

The Internal Combustion Engine will Lead Road Transport for Decades -Using Premium Lubricants-

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Chevron Base Oils



premium base oils

In 1900 Electric vehicles were the rage

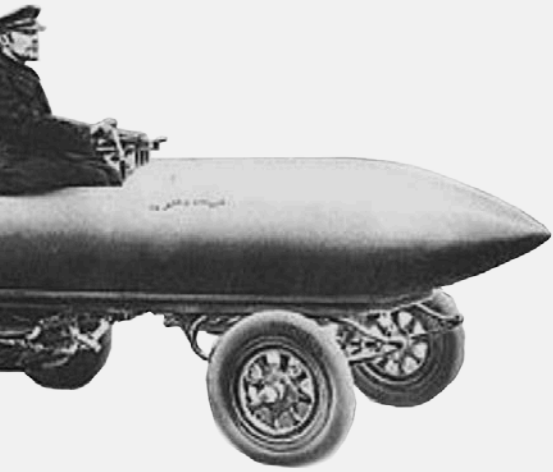


1899

First vehicle to reach 100km/h was electric



20 years later electric vehicles eclipsed by ICE



Greater range

Fast fill-ups

Better infrastructure



90's Environmental concerns ignited interest in electric vehicles

General Motors EV1



1996

First mass produced modern BEV— Commuter car



As interest grew, Tesla introduced futuristic, high-performance vehicles



CYBERTRUCK

Semi



Long recognized limitations slow acceptance



Range



Range anxiety



Charging infrastructure



Time to charge



Cost premium

New Issues



Battery lifetime

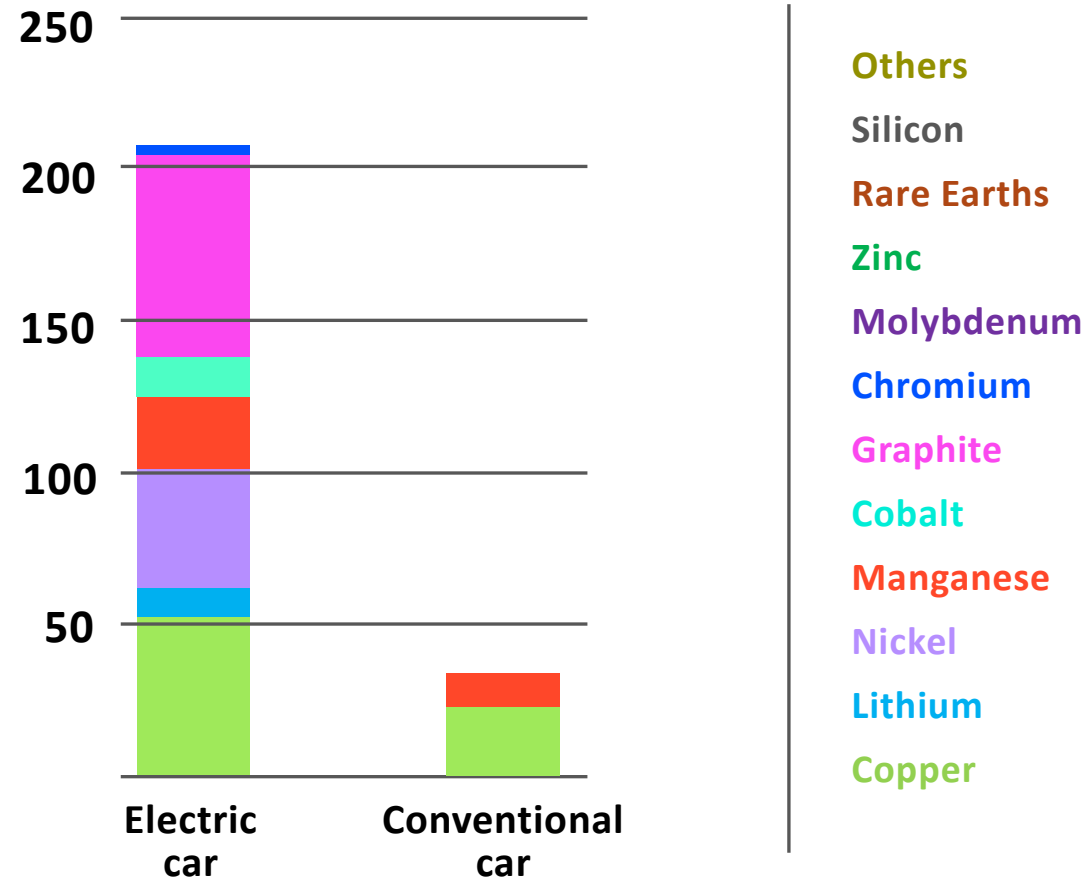


Battery mineral supply

Electric vehicle batteries require a lot of minerals

Energy Transition Minerals in Transport and Power Generation

Transport
(kg/vehicle)



ROBERT BRYCE testimony
to the House Select
Committee on the Climate
Crisis, June 30, 2021

Electrifying $\frac{1}{2}$ of U.S. motor vehicle fleet would
require more minerals than mined globally...

9x cobalt production,

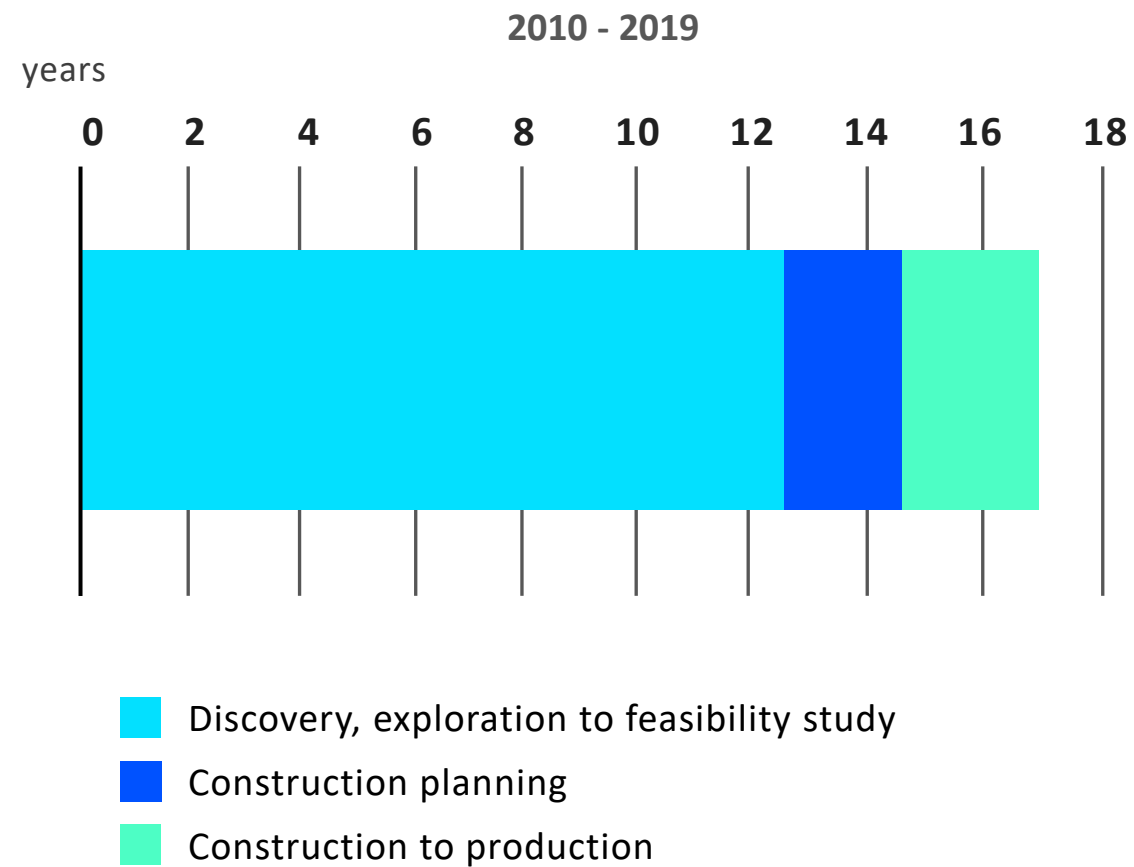
4x neodymium output,

3x global lithium production

2x copper production

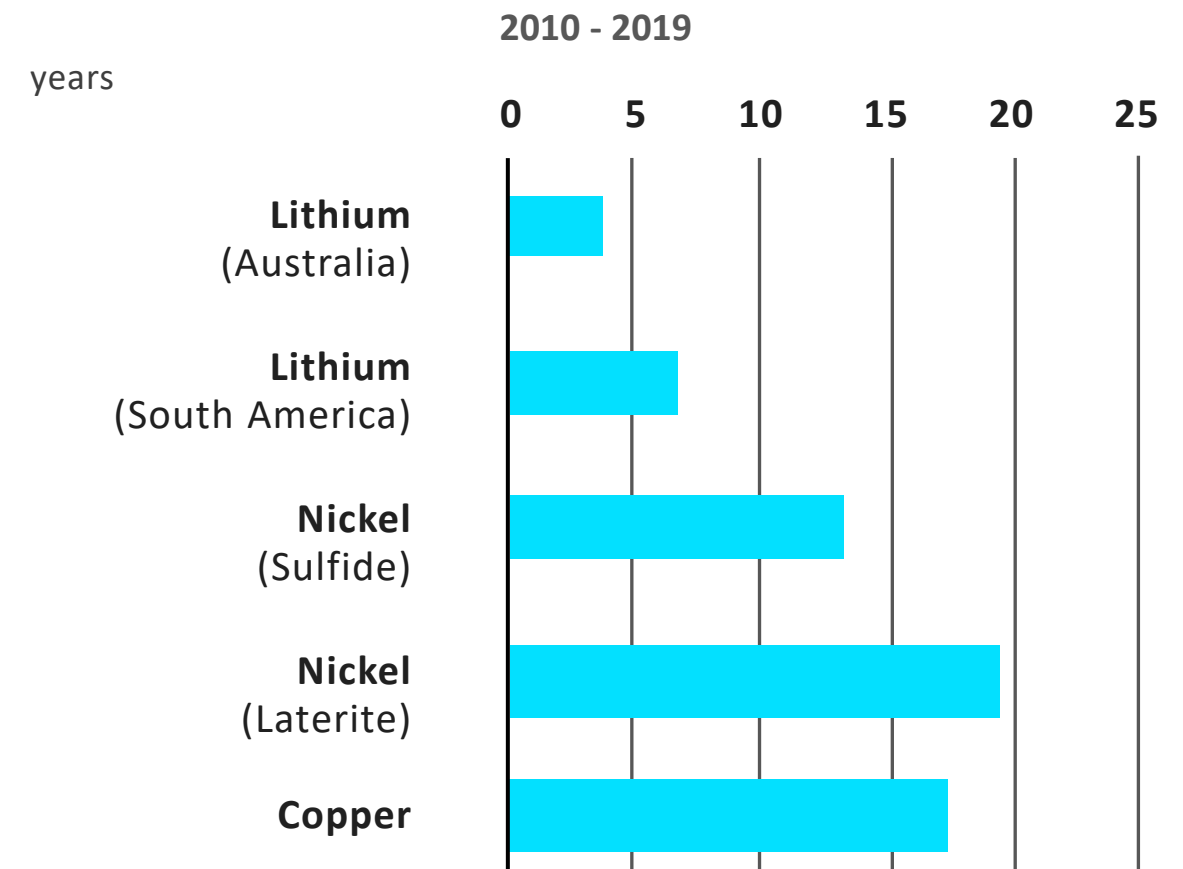
Overcoming the mineral production issue takes a long time

Global average lead times from discovery to production



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Average observed lead times from discovery to production for selected minerals

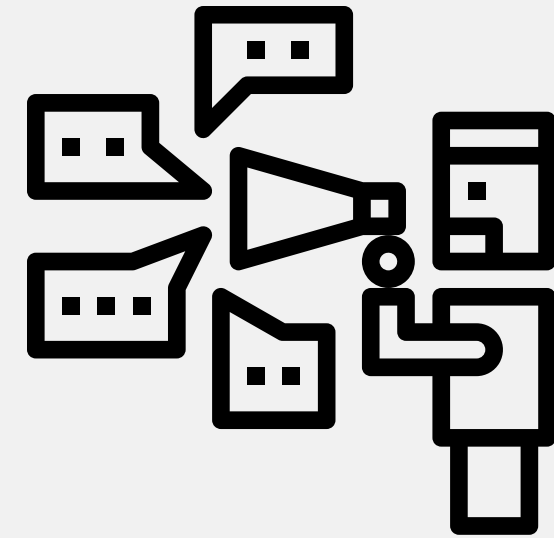


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Growing Pains: Highly publicized events hurt acceptance

In US, National Highway Traffic Safety Admin overseeing recalls

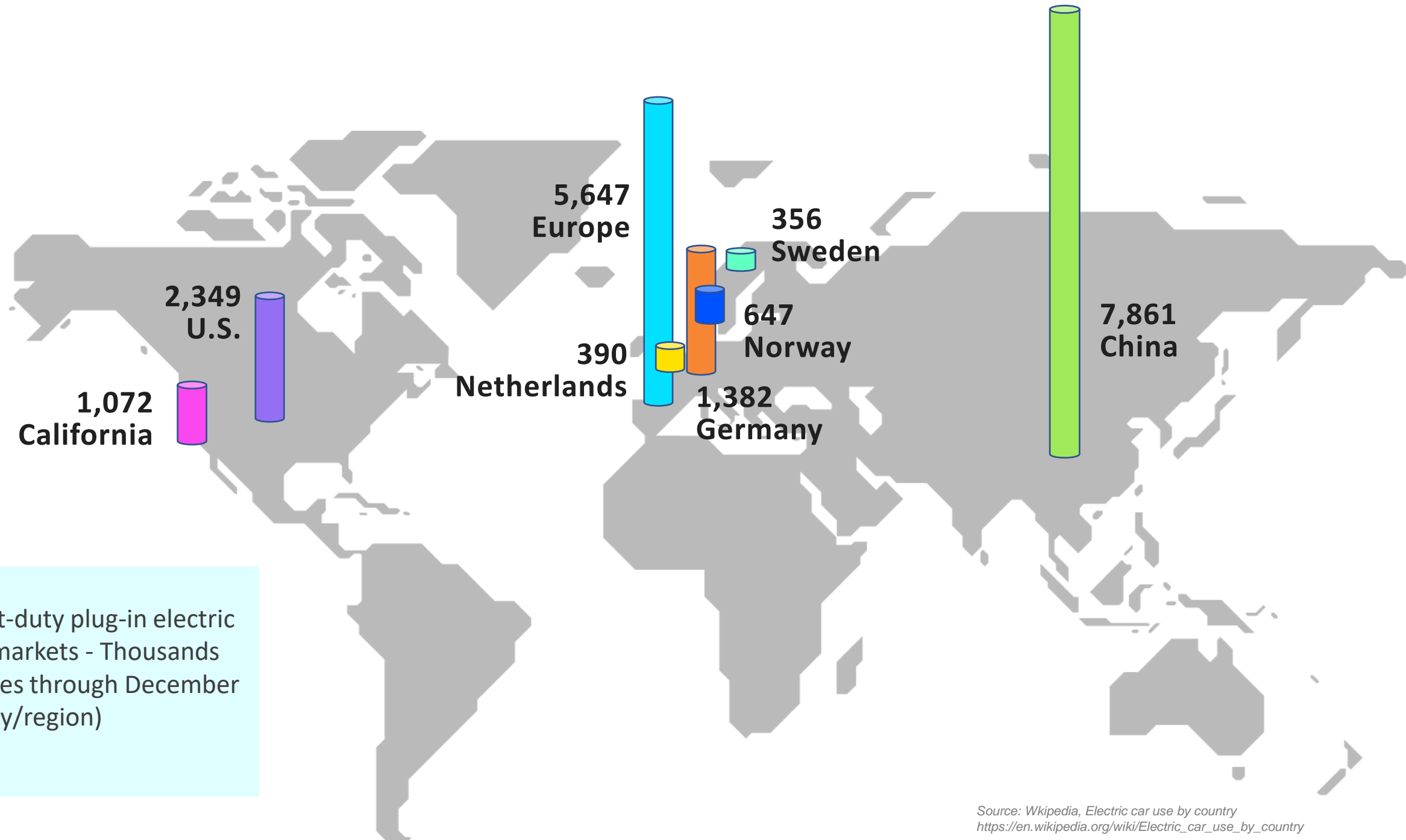
- GM, Mercedes-Benz, Hyundai, Stellantis, VW



All 2017-2022 GM Bolts under recall – don't park inside

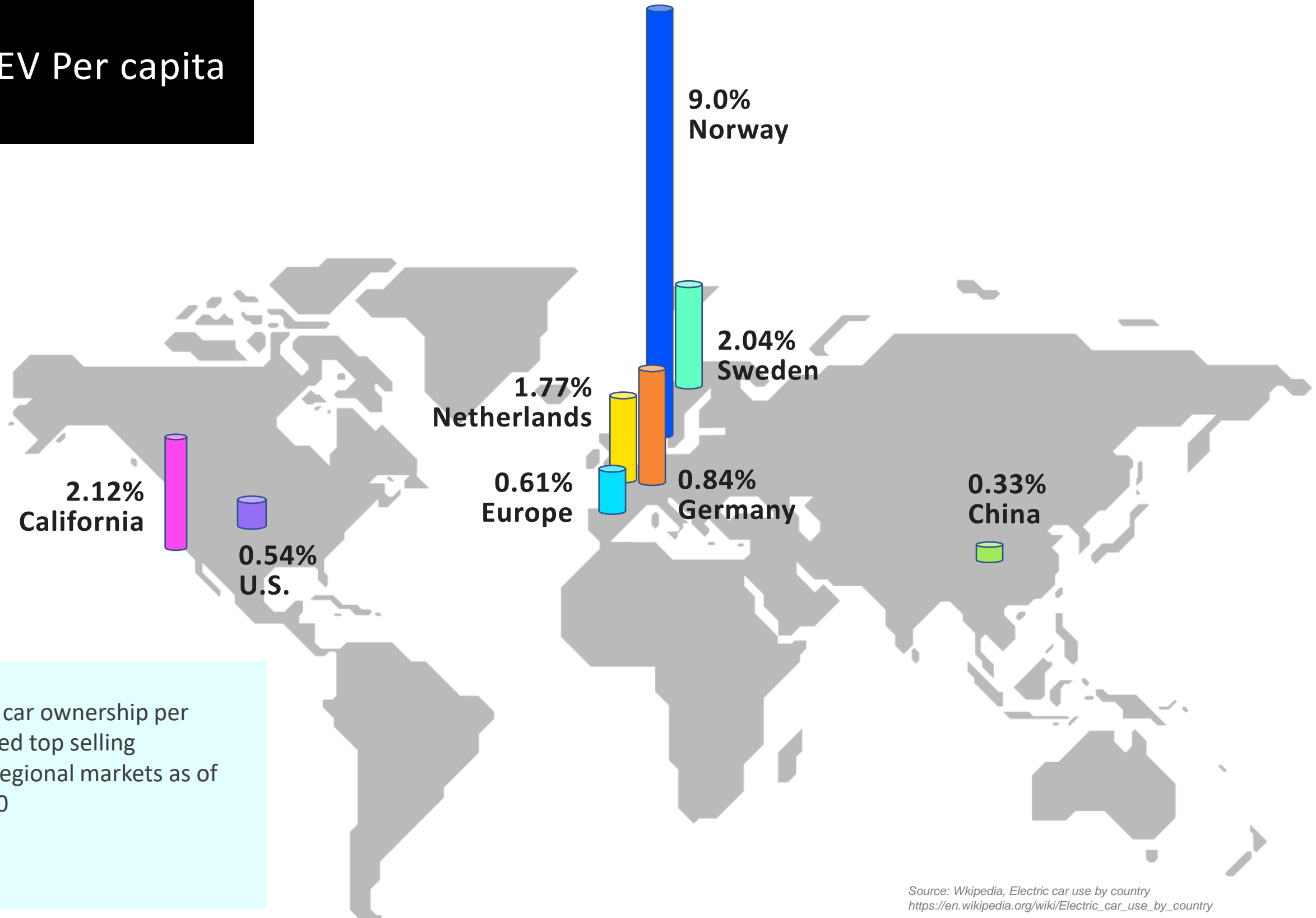
- 142,000 Vehicles
- \$1.8 Billion

Global penetration of plug-in electric vehicles – by volume



Top-selling light-duty plug-in electric vehicle global markets - Thousands (cumulative sales through December 2021 by country/region)

Plug-in EV Per capita



Plug-in electric car ownership per capita in selected top selling countries and regional markets as of December 2020

Early adopters of a Battery Electric Vehicle

Reliable transportation with minimal charging

- Commuters on electric scooters
- Tradespeople with three wheelers
- Urban delivery/Government fleets
- Environmentally sensitive & subsidized

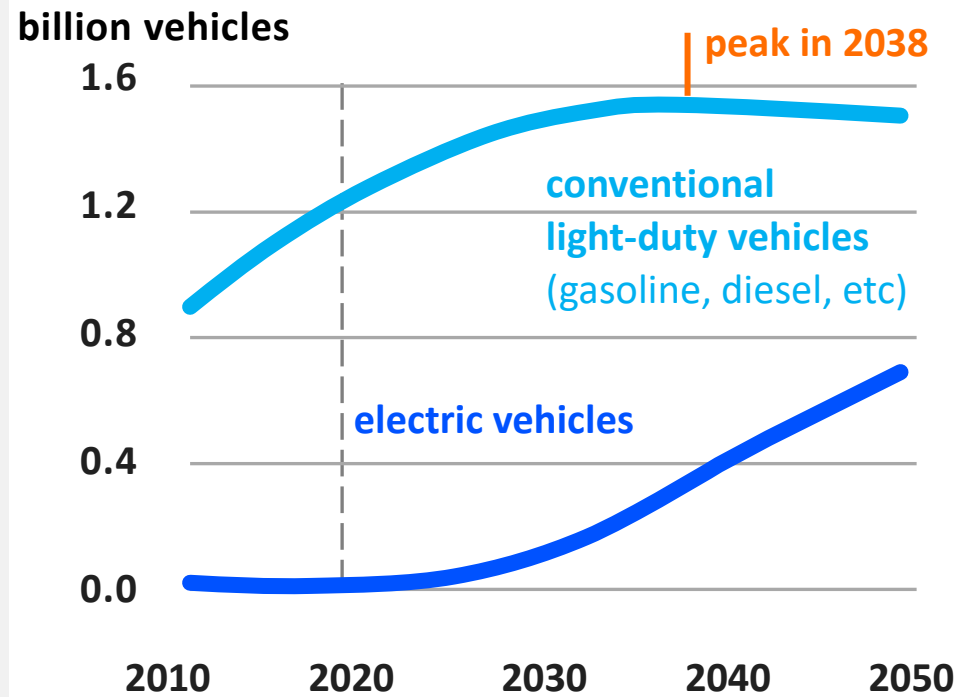


In 2050 there will be one billion ICEs on the road

OECD demand for conventional drivetrains will start to drop ~2030
Non-OECD countries want vehicles now & electrics are not a priority

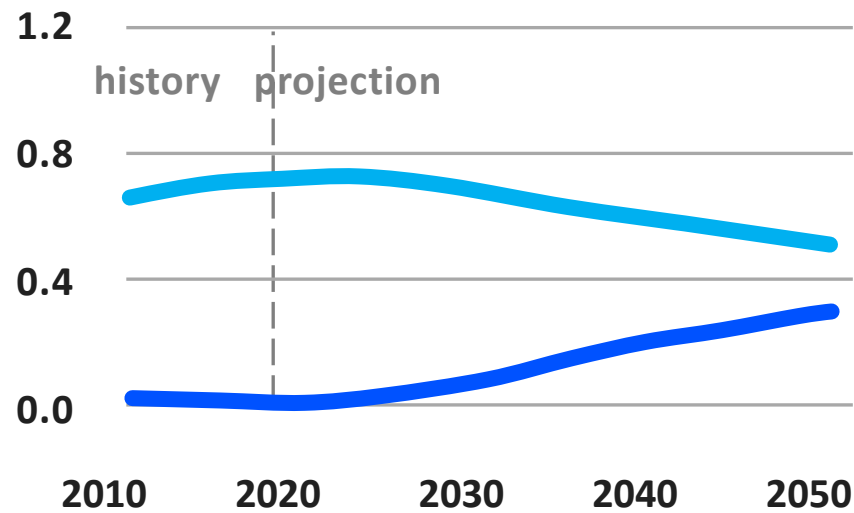
(Organization for Economic Cooperation and Development)

Global Vehicle Stock

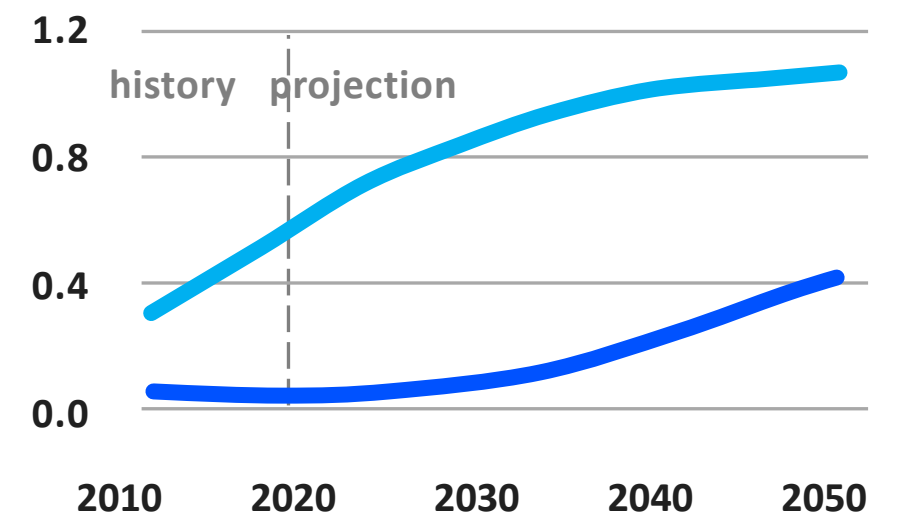


EIA projects global conventional vehicle fleet will peak in 2038

OECD countries



non-OECD countries



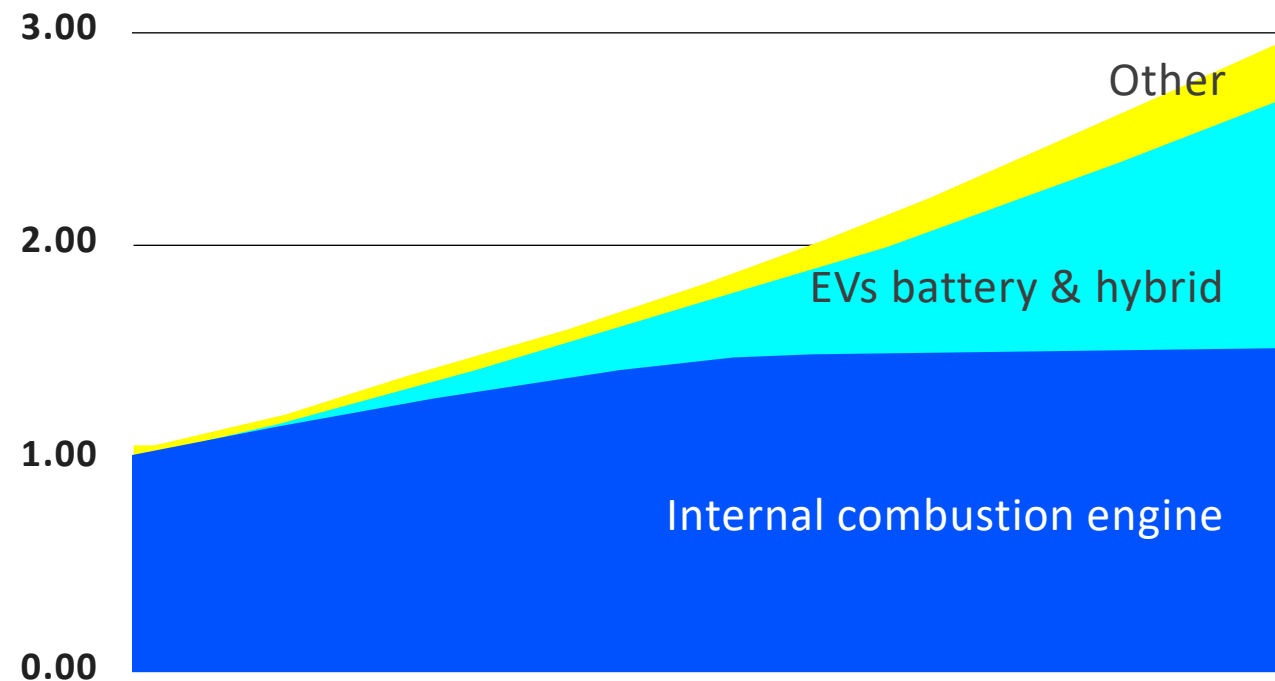
Source: Light-duty vehicle stock in International Energy Outlook 2021 Reference case (2010-2050)



Decarbonizing transportation will require significant changes in design and control of ICE

Vehicles on the road worldwide 2015-2050

billion vehicles



Source: International Energy Agency

Quality lubricants can help

- Improve fuel economy
- Reduce emissions
- Enable wider use of biofuels

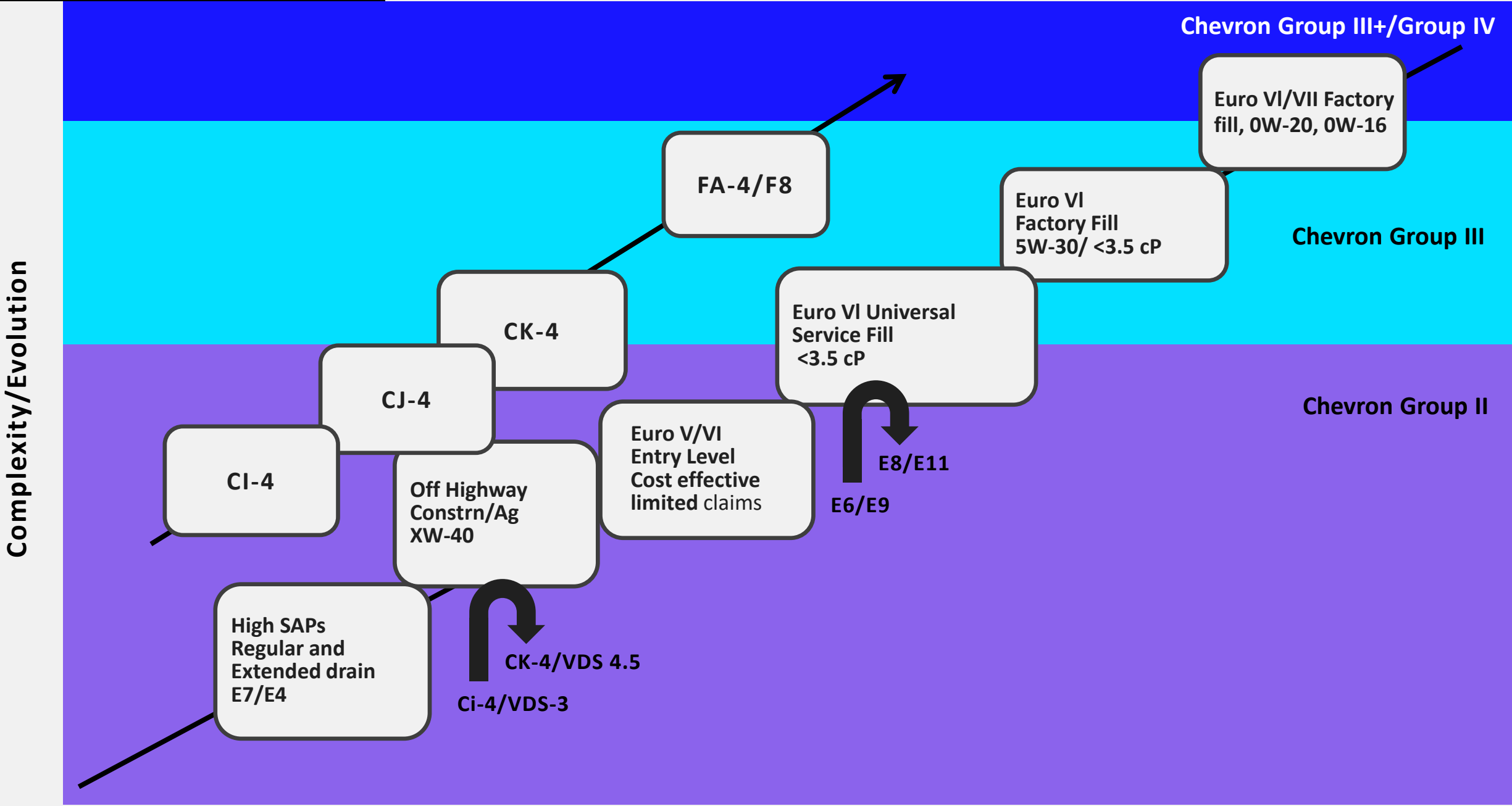
Need base oils with

- Lower viscosity
 - High & low temperature
- Low volatility (NOACK)
- Renewable/sustainable

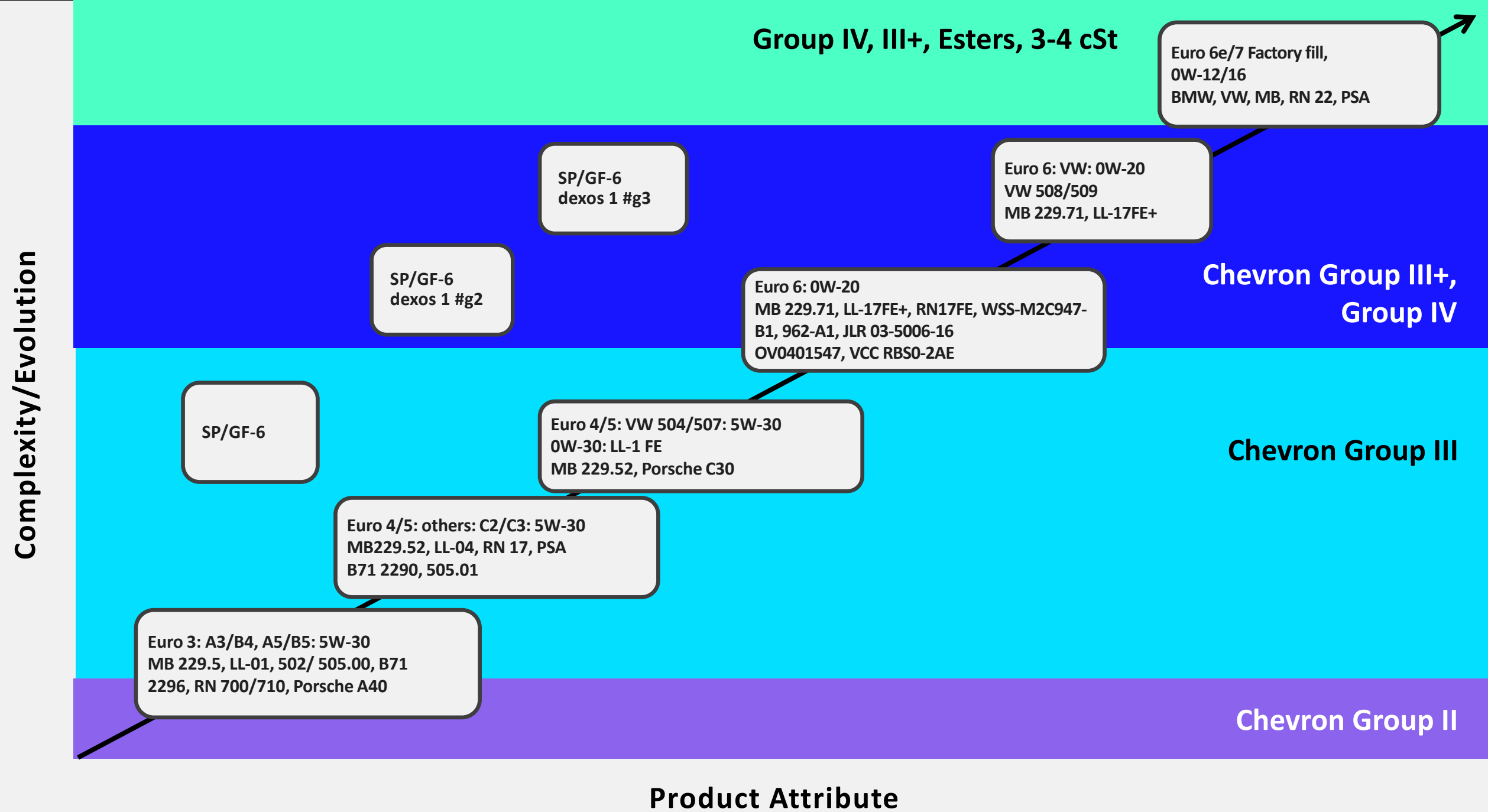
Engine oil development is continuing & moving to low viscosity lubricants



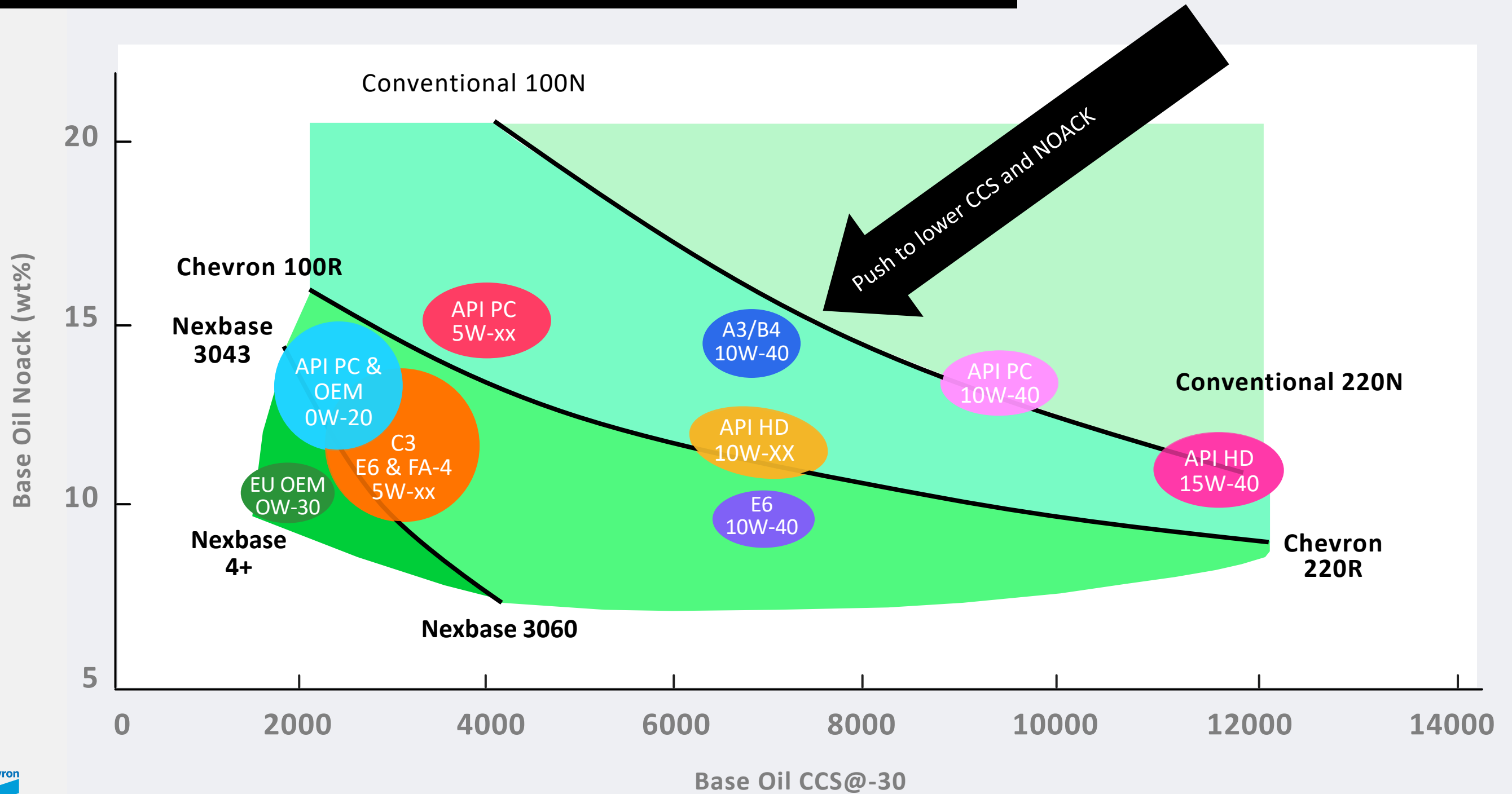
HDEO moving to lighter viscosity base oils



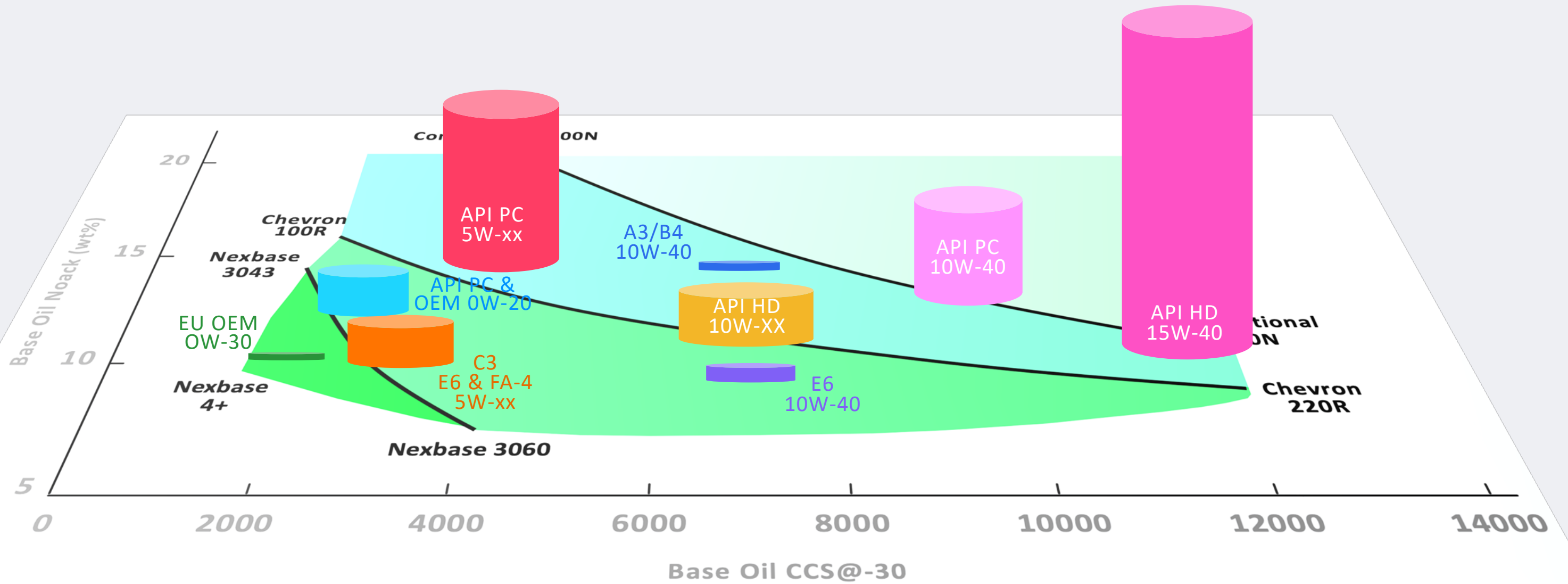
LD/PCMO is already low viscosity



Newest specifications demand premium base oils



Landscape volume favors Group II/III



Specifications with global reach increase challenges in selecting base oils slates

Blending Logistics dictate slate selection

- **Security of supply is paramount**
- **Slates must cover premium API groups from II to III+ to maximize product offerings**
- **Slates must be broadly approved**
- **Global availability reduces logistics complexity**
- **Renewable capabilities open new doors**



Upgraded Chevron BO slate provides
II/II+/III/III+ & renewable

The addition of NEXBASE to the Chevron Slates offers globally available premium formulation blending

		Chevron Global Slate				
		Richmond	Yeosu	Pascagoula	Porvoo	Sitra
Group II/II+	100R					
	150R					
	220R					
	600R					
Group III	3020					
	3030					
	3043					
	3050					
	3060					
	3080					



NEXBASE 4+ a path to performance and sustainability

A drop-in solution for more sustainable lubrication

>60% of the molecules manufactured from
100% certified renewable raw materials.

Replaces fossil-based Group III+ and PAO

0W-XX formulations without higher carbon PAO

Qualifications in place — ACEA 2021

SAE 0W-30 ACEA C2 & 0W-20 ACEA C5

SAE 5W-30 ACEA C4

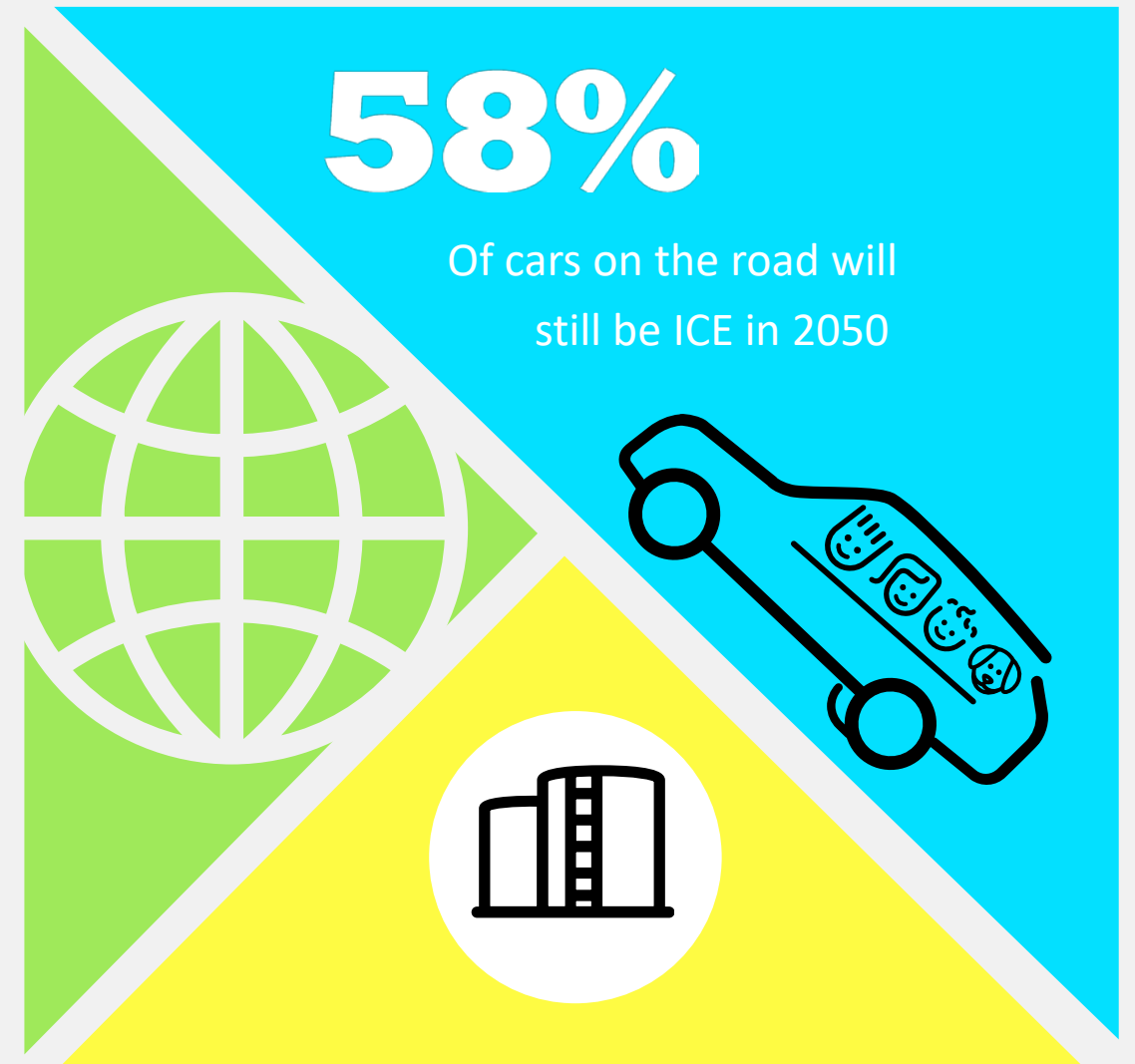
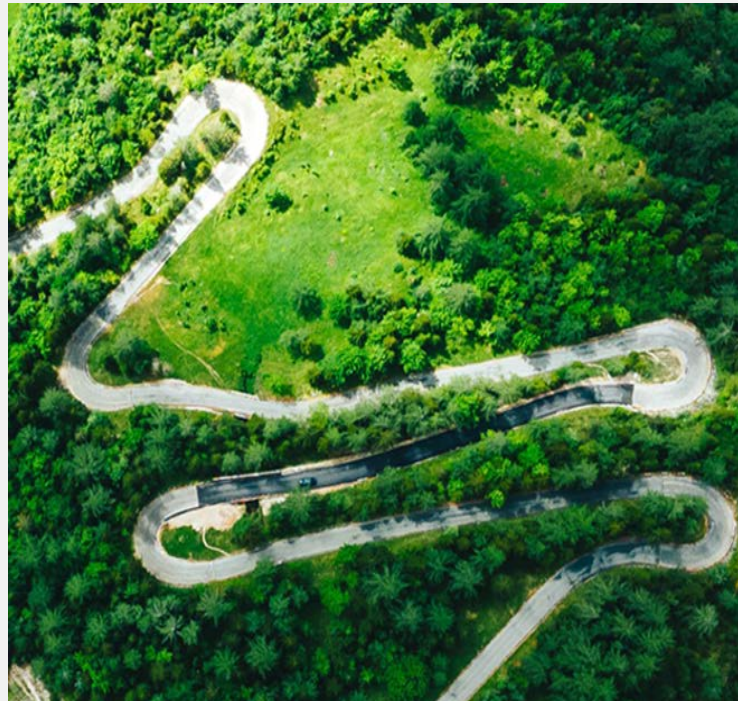
SAE 5W-30 ACEA C3



In 2050,
there will still
be nearly 2 billion
ICEs on the road.



Chevron Premium Base Oils will help them run them as efficiently as possible



The Internal Combustion Engine will continue to lead transport for decades

New engine technologies and control schemes will require

High quality Base oil slates that are approved and cover broad product will be sought after by & partners

Summary

Demand for competitive, high performing renewables are going to increase & blenders will look for climate friendly lubricants

markets moving to new specifications at varying speeds

Global base oil suppliers present the best opportunity for reducing complexity and maintaining security of supply