OEM Perspective on Deep Decarbonization in the LDV Sector

National Academy of Sciences - Deployment of Deep Decarbonization Technologies Workshop

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Presentation Overview

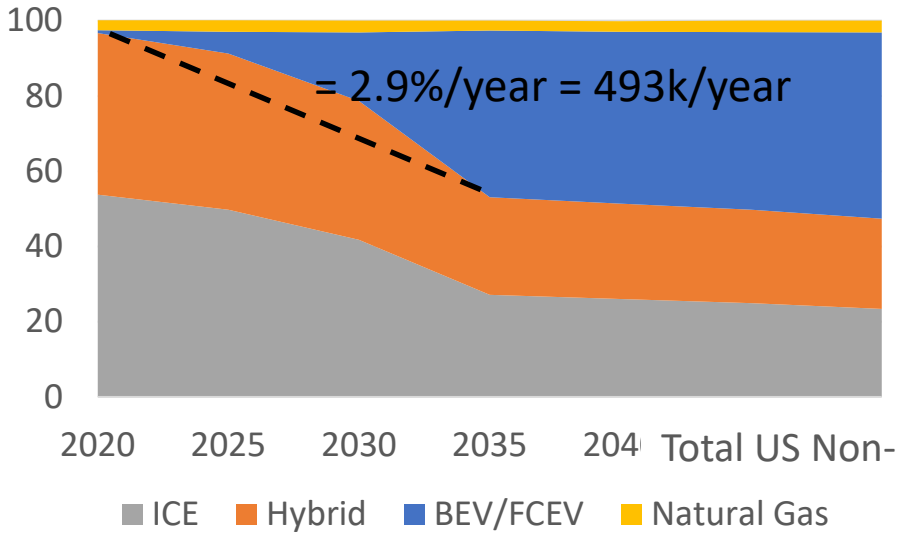
- Motivation
  - Toyota's Environmental Challenge 2050
  - Two degree scenarios in the context of previous automotive trends
- What it takes to get there
  - New platforms & manufacturing capacity
  - Supply chain
  - Crucial: Customers
- Conclusions

TOYOTA ENVIRONMENTAL CHALLENGE 2050

CHALLENGE 1	CHALLENGE 2	CHALLENGE 3	CHALLENGE 4	CHALLENGE 5	CHALLENGE 6
New vehicle Zero CO_2 Emissions Challenge	Life Cycle Zero CO_2 Emissions Challenge	Plant Zero CO_2 Emissions Challenge	Challenge of Minimizing and Optimizing Water Usage	Challenge of Establishing a Recycling-based Society and Systems	Challenge of Establishing a Future Society in Harmony with Nature

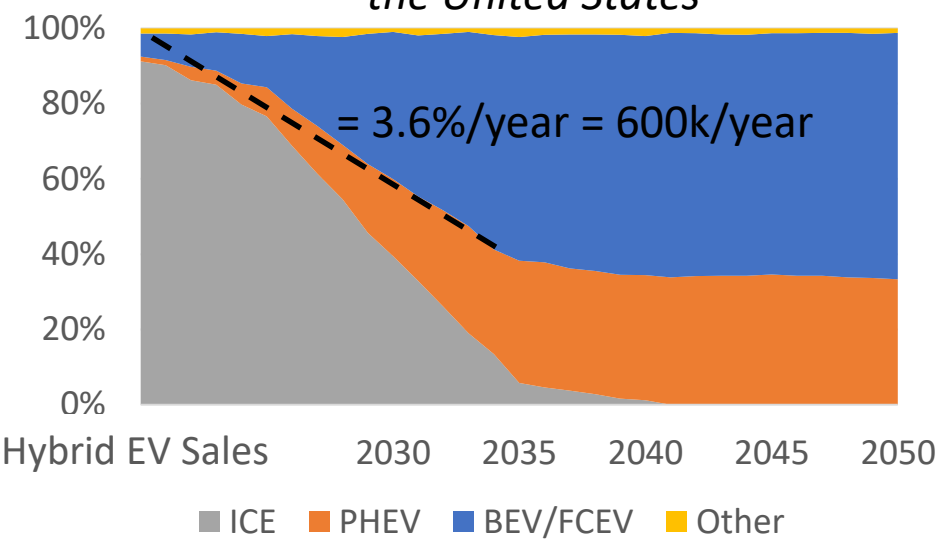
Deep Decarbonization Scenarios Call for Rapid Increase in ZEV Sales

C2ES Pathways to 2050



Source: Lempert R. et al. *Pathways to 2050: Alternative Scenarios for Decarbonizing the U.S. Economy*. C2ES, 2019.

Pathways to Deep Decarbonization in the United States

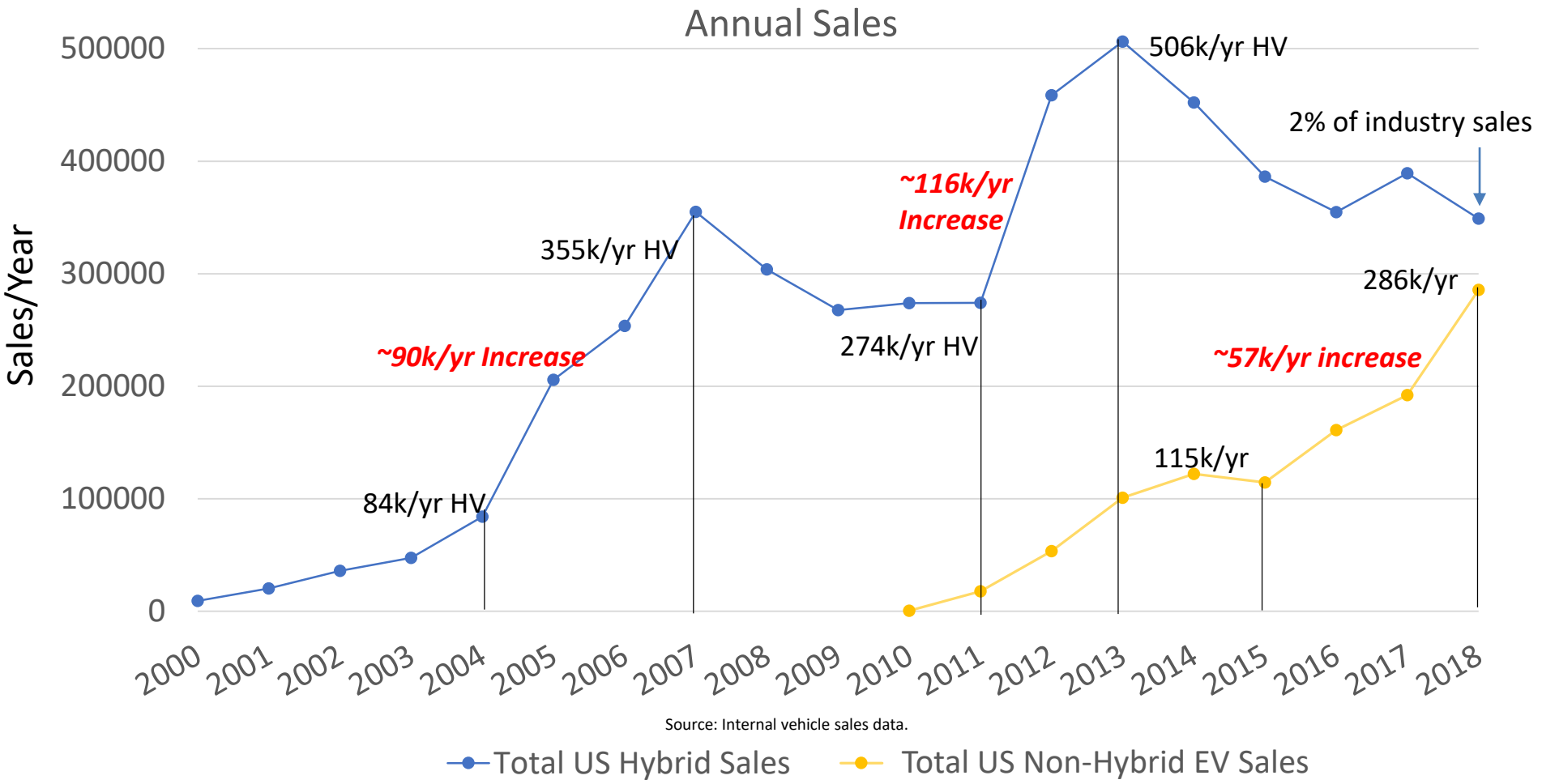


Adapted from Williams, J.H., B. Haley, F. Kahrl, J. Moore, A.D. Jones, M.S. Torn, H. McJeon (2014). *Pathways to deep decarbonization in the United States. Revision with technical supplement*, Nov 16, 2015.

- US LDV (light duty vehicle) market has recently averaged around 17 million vehicles per year, so scale of transition requires increasing volume of ZEVs by ~500k/year+ starting at 2020 through 2035
- Next two slides will put this rate of transition into context

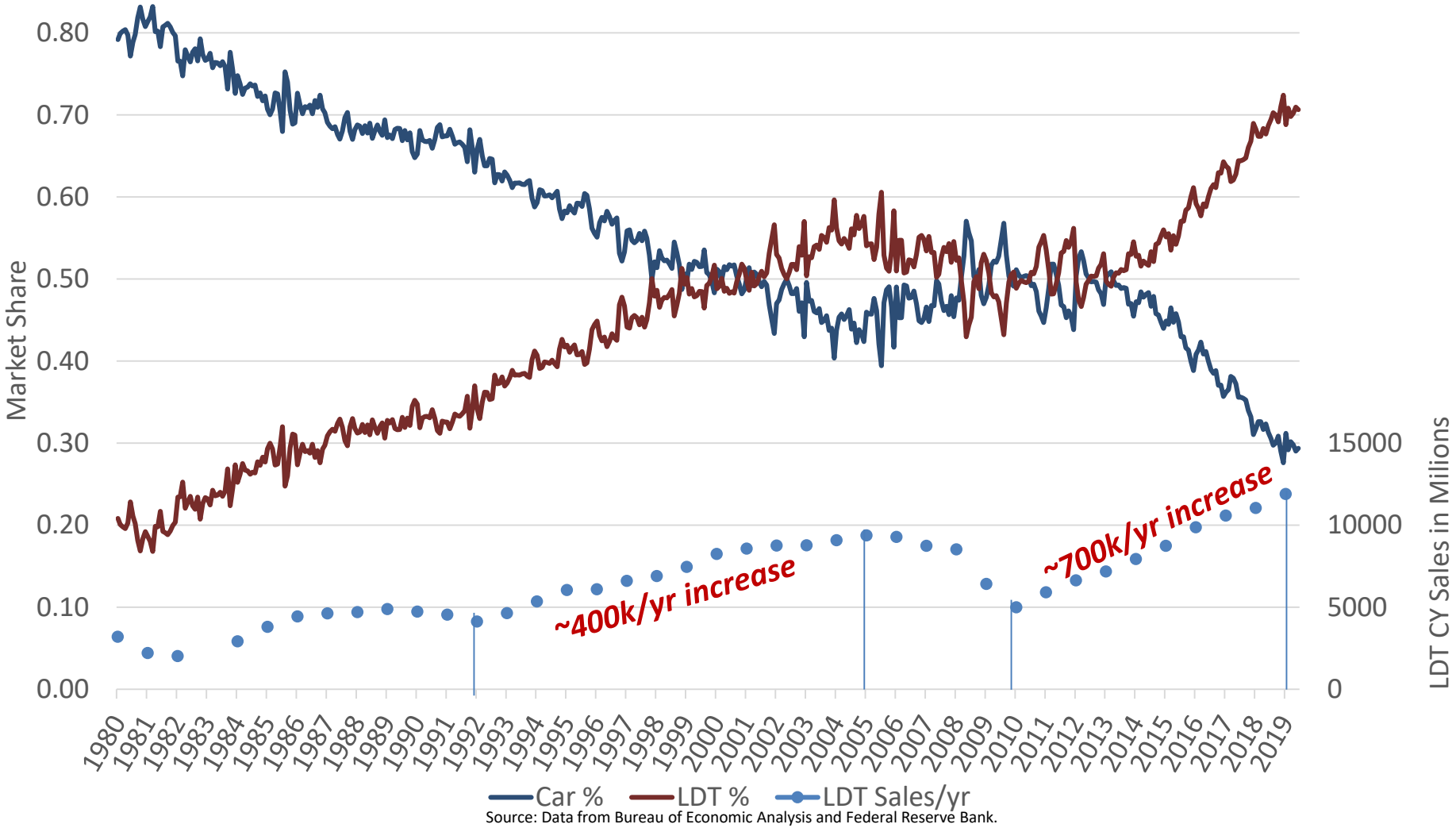
Scenarios call for 500k+/year increase in ZEV sales for 15 years.

Historic Trends in Advanced Technology Vehicle Sales



Hybrid and EV sales have increased as much as 116k/year, but for short periods of time.

The Shift From Cars to Trucks



Source: Data from Bureau of Economic Analysis and Federal Reserve Bank.

Previous increases in sales volume have been as much as ~700k/year for almost a decade.

Switching Car to Truck vs. Non-ZEV to ZEV

Car to Truck

- Shared platforms based on vehicle size and powertrain configuration (e.g. RAV4 and Camry share same platform)
- Suppliers and material supply chains already well established and attuned to product design cycle (~= 5 years)
- Possible to change production in case of soft or changing market

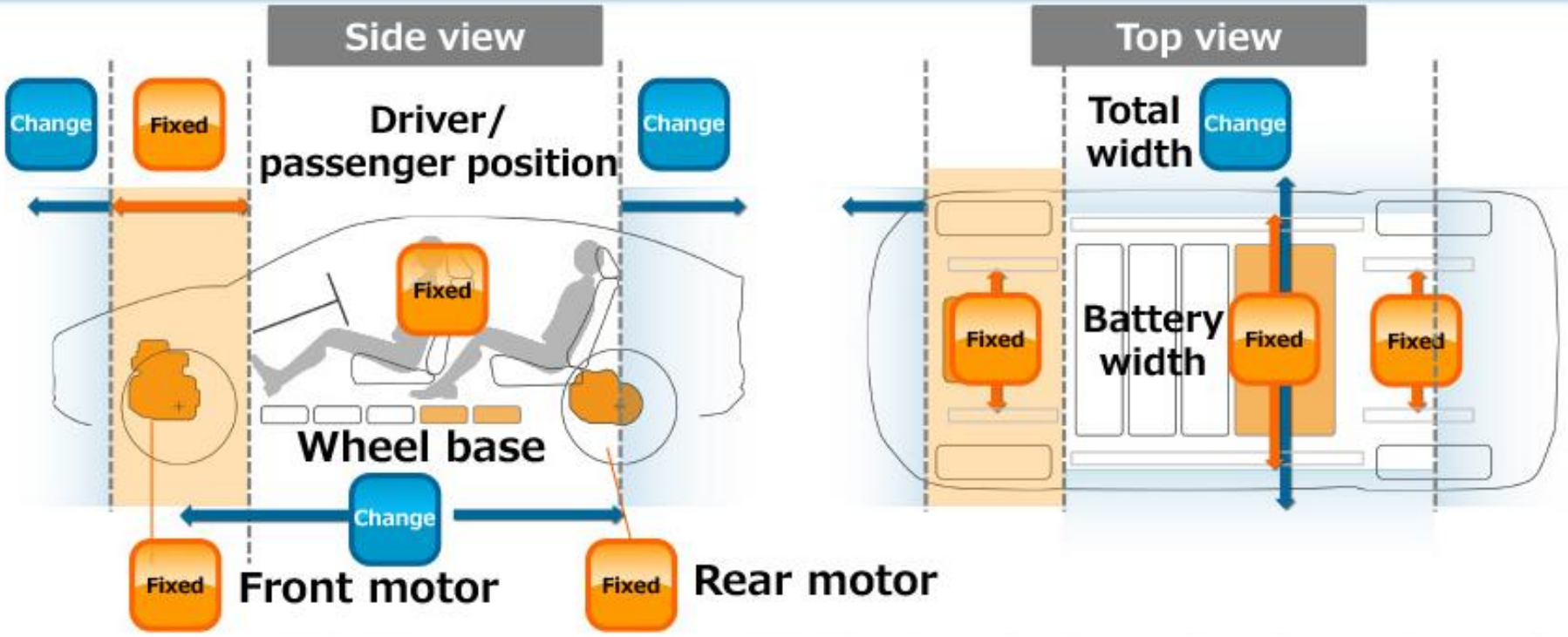
Non-ZEV to ZEV

- Size of battery/hydrogen tanks requires development of new platforms and associated manufacturing
- Need time to develop and scale supply chain
- High capex costs for new platform & manufacturing require strong growth

Shifting to mass production of ZEVs requires major investments & risk by OEMs and suppliers.

Toyota's Efforts on Global Platform Development

Dedicated platform collaborative planning (SUBARU): e-TNGA

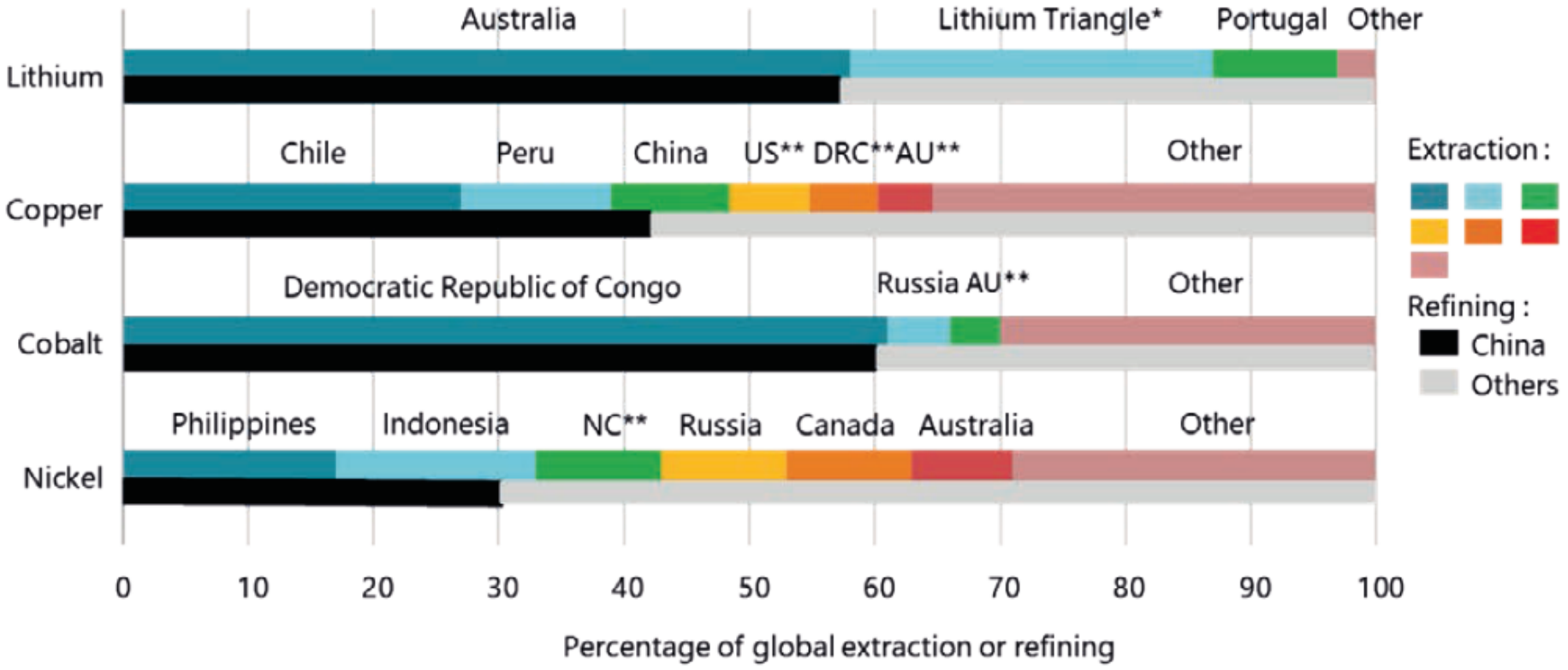


Source: Toyota Motor Corporation. https://global.toyota/en/newsroom/corporate/28474382.html. Retrieved July 18th 2019.

Toyota is developing a flexible platform to accommodate several BEV configurations.

Critical Materials in Supply Chain

Main Extraction & Refining Locations of Materials for Automotive Batteries

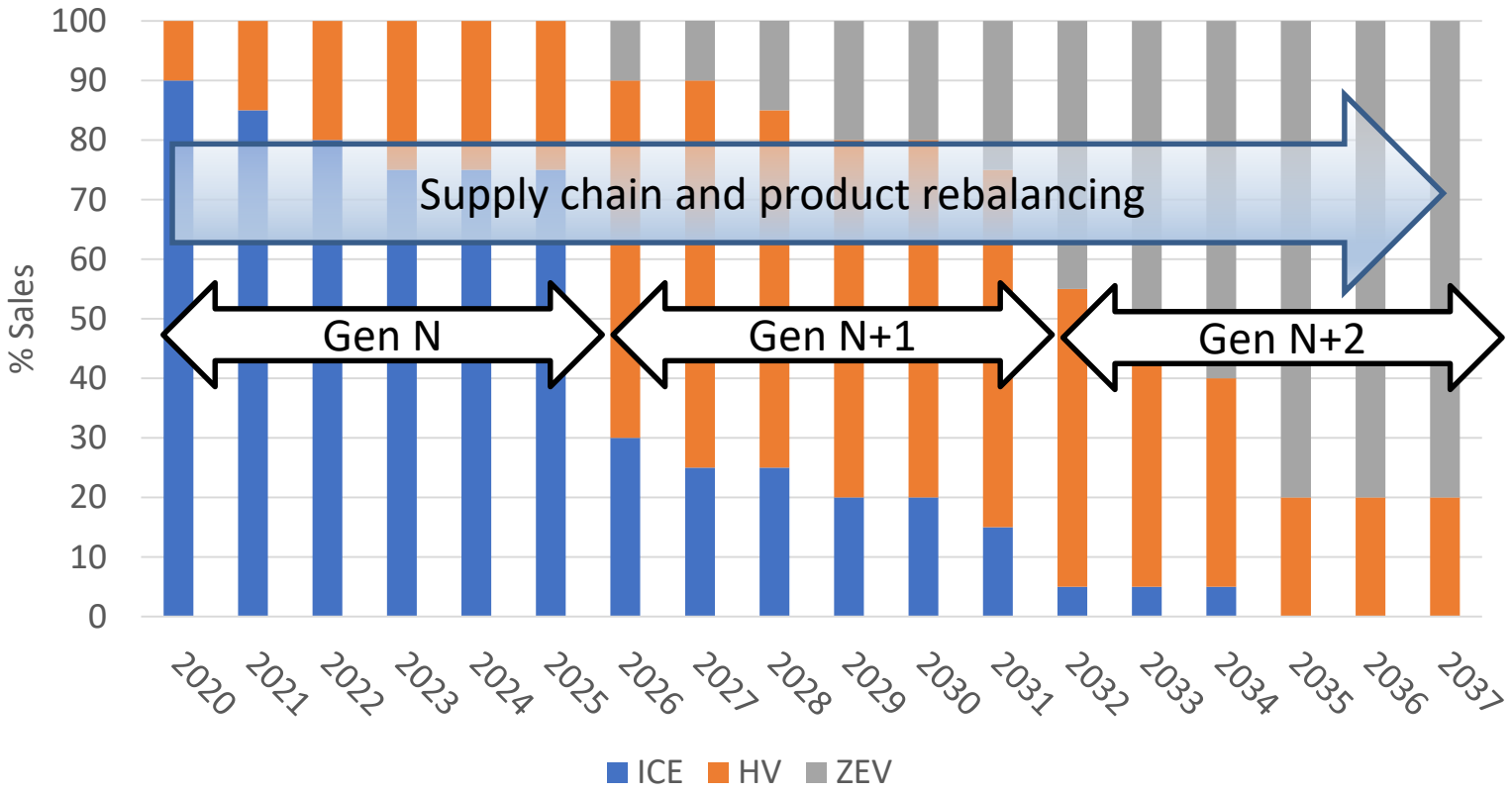


Source: IEA (2019), "Global EV Outlook 2019", IEA, Paris, www.iea.org/publications/reports/globalevoutlook2019/.

- Can this supply chain rapidly and sustainably scale to meet demand?
- Potential limitations could suggest need for other options (battery chemistries, H2)

Multiple technology options can help provide “optionality” to support ZEV growth.

Product Cycle-Based ZEV Transition Example Image



Transition likely to take place over several product cycles, each requiring major investment.

The Needs of Current and Future Customers

- Affordable vehicles which meet their needs in a variety of segments and customer classes, including working as a first and only vehicle (not just secondary vehicles)
- Ample and readily available national charging/fueling infrastructure
- Development of new, sustainable business models to support the deployment of more vehicles, including used vehicles, and managing vehicle end of life
- Open questions: Role of mobility as a service, AVs, and other “new mobility”

Current and future customers are crucial to ensure uptake of ZEVs.

Conclusions

- Most crucial issue is customer acceptance – need a strong marketplace signal from customers
- Rate of change in ZEV sales required by deep decarbonization scenarios is greater than current rate of growth in ZEV/advanced technology vehicles, but in the same range as one previous major industry shift
- Will require sustained investment in development of new platforms, tooling, and supply chain by OEMs and suppliers
- Preserving technology options by not rushing to down-select to one approach (e.g. lithium ion) could help increase likelihood of long-term ability to reach goal

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