DISRUPTIVE TECHNOLOGIES AND THEIR LONG-TERM IMPACT ON HDMO DEMAND

Webinar

December 14, 2021

Kline

Today's Speaker

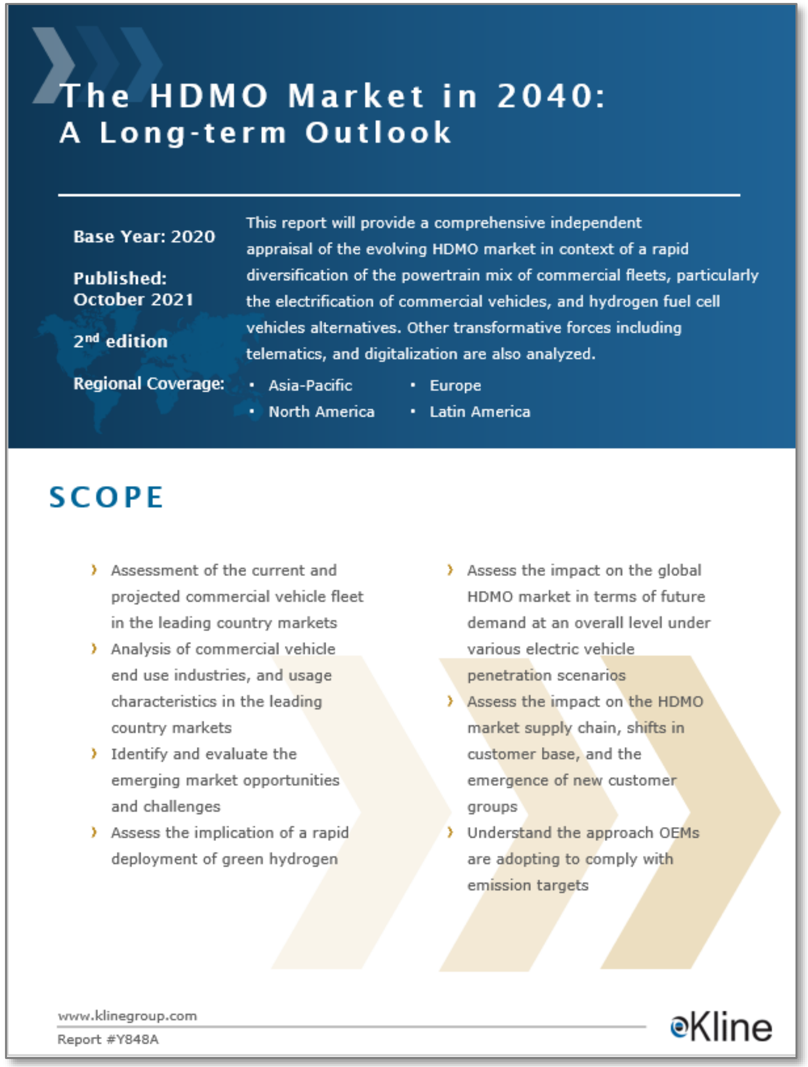
DAVID TSUI

Project Manager,
Energy

Introduction

- This presentation is based on Kline's recently published study **The HDMO Market in 2040: A Long-term Outlook.**
  - The second edition of a comprehensive study covering eight leading HDMO country markets.
  - The base year for the HDMO demand data is 2020.

- The objective of the study is to analyze in-depth:
  - Current and projected commercial vehicle fleet in the leading country markets.
  - Assess future overall HDMO demand based on the commercial vehicle parc's growth, impact of changes in oil drain intervals. Although the outlook for each individual viscosity grade and quality level is not provided as they are assessed on a quantitative basis.
  - The dynamic of transformative technologies, and their impact of commercial vehicles fleets operating and maintenance practices.
  - Current and projected penetration of electric vehicles and impact on the HDMO market.



The HDMO Market in 2040:
A Long-term Outlook

Base Year: 2020

Published: October 2021

2nd edition

Regional Coverage:
- Asia-Pacific
- Europe
- North America
- Latin America

This report will provide a comprehensive independent appraisal of the evolving HDMO market in context of a rapid diversification of the powertrain mix of commercial fleets, particularly the electrification of commercial vehicles, and hydrogen fuel cell vehicles alternatives. Other transformative forces including telematics, and digitalization are also analyzed.

SCOPE

- Assessment of the current and projected commercial vehicle fleet in the leading country markets
- Analysis of commercial vehicle end use industries, and usage characteristics in the leading country markets
- Identify and evaluate the emerging market opportunities and challenges
- Assess the implication of a rapid deployment of green hydrogen
- Assess the impact on the global HDMO market in terms of future demand at an overall level under various electric vehicle penetration scenarios
- Assess the impact on the HDMO market supply chain, shifts in customer base, and the emergence of new customer groups
- Understand the approach OEMs are adopting to comply with emission targets

www.klinegroup.com
Report #Y848A
Kline

Scope and Methodology

- Data for eight countries has been analyzed and forecast, including commercial vehicle population, commercial vehicle population growth, oil drain intervals, sump sizes, and the maximum possible electric vehicle (EV) penetration.
- Long-term HDMO volume estimates will flow from our demand model, and other projections and assessments will stem from our primary and secondary research analysis.

Forces beyond the lubricant industry were assessed as they have great potential to disrupt the long-term HDMO demand outlook

HDMO 2040 REPORT SCOPE

Various dimensions of impact	Influencing factors considered
2040 HDMO demand outlook for selected countries	ICE & EV commercial vehicle population outlook (included in the model)
Impact industry structure: Changing competitive landscape, new stakeholders, emerging route to markets	Regulatory drivers, government aspirations
	OEMs: aspirations, push for technology diversification, investment, impact on sales channels
	Technology evolution (vehicles and its components), impact on lubricants
	Infrastructure and other barriers for EVs
	Stakeholder analysis: emergence of the new important players
	Other technological disruptors: telematics, digitalization, sharing economy platforms

Color legend: Quantitative assessment | Qualitative assessment

Kline

HDMO demand quantitative model includes scenario analysis for every country in scope and assessment of the most important contributing factors

Key model assumptions

THREE EV PENETRATION SCENARIOS

EV Penetration
- Three different scenarios were run based on the future development of the electric vehicle (EV) technology expressed in terms of upper, lower and medium penetration levels (high-EV, low-EV, and mid-EV level scenarios)

Population outlook
- Commercial vehicle population growth forecast
- New commercial vehicle sales

Drain intervals
- They are expected to rise due to the increasing penetration of synthetics and other factors
- Oil drain intervals (ODI) expressed in months

Sump size
- ICE/PHEV/HEV average sump size in liter

Model output

Annual HDMO demand outlook by 2040: Scenario Analysis

EV PENETRATION SCENARIOS

4 HDMO DEMAND OUTPUTS

HDMO demand-1: Impact of CV population change analyzed. All other factors held constant.

HDMO demand-2: Impact of CV population and sump size change analyzed. All other held factors constant.

HDMO demand-3: Impact of CV population, sump size, drain interval change analysed. All other factors held constant.

HDMO demand-4: Impact of CV population, sump size, drain interval and BEV, PHEV, and HEV fleet penetration changes analyzed.

Model: EV penetration is assessed through three scenarios (High, Medium, Low) for each country market as it presents the highest uncertainty. Four HDMO demand models assess the contribution of the most important factors (vehicle population growth, sump size, drain intervals changes, EV penetration) for each scenario

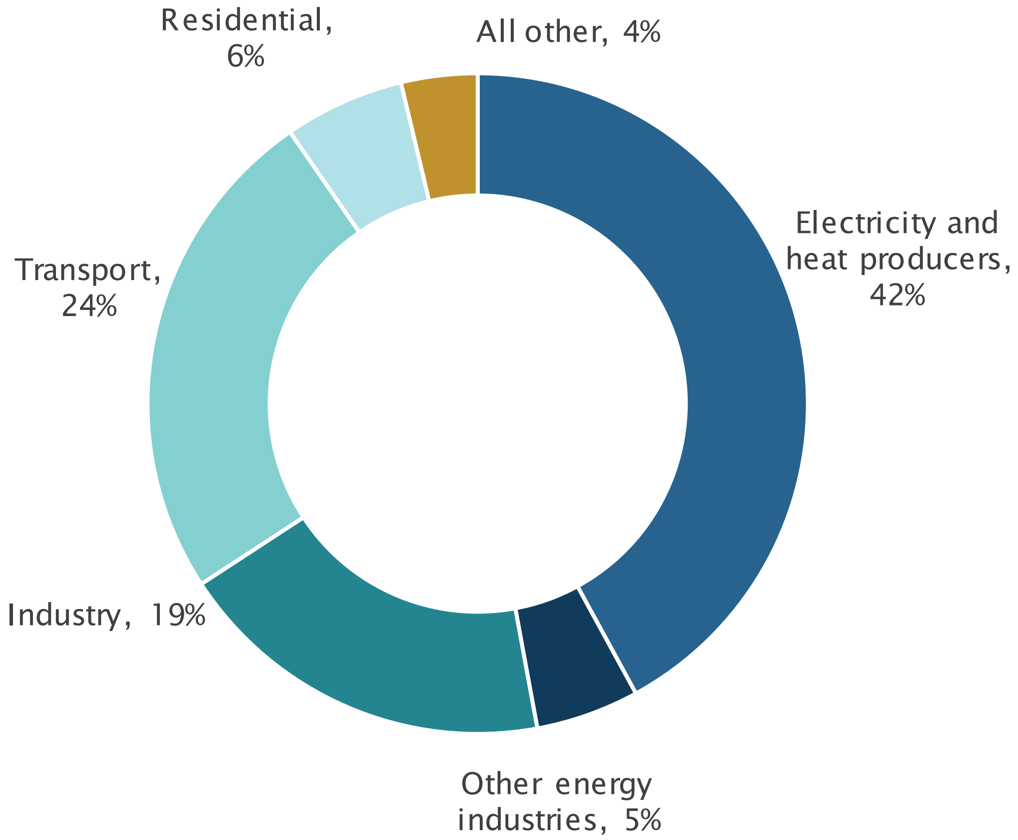
Agenda

- Introduction to Kline
- Report Scope and Methodology
- **Summary of Key Findings**

Stakeholders operating in the commercial vehicles sector are facing serious challenges

- Government polices mandating BEVs and other alternative fuel vehicles in the commercial fleets.
  - Growing emphasis on the commercial fleet as it accounts for nearly 30% of CO_2 in the transport sector. Within transport, passenger and freight road transport are two segments accounting together for nearly 75% of CO_2 emissions.
  - Electric commercial vehicles do not represent the only alternative to internal combustion engines (ICE) powered by diesel. CNG, LPG, hydrogen, and biofuels are also potential alternatives.
- OEM CO_2 mitigation efforts are still centered at improving "Energy Efficiency" notably by means of design and construction of the drivetrain and vehicle (aerodynamic drag, lighter materials, tires).
- Novel powertrain technologies and transition to unconventional fuels are also part of a broader strategy to improve energy efficiency.

Global CO2 Emissions By Activity, 2019



SOURCE: International Energy Agency (IEA)
All other includes commercial and public services, agriculture, and fishing

However, serious infrastructure, technological, and societal barriers must be overcome before a more tangible penetration of these technologies

Higher cost

- BEV trucks can cost several times more than conventional diesel trucks

Charging infrastructure

- There isn't much public, commercial charging infrastructure at the moment
- Corporate charging is slowly being built up but is not mature enough to support a large BEV fleet
- There has been an improvement in the driving range (current EVs have 200+ miles), but it is still a barrier affecting ease of use under certain driving scenarios considering insufficient charging infrastructure and the long time required to re-charge.

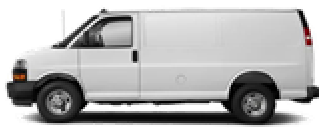
Incremental power generation capacity required for rising EV population will be a significant barrier.

Battery weight penalty means less cargo capacity for long haul trucks until legislation increases allowable tonnage or battery energy density improves.

OEMs have adopted a multi-dimensional approach, opting for a mix of improving ICE efficiency while developing alternative fuels, and powertrain technologies

LIGHT COMMERCIAL VEHICLE (LCV)

MEDIUM COMMERCIAL VEHICLE (MCV)



HEAVY COMMERCIAL VEHICLE (HCV)

PENETRATION OF ALTERNATIVE FUEL AND POWERTRAIN TECHNOLOGIES ACROSS COMMERCIAL VEHICLE SEGMENTS

BEV/PHEV
Alternative fuels

PHEV/HEV
Alternative fuels

CNG/LNG
LPG
FCV

- EV penetration to be faster in LCV because of weight and range considerations, and are better suited to short-range urban deliveries.
- Hybrid vehicles and alternative fuels, but also natural gas powertrains for CNG/LNG, are preferred alternative to diesel/gasoline in MCV, and HCV across the various regions.

An increasing number of companies operating large private fleets are incorporating alternatives to ICE and adopting emission mitigating policies

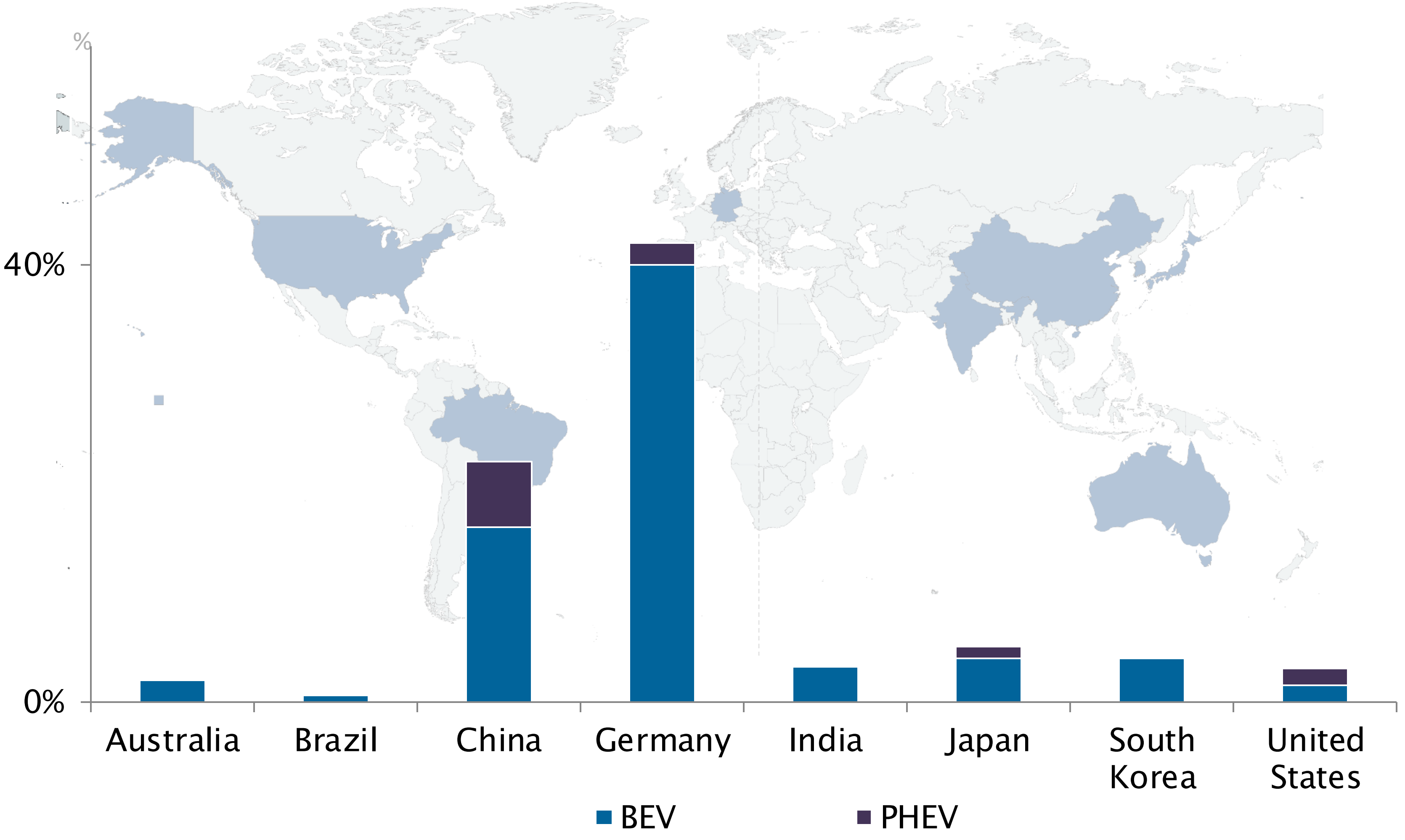
Economic, environmental, and social aspects are being implemented to corporate business strategies in the context of a broader sustainability component helping companies to achieve potential cost savings, reducing operating expenditures while capitalizing of social responsibility and environmental credentials.

FedEx	USPS	UPS	North American Fleets
• Currently has 118 BEVs along with 364 hybrid trucks in their fleet. • 500 GM BEV deliver vans are on order. Est. 2025	• Has begun the process to replace their fleet of delivery vehicles with 165,000 BEVs. Deliver will take place over a 10-year span. • Contract has been awarded to Oshkosh	• Plans to procure up to 10,000 BEV delivery vehicles through their partner Arrival which will build the vehicles. • Currently has around 50 Workhorse BEVs from a 2018 contract.	• Anheuser Busch • Alpha Baking Co. • Biagi Brothers • Cardenas Inc. • NFI • Penske • PepsiCo's Frito-Lay • Purolator • Ryder

Kline

In terms of EV technology: Battery electric technologies are anticipated to become prominent in Germany and China

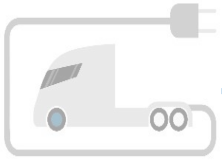
Most Likely EV Penetration in On-highway HCV for Selected Countries, 2040



- Countries with a high EV penetration, notably Germany and China.
- Countries with a lower EV penetration and displaying a more prominent diffusion of alternative fuels such as CNG, LNG, and plug in hybrid technologies (PHEV).

Kline

However, in the near term, EVs are expected to remain a niche market, with a limited influence on HDMO demand

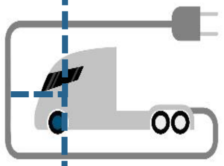


- Energy efficiency and increasing regulatory pressure is leading the technology diversification in commercial fleets.
- CNG/LNG, but also LPG gaining similar/higher prominence.

- **Oil drain interval are the main factor driving HDMO demand.**
- Effects of the ride-sharing economy on HDMO demand is very limited. BEVs are not yet used in shared mobility applications.

- Barriers are gradually surpassed.
- Fleets opt to purchase EVs in LCV for short distance urban deliveries.
- Penetration of EV in transit buses.

- BEVs will take market share from HEVs in LCV/MCV.
- CNG and other alternatives in the HCV segment.
- OEMs are still struggling to find the ideal case.



Limited impact on HDMO demand

Transitional period: barriers are being dismantled

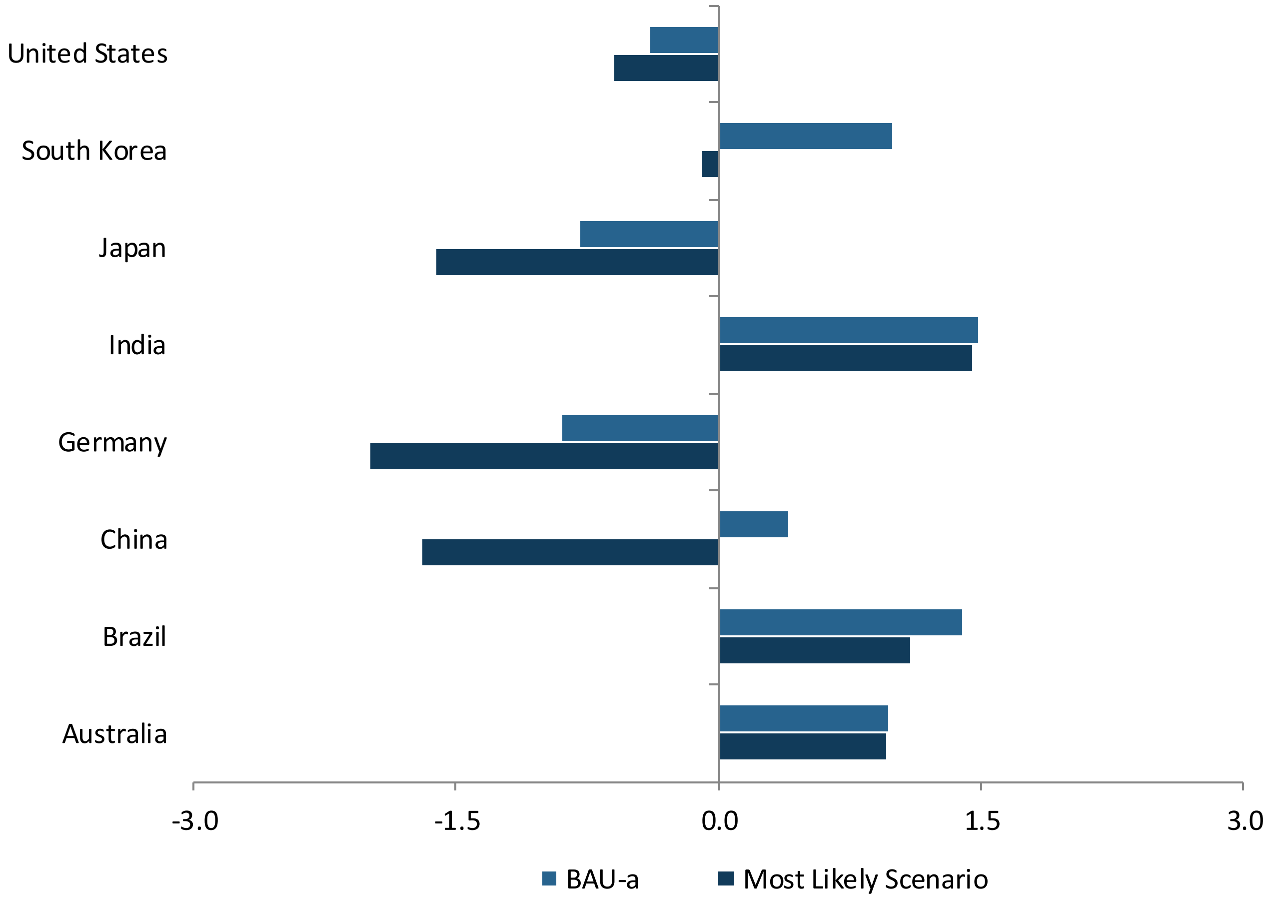
Higher impact on HDMO demand (rise of BEV population)

Kline

However, in the near term, EVs are expected to remain a niche market, with a limited influence on HDMO demand

- Selected country markets covered in this study represent nearly half of the global HDMO market and represent each of five major regions. Growth in EVs is projected to impact the on-highway fleet more as greater government emphasis is for on-highway trucks, while in the off-highway segment, it is assumed that a negligible EV penetration will be the most likely to occur, except in select niche segments.
- The business as usual (BAU) scenario assumes 2020 levels of BEV, HEV, and PHEV penetration remain constant out to 2040. In comparison, the growth in EV penetration had a negative impact on the demand for HDMO across all selected country markets, with some such as China showing a much greater loss as they are projected to have a much higher adoption of BEVs.
- The impact of EVs is projected to be lower in country markets that are less developed or more rural though the main factor is the level of government support. Governments of developed nations typically take a much stronger approach to promoting EV adoption which ranges from incentives for businesses and owners, investment in charging infrastructure, and outright bans on ICE commercial vehicles.
- The LCV segment is expected to see the greatest adoption of BEVs and accordingly, will witness the greatest decline in demand for HDMO.

LONG-TERM HDMO DEMAND FORECAST BY COUNTRY, 2020-2040, %CAGR



a- Business as usual scenario where impact of vehicle population, sump size, and oil drain interval changes are counted, while EV levels are held constant at 2018 level

Continued...

The motivation to adopt EVs and the pace of diffusion will be based on a mix of considerations, with different priorities for each individual geography

MACROFACTORS

- Sustainability
- Competitiveness
- Energy Efficiency

MOTIVATION TO ADOPT

- **High**: China, Germany
- **Medium**: United States, Japan
- **Low**: Brazil

IMPACT ON EV POP → HDMO DEMAND

DIFFUSION RATE

- **High**: LCV, HCV
- **Low**: MCV

ENABLERS

- Governmental Support
- Regulatory Framework
- Socio-macroeconomic
- Infrastructure and Technology

Kline

Key Messages

Impact on the long-term HDMO market outlook

- In contrast to the passenger vehicle segment, Kline foresees a more modest penetration of EVs in the commercial vehicle population due to technological and market-driven reasons.
- Electric commercial vehicles do not represent the only alternative to diesel powered commercial vehicles.
- Despite the modest negative impact on volumetric HDMO demand, the transition to alternative fuels and powertrain technologies along with a shift to highly digital and connected transport will redefine the market structure for HDMO and other finished lubricants in the commercial lubricants segment.
- Disruptive technologies accelerate the penetration of lower HDMO viscosity grades in all regions, albeit at a different pace.
- The heavy commercial vehicle segment will continue to be dominated by diesel engines; however, an increase in the number of alternative fuel vehicles such as battery electric vehicle (BEV) and CNG/LNG powered vehicles is projected.
- EV growth is expected to occur in segments directly under government control as well as highly regulated segments.

Kenworth T680E – est 150 mile range

BYD 8TT est 124 mile range

Volvo VNR est 150 mile range

Kline

Kline is pleased to offer webinar attendees a subscription discount

**** Sectional pricing is available ****

- **Americas**
  Sabrina.Craciun@klinegroup.com
  +44-736-5404321
- **AP/MEA**
  Pierre.Zolghadri@klinegroup.com
  +86-159-2140-4791
- **Europe**
  Erin.Durham@klinegroup.com
  +442081334679
  Kristina.Zablecke@klinegroup.com
  +32-2-776-9440

The HDMO Market in 2040: A Long-term Outlook

Base Year: 2020

Published: October 2021

2nd edition

This report will provide a comprehensive independent appraisal of the evolving HDMO market in context of a rapid diversification of the powertrain mix of commercial fleets, particularly the electrification of commercial vehicles, and hydrogen fuel cell vehicles alternatives. Other transformative forces including telematics, and digitalization are also analyzed.

Regional Coverage:
- Asia-Pacific
- North America
- Europe
- Latin America

SCOPE

- Assessment of the current and projected commercial vehicle fleet in the leading country markets
- Analysis of commercial vehicle end use industries, and usage characteristics in the leading country markets
- Identify and evaluate the emerging market opportunities and challenges
- Assess the implication of a rapid deployment of green hydrogen
- Assess the impact on the global HDMO market in terms of future demand at an overall level under various electric vehicle penetration scenarios
- Assess the impact on the HDMO market supply chain, shifts in customer base, and the emergence of new customer groups
- Understand the approach OEMs are adopting to comply with emission targets

www.klinegroup.com
Report #Y848A

Kline

Kline