



Global Peer Pressure

How California, China & Europe Will Continue To Push
The U.S. Towards Vehicle CO₂ Reduction

2017 EIA Conference

Washington D.C. | June 27, 2017

Devin Lindsay, Principal Analyst

North American Powertrain and
Compliance Forecasting

Devin.lindsay@ihsmarkit.com

+1 248 465 2811

Presentation Outline

- **New Seven-Stars of Alignment Paradigm**
- **Global Regulations and Impact on Powertrain Options**
 1. Right Amount of Electrification For the Right Region
 2. Regional 2025 Outlook
 3. ZEV Mandate
- VPaC Sales xEV Outlooks
- Autonomous Vehicles and New Definition of Mobility
- Summary

IHS Hybrid Nomenclature

ICE – ICE Stop/Start

Internal Combustion Engine
ICE w/Start-Stop functionality

Mild Hybrid

ICE w/electric motor & battery to provide torque assistance
in concert with ICE

FHEV

Vehicle capable of driving using only the electric motor
and battery pack, in concert with ICE, or ICE alone

PHEV

Vehicle capable of driving using only the electric motor and
battery pack, in concert with ICE, or ICE alone, *but is
equipped with a charger to allow for plug-in capability*

Electric

Vehicle propelled by battery and electric motor

The Seven Stars of EV Expansion

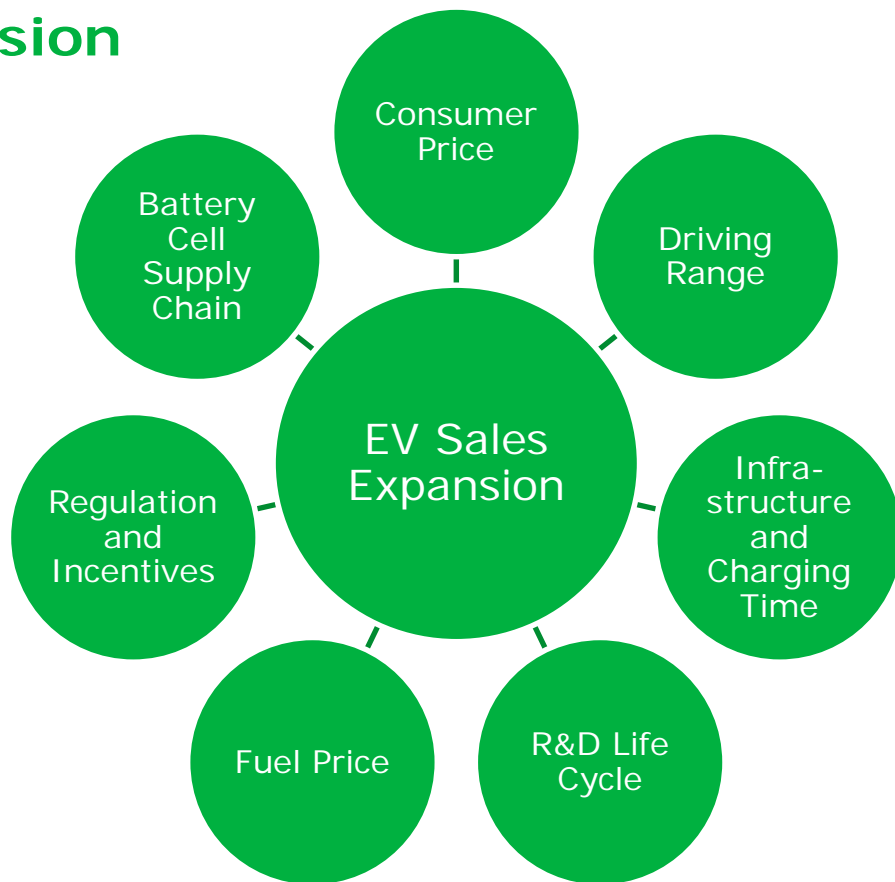
- No single factor will determine the fate of EVs
- The interrelated factors compound one another
- The automotive industry carries great inertia, overcoming it is a constant challenge
- Each global region balances these factors differently

For example:

Fuel prices / USA

Regulation & Incentives / China and Europe

Infrastructure / Japan



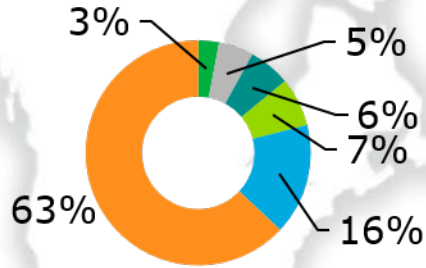
Technology needed to meet the regulations and current demand for such technologies

	US		China		EU		Japan
	CAFE/GHG	CA. ZEV	CAFC	NEV	CO ₂	Emission	Incentive
FHEV	✓		✓		✓	✓	✓
PHEV	✓✓	✓	✓✓	✓	✓✓	✓✓	✓✓
EV	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
FCV	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓

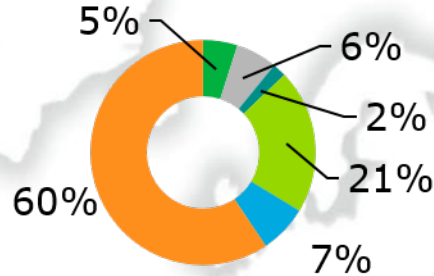
Consumer demand	 High	Effect of efforts to meet the regulations ✓: Some effect ✓✓: Much effect
	 Low but tends to grow	
	 Low and remains stagnant	
	 Low, and there are also difficult obstacles to boost the demand in the future	
	 Almost no demand	

Global propulsion design islands in 2025

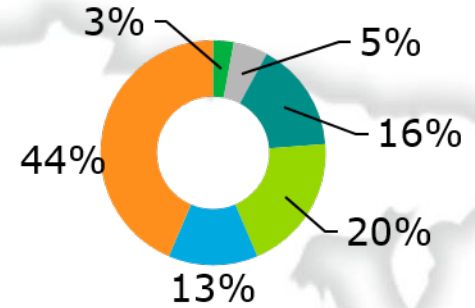
North America



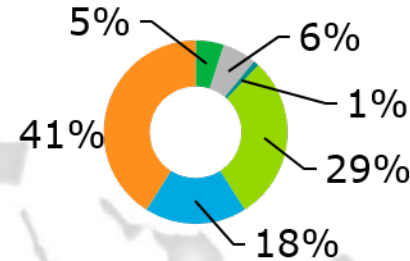
Europe



Japan/Korea



China



Stop-start

ICE

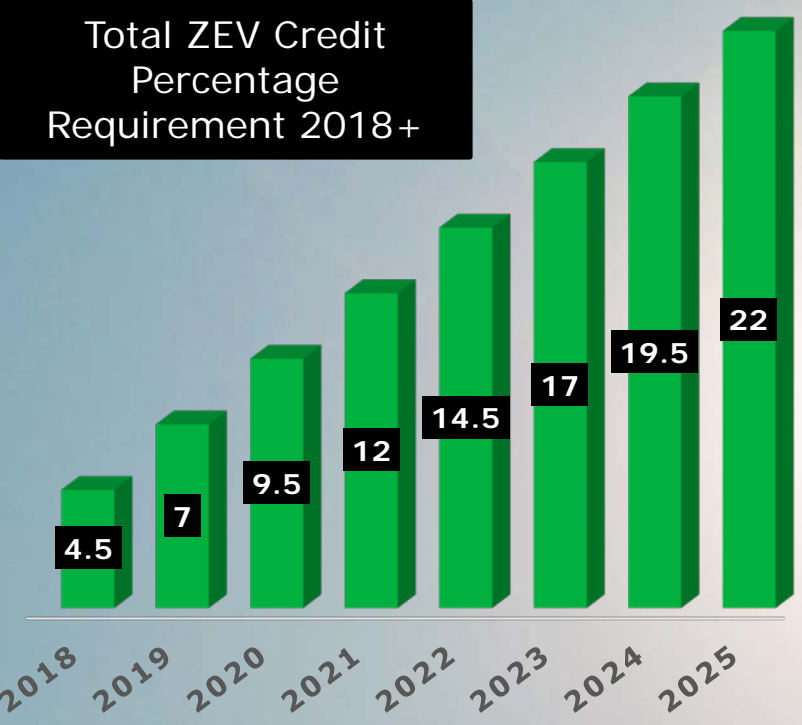
MHEV

FHEV

PHEV

Electric

Is California's Zero Emission Vehicles Mandate the Missing CO₂ Piece?



Are We There Yet?

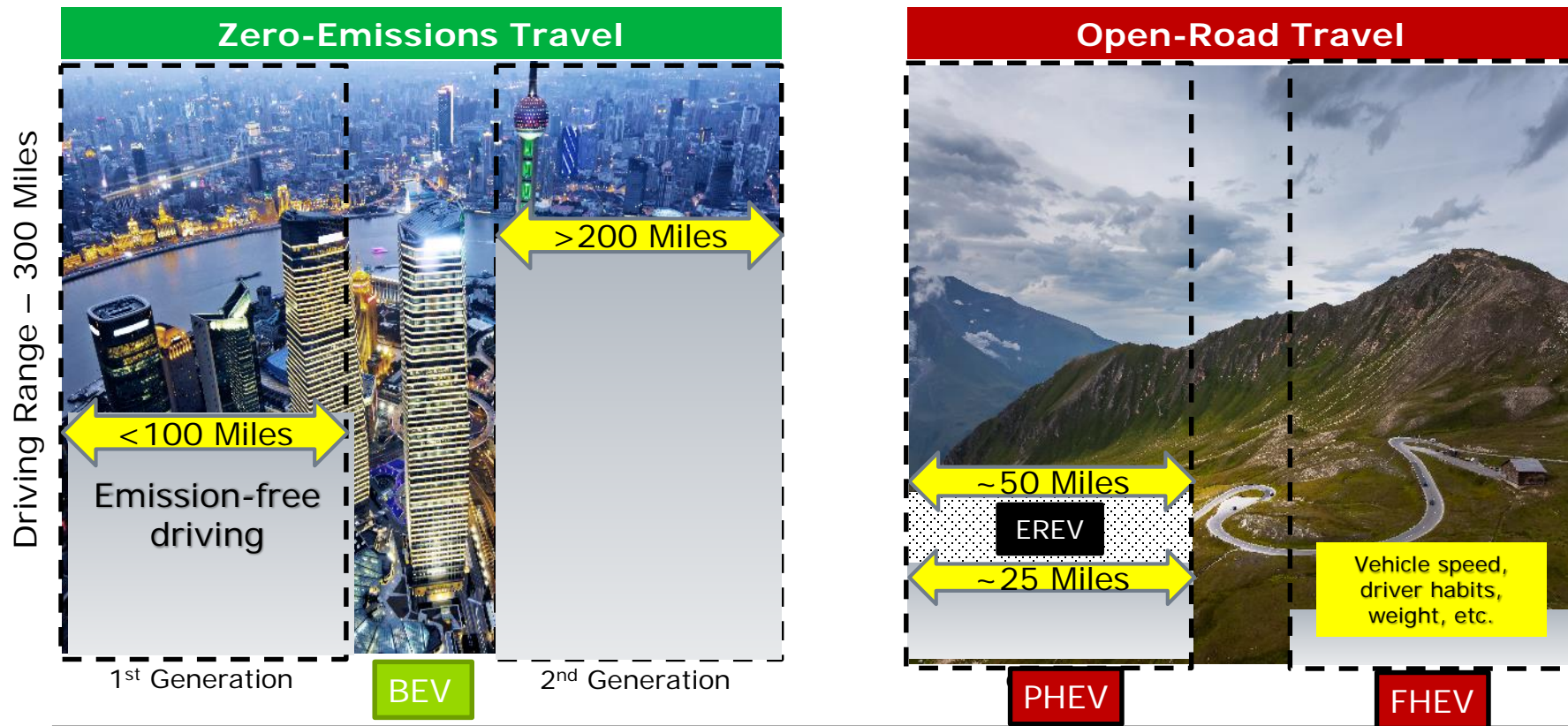
Level 1 Charging	Level 2 Charging	Level 3 Charging
2 to 5 miles of range per one hour of charging	10 to 20 miles of range per one hour of charging	50 to 70 miles of range per 20 minutes of charging

Gasoline



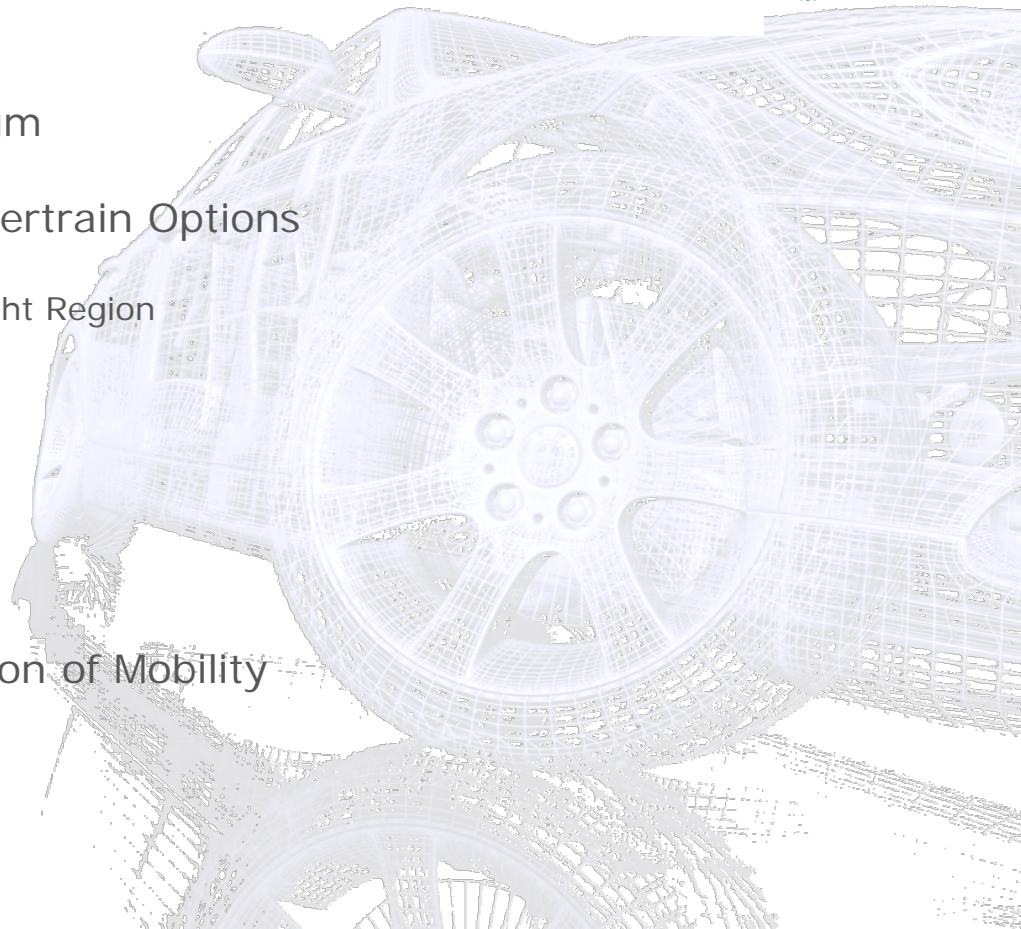
Hydrogen

Legislation: ZEV vs. CAFE & Right-sizing For Consumers



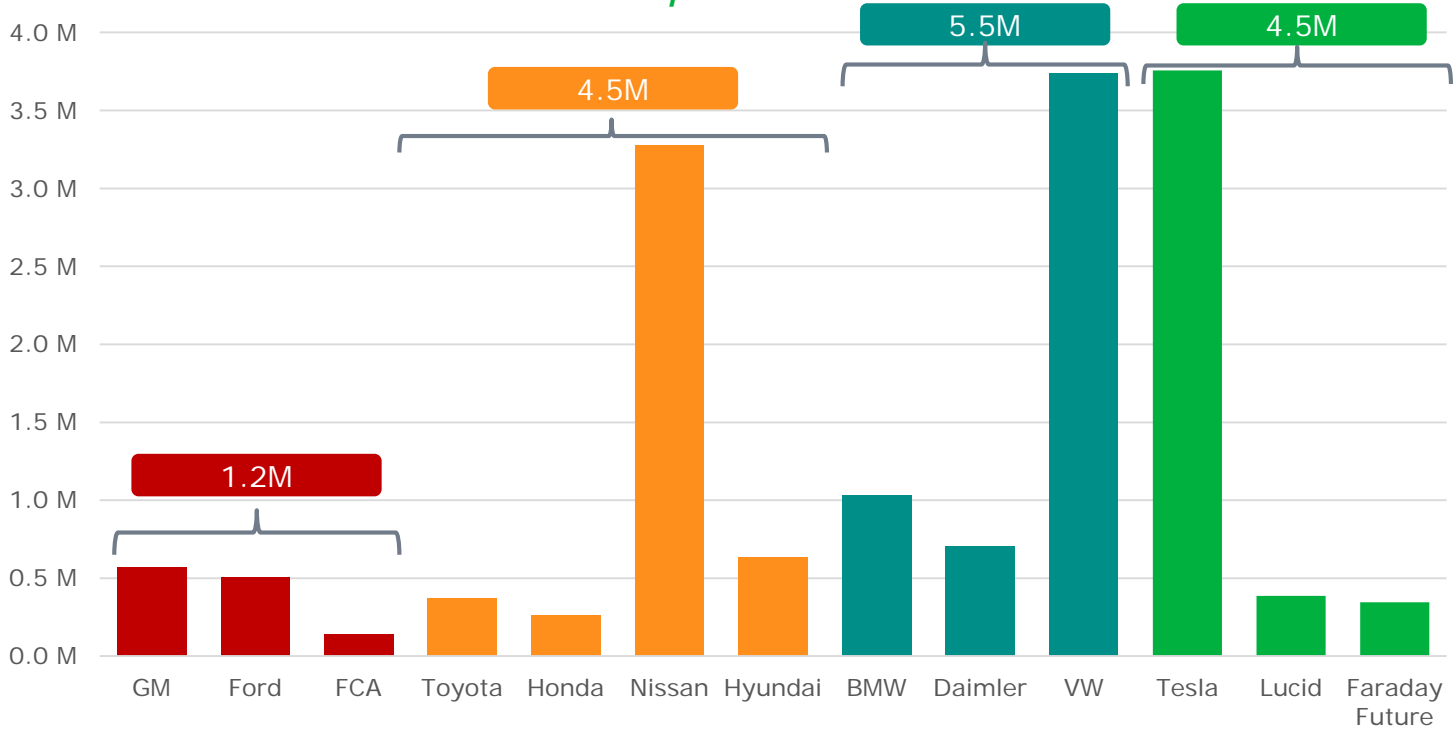
Presentation Outline

- New Seven-Stars of Alignment Paradigm
- Global Regulations and Impact on Powertrain Options
 1. Right Amount of Electrification For the Right Region
 2. Regional 2025 Outlook
 3. ZEV Mandate
- **VPaC Sales xEV Outlooks**
- Autonomous Vehicles and New Definition of Mobility
- Summary



Cumulative Expected EV Volumes

Global volumes from 2018–25 EV production



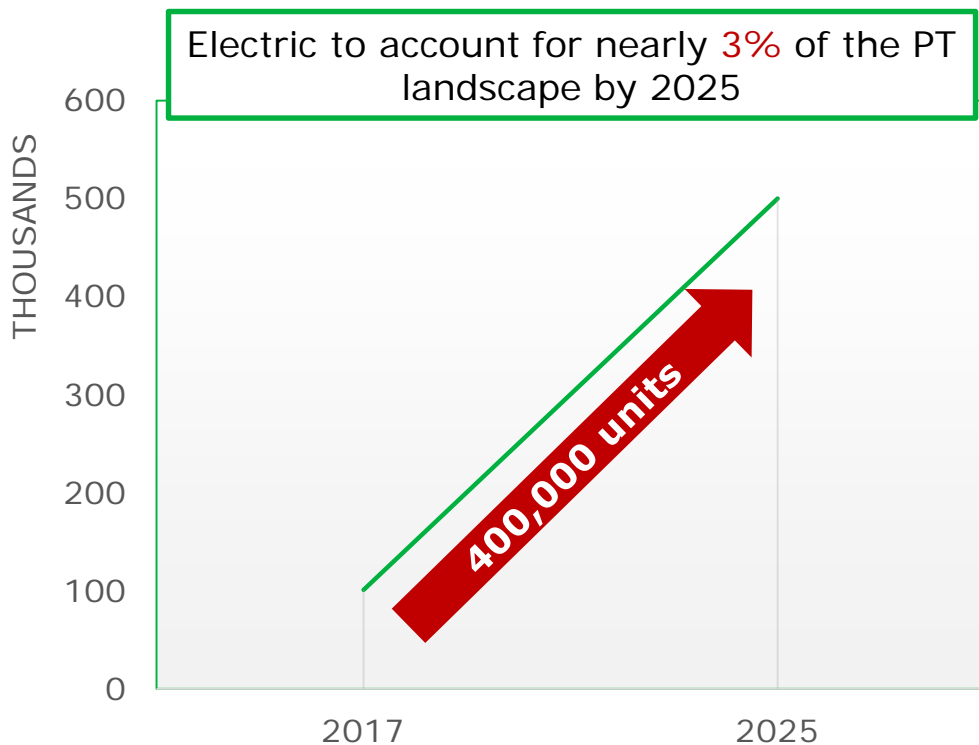
Supply Chain Restraints

"The capacity is not there. Nobody has the capacity", Thomas Sedran, VW's head of group strategy, said last month of the six largest global cell suppliers competing for the VW contract. ANE. Jan 2017

He estimated the capital expenditure needed to supply all of VW Group's EVs with in-house batteries at 20 billion euros. *"We need to check whether [the six suppliers tendering for the cell contract] have the financial means to build the capacity", he added. ANE Jan 2017*

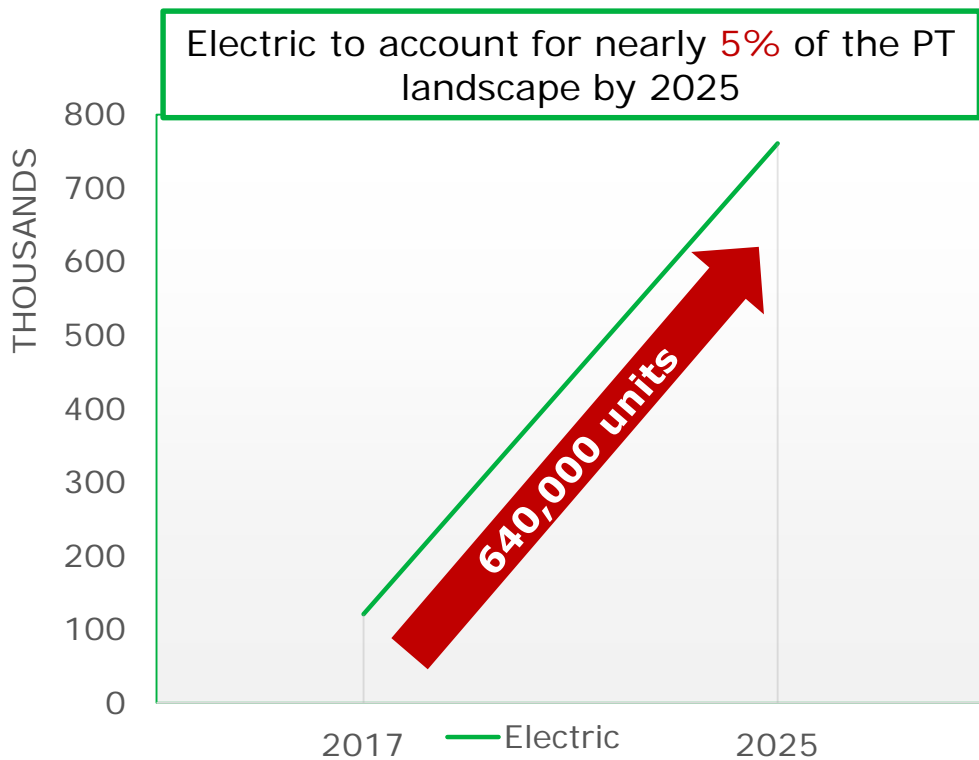
"One weakness in our EV argument is that it currently requires battery supply that does not exist", Exane BNP Paribas. Jan 2017

VPaC Electric Vehicle Powertrain Sales Forecast – USA



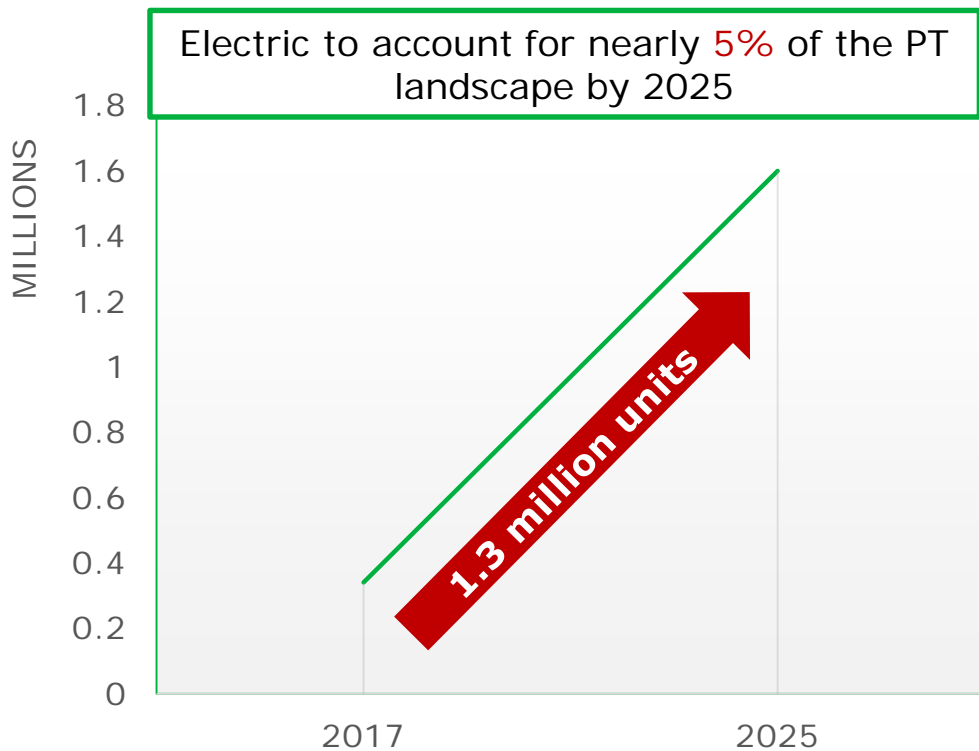
2025 Star	Positive/ Negative for BEV
Government/Legislation	+
Fuel Price	-
R&D/Life Cycle	+/-
Consumer Choices	-
Battery Density	+
Available Vehicles	+
Infrastructure	+

VPaC Electric Vehicle Powertrain Sales Forecast – EU28



2025 Star	Positive/ Negative for BEV
Government/Legislation	+
Fuel Price	+/-
R&D/Life Cycle	+/-
Consumer Choices	+/-
Battery Density	+
Vehicles	+
Infrastructure	+/-

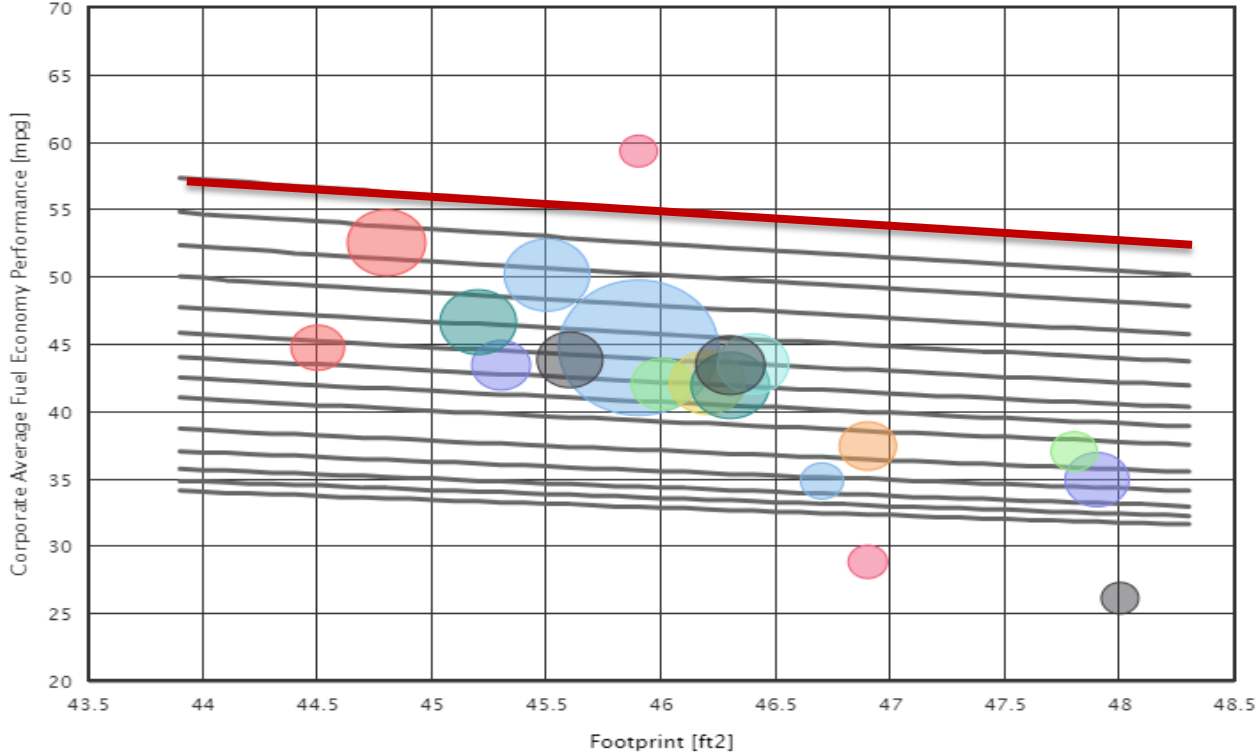
VPaC Electric Vehicle Powertrain Sales Forecast – China



2025 Star	Positive/ Negative for BEV
Government/Legislation	+
Fuel Price	+
R&D/Life Cycle	+
Consumer Choices	+/-
Battery Density	+
Available Vehicles	+
Infrastructure	+/-

Compliance Landscape

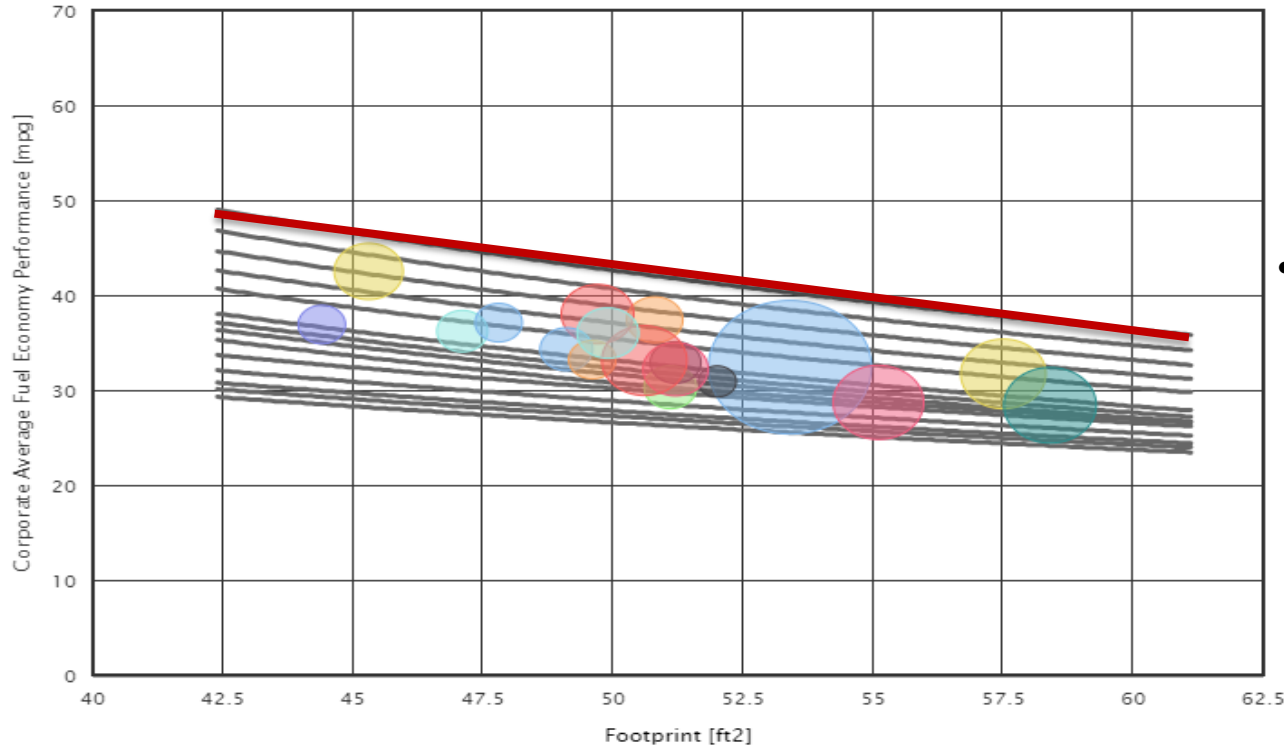
Regulatory VPAC Compliance Passenger Car: 2025



- CAFE & GHG credits excluded
- The baseline does not envisage a softening or delay to the targets as part of the new final determination. More flexibilities and credits expected to be given to automakers
- All Manufacturers of Record could fall short without considerable credits and/or more electrification on high volume models.

Compliance Landscape

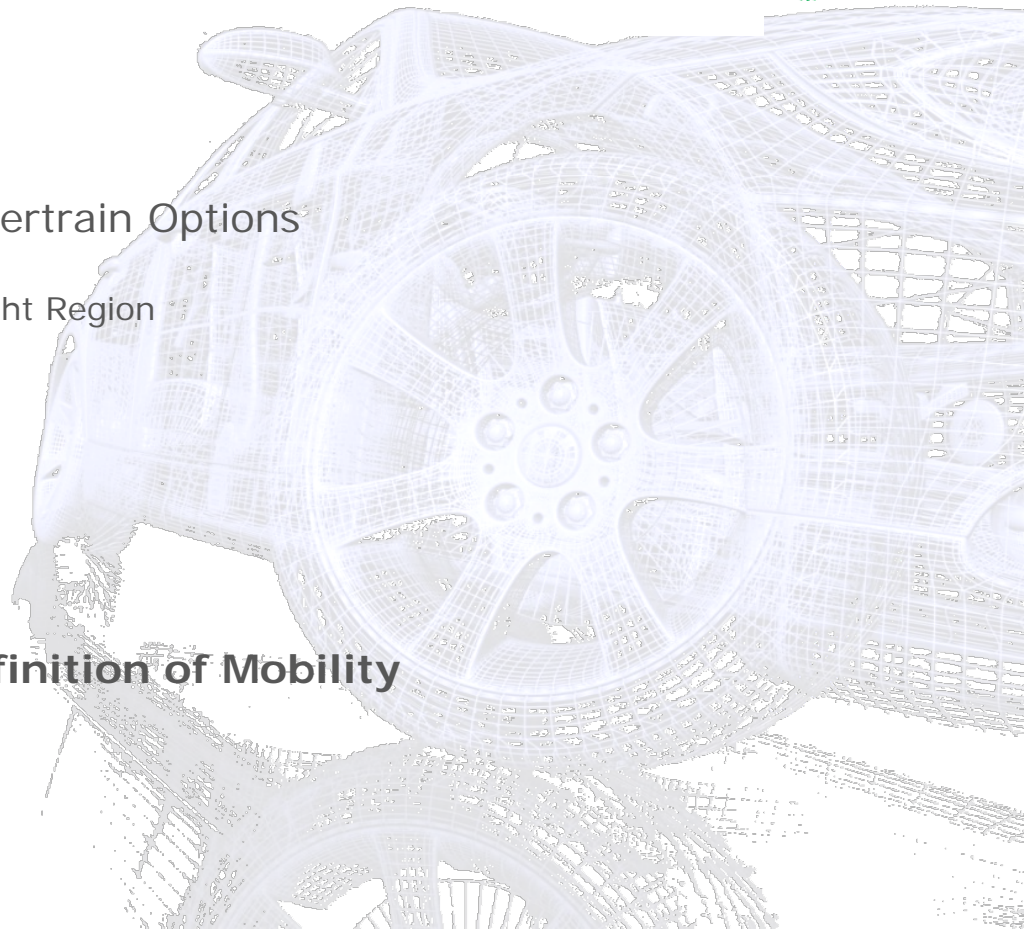
Regulatory VPAC Compliance Light Truck: 2025

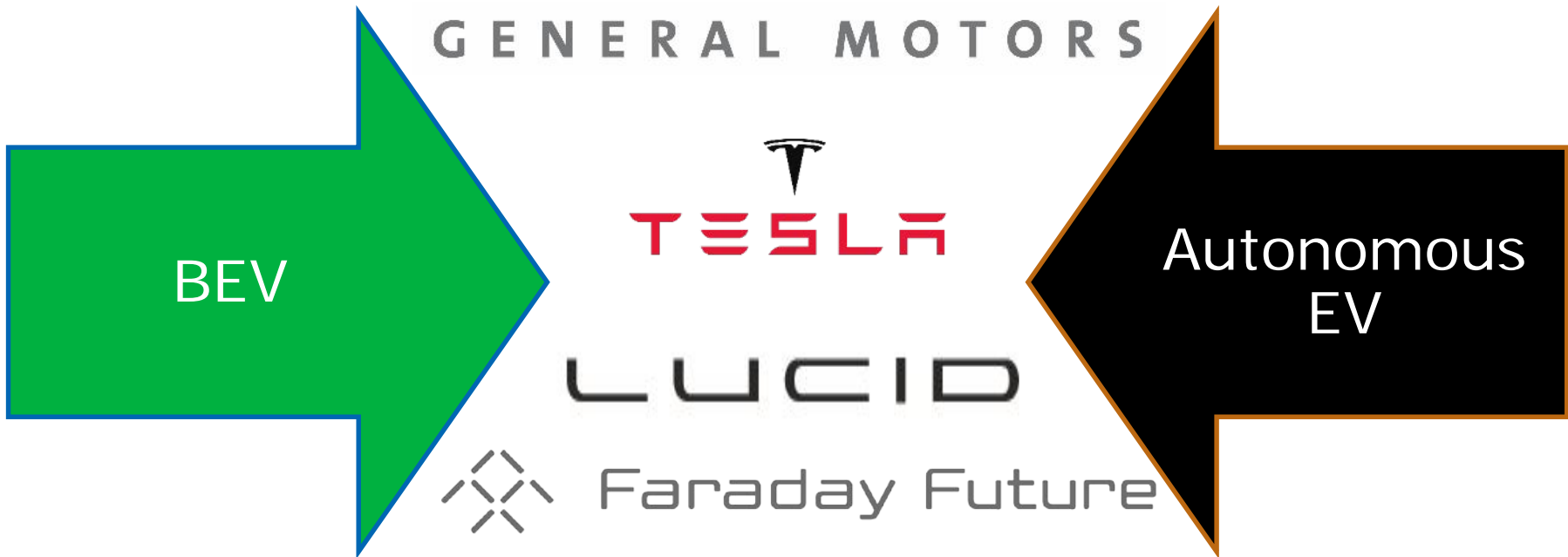


- All Manufacturers of Record could fall short in the LT category (again, CAFE and GHG credits excluded), which contains the most popular vehicles among U.S. consumers
- Manufacturers that are challenged will likely pursue a combination of considerably better conventional powertrain integration, plus greater electrification, focused on MHEV and PHEV that will not require a change of customer behavior; important in this market.

Presentation Outline

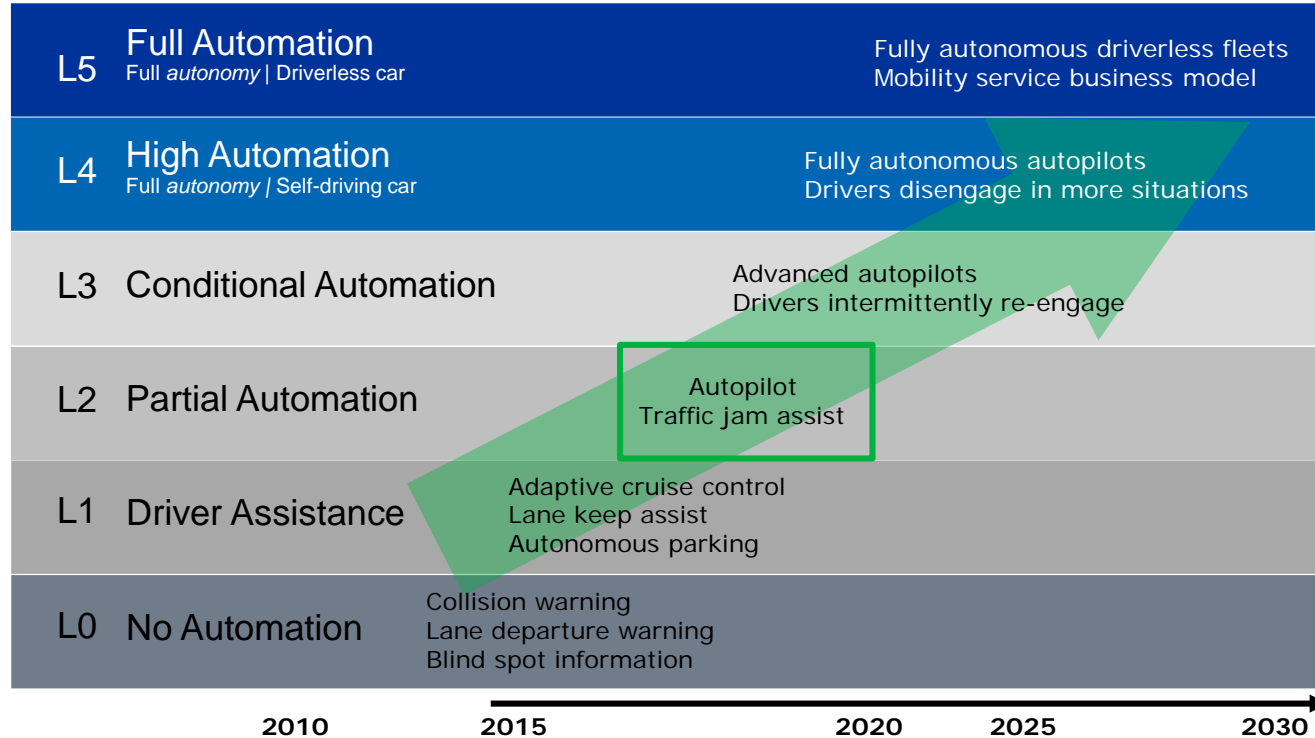
- New Seven-Stars of Alignment Paradigm
- Global Regulations and Impact on Powertrain Options
 1. Right Amount of Electrification For the Right Region
 2. Regional 2025 Outlook
 3. ZEV Mandate
- VPaC Sales xEV Outlooks
- **Autonomous Vehicles and New Definition of Mobility**
- Summary





Language defined – Real-world examples of SAE Levels

Autonomous = Level 4 and Level 5



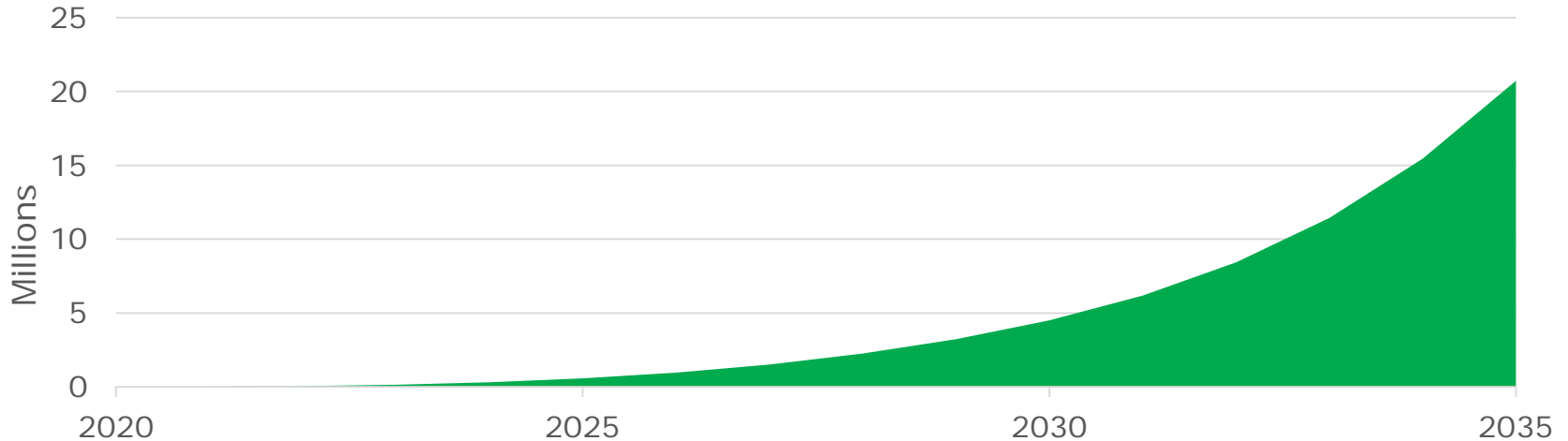
Long-term, fully electric (including fuel cell) powertrains will be the desired propulsion source by Governments and Consumers

Based on Society of Automotive Engineers levels of automation (SAE J3016)

Autonomous vehicle sales growth accelerates post-2025

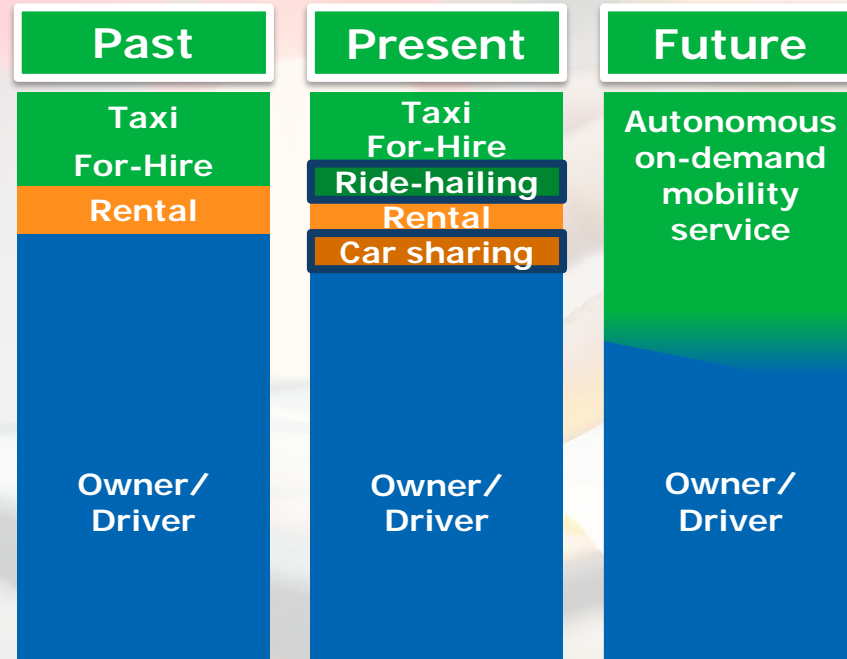
Maturity of technology, manufacturing, regulation and business models converge

Global Autonomous Vehicle Sales Forecast



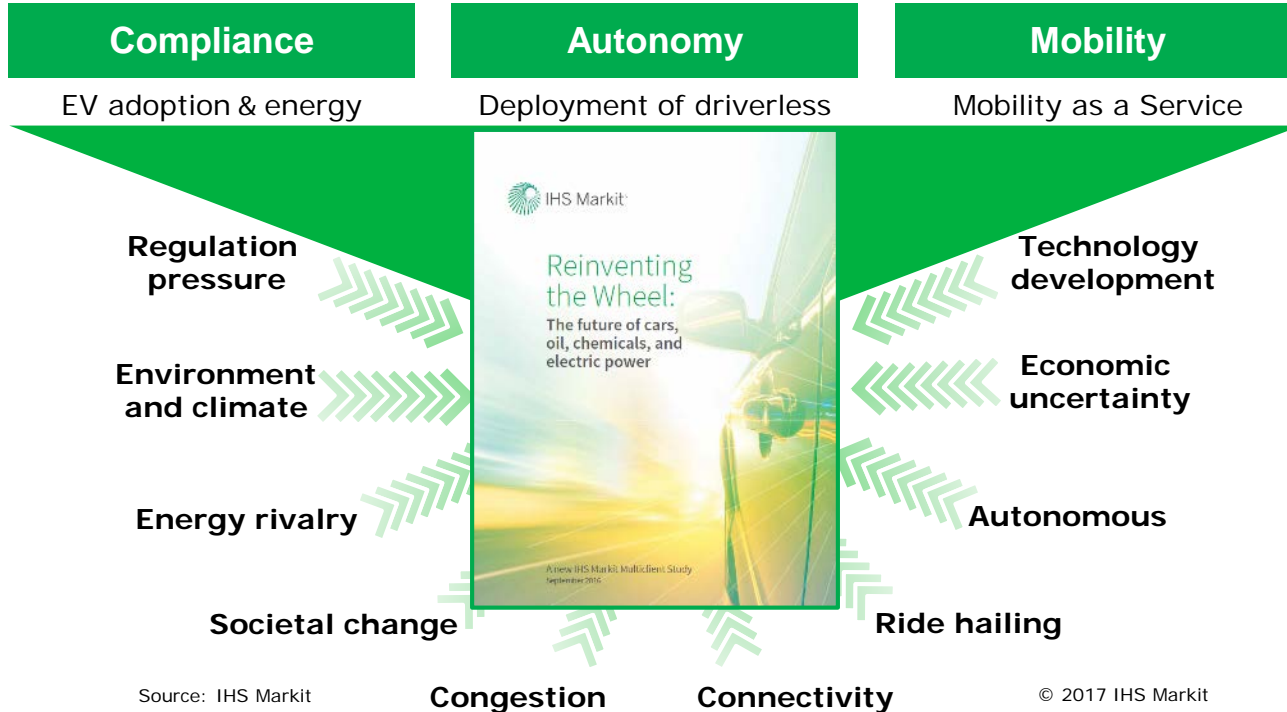
Source: IHS Markit June 2016

© 2017 IHS Markit

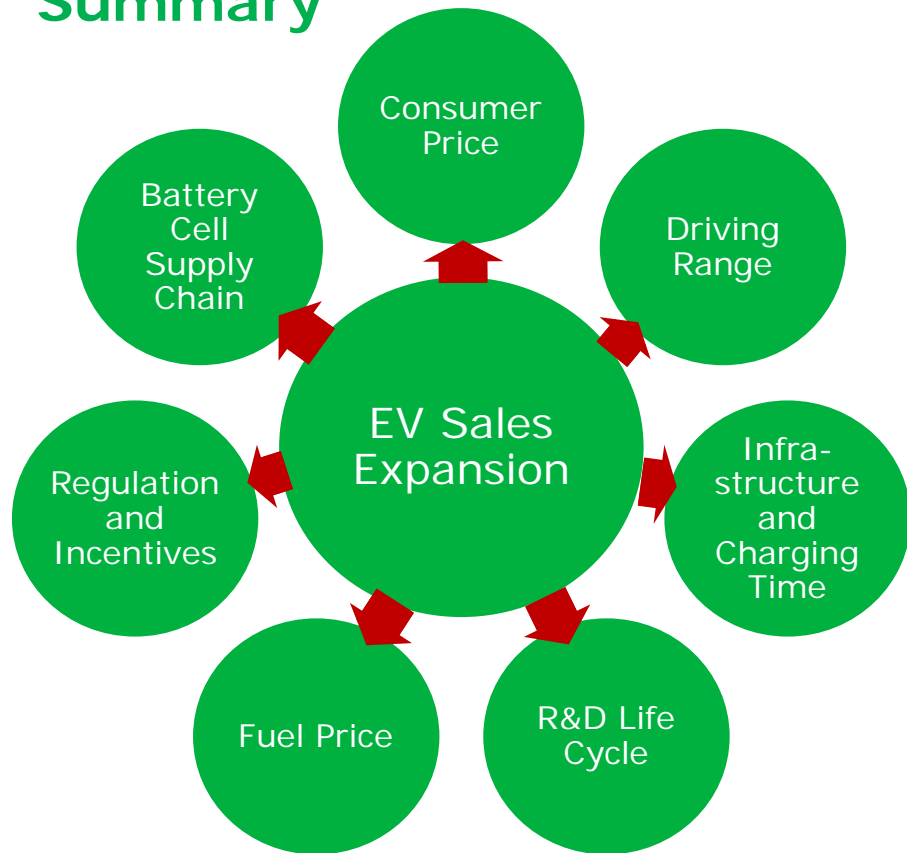


Autonomous capability will blur the lines between today's mobility business models and use cases

Conclusion: Mega-Trend Outlook



Summary



The Peers

- China and Europe continue vehicle CO₂ reduction initiatives
- Increased market penetration for PHEV and BEVs
- Global expansion of Ride sharing and Ride hailing
- Levels of Autonomy for vehicles favor all-electric powertrains

The Pressure

- U.S. Consumer's desire for CUVs and Pick-up trucks
- Battery supply chain and charge times
- CAFE and ZEV standards



IHS Markit™

Thank You!

Devin Lindsay, Principal Analyst

North American Powertrain and Compliance
Forecasting

Devin.lindsay@ihsmarkit.com

+1 248 465 2811