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PERSPECTIVE: FUTURE OF TRANSPORTATION ELECTRIFICATION

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EXECUTIVE SUMMARY

1. Global demand for electric vehicles (EVs) is being driven by China.
2. Original equipment manufacturers (OEMs), both incumbent and new, are responding by increasing the number of EV models they offer and investing in the technology development required to support these vehicles.
3. California customers will have an increasing number of EVs to choose from in the very near future.



CHINA WILL CONTINUE TO DRIVE EV DEMAND

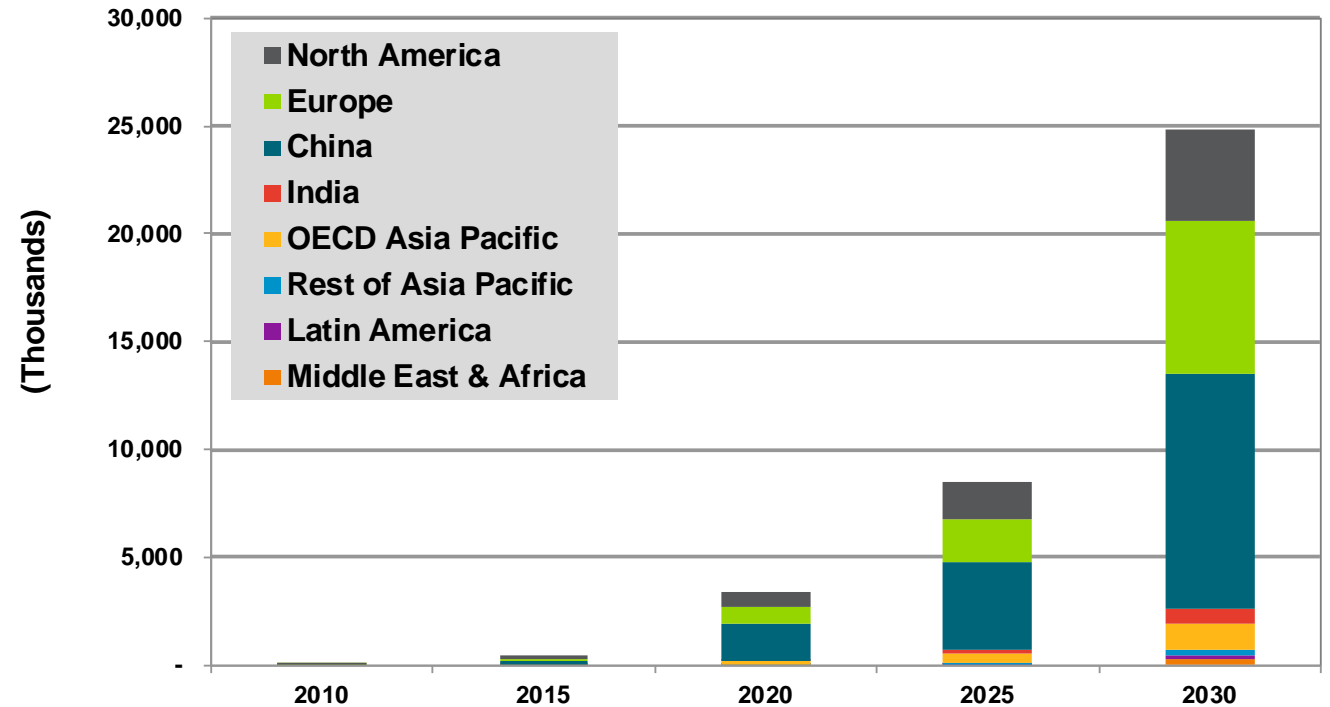
The size of the China EV market requires that OEMs develop products to meet its ZEV requirements

Percent of global PEV sales in 2030

- China: 33%
- Europe: 30%
- North America: 22%

OEMs shifting resources to develop PEVs with global appeal

PEV Sales by Region, Base Scenario, World Markets: 2010 - 2030

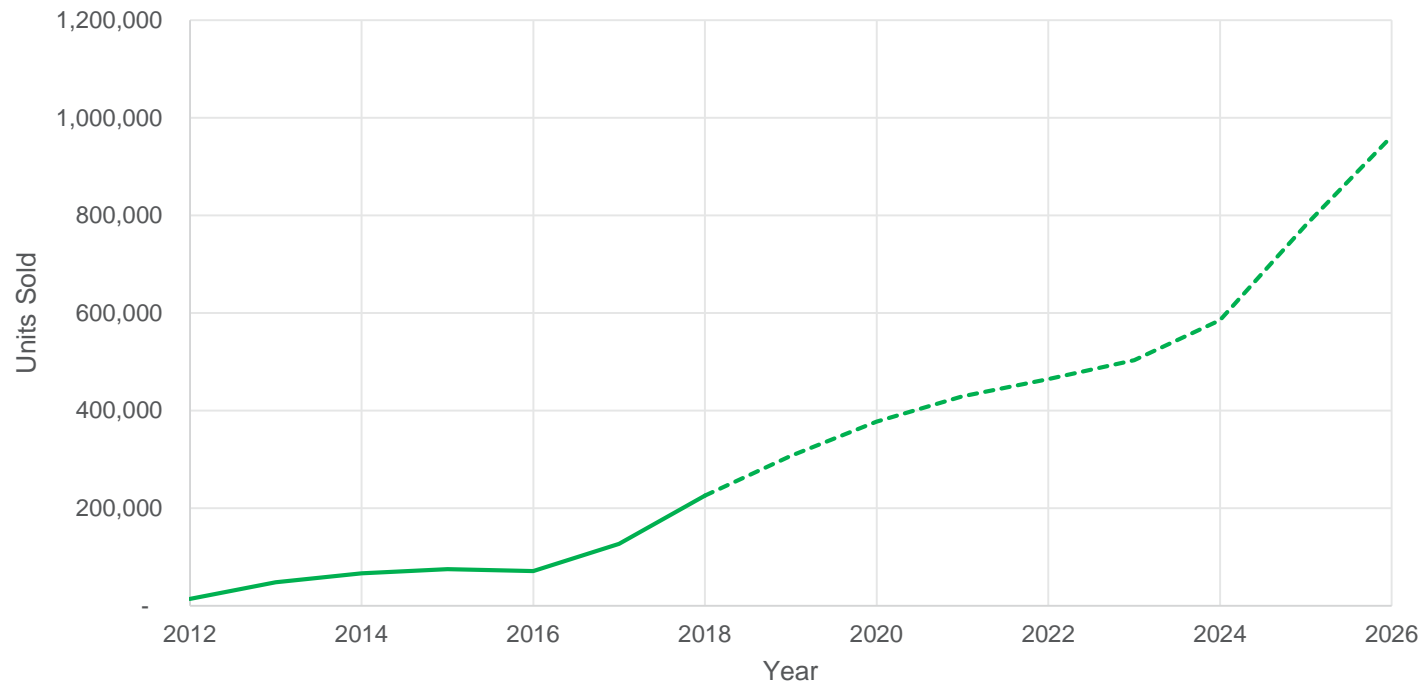


Sources: Navigant Research, Internal analysis

EV SALES: HISTORIC AND PROJECTED

- EV sales have grown steadily as more models have become available
- At present, EV sales represent ~1% of U.S. auto sales

Historic and Projected EV Sales -- U.S.



Year	EV models
2012	6
2013	9
2014	13
2015	14
2016	14
2017	17
2018	16

Sources: Navigant Research, Internal analysis

ELECTRIC VEHICLES MANUFACTURERS: CURRENT AND FUTURE

Current EV OEMs



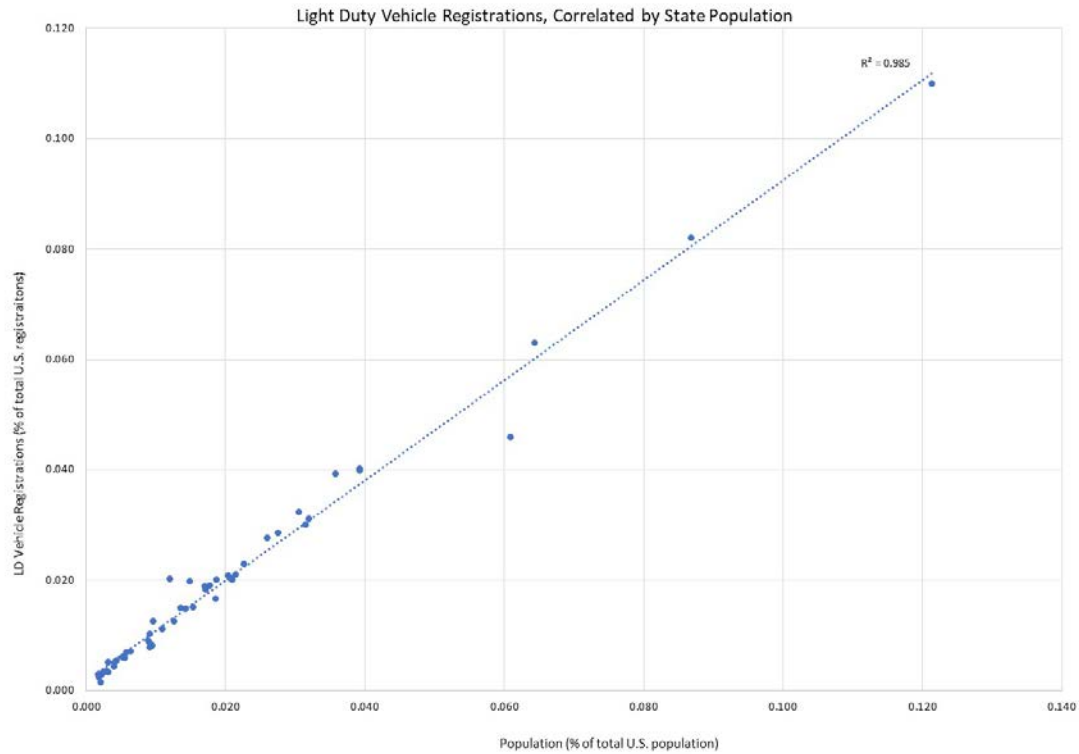
Potential new EV OEM entrants



By 2020, there may be 40 EV models to choose from in the U.S.

ELECTRIC VEHICLES: WHERE THEY ARE BEING SOLD

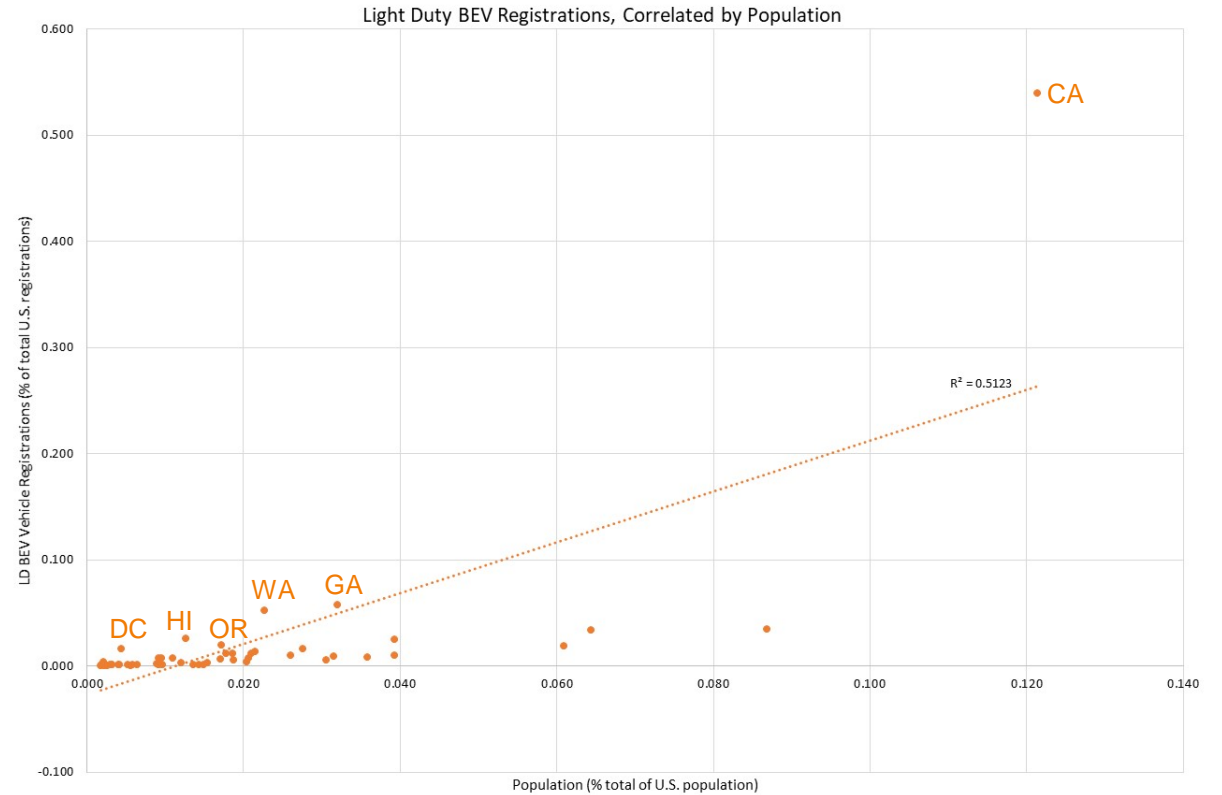
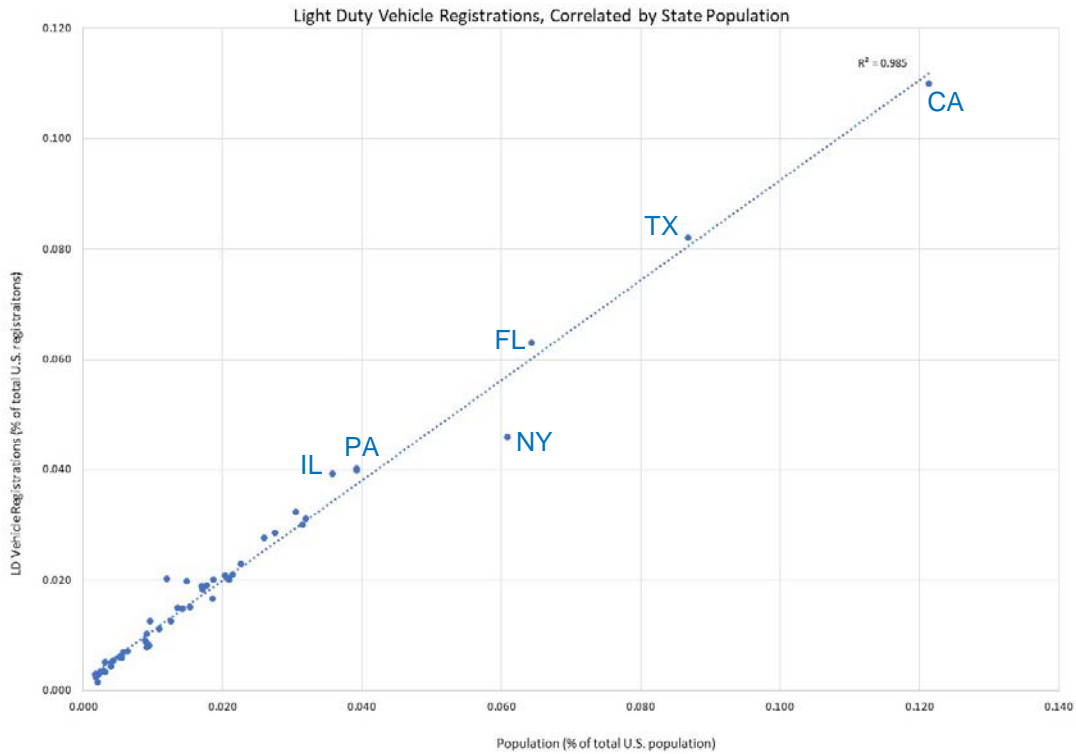
- Strong correlation between population and LD vehicle registrations



Sources: Navigant Research, Internal analysis

ELECTRIC VEHICLES: WHERE THEY ARE BEING SOLD

- Strong correlation between population and LD vehicle registrations
- Much weaker correlation between population and LD EV registrations



Sources: Navigant Research, Internal analysis

PREMIUM BRANDS HAVE STRONG SALES IN ZEV STATES

ZEV state statistics

- Number of states: **10**
- Percent of U.S. population: **28%**
- Percent of registered vehicles: **25%**
- Percent of ZEV registrations: **63%**
- **Percent of premium sales: 46%**

Section 177 “ZEV” States

States that have adopted Zero-Emission Vehicle (ZEV) regulations under Section 177 of the Clean Air Act (14 U.S.C. §7507)



ZEV product technologies likely to begin with premium brands.

Sources: Navigant Research, ww2.arb.ca.gov, Internal analysis

TECHNOLOGY SPOTLIGHT: AUDI

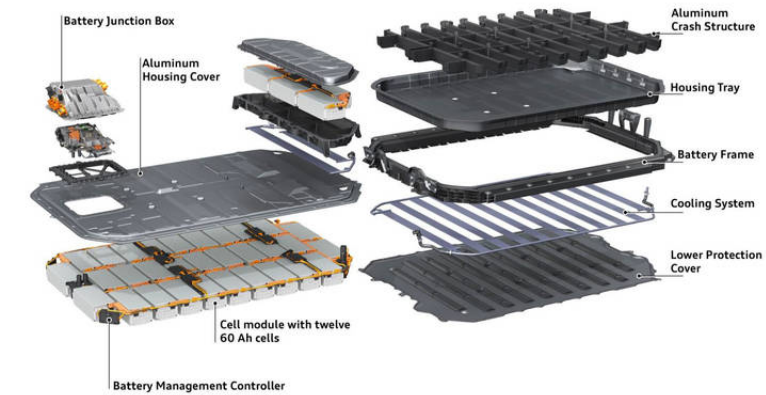
- Proven market demand for high performance EVs have convinced Audi to invest in EV powertrain development

Audi e-tron quattro electric drive motor: Cooling system



- Example: Electric drive motor
 - Asynchronous motor does not require rare earth magnets
 - Motors can be “turned off” when not needed
 - Advanced cooling system enables performance repeatability

Audi e-tron quattro battery: Cell-Agnostic



- Example: Battery pack
 - Standardized global design for pack and BMS
 - Can accommodate cells from different manufacturers
 - Can also accommodate different form factors (e.g. pouch v. prismatic)

TECHNOLOGY SPOTLIGHT: FORD AND RIVIAN

- Ford announced a \$500 million investment in EV startup Rivian on 24 April 2019.
- Specific details include:
 - Rivian may gain access to Ford's self-driving vehicle technology
 - Ford will develop at least one new vehicle using Rivian's "skateboard" platform
- Separately, Rivian recently received a \$700 million investment from Amazon.



TECHNOLOGY SPOTLIGHT: WORKHORSE AND UPS

- First commercial carrier in the U.S. to use medium-duty electric trucks
- Selected specifications:
 - Range: 62 miles
 - Load capacity: 2-3 tons
- UPS is also planning to use Tesla's fully electric semi tractor-trailer system.
 - Expected range: 500 miles
 - UPS has provided Tesla with internal trucking lane data to ensure new vehicles can meet UPS' requirements
- Expected service life of an EV delivery vehicle: 15-20 years



Sources: UPS 2017 Corporate Sustainability Report, Discussions with UPS

TECHNOLOGY SPOTLIGHT: ADOMANI AND SCHOOL BUSES

- Adomani provides EV powertrains for school bus manufacturers, such as Blue Bird
- V2G capability under development; partially funded by U.S. DoE
- Selected specifications:
 - GVWR: 36,200 lbs.
 - EV range: 100 – 120 miles
 - Battery pack size: 160 kWh
 - Recharge time: 8 hours at 19.2 kW
 - Return on Investment timeframe: Varies based on available incentives



Sources: Adomani communications

AVs WILL ALSO BE CONNECTED, ELECTRIC, AND SHARED

Autonomous

Vehicles that can navigate with little to no human interaction



Connected

V2X: Vehicle to (V)ehicle, (I)nfrastructure, (G)rid, (C)loud



Electrified

PEVs: Battery Electric Vehicles (BEVs), Plug-in Hybrid Electric Vehicles (PHEVs)



Shared

Mobility as a Service (MaaS)/Transportation as a Service (TaaS)



TIMING: ACES

Autonomous

Level 4 – Level 5: 15 years away /
Waymo, Aptiv



Conected

Happening today /
Audi, GM Cruise



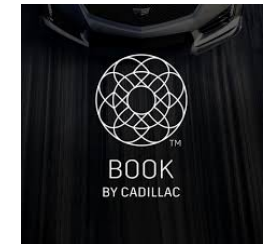
Electrified

Happening today /
Most automakers



Shared

Happening today /
Clutch Atlanta, Passport by Porsche,
BOOK by Cadillac, Lyft, Uber





CONCLUDING REMARKS

- Consumers and business in California will have an increasing number of ZEV choices in the near future
 - The EV market is attracting attention, and investment, from incumbent transportation players.
 - The adoption of EVs in commercial applications, plus awareness generation activities, will help consumers accept EVs.
 - California has established a roadmap for EV adoption.
- EV adoption is poised to accelerate in the coming years.



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