines engine tests and bench tests from:
  - **ILSAC** GF-4 (more severe IIG limits on Weighted Piston Deposits)
  - **ACEA** C3-07 Gasoline
  - **GM/Opel** proprietary tests
- Key engine tests to be run on final formulation
- 5W-30 for factory fill and 5W-20 (possible in future)
- 5W-30 (primary), 5W-20 (secondary) for service fill with 0W-20 and 0W-30 possible in future

**ILSAC GF-4 vs. ILSAC GF-5 vs. dexos1**



**dexos1 Performance Improvements above GF-5**

dexos1™



- Licensing program
  - Administered by Center for Quality Assurance
  - dexos is trademarked
  - License term 5 years
  - **License fee (U.S. \$1,000) per year per formulation**
  - Royalty fee based on supplier's "minimum available dexos1 market"
    - Based on market data obtained by GM
    - Royalty ramps up over the license term as dexos1 gains acceptance

## dexos1™ Market Situation – Not all are taking it

- Factory fill – August 2010
- Service fill – TBD 2011
- Officially licensed dexos1™ oils are now in the market
  - If dexos1™ cannot be found, certain manuals will say that ILSAC GF-5 oils can be used

	<u>No</u>	<u>Yes</u>	<u>Undecided</u>
Valvoline	✓		
ExxonMobil		✓	
Shell		✓	
Castrol	✓		
ConocoPhillips			?
PetroCanada			?
CITGO	✓		
Chevron	✓		
ARG			?
ALS		✓	
CAM2		✓	

*Source: Jobbers World and OEM/Lube News*

## Summary on GF-5 / SN / dexos1™

- ILSAC GF-5 oils represent a true upgrade over GF-4 oils
- Officially licensed ILSAC GF-5 oils are available for purchase in the market as of 10/1/2010.
- ILSAC GF-4/API SM oils are still available for licensing until September 30, 2011
  - Two quality levels will be available showing the Starburst until then
- Officially licensed dexos1™ oils are now available in the market.
  - If dexos1™ cannot be found, certain manuals will say that ILSAC GF-5 oils can be use

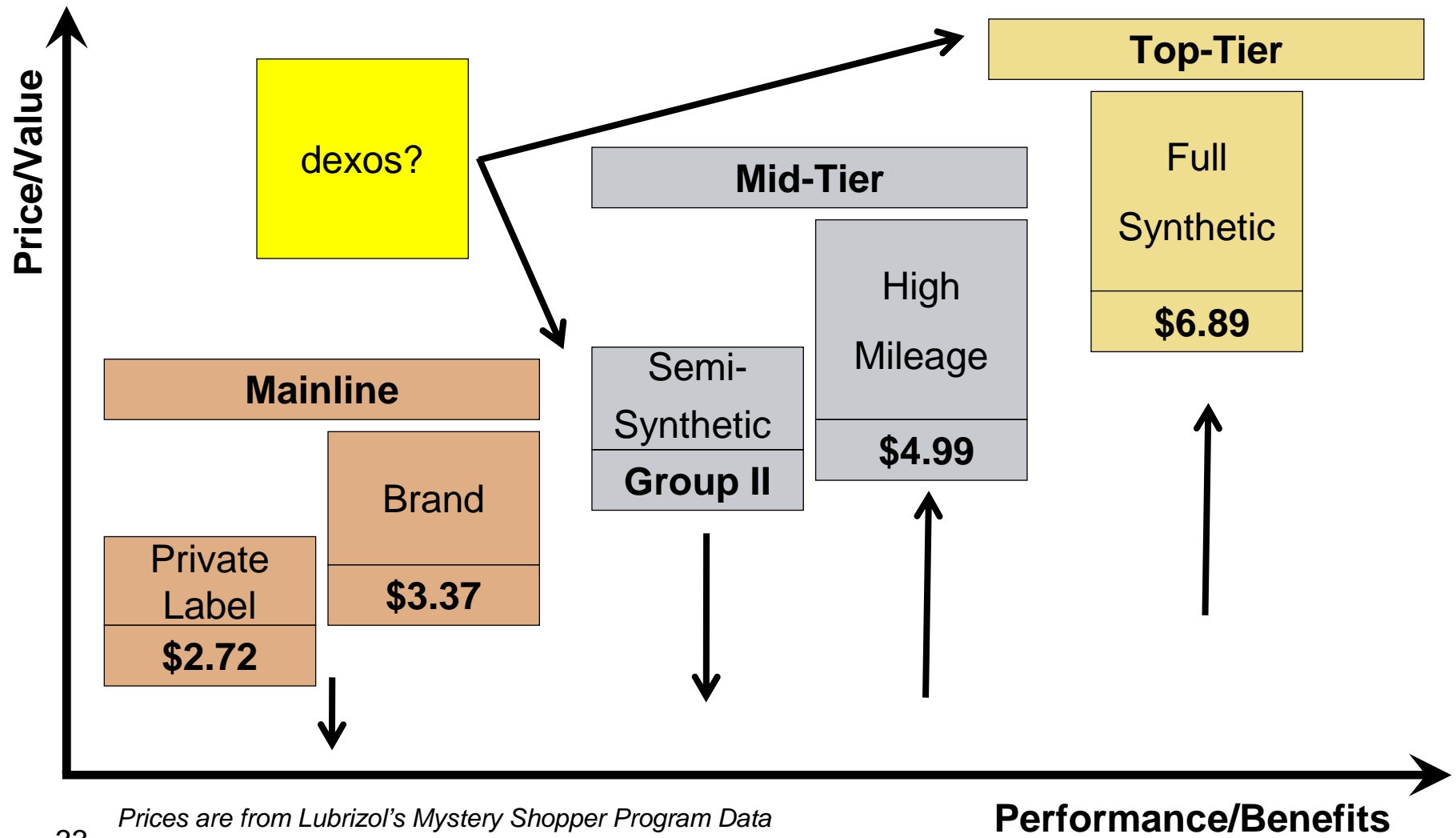
## Impact of ILSAC GF-5



- Market will be more complex
  - Ultra low viscosity grades and a shift to lower 5W's
  - More synthetics or semi-synthetic due to Group III use
  - Robustness and fuel economy performance will increase DI complexity
  - Emissions system durability require changes in the ZDP system while maintaining excellent wear protection
- Additionally an OEM claim to deal with?
  - GM introduced a global engine oil specification, **dexos1™**, for service fill in place of GF-5 for 2011 MY and future vehicles



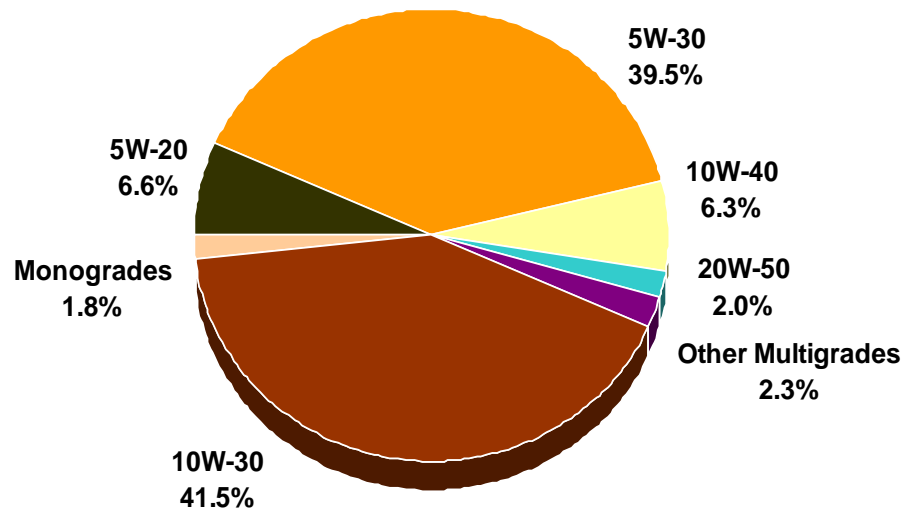
Passenger Car Oil – NA Market Structure



Prices are from Lubrizol's Mystery Shopper Program Data

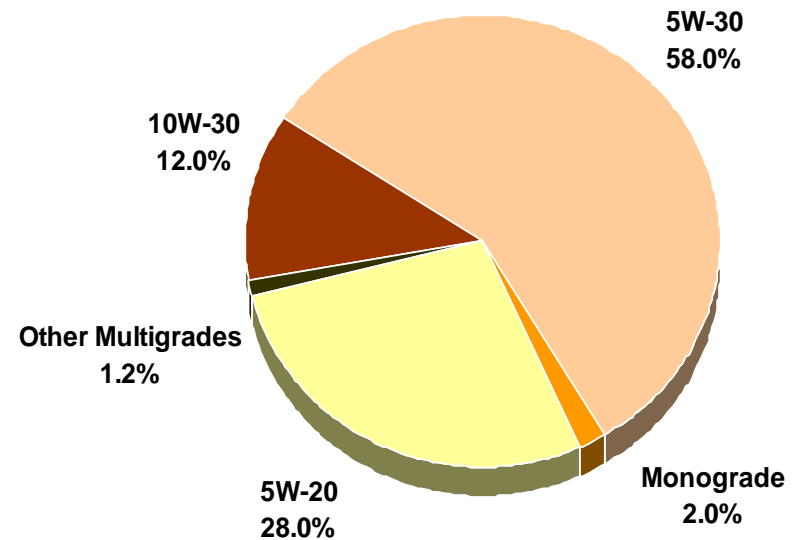
# Viscosity Grade: GF-4 Era

## United States



U.S. Market  
623 Million Gallons

## Canada



Canadian Market  
47 Million Gallons

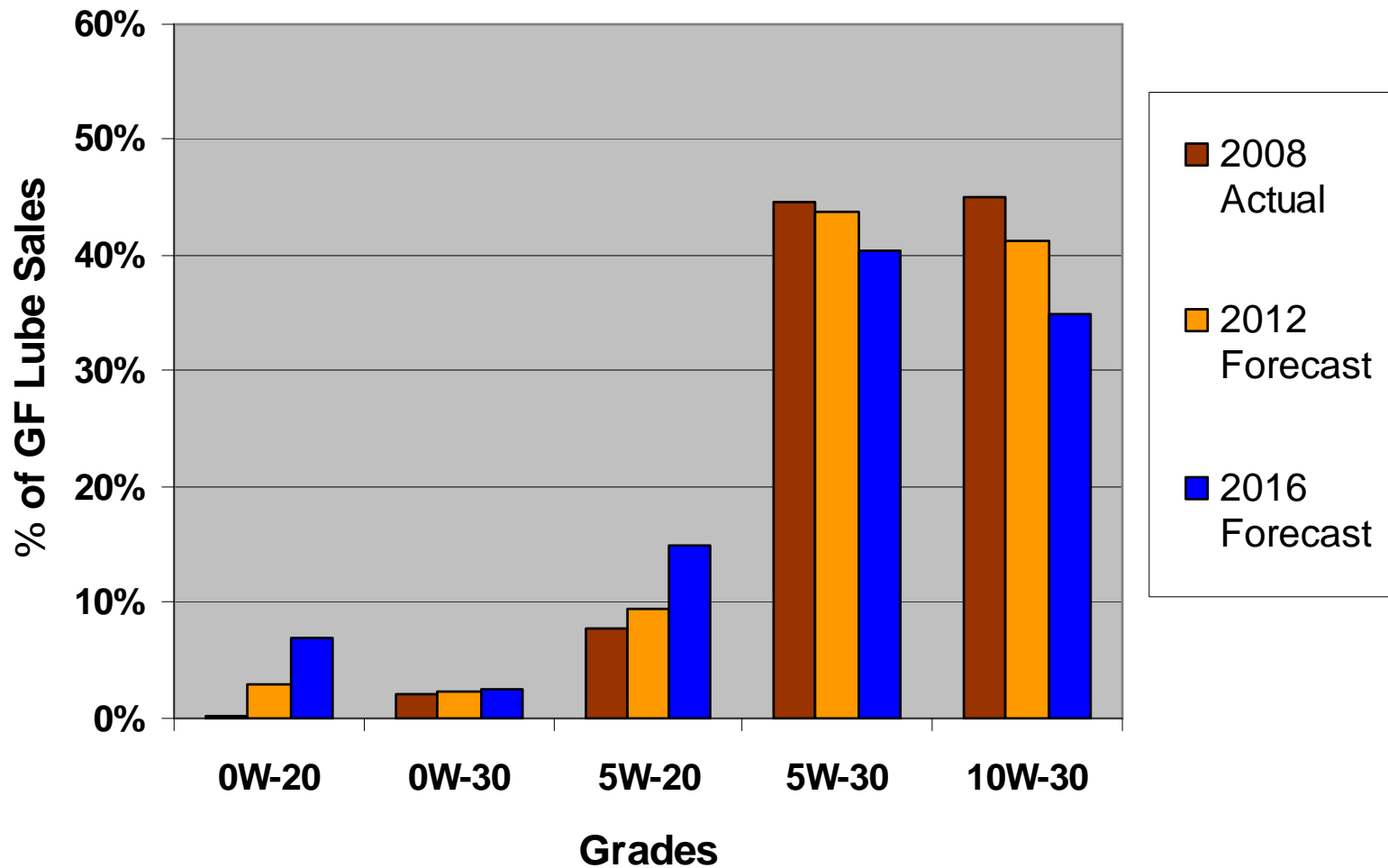
**GF-5 yields more 0W and 5W-20 and less 10W-30**

Source: Kline and Company

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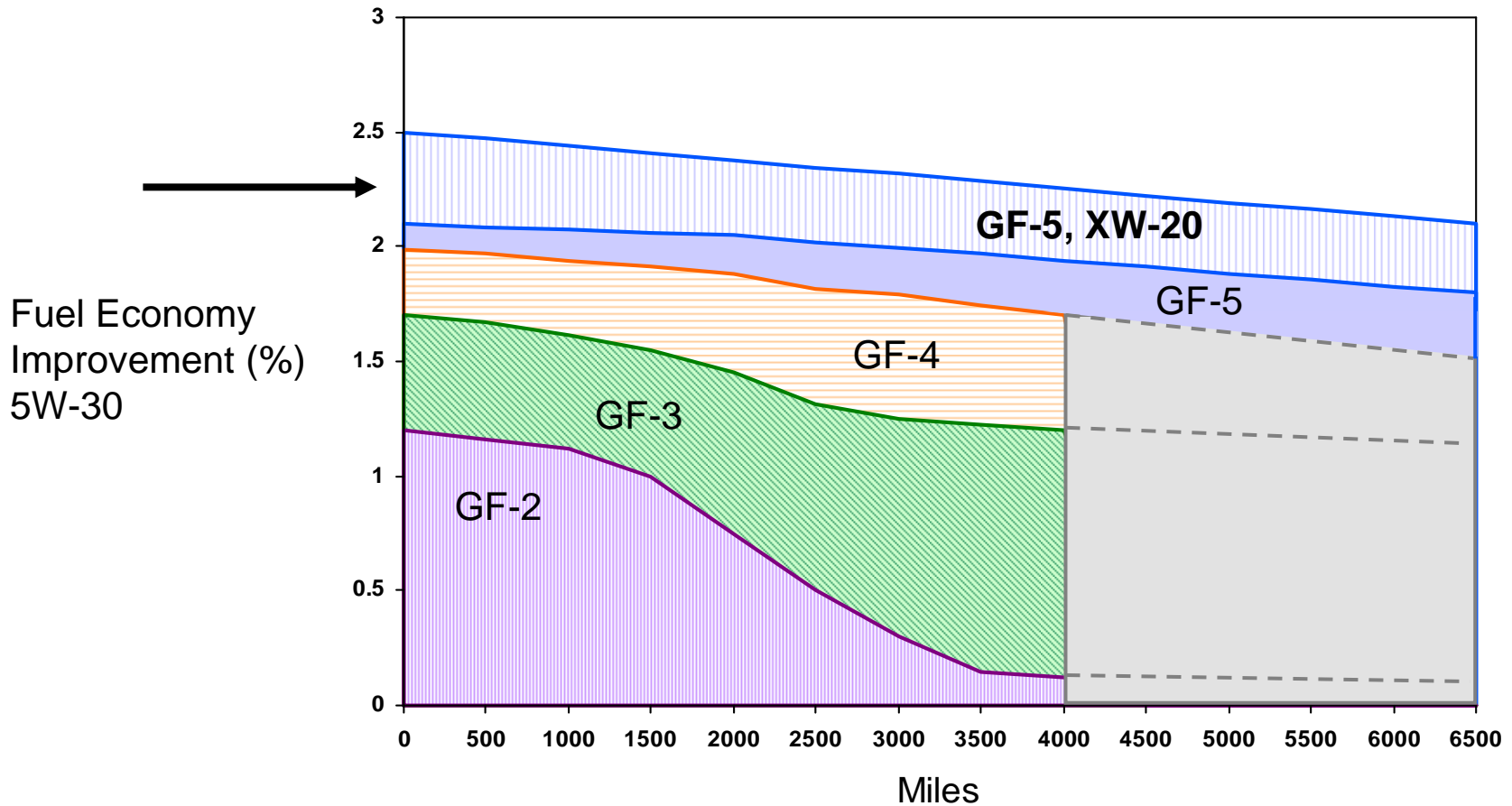
## Viscosity Grade Trends: North America 2008 - 2016

**ILSAC GF-4** → **ILSAC GF-5**



# What's next: A Drive to Synthetics?

Improvement of GF-5 XW-20 over 5W-30



Note: GF-5 level shown is based on a single data point as information for this specification is still so new

## What's next: Non-traditional grades?

- Ultra low viscosity grades (0W-15 / 0W-10 / 0W-5)
  - Protection: Lube oil viscometrics have a major impact on FE but many older and some current engines may have durability issues with ultra low viscosity oils
  - Latest news: Honda and Toyota have announced that they will use 0W-20 GF-5 oils. Some OEMs are exploring 0W-10 for further FE gains.
  - J-300 challenges: J-300 revisions are being considered to perhaps define 0W-15, 0W-10, and 0W-5 viscosity grades

**Takeaway: Synthetics look to be the end game**



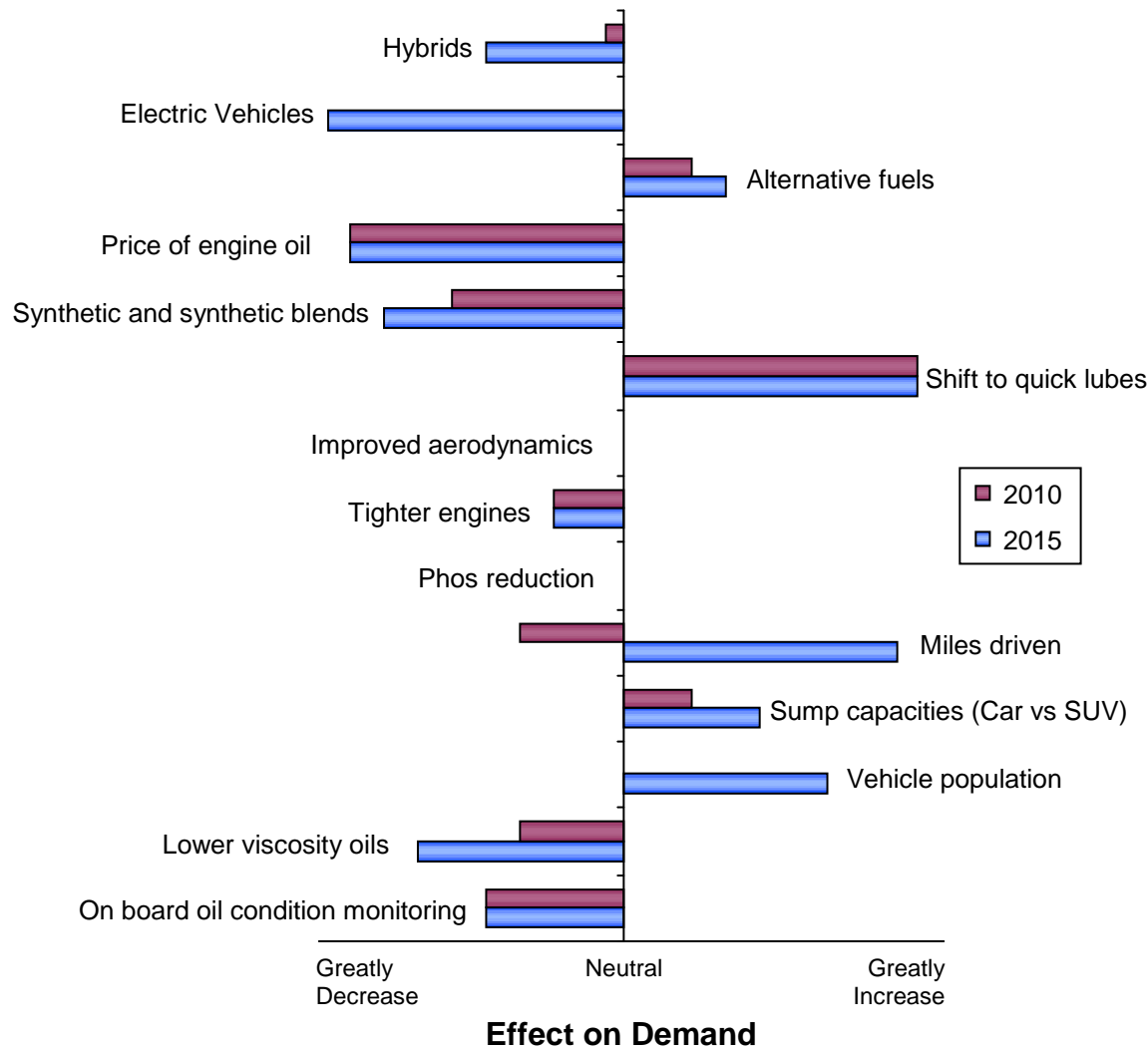
# Lube Demand Perspective



## Factors That Impact Lubricant Demand

- Lube Quality and Performance Requirements
- Oil Drain Interval (ODI)
  - Technical and consumer purchase and oil change behavior
  - Sensors
- Automotive vehicle fleet size and sump capacity
- Production, use and scrappage
- OEM warranty and influence with retail and installed market channels

# Future Passenger Vehicle Lubricant Demand Impact Map



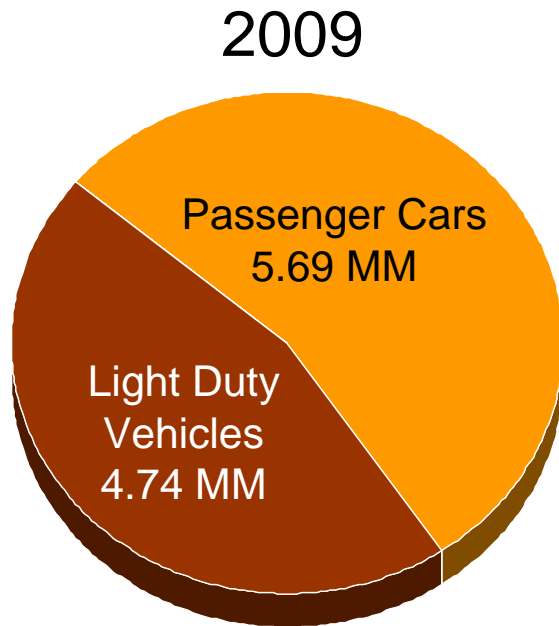
- The chart shows various parameters that impact lube demand looking forward
- A move to synthetics for lower viscosity FE oils, smaller sumps, and on board sensors hurt lube demand
- + More miles driven, increased DIFM, and higher vehicle population counter balance demand
- **FACT:** Current ODI recommendations range from 3K → 10K for PCMO and 100K = Fill for Life for ATF fluids (30K to 50K severe duty)



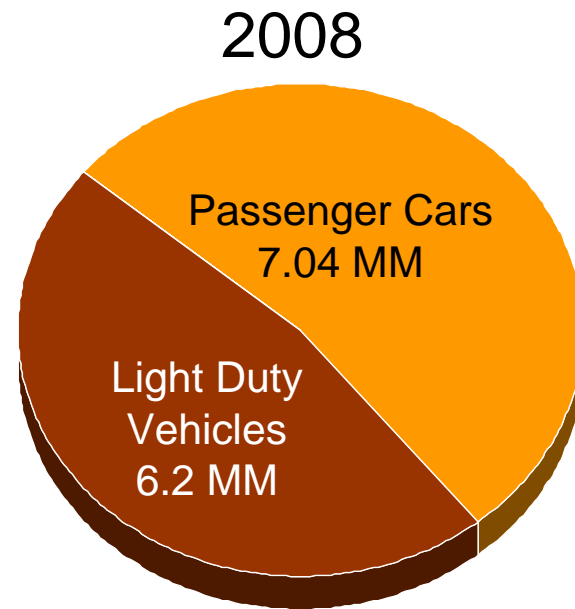
## Typical ODI Recommendations

Miles	Recommendation
3,000	Quick change shops today
5,000 to 6,000	Many late 1990s and early 2000s OEM recommendation, many OEM service centers today
5,000 to 8,000	GM Oil Life Monitor (typical service)
7,500	OEM typical recommendation today
10,000	Ford Escort Hybrid, 2011 Mustang (large sump), Corvette
>10,000	Typical European ODI using ACEA oil

# U.S. New Vehicle Sales



10.43 Million Vehicles



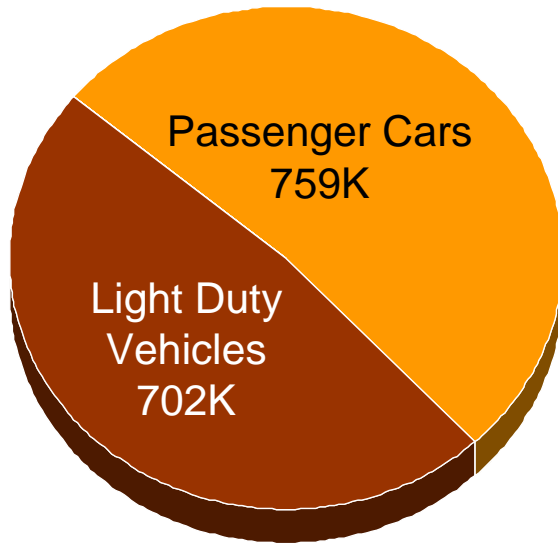
13.25 Million Vehicles

**Greatly Reduced**

Source: Automotive News, January 11, 2010

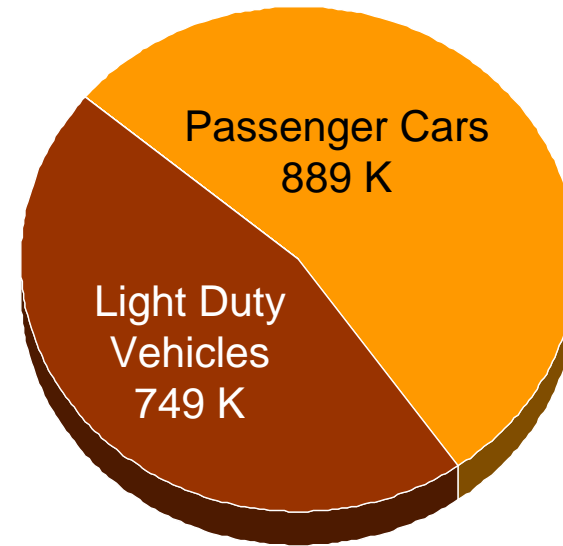
# Canada New Vehicle Sales

2009



1.46 Million Vehicles

2008



1.64 Million Vehicles

**Slightly reduced to flat**

Source: Automotive News, Data Center, March, 2010

## 2009 vs. 2008 New Vehicle Sales

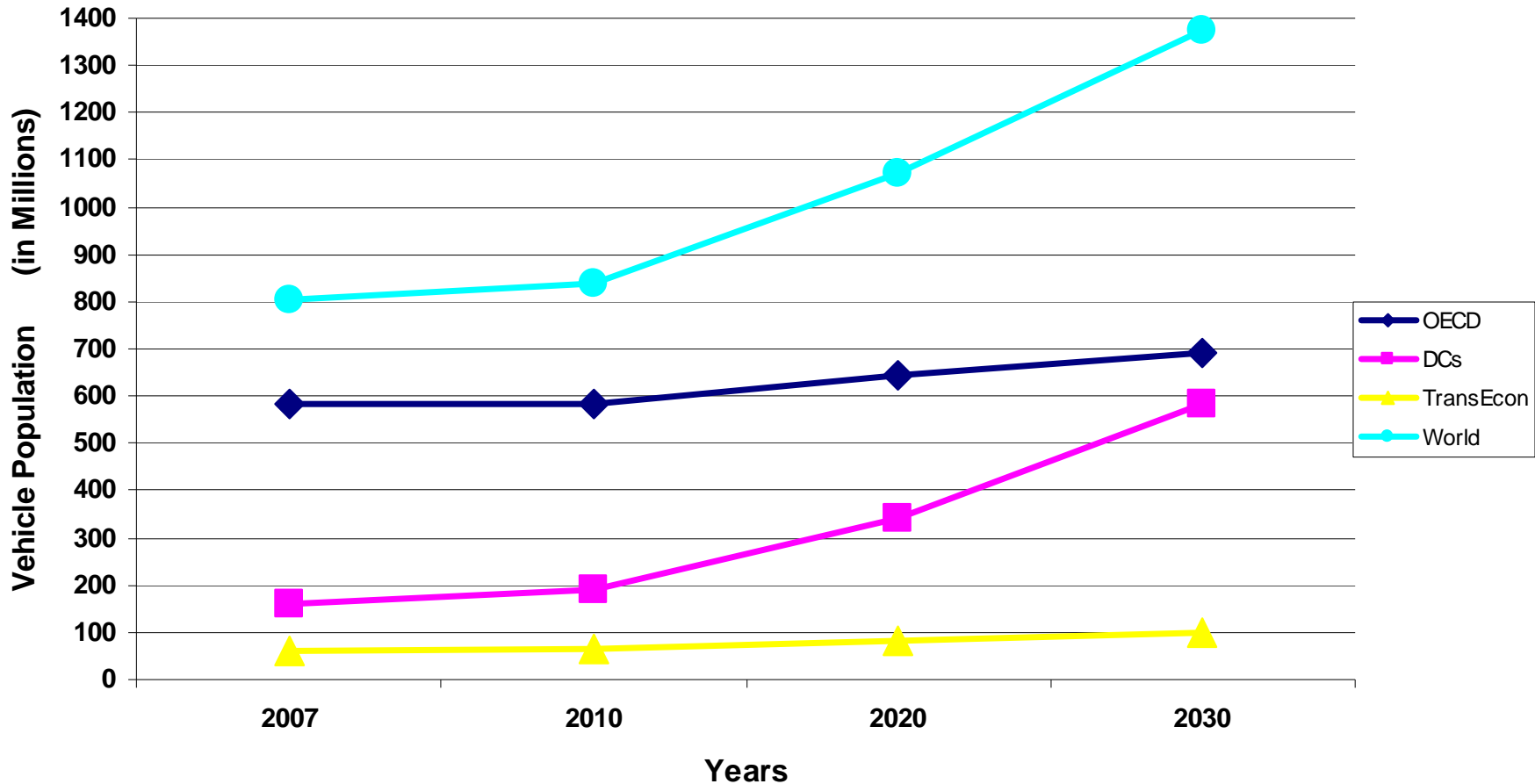
Manufacturer	U.S.	Canada
Chrysler	↓56%	↓27%
Ford	↓19%	↑ 6%
General Motors	↓43%	↓30%
Toyota	↓25%	↓ 9%
Honda	↓24%	↓18%
Nissan	↓24%	↓ 5%
VW	↓ 5%	↑ 4%
<b>**Hyundai-Kia</b>	↑ 8%	↑26%

**\*\* Hyundai-Kia is the Fuel Economy / High Value Leader and Global Long-term Survivor**

Source: Automotive News, Data Center, March 2010

## Car park

Global Vehicle Population  
2007 - 2030



**Car park will continue to grow in OECD (Organization for Economic Cooperation and Development) region. However, while car park is growing, ODI Increases will keep demand flat to 1% growth.**

## Summary on Passenger Car Trends

- Regulations are moving forward to improve fuel economy and reduce greenhouse emissions. Lube is a minor contributor.
- GF-5 is an upgrade that adds significant protection for the engine, the oil, and the three way catalyst
- The market will be more complex with GF-5 and dexos 1
- New engine technologies aimed at consumer driving experience and balanced within regulatory constraints will drive engine additive advancements like improved ZDDP and additives for ethanol fuels along with new improved multi-functional additives.
- OEMs are nearing the lowest currently defined viscosity grades making redefinition of J-300 ultra-low viscosity grades necessary.
- Regional demand is flat but long term global growth of car population.
- Cost of lubricants will go up driven by raw materials, treat rates and increased use of synthetics