



# Industry view: 2025 and beyond

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4/20/2018

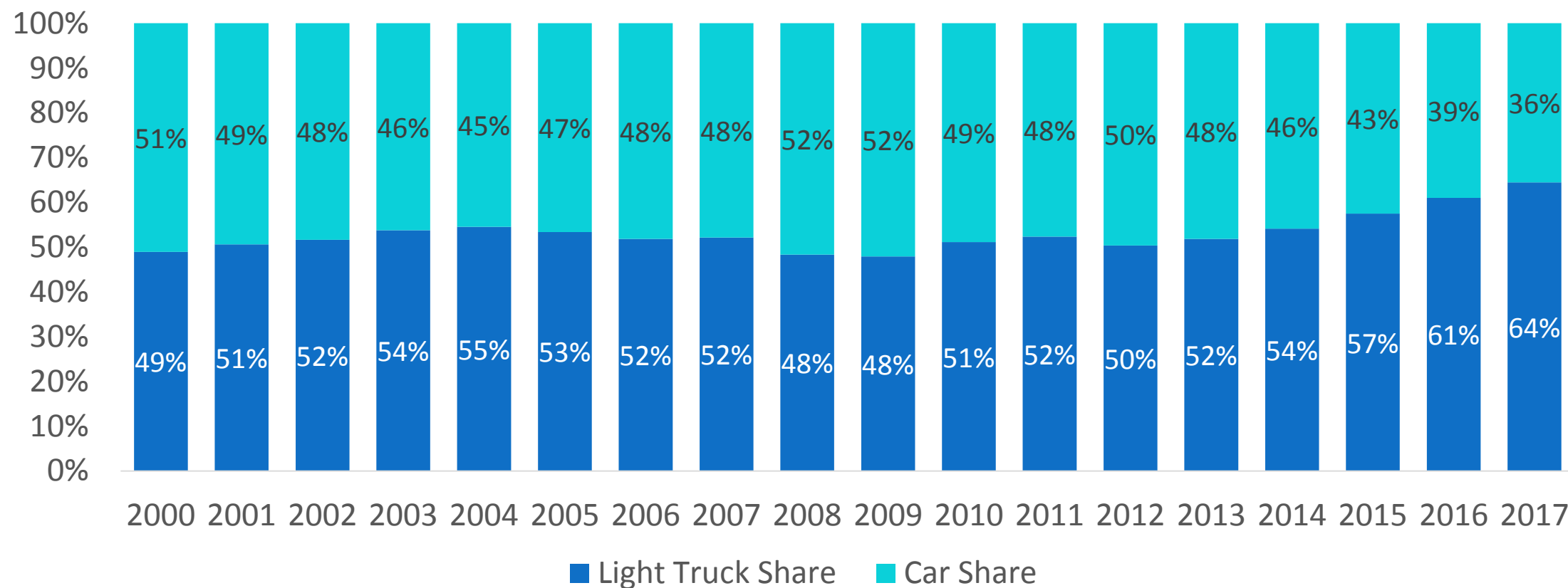
# AGENDA

## Industry view of 2025 and beyond:

- Current Market & Technology Roadmaps
- Powertrain & Electrified Propulsion
- Innovative Mobility Services & Connected and Automated Vehicles
- Convergence of Electrified Powertrains & Connected and Automated Vehicles
- War on Talent & Leveraging Partnerships
- Some Conclusions

# Current Market

# U.S. Car-Truck Market Share Split, 2000-2017



Source: IHS/Markit

# CAR Publication



## **The Great Divide:**

What Consumers Are Buying vs.  
The Investments Automakers &  
Suppliers Are Making in Future  
Technologies, Products & Business  
Models

“

Most automakers & suppliers agree that automated, shared, and electric vehicles will be transformative, but it may take decades for this idealized future to take hold. . ”

Visit [www.cargroup.org/publications](http://www.cargroup.org/publications) to download this and other publications.



# CAR Publication



## Technology Roadmaps:

Intelligent Mobility Technology;  
Materials and Manufacturing  
Processes; and Light Duty Vehicle  
Propulsion

“As technology advances, cross-industry collaboration among the automotive industry as well as other industries will significantly increase due to the sophistication of technologies. While uncertainty in public policy or the regulatory environment can be a barrier to technology advancement, long-term agreements on the regulatory future can also act as a technology enabler.”

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# Technology Roadmap Summary

## Future Trends in Auto Industry

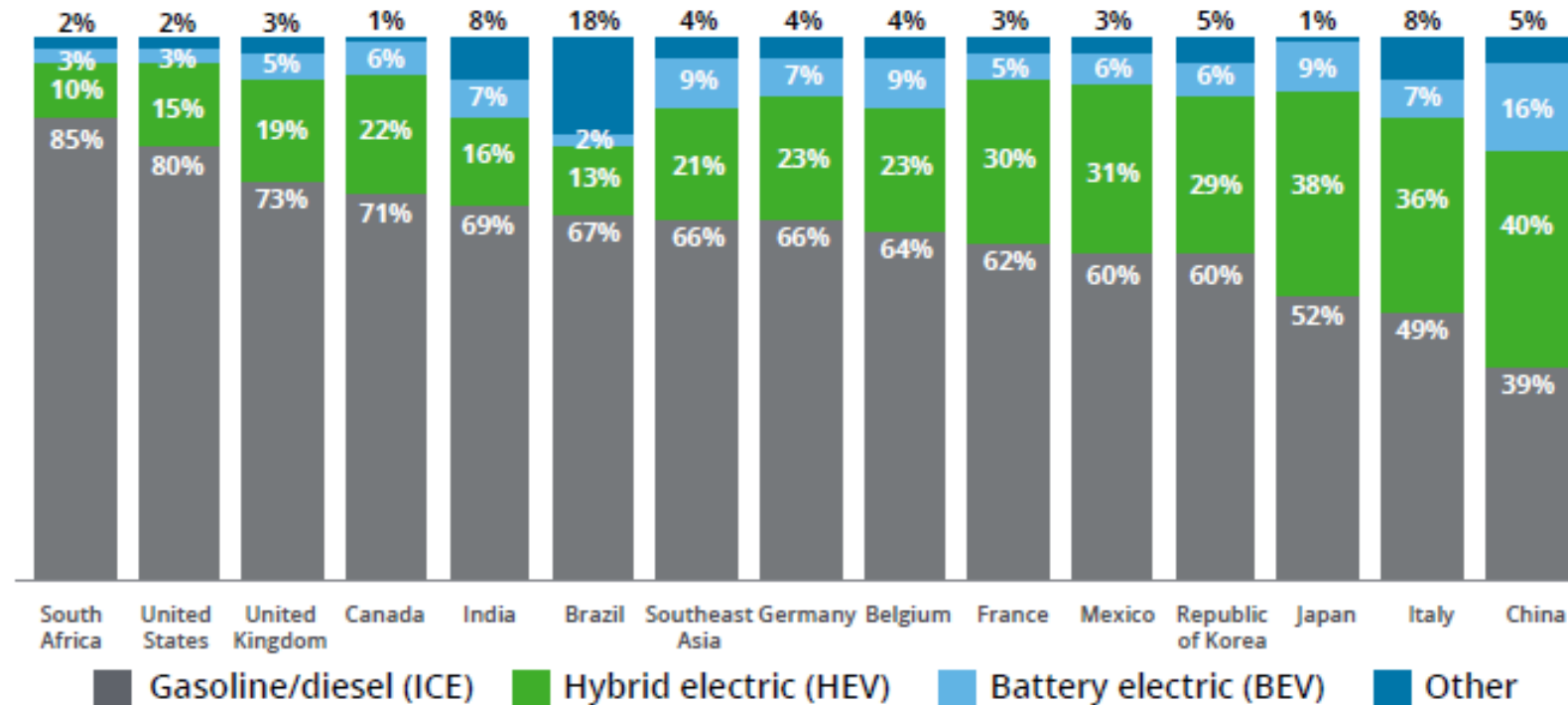
		TODAY	2020	2025	2030
VEHICLE TECHNOLOGY	POWERTRAIN, ICES, & ENERGY STORAGE	Mostly gasoline, few diesels and few electric and hybrids	Downsized-boosted gasoline engines dominate, Atkinson cycle for non-hybrids may add efficiency		Major reduction in battery cost
	MATERIALS	Mostly Steel Structure. Common grades Mild, BH, HSLA, and DP		Composite use in powertrain components	Optimized mixed material architecture with greater use of composites
	CONNECTED AND AUTOMATED	SAE level 1 automation and some level 2 models	Active safety mechanism - Lane assist, pedestrian detection, automatic braking etc.		SAE level 5 automation
PRODUCTION TECHNOLOGY	MANUFACTURING	Cold stamping of parts	Hot forming and Warm forming of metals		Additive manufacturing for production parts
	PRODUCTION SYSTEMS	Programmable automation		Compact paint shops. Multi material capable.	High utilization of renewable energy
NEW BUSINESS MODEL	MOBILITY	4% of global miles traveled are shared (ride hailing + taxi)		Vehicle sharing models are a convenient alternative to vehicle ownership	26.2% of global miles traveled are shared



# Powertrain and Propulsion

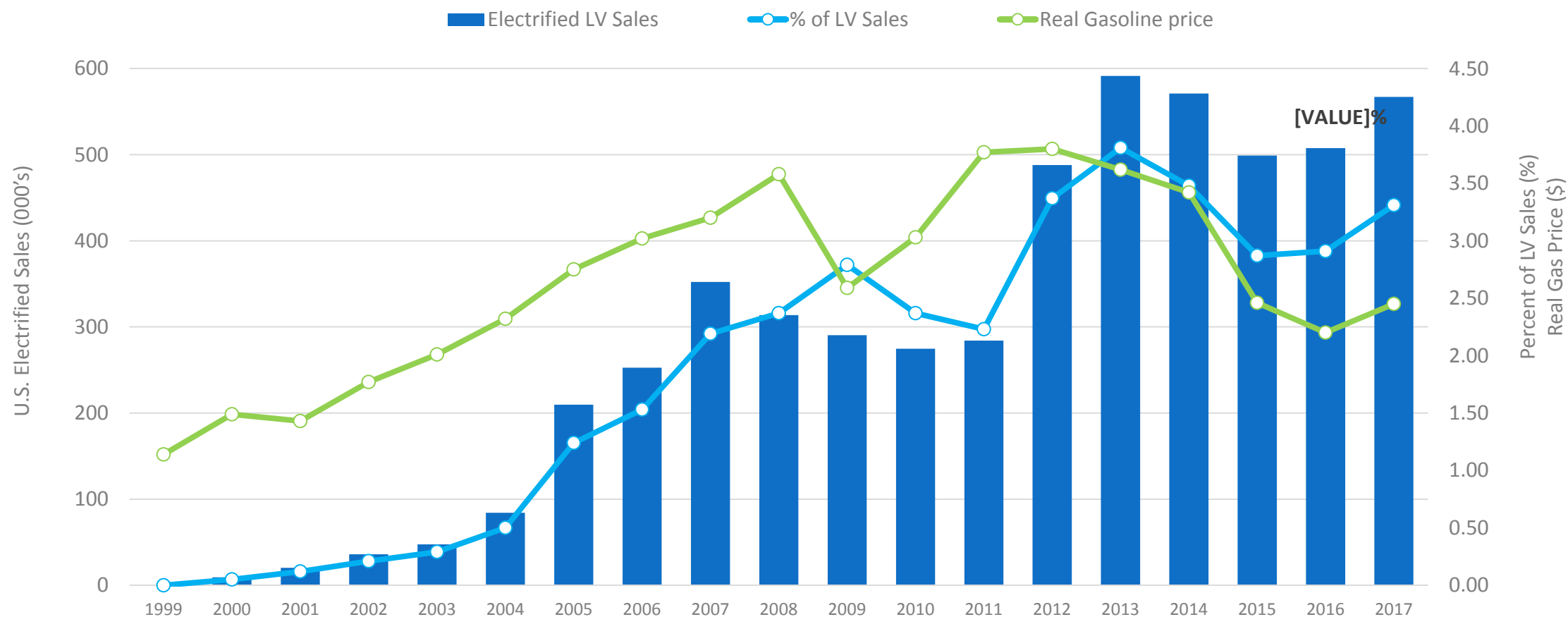


# Consumer Preference for Type of Next Vehicle, 2018



Note: 'Other' category includes ethanol, compressed natural gas, and hydrogen fuel cell.

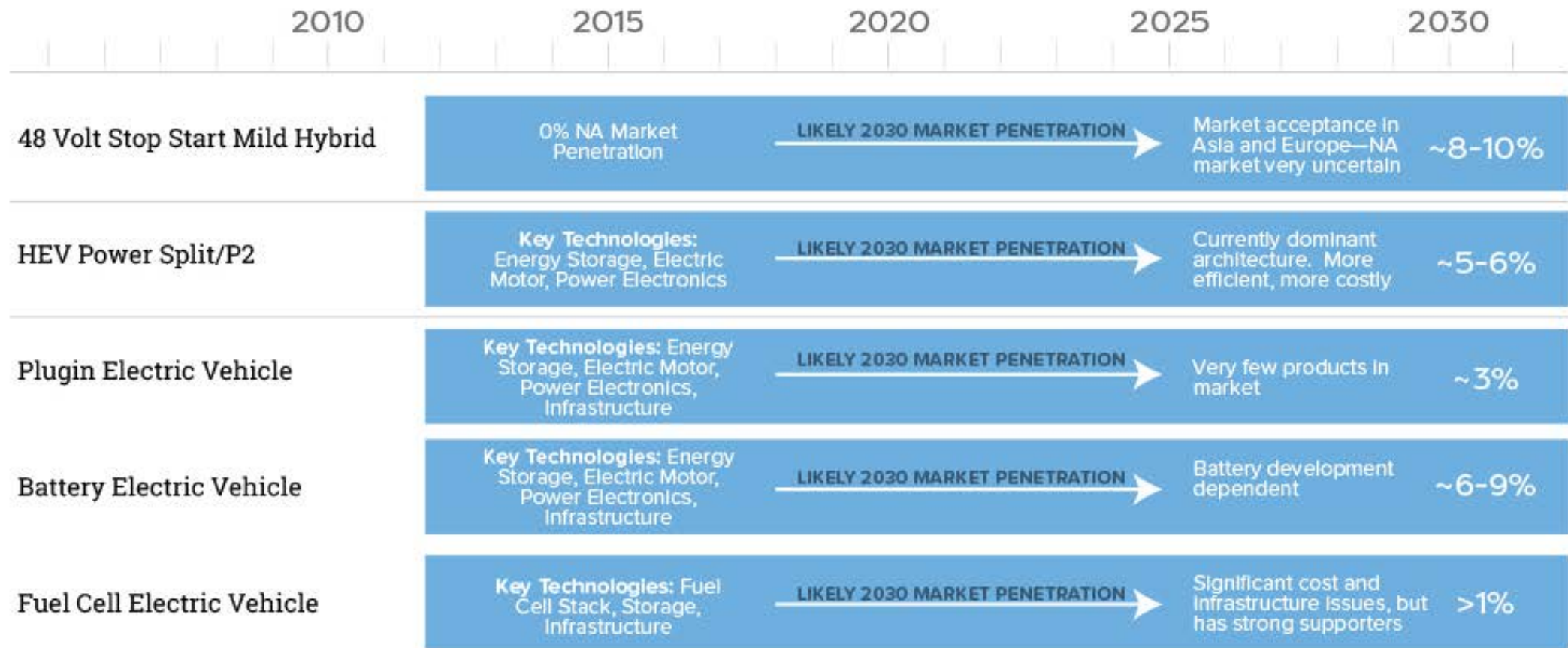
# U.S. Electrified Light Vehicle Sales and Take Rate, 1999 – 2017



Note: Electrified vehicles consist of BEV, HEV and PHEV

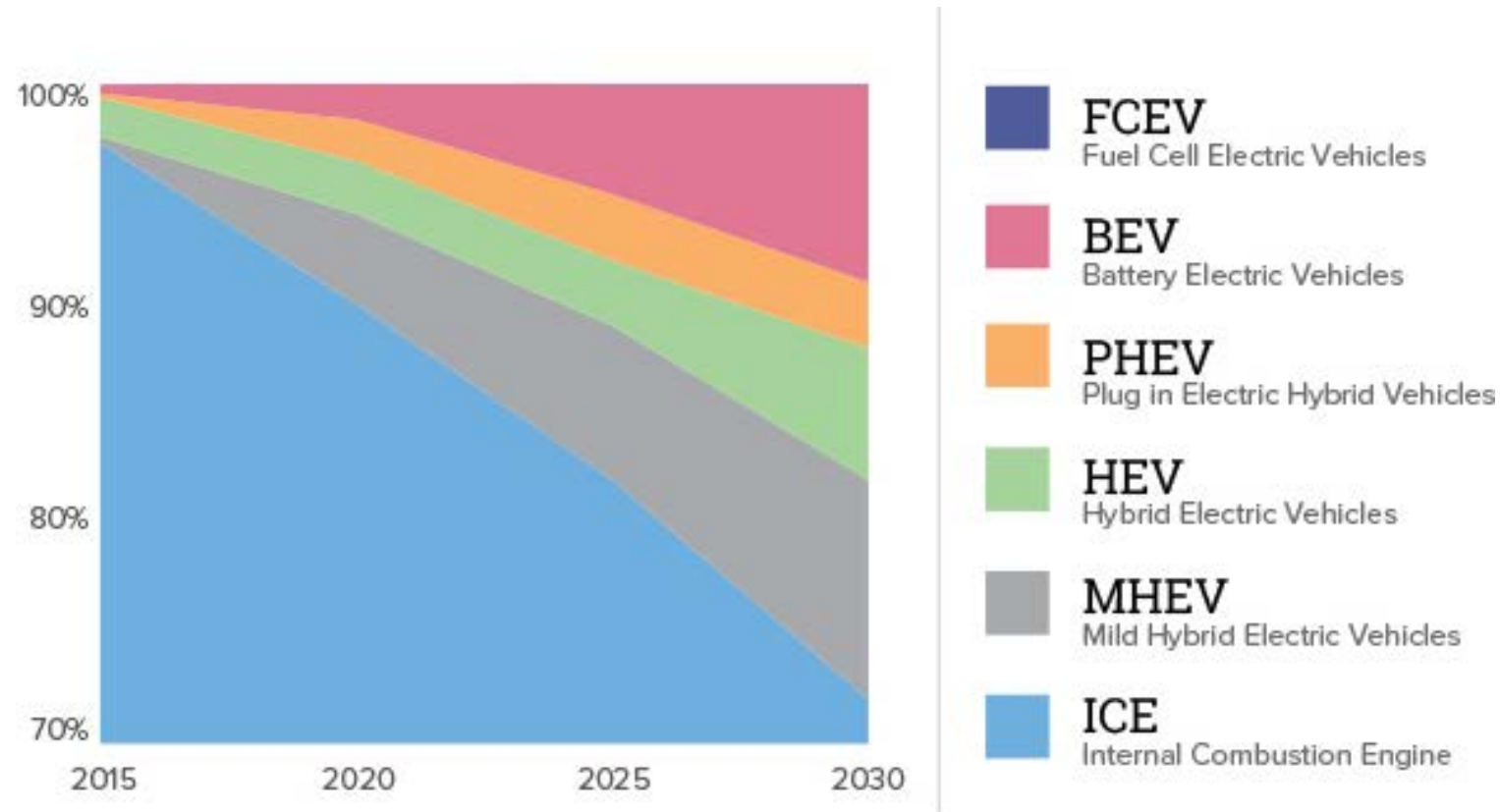
Source: Ward's Automotive Reports, HybridCars.com and CAR Research

# Electrified Vehicle Pathways



Source: CAR Research, summary of various reports

# Global Powertrain Market Share, 2015-2030



Source: CAR Research; USEPA/NHTSA Technical Assessment Report; Global EV Outlook 2016, International Energy Agency; Joining Forces to Tackle Road Transport CO2 Challenge, European Automobile Manufacturers Association; various others



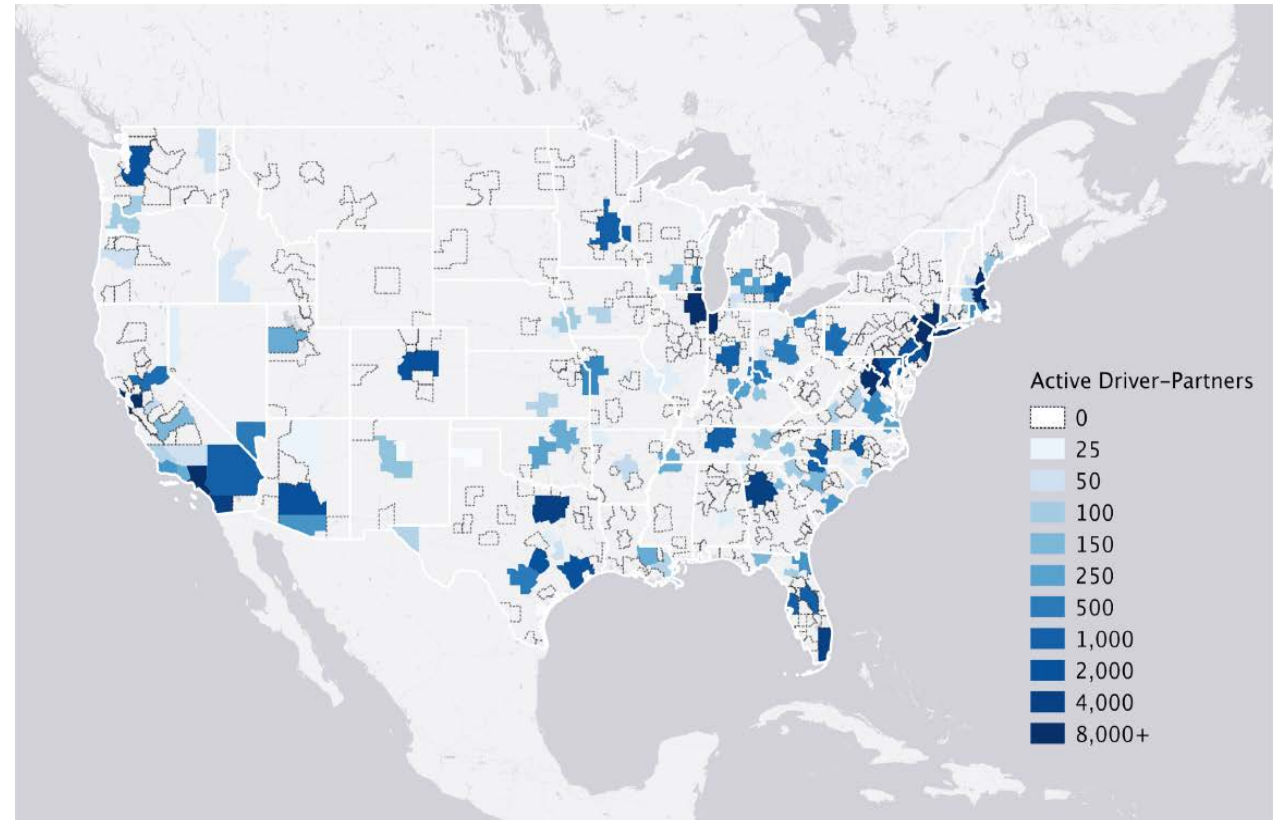


# Innovative Mobility Services and Connected and Automated Vehicles



# Markets of Innovative Mobility Services

- Target markets: denser and walkable urban areas with mass transportation networks.
- IMS are less convenient in less densely-populated areas.

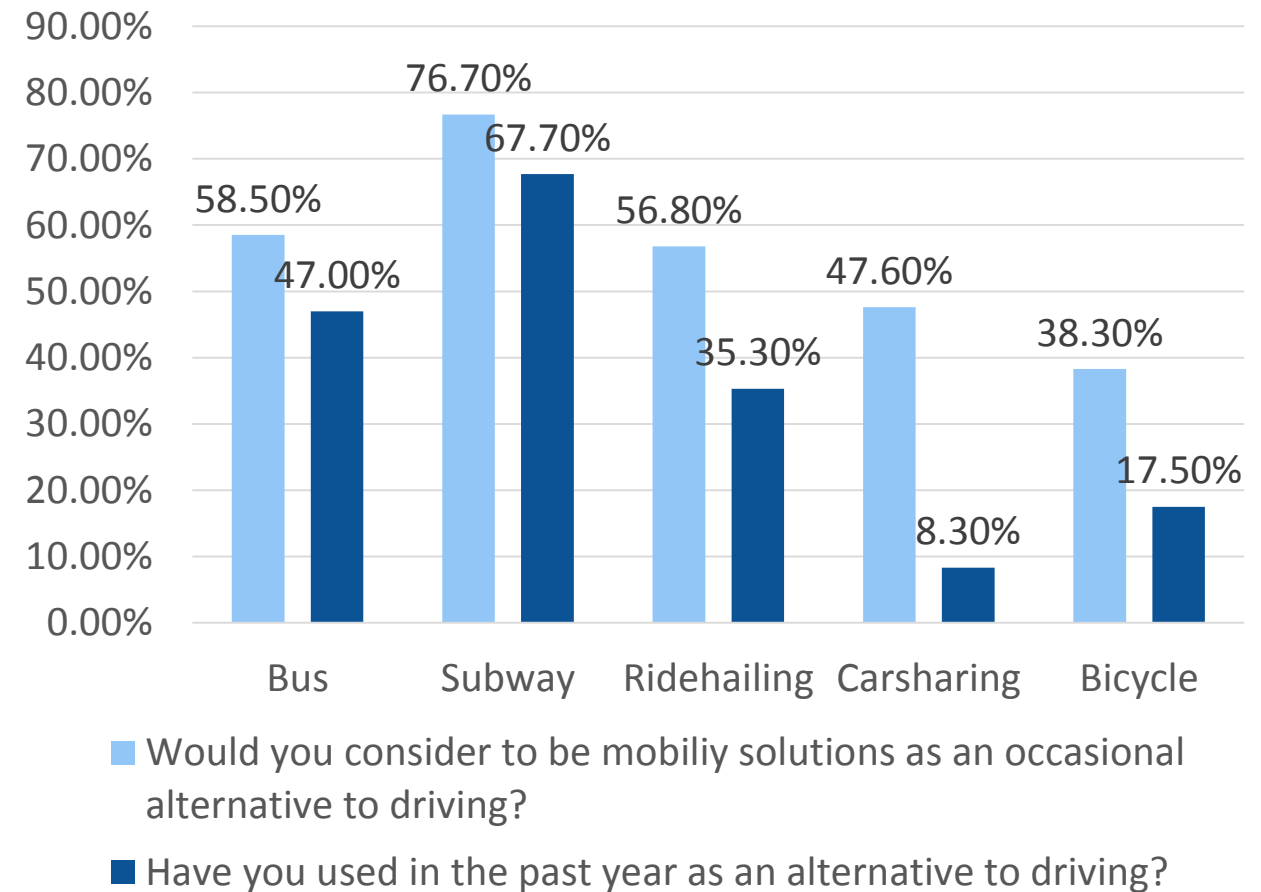


Active Uber Drivers in 2014 in the United States

*Source: Hall and Krueger, 2015*

# Target Users of Innovative Mobility Services

- Early adopters: urban dwellers with higher income and education.
- Millennials will account for much of the expansion of innovative mobility services.
- Aging Baby Boomers will seek transportation alternatives to driving.



Alternatives to Driving

Source: Abraham, 2016

# Consumer Attitudes Related to Automated Vehicles

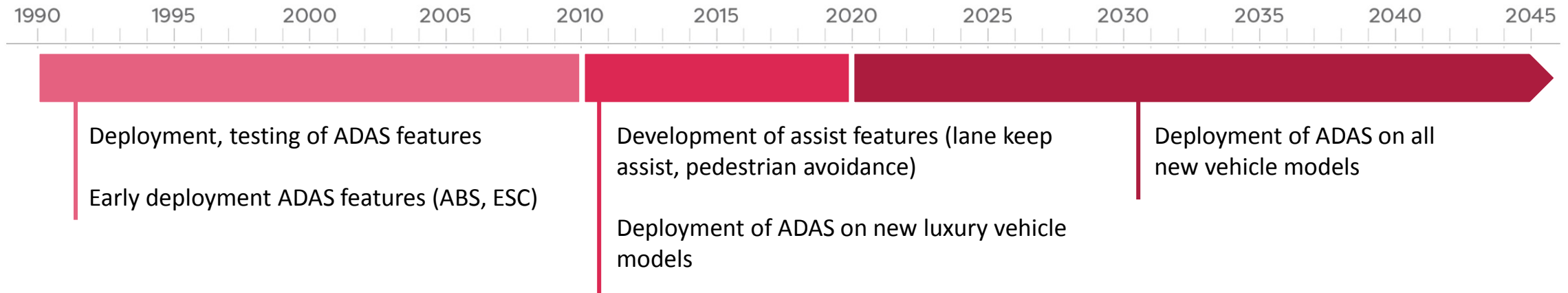
Level of Automation	Age						
	16-24	25-34	35-44	45-54	55-64	65-74	75+
No Automation	12.4%	8.0%	9.7%	6.1%	5.0%	3.8%	3.1%
Emergency Only	18.3%	11.3%	15.7%	16.0%	14.7%	12.2%	16.7%
Help Driver	26.7%	25.4%	21.1%	41.2%	44.4%	56.0%	52.2%
Partial Automation	16.3%	15.3%	19.0%	13.2%	17.0%	13.9%	15.4%
Full Automation	26.2%	40.0%	34.4%	23.4%	18.9%	14.2%	12.7%

Age Differences in Willingness to Use Automation in Vehicles – Maximum Level of Automation Respondents Would Be Comfortable With

*Source: Abraham, 2016*

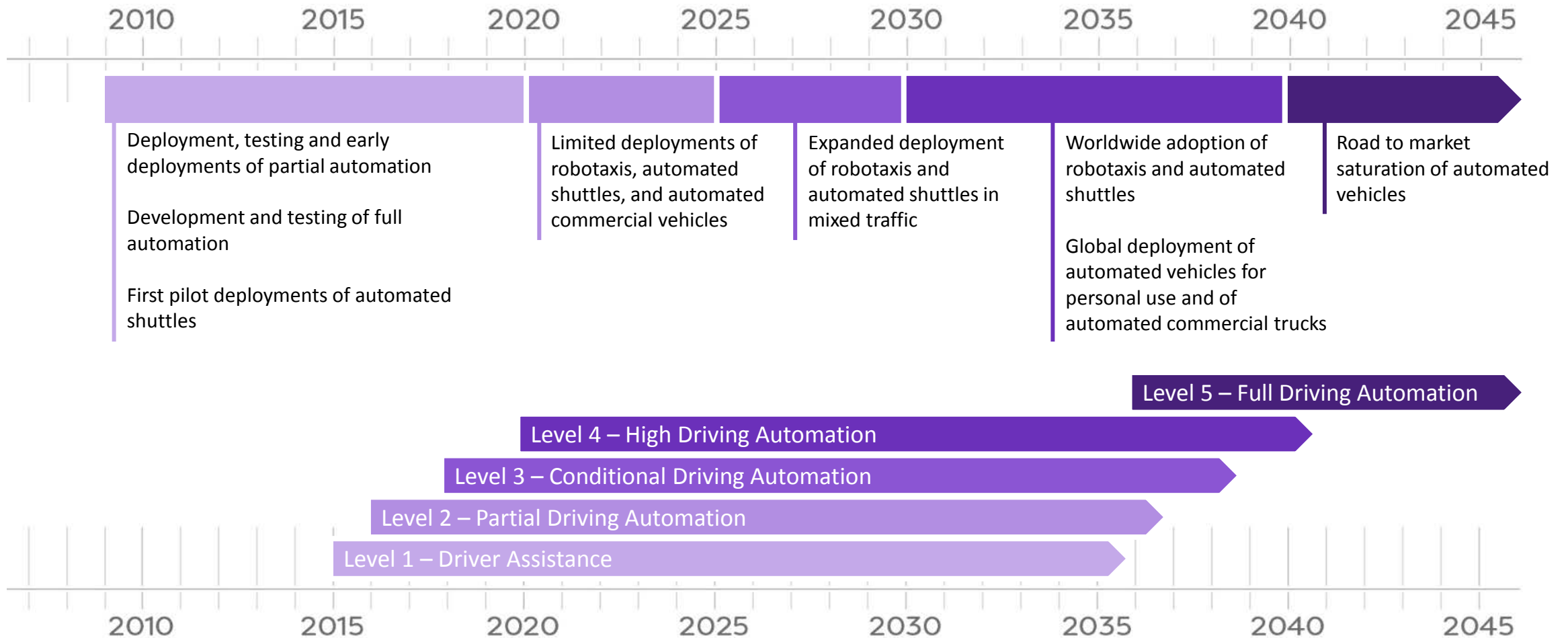
# Intelligent Mobility Technologies: ADAS

## Global General Evolution Timeline, 1990 to beyond 2040



# Intelligent Mobility Technologies: Vehicle Automation

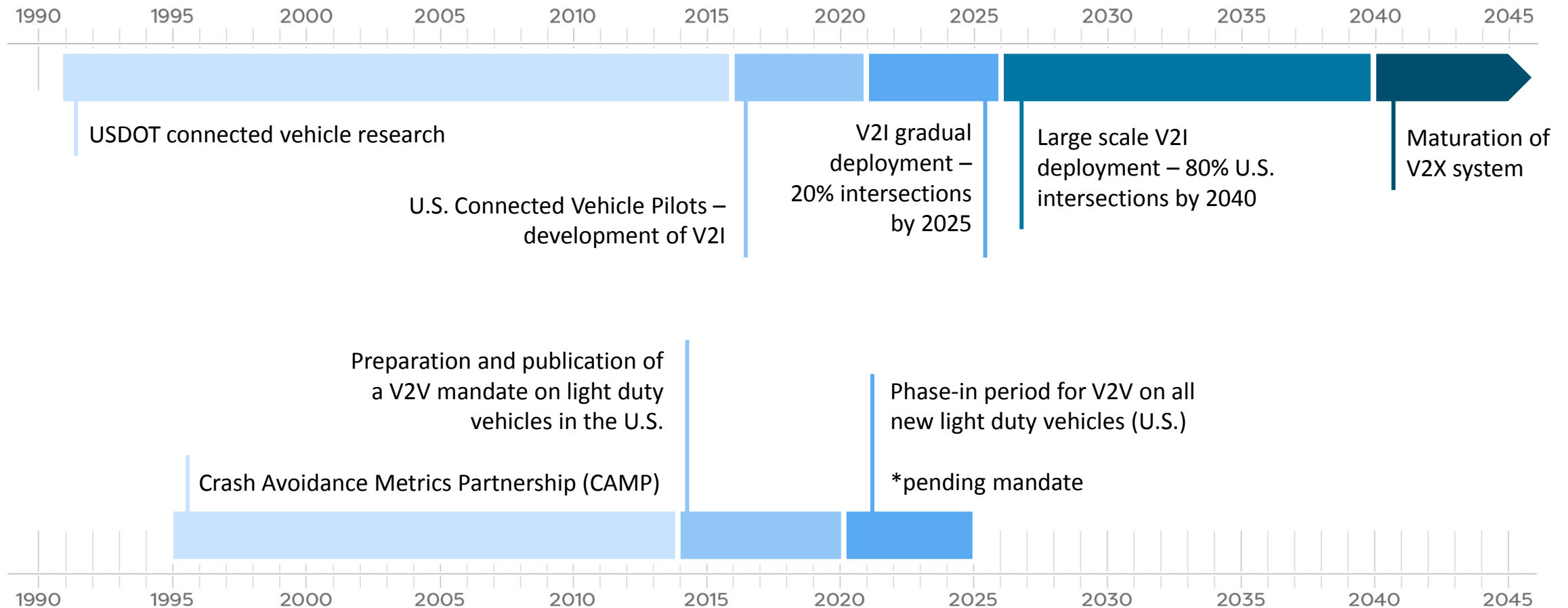
## Global General Evolution Timeline, 1990 to beyond 2040





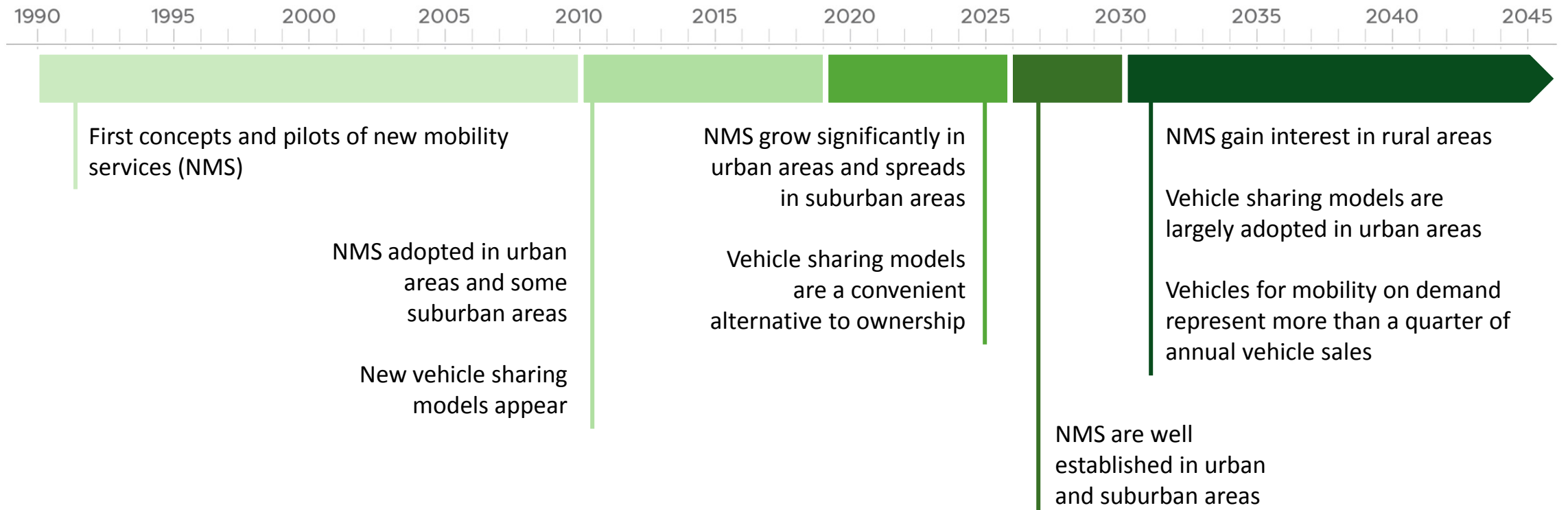
# Intelligent Mobility Technologies: Vehicle Connectivity

## Global General Evolution Timeline, 1990 to beyond 2040

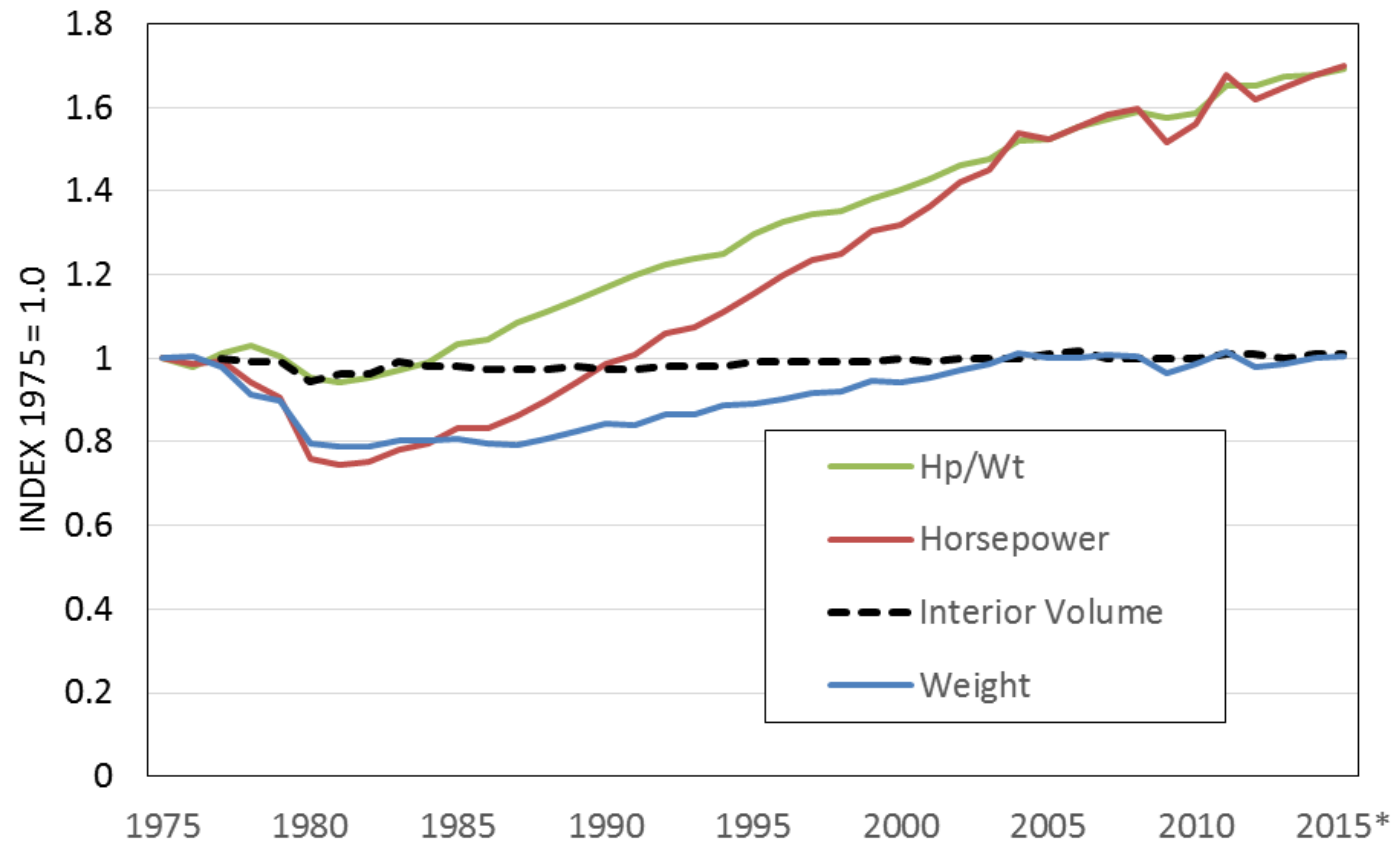


# Intelligent Mobility Technologies: New Mobility Services

## Global General Evolution Timeline, 1990 to beyond 2040



# Selected Attributes of U.S. Passenger Cars, 1975-2015



# Connected and Automated Vehicles

## Potential Impacts on Travel

- Most simulations of CAVs predict an increase in overall vehicle miles traveled.
- CAVs will enable more efficient use of existing parking supply and lower parking demand.
- CAVs bring opportunities and challenges for public transit, biking, and walking.

**Zero occupancy travel of shared CAVs is estimated at 7.7% - 11% of total VMT.**

*Source: Chen and Kockelman (2016), Zhang et al. (2014), Fagnant and Kockelman (2014)*

# Connected and Automated Vehicles

## Potential Impact on Land Form

### More sprawl



### More density





## Major Automakers' Partnerships Related to Mobility, Connectivity, and Driving Automation





# Convergence of Electrified Powertrains & Connected and Automated Vehicles



# Convergence of Electrified Powertrains & Connected and Automated Vehicles

- Tesla
- Volkswagen: I.D. Buzz, I.D. Vizzion concepts
- General Motors: Cadillac and Chevy Bolt
- Daimler - Smart Vision EQ Fortwo concept



Automated Chevrolet Bolt GM-Cruise test vehicle

*Source: Cruise Automation*



# Talent



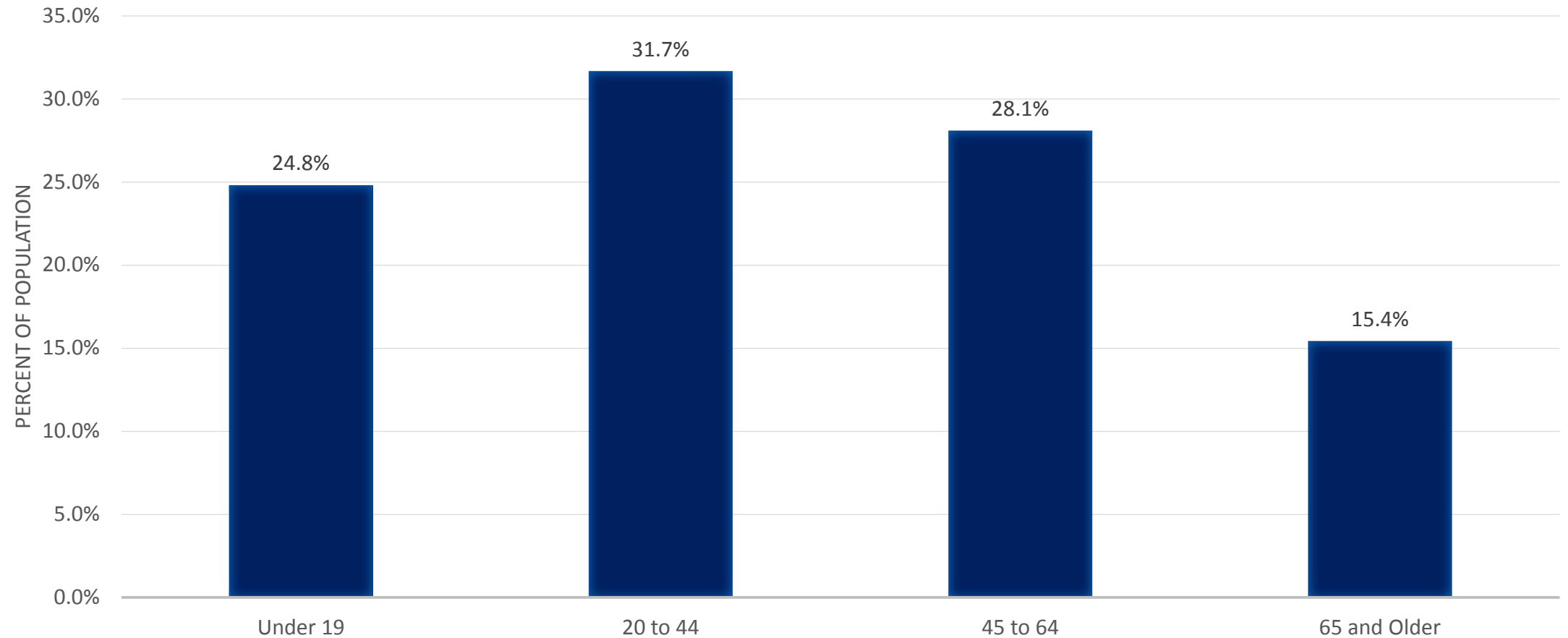


# Overview of Labor Force



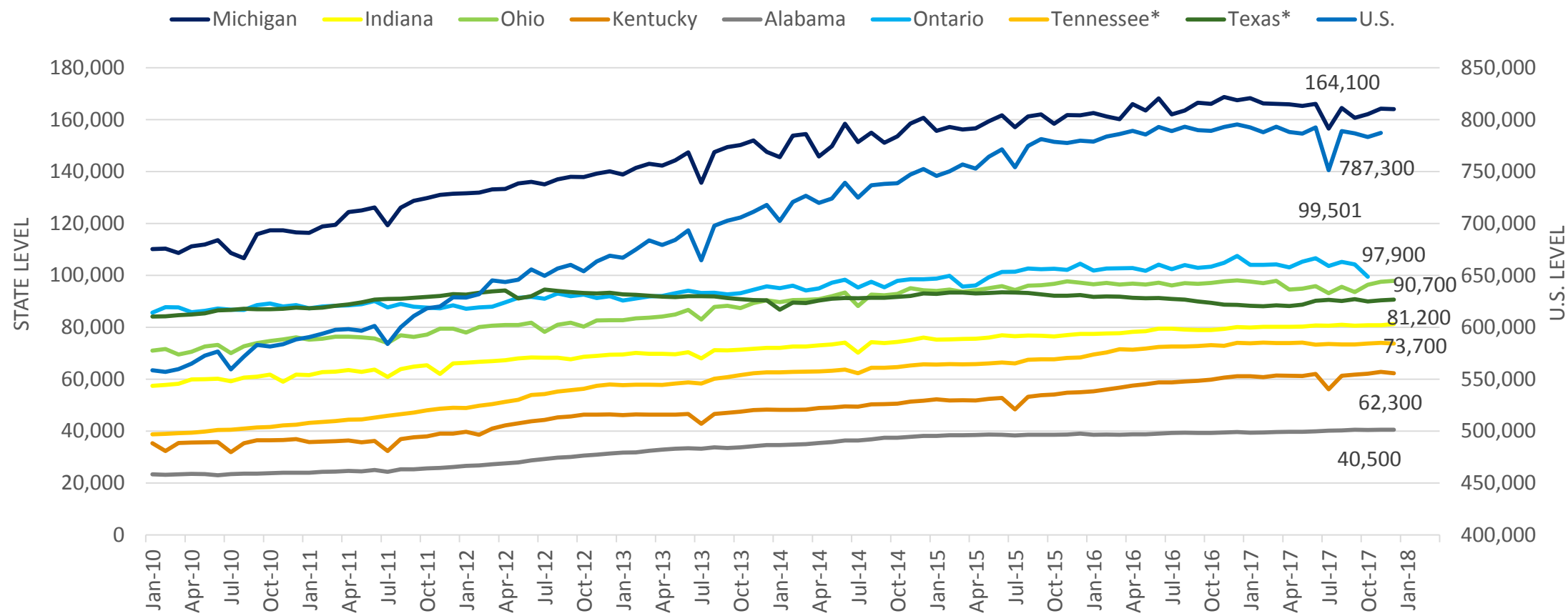
# Age Distribution

Detroit-Warren-Ann Arbor CSA, 2016



# U.S. Motor Vehicle & Parts Manufacturing Employment

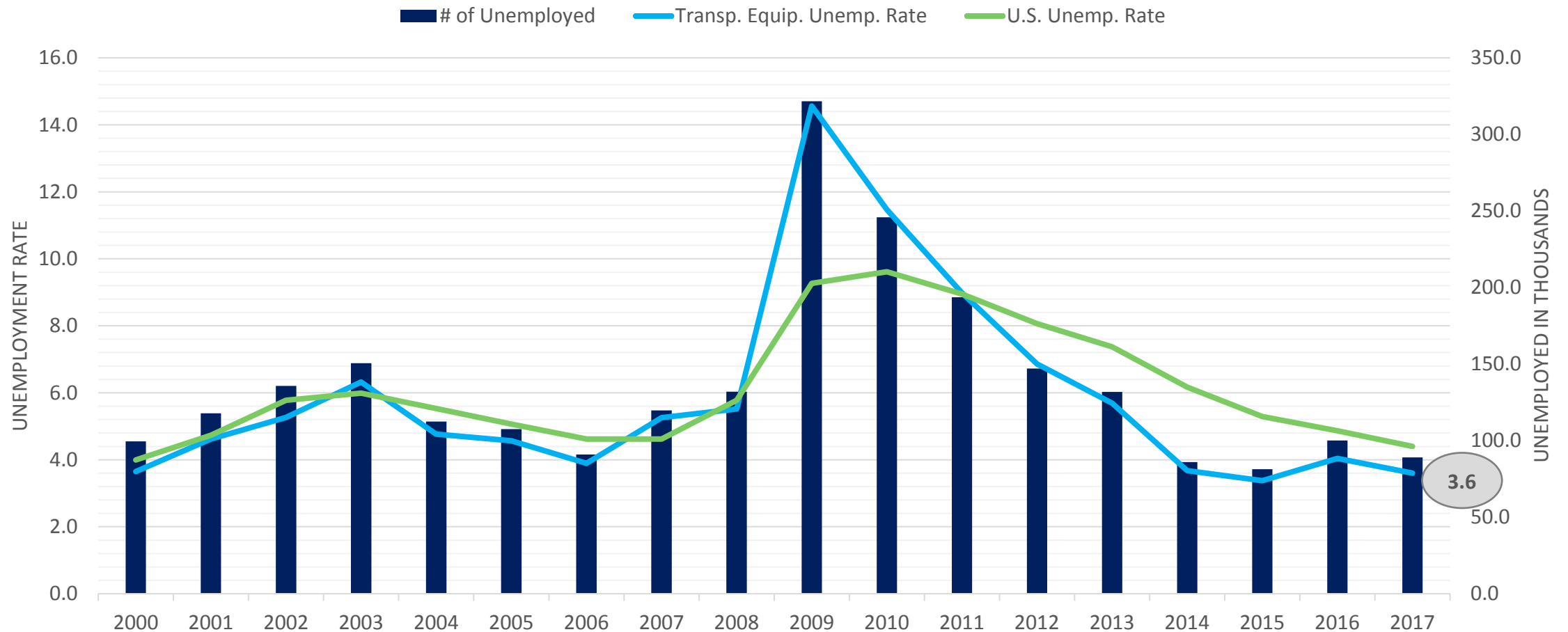
## 2010 – 2017



\*Transportation Equipment Manufacturing Employment

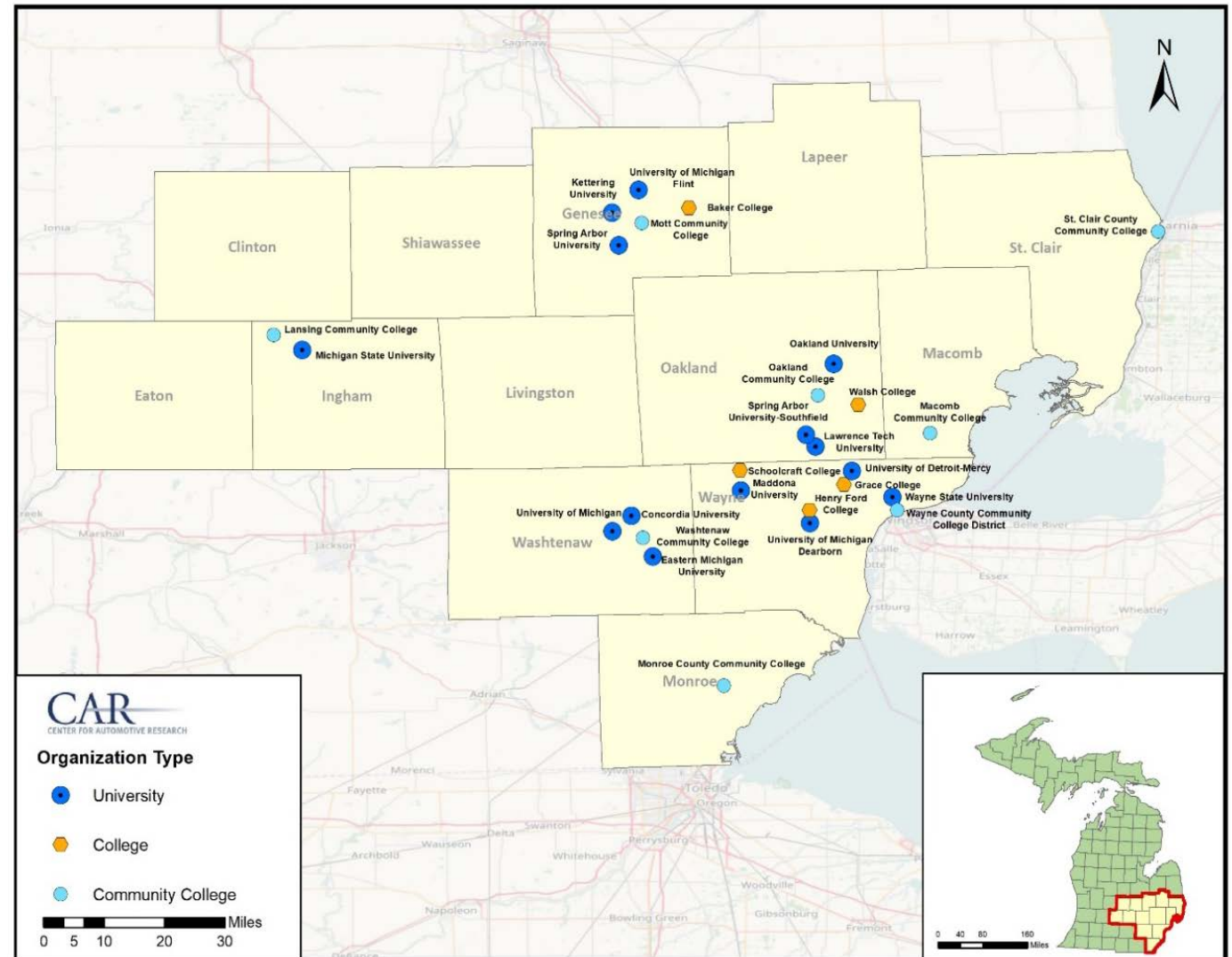
\*\*National data follows one month behind State data

# U.S. Unemployment in the Transportation Equipment Sector 2000-2017



# Academic Institutions in SE Michigan, 2017

- 20 Universities located in Southeast Michigan
- 10 Community Colleges in Southeast Michigan
- Over 200 programs offered across educational institutions in CAV-related fields\*.



\*Includes courses related to computer science, cybersecurity, engineering, IT/data, math, and software/design.



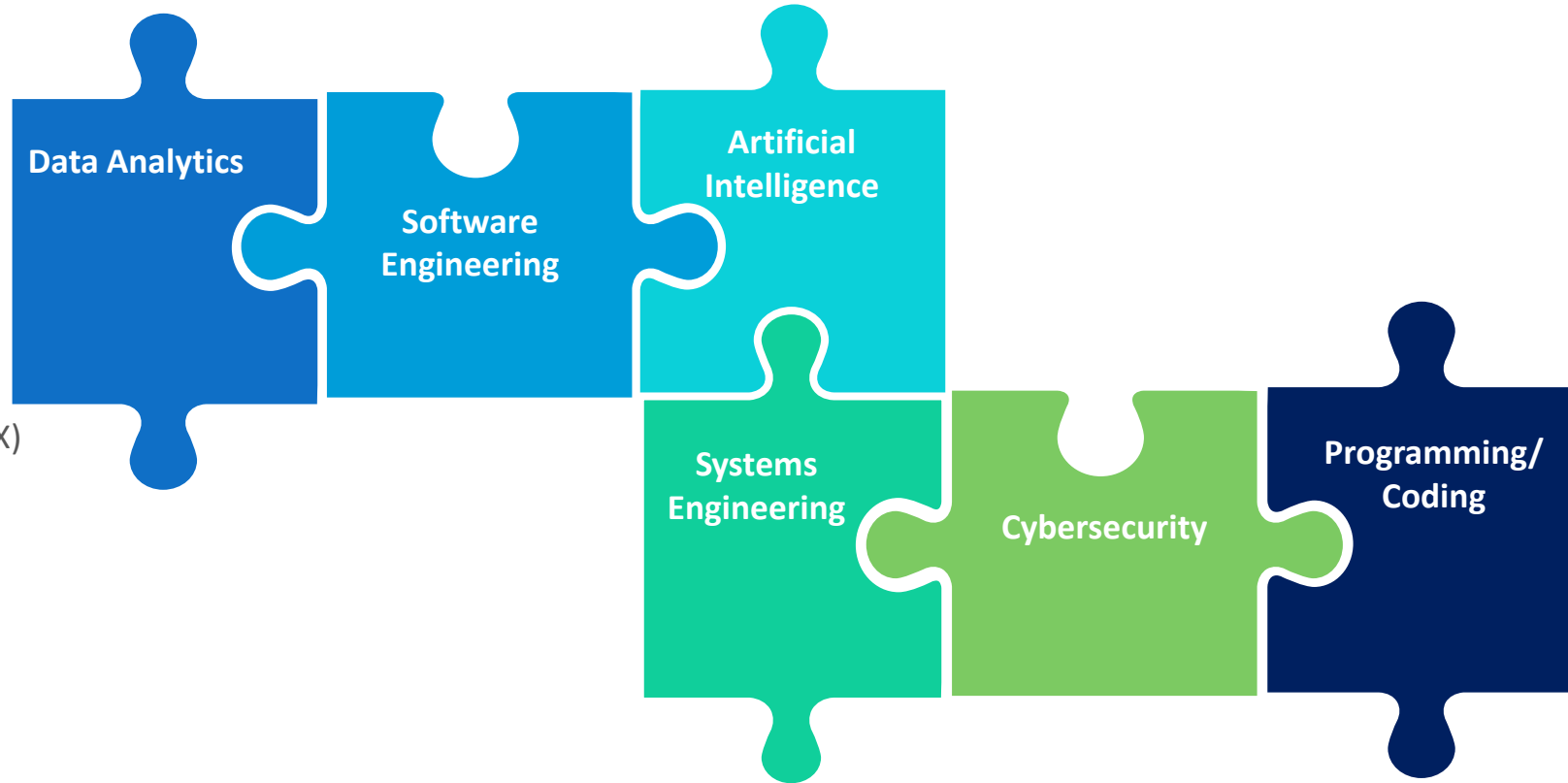
# Talent Shortage



# Rapid Technological Advances Ahead...

## Skills Needed:

- Advanced Driver Assistance Systems
- App Development
- Applied Data Analytics
- Artificial Intelligence
- Auto Testing/Developing
- Business Analytic Tools (Cognos, QlikView)
- Connected Vehicle Technologies (V2V, V2I, V2X)
- Cybersecurity
- Data Analysis
- Electrical Systems and Components
- Information Security
- Mid-level Engineering Managers
- Programming/Coding
- Robotic Engineering
- Software Development (LINUX, UNIX)
- Software Engineering
- Statistical Modeling
- Systems Engineering



# CAR Research for Arconic Foundation

- April 2017, CAR completed *New Materials/New Skills for Automotive Skilled Trades* Report.
- Focused on the impact of new materials on skilled trades training and apprenticeship needs.
- There are three main talent challenges facing automotive tool and die producers—both at the large automakers and suppliers, and at small shops:

1



New materials & new processes

2



An aging workforce, and...

3

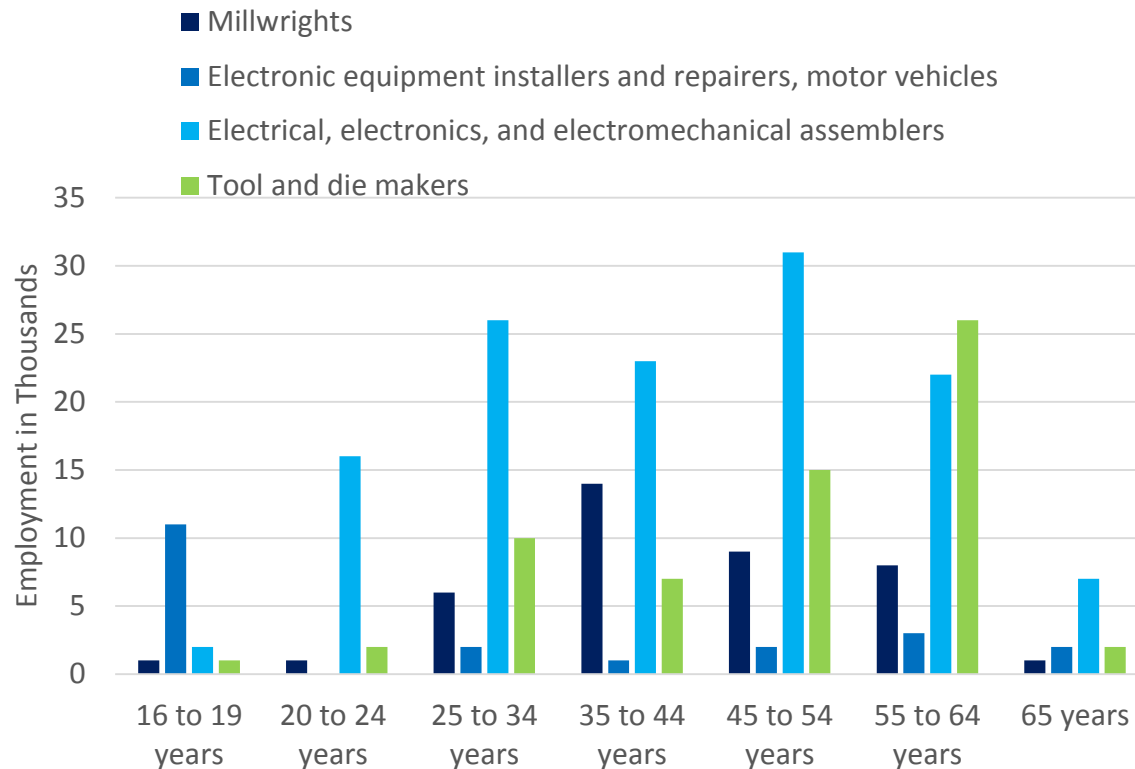


Implications of trade and purchasing decisions on apprenticeships.

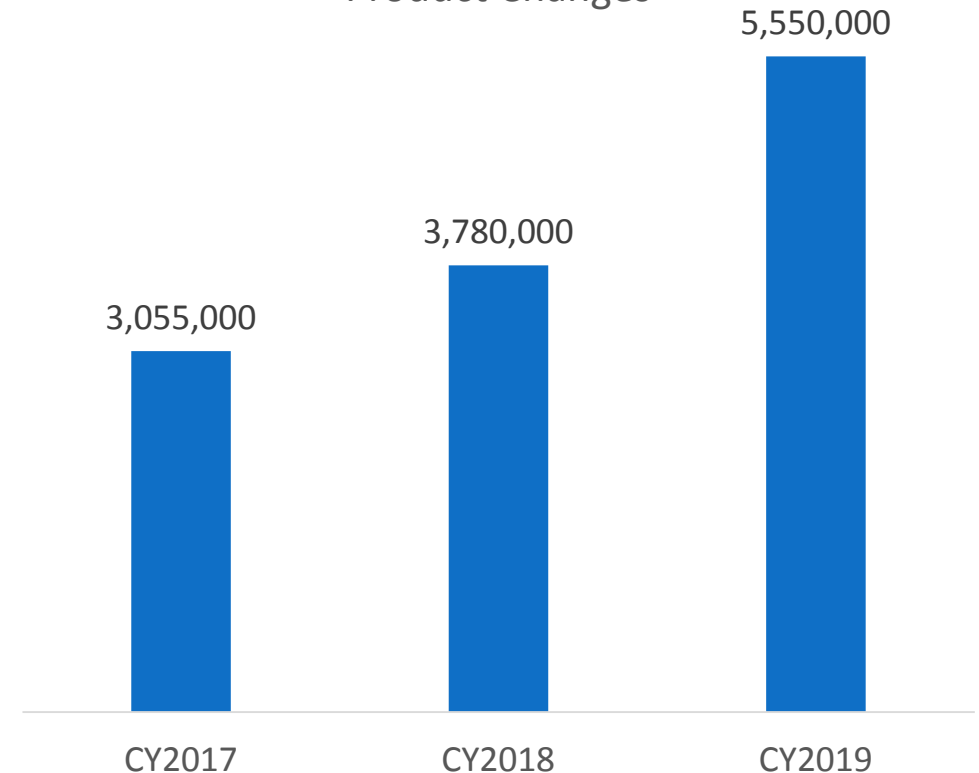
# 77 Percent of the Current U.S. Tool and Die Workforce is Over Age 45

## There is Tremendous Replacement Hiring

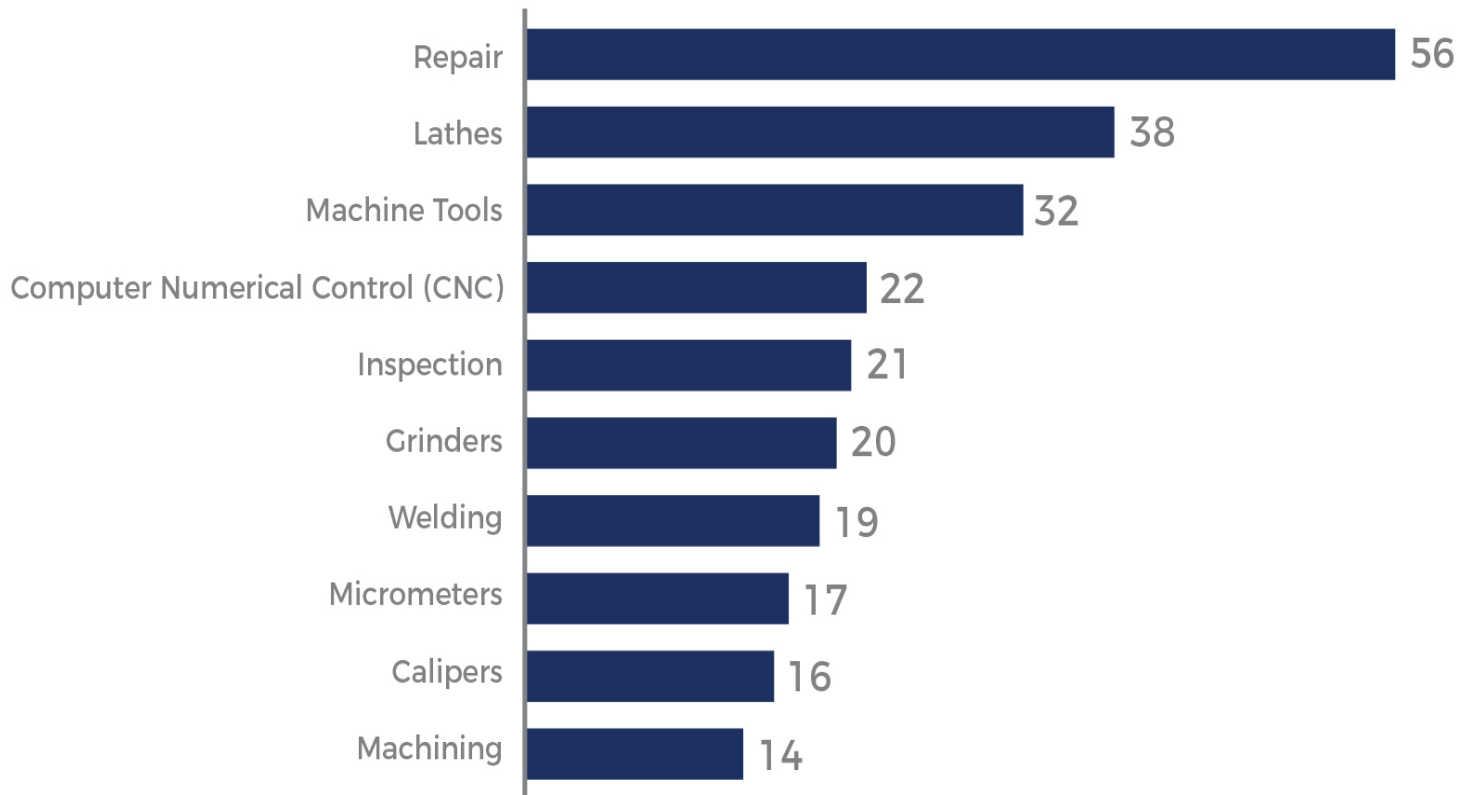
Age Distribution of Tool & Die, Electrical, & Millwright Workers in U.S., 2017



Estimated Tooling Workload Hours Based on FCA, Ford & GM Planned Major/Minor Product Changes



# Tool & Die Workers are in High Demand, and Repair is the Number One Skill Requirement.



## Tool & Die Workers Need to Have:

- Lifelong learning commitment
- Machining knowledge
- Ability to read engineering drawings
- Problem solving abilities
- An understanding of metallurgy and the chemical properties of the materials their tools will form
- Knowledge of physics, processing, and types of joins affect formed part
- How to prioritize critical adjustments to achieve dimensional tolerance of overall part or assembly



# Current State



# Current Legislation

- 2019 FY Budget of the U.S. Government
  - CTE/STEM Highlights–
    - Carl D. Perkins Career & Technical Education Act of 2006 – Reauthorize to “*ensure CTE programs prepare students for careers in STEM fields and other high demand areas; promoting partnerships between schools, businesses, and other community organizations; and expanding access to apprenticeship and other work-based learning.*”
    - Funding for CTE programs – Maintains \$1.1B
    - Funding for STEM education – Maintains at least \$200M
      - New \$20M grant program for STEM-focused CTE programs

# Technical Industry Trends

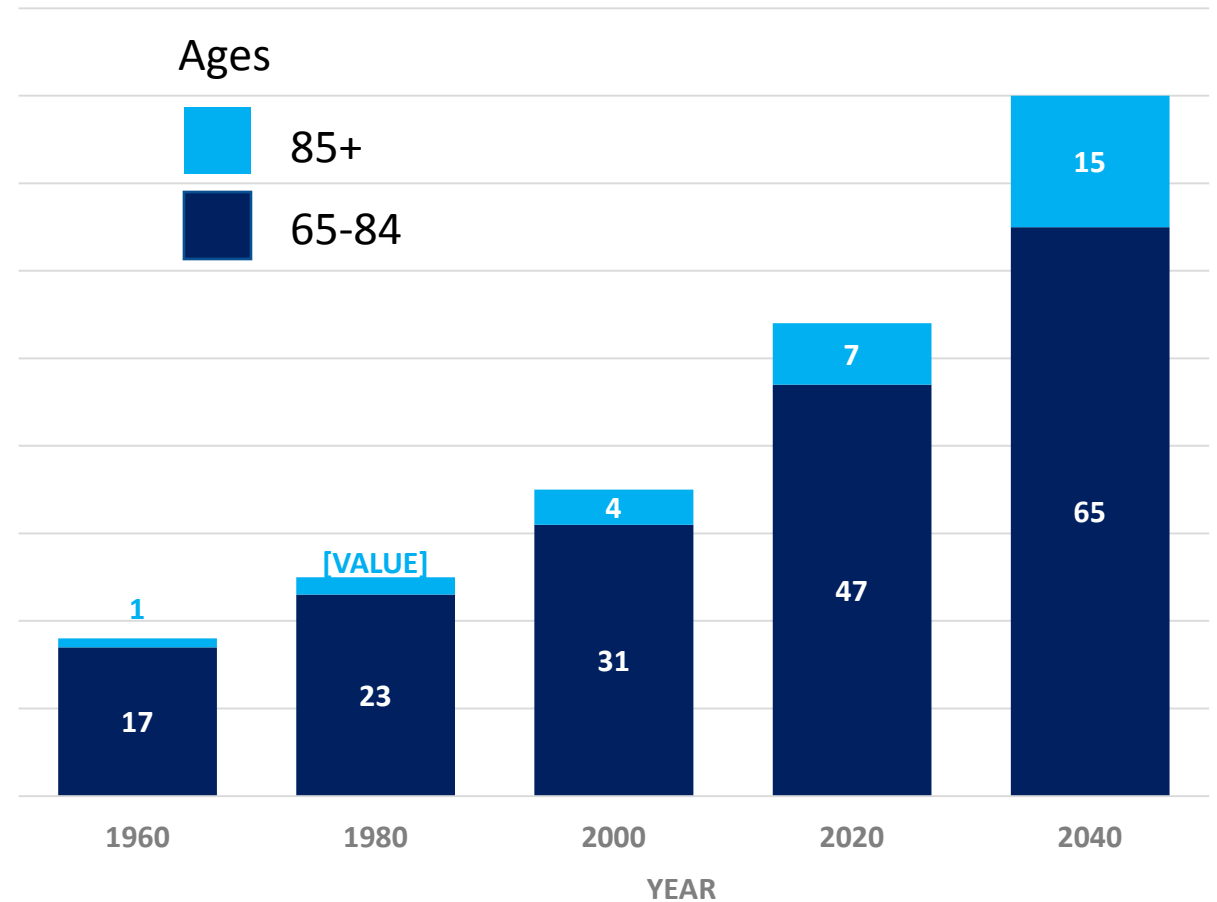
## Why technical skills are so needed!

- Disruption Demographics
- Rapidity
- Collaboration
- Industries
- Cross-discipline
- Academia



# Disruption Demographics

- Ageing Population
- Urbanization
- CAFE 2025



# Gartner's Top 10 Strategic Technology Trends for 2017

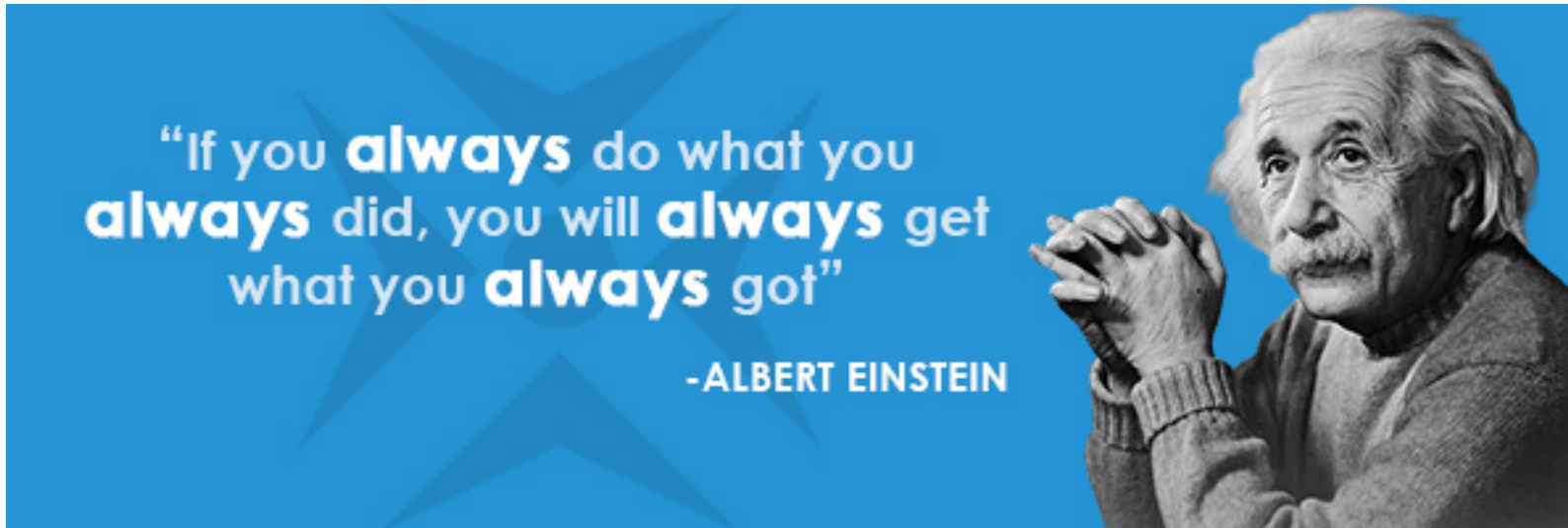
1. AI and Advanced Machine Learning
2. Intelligent Apps
3. Intelligent Things
4. Virtual and Augmented Reality
5. Digital Twin
6. Blockchain and Distributed Ledgers
7. Conversational Systems
8. Mesh App and Service Architecture
9. Digital Technology Platforms
10. Adaptive Security Architecture



**“DATA IS EATING  
THE WORLD”**

# Rapidity – “Innovate or Die”

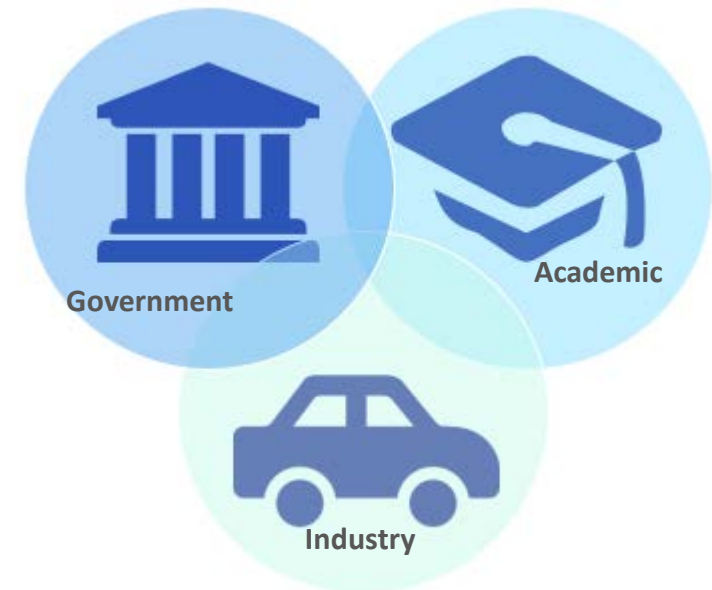
- Customer Expectations
- What is the next big thing
- “Boutique” Customer Experience





# Collaboration Efforts to Grow the STEM Field

- Triple Helix Involvement between Government, Academia, & Industry
  - *FIRST* Robotics, *FIRST* Tech Challenge, *FIRST* LEGO League
  - Girls Who Code
  - Manufacturing Day
  - Million Women Mentors
  - Square One Education Network
  - And so on...



# Impacts of Programs

- First Robotics, First Tech Challenge, First LEGO League
- Girls Who Code
- Manufacturing Day

Over **75%** of *First* Alumni are in a STEM field as a student or professional

Girls Who Code has approximately 5,000 college-aged alumni. Those who have already declared their majors are choosing to major in Computer Science, or related fields, at a rate **15x the national average.**

Students perception results from Manufacturing Day 2016:  
**64%** said they were more motivated to pursue careers in manufacturing

# Collaboration is the Key to Success!

- Speed must match start-ups – mentality shift!
- Research is key – this needs to be applied and commercialized quickly
- Triple Helix (Government-Industry-Academia)



# How about Academia – What should you expect?

- Technology Opportunity
- Collaborative projects
- More elective opportunities
- “Customized degrees”





# Technology Talent Gap

- Crisis in manufacturing and engineering
- Multi-disciplinary and systems engineering skill set is needed
- Skill trades are sorely lacking
- Industry and community college collaboration similar to research is needed



# Diversity and Inclusion

- Percentages haven't changed in 35 years!
- Some disciplines are making progress, but....why not all?
- Seek ways to be inclusive and break biased exclusivity
- Early involvement
- Need industry, government strong support



**INNOVATION**

# Student Preparation – things to consider

- Core curriculum – enough?
- More courses to be included in engineering for HMI and systems?
- More internships – like European model?
- More Certification for Specialized Fields?



# What more NEEDS to be accomplished?

- Further grow & support STEM education
- Continue to educate younger generations at an early age of the opportunities in the automotive industry
- Efforts to retain qualified candidates – i.e. mentorship programs, leadership development, growth opportunities



# Conclusions

- 2030:
  - 3.8% of vehicle sales will be L4 or L5 capable
  - 8% of global vehicle sales will be BEV or FCEV
- ACES and personal vehicles will co-exist for decades
- Faster turnover of the ACES fleet will widen the technology gap between shared and personal vehicles
- Most of the safety and convenience benefits of ACES will be realized in urban and suburban deployment



# Conclusions

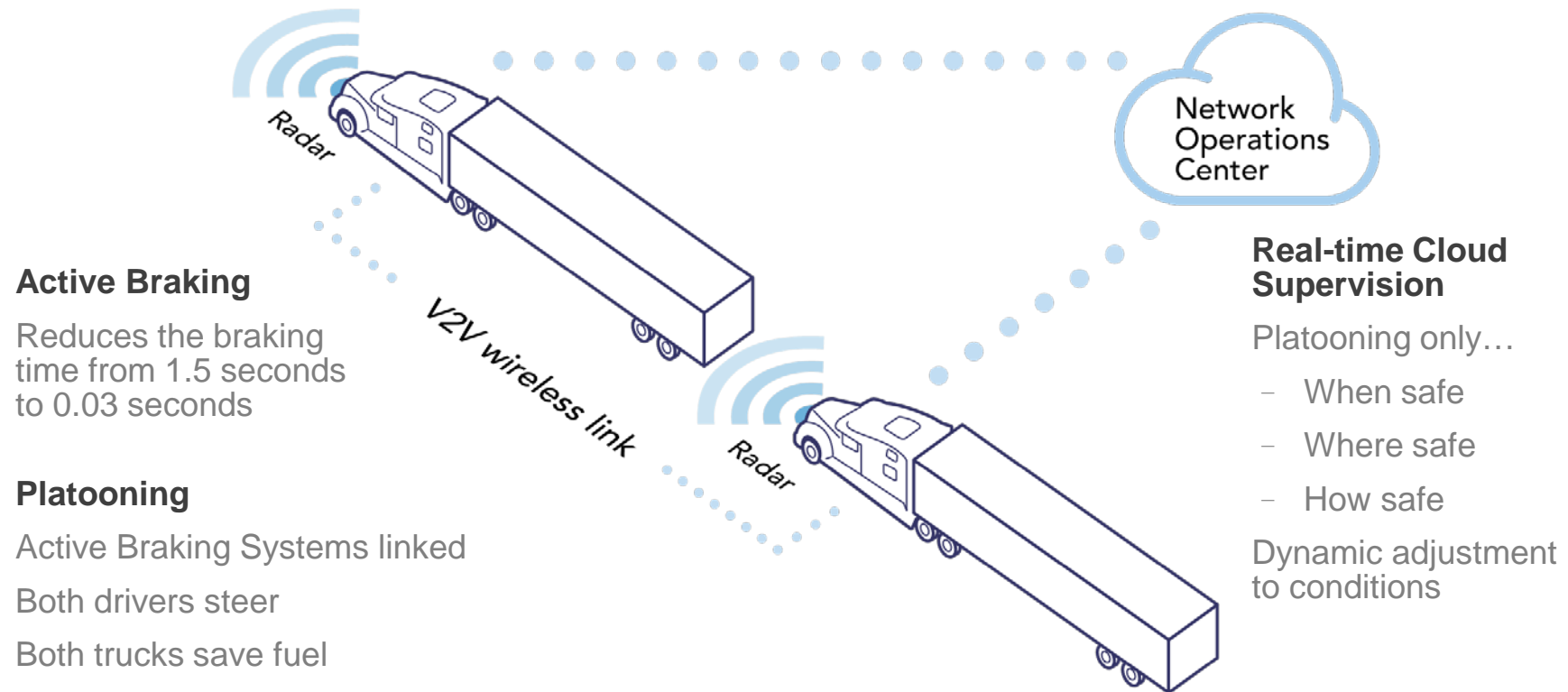
- A downward turn in the business cycle will delay investments and technology development/deployment
- Automakers and suppliers will develop these technologies for—and in—those markets and countries where:
  - Consumers demand them, and
  - Where infrastructure, incentives, and regulatory mandates are aligned
- There are implications for U.S. engineering and skilled talent development institutions and the overall technological leadership of the United States



# Thank you

CAR  
CENTER FOR AUTOMOTIVE RESEARCH

# Connecting Trucks



Slide courtesy: Peloton