

## PCMO: Building Value Beyond Specifications

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The way passenger car OEMs are responding to pressures from fuel economy and emissions legislation is driving diversity and innovation in engine hardware. In parallel, economic, lifestyle, and environmental factors are influencing consumers – from the types of vehicles they purchase, how they use them, and the length of time they keep them. The combination of these factors presents an interesting opportunity to work beyond specifications and deliver differentiated engine oils that meet the needs of both consumers and hardware, delivering value now and in the long term.

## OEM Trends & Insights

**One of the biggest influences in the PCMO market remains the drive for improved fuel economy. Of the many hardware solutions that can extract more miles from fuel, each one impacts the lubricant differently.**

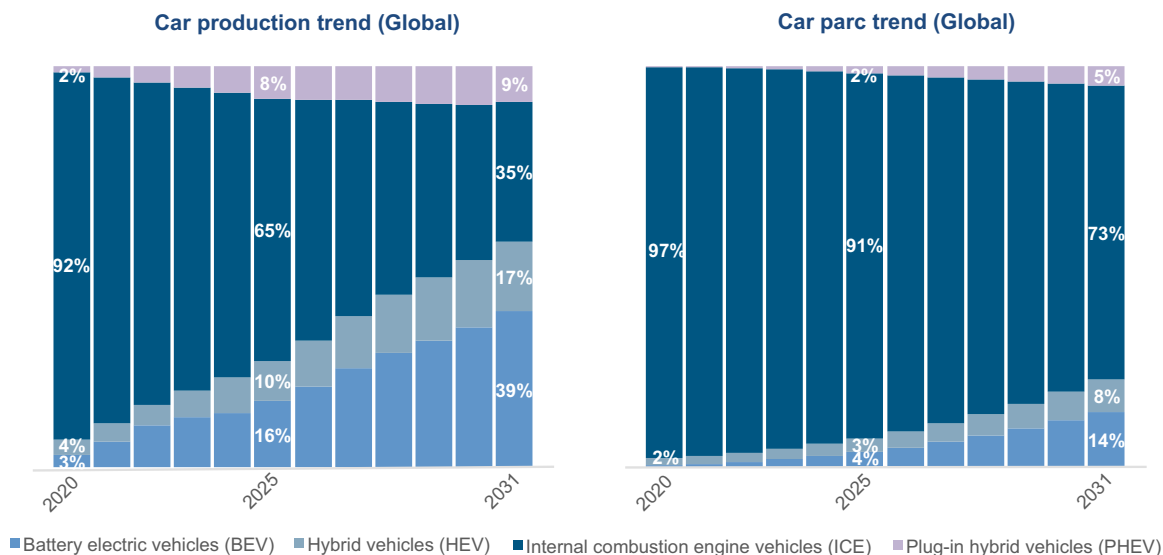
Systems that improve internal combustion engine efficiency and fuel economy, such as direct injection, turbocharging, and stop-start technology, can be found in the majority of today's passenger cars. Gasoline direct injection (GDI) is the most prevalent technology, currently found in over 80% of gasoline engines sold worldwide. As GDI can generate more particulate emissions, this technology often requires a gasoline particulate filter (GPF) to be fitted, which the lubricant must also support. The most critical lubricant property for this segment is the ability to combat low-speed pre-ignition (LSPI), which can be a particular challenge for GDI engines – especially as the lubricant ages. Just one pre-ignition event can cause severe damage to pistons and cylinders. Using unsuitable or older specification lubricants in GDI engines is risky, to say the least.

Electrification is another key path to better fuel

economy, although OEMs have been turning away from the single-minded pursuit of full-battery electric solutions. Instead, they are increasingly developing hybrids as a bridging technology that consumers feel more comfortable adopting. Hybrid internal combustion engines (ICE) require more from the engine oil as their operating conditions are more severe than those of conventional ICE. Cold engine starts can potentially occur at speed and under load when the vehicle is already moving on battery power. The frequent stops and starts involved in urban driving cycles can increase condensation. Although the level of condensation is easily handled by the lubricant in non-hybrid applications, the potential for a lubricant to become overwhelmed by condensation is much greater in a hybrid. This can lead to freezing in low temperatures, pockets of pure water passing through critical lubrication systems, and corrosion that could break away and make its way through an engine as it forms. These issues can all factor into overall engine life if the additive technology is not built to withstand higher levels of water from condensation in the oil. Although a few OEMs already have specific hybrid engine oil specifications, dedicated hybrid fluids or hybrid specifications are not yet commonplace.

## Passenger Car Sales Forecast

EV car parc expected to increase — Hybrid and ICE engines to hold 86% market in 2031



- BEV new vehicle sales expected to hold ~40% share by 2031, lower than combined ICE and Hybrid engines
- ICE and Hybrid to hold significant share in the car parc, ~86% car parc still needs engine oils by 2031

Source: Bloomberg Data for countries: Global (2024 Data)

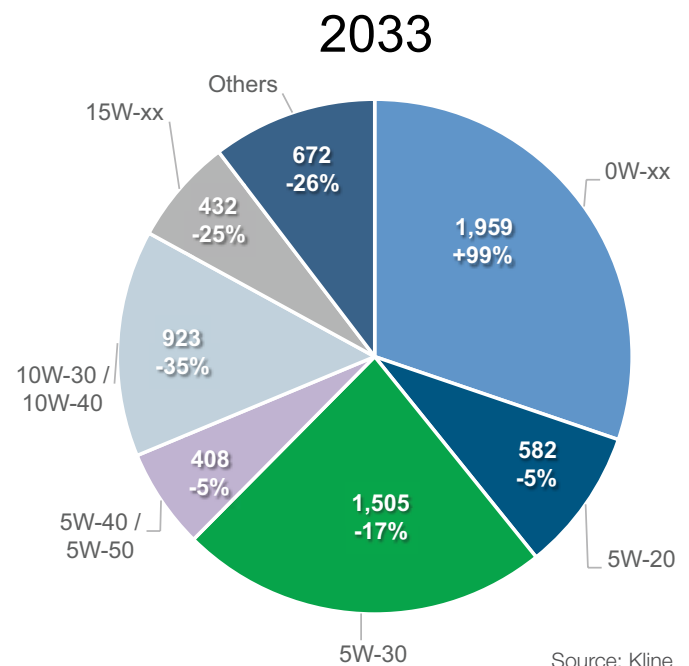
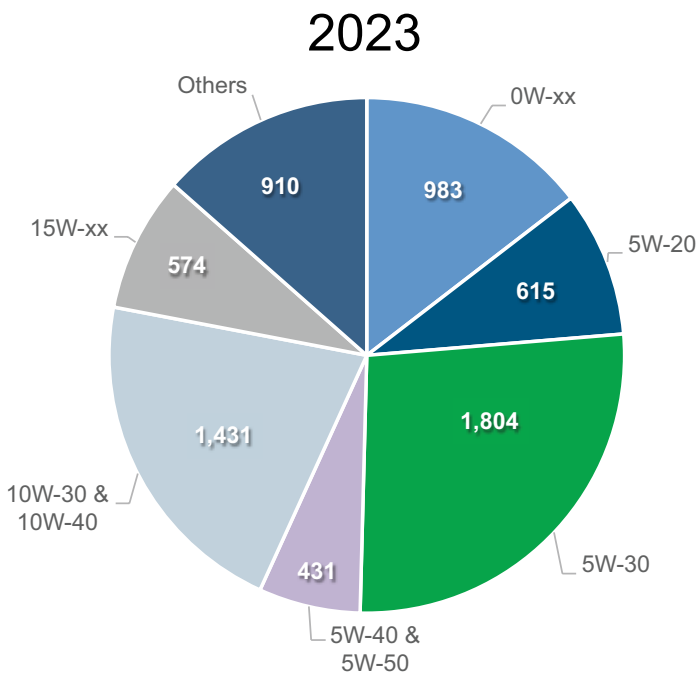
## Lubrication Trends & Insights

Overlaying these hardware changes are the trends in lubricant characteristics. Low fluid viscosity is desirable as it is less resistant to flow and pumping, especially at lower temperatures, improving overall engine efficiency. Because of these advantages, the market for SAE 0W-XX lubricants formulated with Group III base stocks is growing worldwide. Group III 0W-XX lubricants are set to have a greater share than either 5W-XX or 10W-XX oils by 2033, as reference in the chart below. For the lower end of the 0W-XX viscosity spectrum, such as 0W-16s, 0W-12s, and 0W-8s, the biggest challenges are cost and accurately predicting demand. These lower viscosity grades require more expensive compo-

nentry, and in some cases, can be more expensive to manufacture. In addition, many vehicles that come from the factory with a 0W-16 can use a 0W-20, a much more commonly stocked and produced viscosity grade. The low volume of cars on the road that require these viscosity grades, combined with their ability to use higher, more common grades, gives very little incentive for dealers and service centers to stock these oils. And when they do, they are expensive. If an additive package is not developed to be compatible with a wide range of viscosity grades, from standard 5W and 10W-XX grades to lower 0W-XX grades, oil marketers and their customers may be forced to deal with increased operations, complexity, and higher costs.

## PCMO Viscosity Grades and Trends

Global Lubricant Demand, (KTonnes) 2023-33



Source: Kline

A focus on sustainability is also impacting the PCMO market, with re-refined base oils now playing a greater part. Initially only available for Group I or II base stocks, some companies are now producing re-refined Group III base oils that can be used to blend low-viscosity, high-performance engine oil. Supply is likely to continue rising to meet the general increase in demand for Group III oils.

So, despite the onward march of electrification, which might have heralded a significant slow-down in gasoline engine oil development, this diversity has spawned renewed interest in industry specifications. In the US, this means that current specifications, such as ILSAC GF-7 and API SQ, are now scheduled to be replaced by ILSAC GF-8 and corresponding API spec: most likely API SR in 2028. Key differences are likely to include greater fuel efficiency, a lower ash formulation for compatibility with GPFs, and enhanced piston cleanliness. Key tests are also being updated to adapt to changes in modern engine technologies.

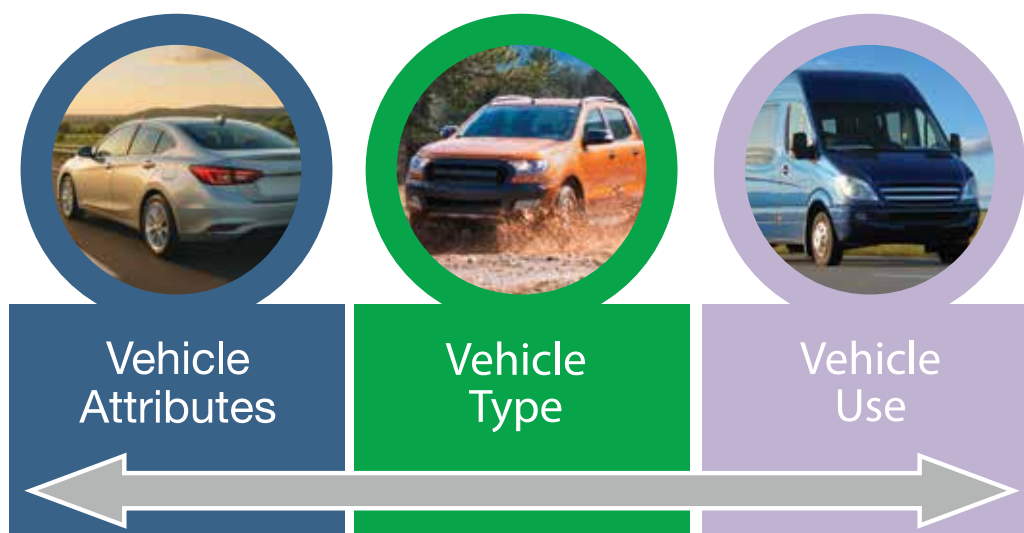
Although industry specifications are usually backward compatible, in North America the latest specification generally replaces previous ones and becomes the new standard. Not only does this support the latest technology, but it

also helps to extend the life of older engines and components such as catalytic converters. This approach is not always reflected in other markets, where older specifications may still be used in older vehicles, resulting in a much more fragmented fluid market.

European ACEA specifications have also introduced additional sequences (C6 in 2021 and C7 in 2023) that further enhance fuel economy. OEM specifications are following suit with a strong focus on cleanliness. For example, updates to GM's dexos™ 1 Gen 4 engine oil specification will be centered around deposit and sludge control, as well as a new focus on intake valve deposits (IVD). In fact, GM will be designing an IVD test from the ground up to be incorporated into the new dexos® 1 Gen 4 specification.

Beyond the updated changes and technological advancements seen in industry specifications for passenger engine oil, as marketers and value creators, there is still a significant opportunity to improve how we sell our engine oil and tailor the benefits of such products to specific segments of the market. Thinking beyond the specification and how we translate the value of our product for real-world conditions is where additional value can be unlocked.

## New Value Propositions





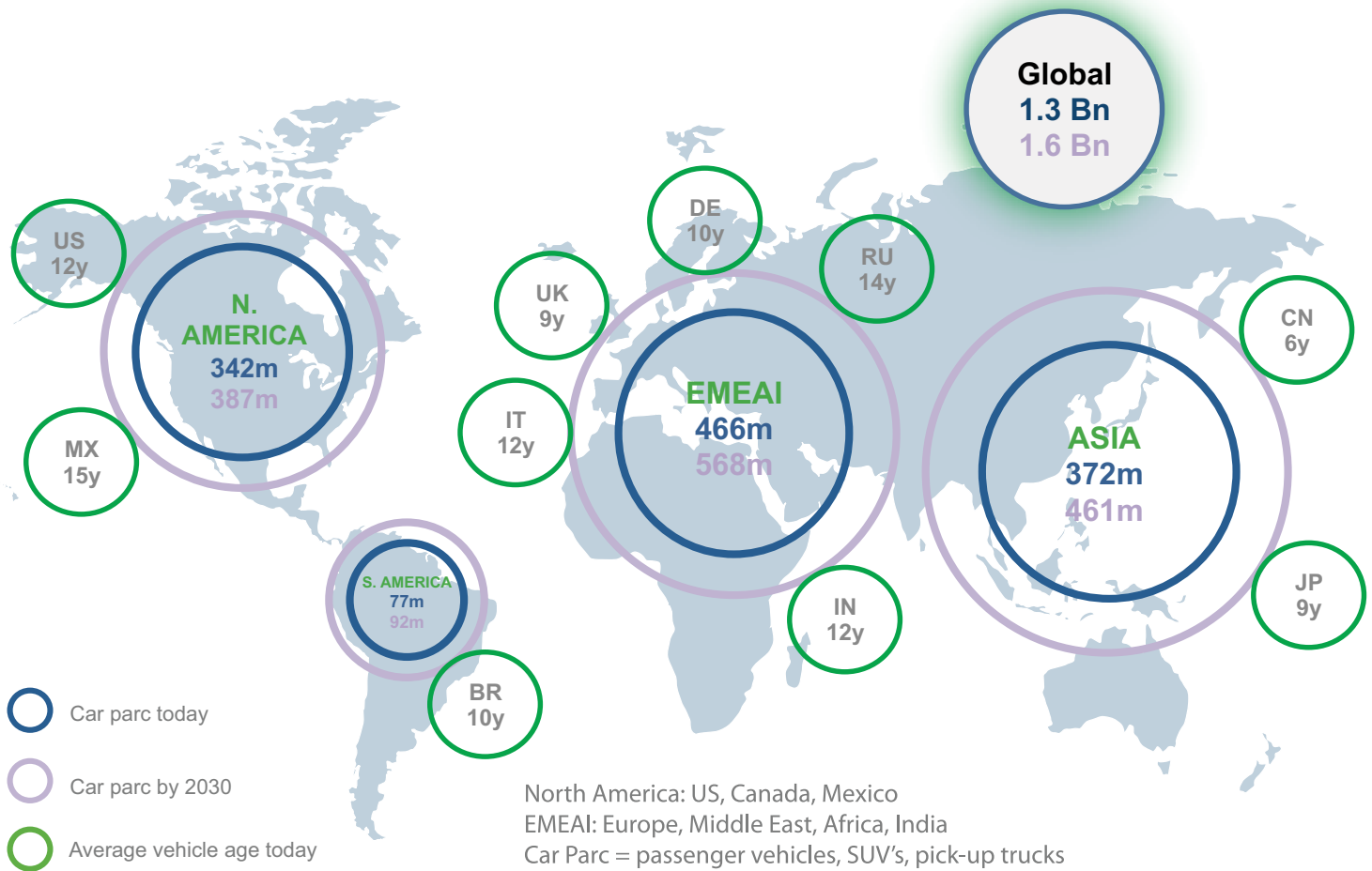
## Beyond Specifications – Vehicle Attributes

As the car parc ages, average miles traveled naturally increases, vehicles over 75,000 miles are classed as 'high mileage'. Over two-thirds of North American passenger cars and light trucks are now out of warranty and are increasingly classified as high-mileage vehicles, likely driven by improved vehicle build quality combined with

an increasingly uncertain economic outlook, is that owners are keeping their vehicles for longer. This means the global car parc is not just growing but changing in composition and age. In North America, the average vehicle is now 12 years old, similar to southern Europe and India; Northern Europe and Japan are closer to 9-10 years, while Chinese vehicles are almost half the average age, at just 6 years as seen in the graphic below.

### Global Passenger Car Parc

Increasing vehicle parc population by 2030 with aging car parc



Engines with high mileage or those in older vehicles often experience a range of performance issues. These can include poor engine responsiveness, the need for frequent oil changes, and increased smoke and noise, all of which signal underlying mechanical deterioration.

As these engines age, their motor oil begins to suffer in quality. This is due to changes in oil properties, which can lead to the formation of sludge and deposits that impair engine efficiency. At the same time, oil consumption tends to increase, fueled by factors such as excessive blow-by gases, loss of piston-cylinder oil control, and degraded valve stem seals. Oil loss is another common issue, often caused by leaky seals or malfunctioning components in the positive crankcase ventilation (PCV) system.

To address these concerns, it's crucial to use engine oils with strong oxidation and deposit control, which help manage sludge buildup and

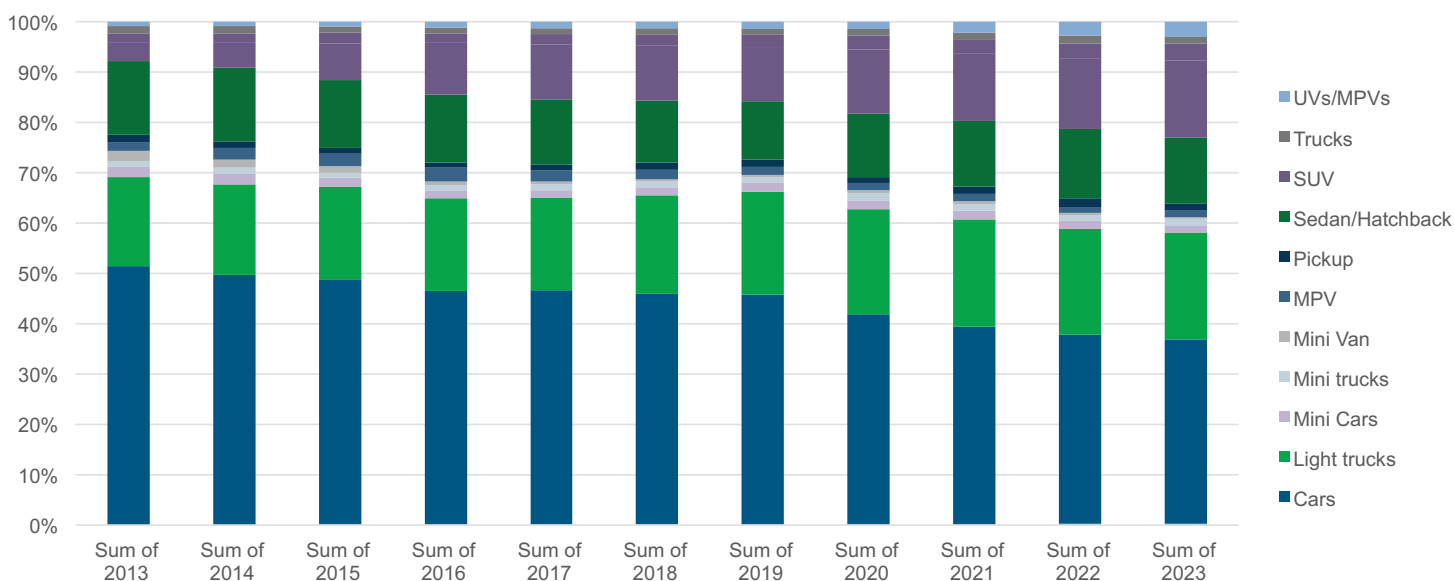
internal residue. Additionally, formulations that provide enhanced wear protection are vital to reducing abnormal oil consumption. Finally, ensuring seal compatibility and protection can play a significant role in minimizing oil loss, helping extend the life and performance of older engines.

## Beyond Specifications – Vehicle Type

Consumer preference for buying light trucks and SUVs, whose sales have overtaken those of sedans for some time, is expected to continue in the US, and this trend is also seen globally. Traditional car demand continues to shrink as consumers demand alternative modes of transport related to activity, application, use, availability, cost, and choice. 'Cars' represent <50% of overall global demand, with light trucks ~25% and SUV's and pickups accounting for ~20%.

## Global Application Segmentation by Year

Key Countries: EU, Japan, USA, India, SEA, South Africa, LATAM

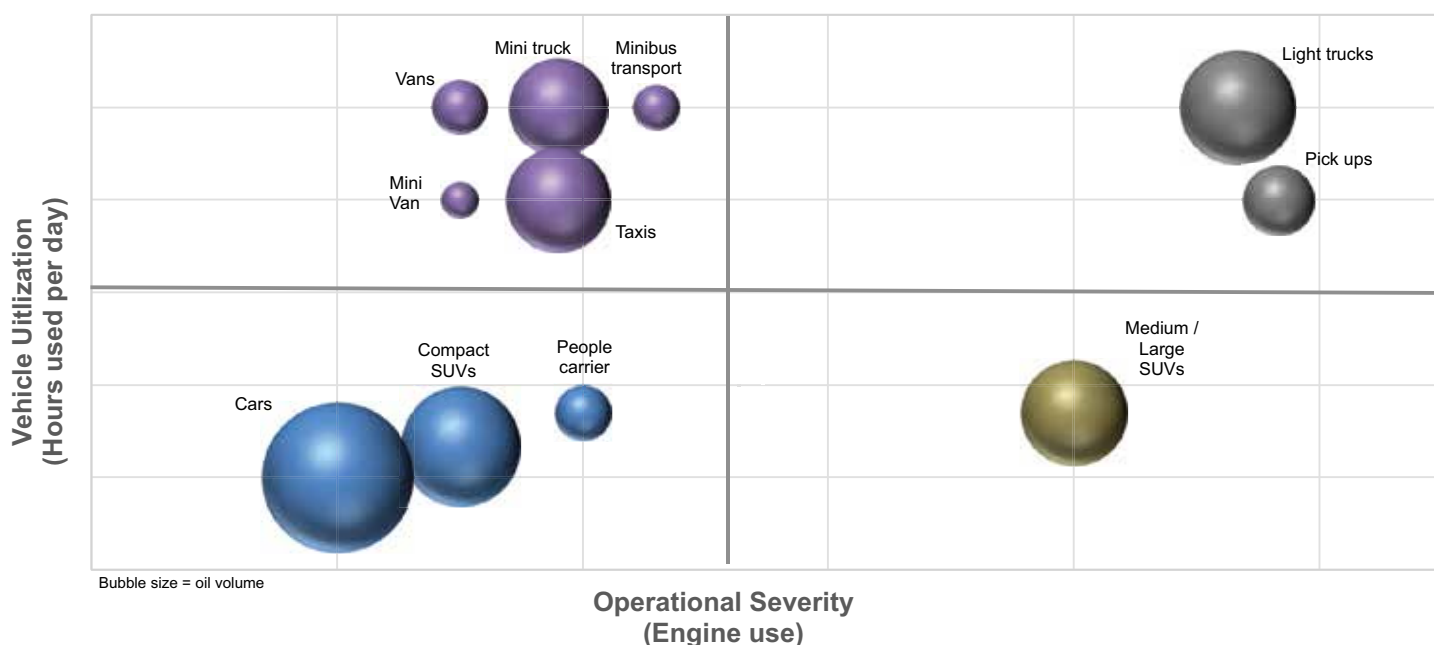


## Beyond Specifications – Vehicle Use

While engine oils are formulated to meet rigorous industry specifications, the requirement for passing the specification often overlooks how vehicles are used in real-world driving conditions and the various operating conditions and stresses that engines are put through that impact lubricant performance. In simple terms, a light-duty vehicle commuting on a highway for 30 minutes each

day will require a different level of lubricant performance than a utility vehicle or taxi service, which is often operated for longer hours in numerous stop-start driving conditions and carrying heavy loads. As we visualize this vehicle and its application, the assumption that an ILSAC GF-7 or API SL solution is designed for both drive cycles is misplaced. As marketers, this type of insight offers an opportunity for new value creation and new segments that value different types of lubrication performance.

### Vehicle segmentation: Vehicle utilization vs. operational severity



One oil cannot serve all of these segments due to variations in hours on road and operational severity

Armed with the latest chemistries, application insights, extensive testing capabilities, and global OEM liaison teams, Afton is well equipped to collaborate with partners who wish to take a different approach to marketing engine oil by going beyond the spec. Differentiated lubricant solutions for high mileage engines, hybrid vehicles, SUV's, and light duty trucks are available from Afton Chemical.



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